

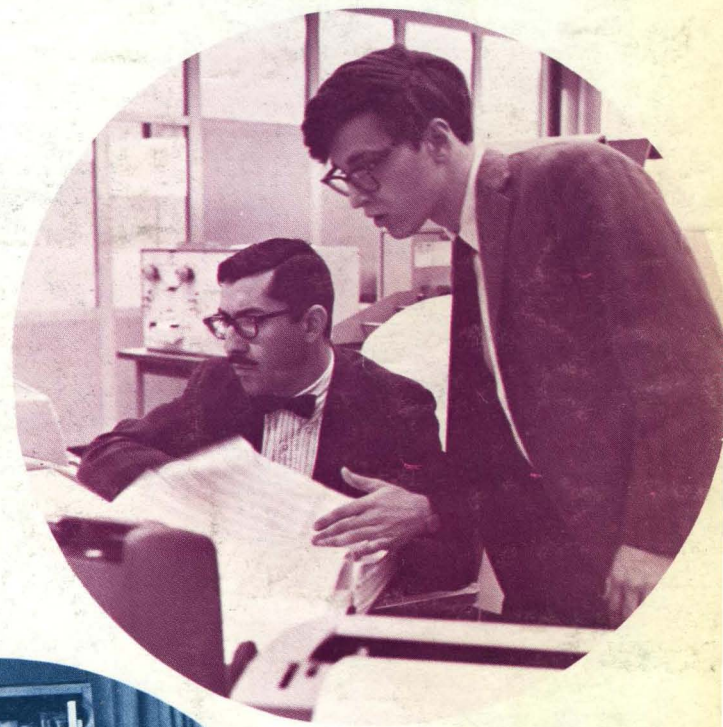
PERIODICALS SEC 1203 41111 ✓
0104
MARKET & SAN FERNANDO *N1267
SAN JOSE CA 95113

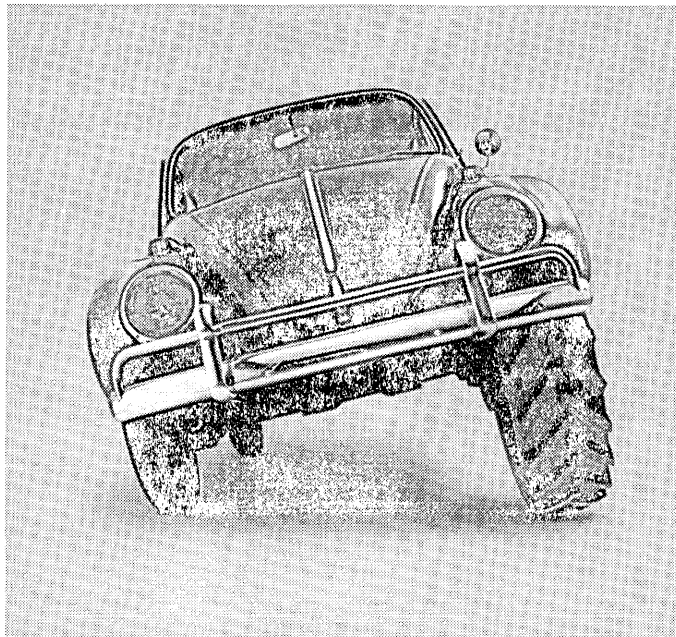
October, 1967

SAN JOSE
PUBLIC LIBRARY

computers and automation

Time Sharing in Action





Why not?

COMPUTERS AND AUTOMATION
OCTOBER, 1967

• 65

—because The Kelly-Springfield Tire Company gets the right tire to the right place at the right time, with a modern communications and data processing system, that's why not. And they sell over 2600 different sizes and types of tires in the U.S., Canada and 66 other countries.

Here's how the system works: at each warehouse Bell System Teletype[®] machines use master tapes to enter standard information on customers and their purchases while the variable sale information is typed in manually. The machines make printed orders and by-product

from each of the 26 warehouses stored for factory production lining.

result: Information flow is more accurate. Customers get the best possible service, everywhere in the Kelly-Springfield marketplace.

For more information, call your telephone Business Office and have a talk with one of our Communications Consultants. And don't be late to call us early—because only we can serve you best.

If you work with data communications, work with the Bell System.



ONE SIGMA COMPUTER
IS GOING TO HANDLE
ALL THE TELEMETRY
FROM POSEIDON
FLIGHTS.

IMPOSSIBLE.



Poseidon will be one of the most advanced strategic missiles in our inventory. Lockheed is developing it.

Telemetry from Poseidon test flights will be recorded by three stations along the range at up to a 100-kc word rate (1 million bits per second). The tapes will then be processed in real time by a Sigma 7 computer system located at Sunnyvale, California.

In the foreground the Sigma 7 computer will have adaptive control of the telemetry front end. In the background it will perform mathematical analyses and comparisons of the refined data.

The front end will decommutate the incoming streams,

minimize the noise, edit and compress the data, merge the three tapes into one optimized record, and sort the information into measurement strings with time correlation.

Concurrently, Lockheed engineers will be able to type questions into the computer and obtain immediate answers. They will have their test results 10 to 25 times faster than they could get them from a conventional telemetry system.

Sigma is the only system that can do decommutation, data compression and merging all at once in real time. Other systems can barely perform one of these functions at a 100-kc word rate.

Sigma can do it because of the high-performance telemetry front end, the computer's enormous throughput rate, and the specialized telemetry software.

Like all Sigma telemetry systems, this one is composed of standard modules. Even the software is modular. Thus, although the system is custom-tailored for Poseidon, there are no subsystem interface problems, and virtually no special programming will be required.

All the operating software is provided, so that the telemetry engineers can operate the system, using FORTRAN statements and the SDS Telemetry Compiler.

We are currently putting together five Sigma 7 telemetry systems for major missile and space programs, and each one is custom-engineered through the use of standard hardware and software modules.

We developed the modular concept from experience in producing more than 500 special-purpose data systems. All we needed to make it work was a computer that could manage the whole job.

Sigma makes it possible.

SDS

Scientific Data Systems,
Santa Monica, California

The new, small DECdisk provides 32K words extra memory for the PDP-8 for \$6,000. Additional 32K DECdisk units cost \$3,000 each. Since a basic \$18,000 PDP-8 computer has 4096 words in core, with four DECdisk units, that could give you a high speed computer with 135,168 12 bit words for \$33,000!

DECdisk is compatible with the \$10,000 PDP-8/S, too. Adding four DECdisk units gives you a slightly slower computer with 135,168 12 bit words.

More memory for less cost than any other computer.

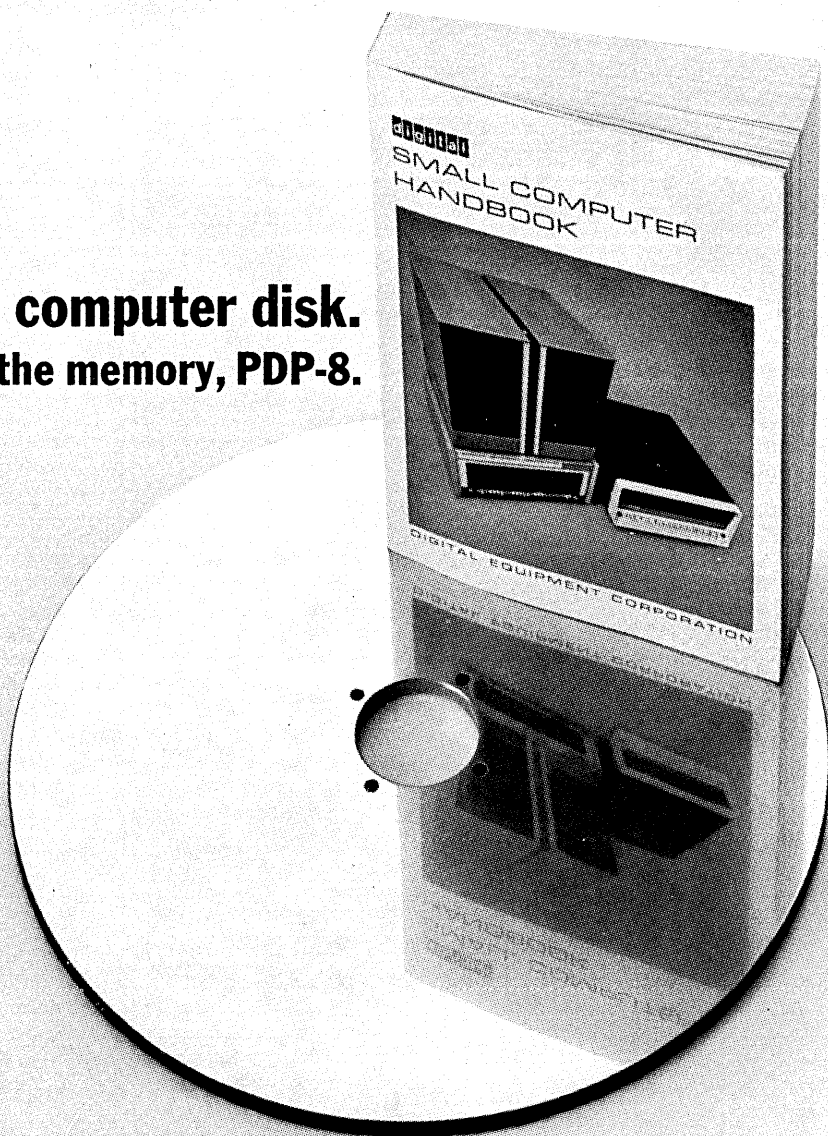
At last count, more than 700 PDP-8 computers have been sold to scientists and equipment manufacturers. The PDP-8 is, by far, the most successful and proven on-line, real time,

small computer in the world. And that was before DECdisk.

DECdisk was developed, like all DIGITAL peripherals, to customize a basically inexpensive computer to special applications. Yours. DECTape was developed the same way. The unique 3½" reels of magnetic tape not only provide low cost storage, but permit you to carry your program library in your pocket. And displays — did you know that DIGITAL was the first computer manufacturer to put a CRT on a computer?

Computer manufacturers who worry about what the customer needs, worry a great deal about peripherals. DIGITAL has one of the largest lines of peripherals in the industry. Write, and we'll send you a free "Small Computer Handbook" and tell you all about our peripherals.

New, low cost, small computer disk. Thanks for the memory, PDP-8.



DIGITAL EQUIPMENT CORPORATION, Maynard, Massachusetts 01754. Telephone: (617) 897-8821 • Cambridge, Mass. • New Haven • Washington, D.C. • Parsippany, N.J. • Rochester, N.Y. • Philadelphia • Huntsville • Pittsburgh • Chicago • Denver • Ann Arbor • Houston • Los Angeles • Palo Alto • Seattle • Carleton Place and Toronto, Ont. • Reading, England • Paris, France • Munich and Cologne, Germany • Sydney and West Perth, Australia • Modules distributed also through Allied Radio

digital
MODULES • COMPUTERS

Designate No. 8 on Reader Service Card

computers and automation

The front cover shows three "time sharers" using what is believed to be the first, fully general-purpose, time-sharing system designed, developed and implemented by an industrial company for its own use. For more information, see page 70.

OCTOBER, 1967 Vol. 16, No. 10

- 52 *Across the Editor's Desk*
Computing and Data Processing Newsletter
- 70 *Advertising Index*
- 66 *Books and Other Publications*
- 68 *Calendar of Coming Events*
- 68 *C&A Problem Corner*
by Walter Penney, C D P
- 64 *Computer Census*
- 62 *New Contracts*
- 63 *New Installations*
- 69 *New Patents*
by Raymond R. Skolnick

Editor and Publisher
Edmund C. Berkeley

Assistant Editors
Moses M. Berlin, Charlene J. Hofer, Linda Ladd Lovett, Neil D. MacDonald

Contributing Editors
John Bennett, Andrew D. Booth, Dick H. Brandon, John W. Carr, III, Ned Chapin, Alston S. Householder, Peter Kugel, Rod E. Packer

Advisory Committee
T. E. Cheatham, Jr., James J. Cryan, Richard W. Hamming, Alston S. Householder, Victor Paschkis

Art Director
Ray W. Hass

Fulfillment Manager
William J. McMillan, 815 Washington St.,
Newtonville, Mass. 02160, 617 DE 2-5453

Advertising Representatives
NEW YORK 10018, Bernard Lane-
37 West 39 St., 212-279-7281

CHICAGO 60611, Cole, Mason, and Deming
737 N. Michigan Ave., 312-787-6558

LOS ANGELES 90005, Wentworth F. Green
300 S. Kenmore Ave., 213-387-8135

SAN FRANCISCO 94123, Richard C. Alcorn
2152 Union St., 415-897-1620

ELSEWHERE, The Publisher
815 Washington St., 617-332-5453
Newtonville, Mass. 02160

Special Feature :

Time-Shared Computer Systems

- 16 **AN EVOLVING SPECIAL-PURPOSE TIME-SHARING SYSTEM**, by Paul A. Castleman
A discussion of the problems of designing, constructing, and operating an evolving, special-purpose, time-sharing system . . . and a description of one system for which the evolutionary period was not a brief initial phase, but a process which took place over a period of several years.
- 20 **THE ROCHESTER DIRECT-ACCESS TIME-SHARED SYSTEM**, by Kurt Enslein, Anthony G. Lauck, Robert MacIntyre, and Robert E. Hopkins
The evolution and present status of a direct access terminal in Rochester, New York, linked to a Control Data Corporation computer in Cambridge, Mass. . . . including users' needs, previous solutions, and a description of facilities now being used.
- 23 **COMPUTER TIME SHARING: ITS ORIGINS AND DEVELOPMENT**, by T. James Glauthier
Where the general purpose time-sharing systems came from and who developed them . . . and an outline of the general-purpose systems that are operating today.
- 30 **PROGRAMMING SELF-TAUGHT**, by Hal B. Becker
An exploration of a self-teaching system for programming . . . demonstrated in a series of lessons in the fundamentals of programming in BASIC.
- 38 **COMPUTER TIME SHARING — A REVIEW**, by Nicole Pointel and Daniel Cohen
A review of the essential and complementary features of a time sharing system . . . and how these features improve man-machine relations by permitting undelayed conversation between man and machine.
- 48 **THE MANY NEW USES OF TIME SHARING**, by Thomas J. O'Rourke
How the president of a time-sharing facility with over a thousand subscribers evaluates: the impact of time sharing; the question of time sharing vs. direct access; and the economics of time sharing.
- 7 *Editorial*, by Edmund C. Berkeley
In the Beginning — and in the Future
- 47 *World Report — Great Britain*, by Ted Schoeters
GE launches time sharing in UK; IBM foresees gold mine in communications; the first CDC 6600 is placed in Britain.
- Multi-Access Forum*
- 10 The Computing Sciences Are the Tools Which Bring Organization and Understanding to Exploding Knowledge, by Senator Howard H. Baker, Jr.
A look at the relationship between scientists and politicians, with emphasis on eliminating the information gap which presently exists between these two professions.
- 11 The Intellectual Implications of Technological Change, by Dr. Emmanuel G. Mesthene
- 12 Human Protests and Objections to the Computer, and the Philosophical Sources of Them, by Peter Warburton
- 13 Powerful Ideas: Responsibility for Truthful Input, by Neil Macdonald
- 13 Tiny Flaws in Medical Design Can Kill
- 14 Applications for 1968 Examination for DPMA'S Certificate in Data Processing Due Nov. 1, 1967
- 14 ACM to Hold Professional Development Seminars on Computer Graphics
- 14 Indexing of Data Processing Literature: An International Effort
- 15 Index of Government-Sponsored Computer Projects is Completed
- 15 Annual Computer Art Issue — Comments
- 15 The Paid Circulation Policy of "Computers and Automation"
- 67 GE Time Sharing Services — Correction
- 67 Artist in Computer Art — Correction



COMPUTERS AND AUTOMATION IS PUBLISHED MONTHLY AT 815 WASHINGTON ST., NEWTONVILLE, MASS. 02160, BY BERKELEY ENTERPRISES, INC. PRINTED IN U.S.A. SUBSCRIPTION RATES: UNITED STATES, \$15.00 FOR 1 YEAR, \$29.00 FOR 2 YEARS, INCLUDING THE JUNE DIRECTORY ISSUE; CANADA, ADD 50¢ A YEAR FOR POSTAGE; FOREIGN, ADD \$3.50 A YEAR FOR POSTAGE. ADDRESS ALL EDITORIAL AND SUBSCRIPTION MAIL TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE, MASS., 02160. SECOND CLASS POSTAGE PAID AT BOSTON, MASS.

POSTMASTER: PLEASE SEND ALL FORMS 3579 TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE, MASS. 02160. © COPYRIGHT, 1967, BY BERKELEY ENTERPRISES, INC. CHANGE OF ADDRESS: IF YOUR ADDRESS CHANGES, PLEASE SEND US BOTH YOUR NEW ADDRESS AND YOUR OLD ADDRESS (AS IT APPEARS ON THE MAGAZINE ADDRESS IMPRINT), AND ALLOW THREE WEEKS FOR THE CHANGE TO BE MADE.

If you think your system can't afford computer power, take a look at the new DATA 620/i

from
varian data machines

Data 620/i was designed from scratch as a powerful systems computer. That's why it so efficiently solves problems previously considered too difficult or expensive for computer solution. Data 620/i has a bigger instruction set, one-half the components, and costs less than any computer in its class.

Data 620/i has speed—1.8 microseconds cycle time, arithmetic power—long 16 or 18 bit words and 1K-32K word memories, control and I/O facilities, multi-level priority interrupts, and field-proven software.

Data 620/i is extremely compact, requiring only 10" of 19" rack space, and comes at an even more compact price, with a 4K 16-bit memory and an ASR 33 Teletypewriter. Write for our new Data 620/i brochure full of facts and figures.



varian data machines
a varian subsidiary
Formerly Decision Control, Inc.

1590 Monrovia Ave., Newport Beach, Calif. (714) 646-9371

See Data 620/i, the new VersaSTORE II, and MicroVersaLOGIC at Fall Joint Computer Conference, Booths 219 through 221.

Designate No. 10 on Reader Service Card

In The Beginning — and in the Future

In Washington in August, the Association for Computing Machinery held its 20th anniversary meeting.

The ACM began in the summer of 1947. A temporary organizing committee called the first meeting that September at Columbia University, New York; 75 people were present, and T. Kite Sharpless, then of the Moore School of Electrical Engineering, read a paper on "The Pilot Model of EDVAC" (Electronic Discrete Variable Computer). At that meeting, as temporary secretary of the organization, I signed up 58 people who desired to become members of what was then called the "Eastern Association for Computing Machinery." And I continued as secretary of the Association for Computing Machinery until 1953.

Kite Sharpless was not at the August 1967 ACM meeting. He died a few weeks before.

The 20th anniversary was celebrated in a long afternoon meeting on Wednesday, August 30, devoted to the theme "In the Beginning." Some two thousand people were present in the audience; and some twenty "computer pioneers" spoke of the early developments they had participated in or witnessed.

Sam Alexander of the Bureau of Standards was released from the hospital for the afternoon, and was presented with the Harry H. Goode Memorial medal. Thin and pale, he gave a moving report of the "fear-induced inspiration" and hard work connected with making the first Bureau of Standards computer, SEAC, saying it "stood on the shoulders" of many, many contributors, and "had more intellectual parents than any other device."

Herman Goldstine, then of the Ballistic Research Laboratories at Aberdeen, told a number of stories about the distinguished mathematician Dr. John Von Neumann, who initiated several early computers, and who died some years ago. Goldstine spoke of the great interest in computers among mathematicians and scientists studying the atomic nucleus, who were:

"interested in solving by calculation what they could not solve by experimentation."

Grace Hopper of Remington-Rand Univac and the U. S. Navy, made some friendly and touching remarks about the early days of computing and programming, and the importance of teaching, and the entire audience gave her a standing ovation.

Maurice Wilkes, of the Mathematical Laboratory at Cambridge University, England, talked of the computer EDSAC built there, and laid claim to an "unanticipated discovery," which he made in 1949:

"I discovered debugging."

Not all the remarks dealt with the past. One was:

"The ACM now has twenty thousand members. The time will come when it will have two hundred thousand members."

The reporter Lincoln Steffens' famous remark, made in the 1920's in another connection, was quoted as applying to computers:

"We have seen the future and it works."

For a while the flavor of the old days in computing was recaptured, the days when we first tread on the new and fascinating territory of the computer field. The ACM, with help from Ampex and other organizations, recorded the whole session, in video and sound. Some of the flavor of those days will in this way hopefully spread to those who come after.

What was this flavor? There were several strong factors. In the first place, there were only a few hundred people in the computer field, and almost everybody knew, and could talk to, almost everybody else. This tradition is partly preserved in the annual cocktail party and reception of the ACM — but in the old days at every meeting you spoke to everybody and assumed you knew him even if you didn't, and you compared ideas quickly and found congeniality quickly.

Second, the field was so much smaller that you could understand and even be interested in a great many of the papers and reports. Now the field is so sophisticated, and so much of the language is so specialized, that many of the papers are hard to understand, and have a narrow audience:

Third, almost the only computer makers were staffs of scientists — either at universities or in small groups who had just left universities and were trying to start making computers on their own. The big manufacturers of office and business machines had almost no idea of and no interest in the "computer revolution," but were content with punch card machines, desk calculators, and cash registers. There was not even a glimmering of the present vast commercialism. Instead, the emphasis everywhere was on discovery, on doing things for the first time.

Can we get back any of this flavor in the future? I think so.

One possibility I see would be to make a new social invention whereby relative strangers could communicate well in the first two minutes. For example, a punch card with holes showing your interests, activities, and background — which you could overlap with the similar punch card of a new acquaintance — could be a big stride forward. Another possibility is a sensible and vigorous attack on the problem of making papers explanatory, understandable, and interesting to a wider audience. Still another possibility is a practice which the English already use — limited attendance, so that only some persons can go to certain meetings — although this would certainly go against the grain of many Americans.

Certainly we should start preparing now for the time when the ACM will have 50,000 members.

Edmund C. Berkeley

Editor

"NO-GES" SHOTGUN PATTERN CHART



DATE _____
MAKE AND GAUGE GUN _____
MAKE OF CHOKE _____
CHOKE SETTING _____
MAKE SHELL _____
SIZE SHOT _____
OUNCES SHOT _____
POWDER LOAD _____
YARDS DISTANCE _____
NO SHOT IN QUAIL _____
NO SHOT IN DUCK _____
NO SHOT IN 30' CIRCLE _____
TOTAL SHOT IN SHELL _____
PATTERN PERCENTAGE _____
SHOOTER'S NAME _____



Guns, courtesy of Abercrombie & Fitch. For quality reproductions of this photograph, write us at Memorex.

THE TWO GREAT TAPES,



**"NO-GES"
SHOTGUN PATTERN CHART**

DATE
MAKE
GAUGE
MAKE
CHOKE
MAKE
SIZE SH
OUNG
POW
YAR
NO
NO
NO
TO
PATT
PERCENTA
SHOOTERS NAME

LIKE THE TWO GREAT SHOTGUNS, ARE NOT IDENTICAL.

When you buy a Purdey or a Holland, you buy the finest in guns. They cost about forty-five hundred dollars each. They last for generations.

When you buy the two great tapes—ours or the one the computer company makes—you buy the most durable, most reliable computer tape around. Naturally, they cost more. It's not surprising, therefore, that they make pass after pass after pass without a drop-out.

The two great guns are pretty much alike in total performance. But although each is exquisitely crafted

to perform unerringly, they are not identical. You'd have to use them both to know exactly what each can do.

It's the same with the two great tapes: they aren't exactly alike, either. In fact, some tape-users insist that our great tape out-performs the other.

Could be.

(Brochures? Specs? Write us at 213 Memorex Park, Santa Clara, California 95050.)

MEMOREX

MULTI-ACCESS FORUM

THE COMPUTING SCIENCES ARE THE TOOLS WHICH BRING ORGANIZATION AND UNDERSTANDING TO EXPLODING KNOWLEDGE

**Senator Howard H. Baker, Jr.
U.S. Senate
Washington, D.C.**

(Based on an Address to the Members of the Association for Computing Machinery, meeting at Washington, D.C., August 30, 1967)

Your field of interest is as broad as the entire scope of the activities and the environment of mankind. The computing sciences provide the tools and techniques which permit us to bring coherence and organization to the exploding body of knowledge, which will directly affect every life and all our governmental institutions now and in the future.

In the social sciences, as distinguished from the physical sciences, your industry, talents, and imagination will permit us for the first time to engage in systematic and profound scientific inquiries. For the first time theoretical science, applied science, engineering, economics, and government are discernibly interacting.

It is imperative that we begin now to plan for the great technological revolution which is almost upon us. We must make the necessary adjustments and preparations to assure that this revolution works for our benefit, that it makes us freer, and that it does not destroy the basic values upon which our nation was founded.

You are well aware of the fears expressed of the "big brotherism" aspects of the computerized society. And you've heard the humorously told accounts of people fighting frustrating battles against an immutable computer which insists on sending a bill which for some reason or other is erroneous.

These stories and jokes are funny today. But tomorrow when our society becomes completely dependent on computerization, they could become nightmares, unless we plan for the new age computers are bringing us.

To attack the problems of revolutionary technology we need a coherent and coordinated approach to the socio-technological and political implications.

Some of us are not scientists or technicians, but politicians, whose roots are in experience of people, their idiosyncrasies, their prejudices and vagaries. The future lying ahead consists of automated machines, the cybernetic revolution, manipulated genetic structures, self-contained cities recycling their own wastes, giant supersonic airplanes with thousands of passengers, nuclear devices that will produce costless energy. This kind of future gives substantial concern to us on Capitol Hill.

We lack in the Senate, in Congress, in the Executive Branch, and among our State and local governments, a

mechanism for inquiring into and reporting on the broad impact of science and technology — on man's thinking, his health, work, living habits, and individual security over the next fifty years.

There is a tremendous information gap between the politician and scientist.

We really don't know where we are heading — where the benefits of technology can be best applied, and what hazards and problems may flow from any technological application.

In an attempt to meet this information gap, Senator Muskie has proposed legislation which would establish in the U.S. Senate, the Select Committee on Technology and Human Environment, composed of members from each of the standing committees most involved with legislation affecting human needs. This committee would provide an excellent forum where scientists and legislators could face each other and discuss the critical environmental problems ahead, and what science and technology can do to solve them. It would provide a central source of information and analysis, cutting across the technological spectrum, which the standing committees and members of the Senate would use in developing their legislative policies.

This Select Committee would have no jurisdiction over legislation or powers of legislative oversight; but its reports and recommendations could well become a cornerstone for the development of national goals and planning involving science and technology.

In the military and defense sectors, and in our efforts to put a man on the moon, we are well along with our scientific and technological planning and programming, our systems management, our cybernetic progress. It is true there have been problems in these sectors, but extraordinary minds and machines have worked to solve them.

But for man on earth, what do the next fifty years of science and technology hold? Is he to be consigned to ghettos, stalled in traffic, choked by poisoned atmosphere, subjected to continuing noise and strain? Is he to suffer tension and social instability in our increasingly crowded city and suburban environments? Or can he be released from intolerable conditions, through the kind of cooperative political

and scientific effort that is going forward so energetically in the space and defense fields?

And supposing we do bring in to consultation the scientists and the technologists, and their 21st Century equipment and ideas, do we have the type of governmental structure and administrative processes to implement effectively the rebuilding process? How much of our concepts of free enterprise, of individual freedom and initiative, and of democratic decision-making will have to be forfeited or modified in order to build a new American society along scientific lines?

These are hard questions requiring some hard decisions and hard answers. But the internal conditions of many areas, urban and rural, in this country are becoming so serious that we are being forced to make decisions.

Could it be that we as legislators representing a hundred and ninety million people are locked into a technological system which in the long run we are powerless to control?

Atomic power and computerization will be at the head of the operations of a city of the future. The computer complex would be the city's largest decision-making body.

What kind of a government would such a city have? What kind of political decisions would be needed? What kind of competition would there be? How much private ownership? How much individual freedom would a person have?

Never before in our Nation's history has it been quite so critical that we shorten the ten to twenty year gap between basic research discoveries and their practical applications. Never before has it been quite so critical that Congress legislate intelligently so that taxpayers, impatient to achieve

effective solutions to a myriad of social problems, get their money's worth from each dollar spent.

In summing up, the first proposition that I want to leave in your minds is this: that all of us — you in the computer field, we in the Congress — have got to do a great deal more thinking about where science and technology is leading us. We have to think about what kind of mechanism we can devise for coordinating information about what is happening, and what benefits and hazards are developing as a result of the technological revolution.

Second, the time is long overdue for the development of national goals and planning with respect to the relationship between our scientific and technological achievements and the improvement of our human environment. We can no longer rely on Federal grants in aid and State and local administrators to solve the problems of our cities. Science and industry have got to be brought into the discussion.

Third, we have to think very seriously about the kind of creative Federal system of government that will best serve our needs in the 21st Century, that will preserve to the greatest extent possible individual freedom, and the democratic process of decision-making.

And finally, we must develop a national purpose, to which everyone will become dedicated — to rebuild, refurbish, rejuvenate this nation at every level of human activity, and in this way reduce the widening gap between affluence and despair that is threatening the strength of this nation.

THE INTELLECTUAL IMPLICATIONS OF TECHNOLOGICAL CHANGE

Dr. Emmanuel G. Mesthene
Harvard University
Cambridge, Mass. 02138

(A Summary of an Address at the Meeting of the Association for Computing Machinery, Washington, D.C. August, 1967; limited according to permission to "less than 400 words")

The intellectual effects of technological change may well be crucial to understanding all the other effects — military, economic, social, political, etc.

It is through enhancing the status and importance of knowledge in general, that science and technology may affect society most significantly.

Technology denotes not only physical tools and machines but also intellectual tools — from language, ideas, and science, all the way to computer programs, systems analysis, and program planning and budgeting systems.

So the relation of technology to society must be redefined as the relation of knowledge to society.

Why?

Because contemporary society is marked by change more fundamentally than any previous society. Change comes from: economic pressures for greater efficiency; weapons technology; the "Everest complex" — which spurs action because new technology makes something newly possible; the "Apollo syndrome" — where powerful interests engaged in new technology successfully urge its adoption and use.

New technology: generates change; presses innovation forward; induces changes in human values; calls forth new forms of social organization; causes new objectives to be discerned.

So the world that we know becomes one in which change is all-pervasive — in which our lives, concepts, ideas, the ways we think, all change.

Change in society is no longer a temporary perturbation of a steady state, or a short transition to a new stable state. Change is continual and increasingly rapid.

A society full of change: requires more knowledge of the social sciences; poses new questions; probes at technological and intellectual frontiers; searches out new implications of science and technology; explores the intersections of disciplines.

In these unusually difficult and important enterprises the computer will be a most helpful intellectual tool.

We are led to renewed commitments to the beliefs:

- There is nothing in nature or existence that is inherently unknowable.
- Rationality is the most important instrument for social control.

We are abandoning the traditional American suspicion of planning.

The experimental domain of science increasingly requires the whole world as a laboratory; and science must change its traditional ground-rules for experiment to prevent permanent damage to the world it explores.

Social responsibility consists of more than good will or an annual panel discussion — it requires a deep understanding of the social meaning of technical activity.

HUMAN PROTESTS AND OBJECTIONS TO THE COMPUTER, AND THE PHILOSOPHICAL SOURCES OF THEM

Peter Warburton
Chevy Chase, Md. 20015

There are, it seems to me, two quite different kinds of objections to computers by human beings.

First, some people see computers as another tool created by man that leads to human detriment because we are not able (either we lack the intelligence, or more often, the social and political "will" or control) to establish an adequate social context. Thus, computers could result, primarily because of anarchy resulting from a lack of system control and each computer user going off in his own direction, in a mess analogous to our congested automobile traffic. All of us frequently get into traffic jams; and all that our highway engineers can nowadays suggest is that we tear down people's houses to build more freeways and parking lots.

This sort of objection to computers, it seems to me, comes from the point of view that sees no particular good or evil inherent in technology, but at the same time realizes that often we handle technology piece-meal, without implementing a system for good use. The result is better than before we had the tool (nobody in his right mind proposes that we go back to horse and buggy or bicycles — people who feel that way move out of the United States), but by no means without inconvenience, and things are nowhere nearly as good as they could be. But the social system for tool-use is man-made, and presumably can be remade by men, if they care enough.

The second kind of objection is, I believe, quite different. Critics stating this kind of objection do not see computers as a system problem, but as a moral problem. Somehow computers are a threat to human dignity, and we ought to go back to farming before man is thoroughly corrupted. Or computers are not just another machine, but part of a technology which is taking over with a life of its own, and this technology is oblivious to human values and will crush us all.

I propose that these two kinds of objections stem from two, rather incompatible, points of view which are part of our cultural heritage, but which we rarely if ever are aware of.

One point of view is that of traditional Christianity, that man is a two-part combination of a body (nature) and a soul (god-like). This point of view has been threatened by Copernicus, Darwin, and Freud, and the viewpoint of science and technology which sees man as a one-part animal that has evolved body, mind, and culture out of lower forms of life. Most thinkers nowadays accept Copernicus and Darwin, accept that man's body evolved, but not everyone accepts the view that man's mind and culture evolved. This point is made by Robert Ardrey in *The Territorial Imperative*: that while cultural anthropologists have accepted man's body evolution, they have not accepted his cultural evolution from animals. I personally did not realize how strongly pervasive this attitude was until I talked with people about Ardrey's book and read the reviews of it. Then I came to realize that Ardrey is striking a very sensitive point. Apparently, many people feel that if there is nothing unique about man, nothing that has not evolved from animals, then man has neither dignity nor meaning for his life.

It is apparent therefore why people holding this view feel very distrustful of computers. To these people it is not just a technological impossibility for machines to think, it is a logical impossibility, because whatever a machine is, it is not like a human soul and therefore cannot possibly think. From the two-part point of view, machines are bodies, not

souls; but from the one-part point of view, machines, like man, are a product of nature, and there is no fundamental logical reason why a machine cannot think. Men think, so why can't a machine?

I do not claim that this distinction is obvious. I think it is anything but obvious. It has taken many years for me to trace it down and uncover it. Let me give some examples.

John Wilkerson of the Center for Study of Democratic Institutions, Santa Barbara, Calif., has popularized and extended Jacques Ellul's attack on technology. Wilkerson thinks it is impossible for computers to have values, except as a programmer puts his values into the criteria by which a program decides in one way rather than another. Why does Wilkerson feel this way? After all, if man is a data processing machine and if man has values, in what way is a machine logically different? I think the answer is that Wilkerson sees man as a two-part combination of body (chemical and data processing) and of soul (values), and a machine as a one-part body. But the machines have great energy and power, over man and other things, and since the machine has no values innately, it will be a force for man's detriment. In fact, Ellul sees technology as possessing a Hegelian "will" and "rationality" all its own.

An intellectual does not have to be a Christian to hold the two-part view. Jean Paul Sartre, who is an atheist, does not believe machines can think. For the same reason he does not accept the theory of evolution as anything more than an interesting speculation. Sartre is concerned with man's consciousness, which he believes is quite non-body. He does not know where it came from, but he is quite certain consciousness is so different from body that it could not possibly have evolved from material beings. Sartre's belief is, of course, grounded in systems of thought he acquired from Descartes, Hegel, and Husserl.

What has all this to do with the original problem? Just this: If you start with the two-part view of man, then any indication that machines have human-like qualities is a threat to your sense of man's dignity, — just as Copernicus's moving man out of the center of the universe was a threat to man's concept of himself as something special in the universe, just as Darwin's theory of evolution was a threat to man's concept of himself as something special, just as Freud's theory of man's irrationality was a threat to those who saw man as a special rational something in the universe, just as Ardrey's theory that man's culture evolves from animal behavior is a threat to man's uniqueness. And so computers are a threat to the concept of man which gives man a special place in the universe.

But none of these concepts is a threat to the holder of the view that man is a one-part animal product of evolution. Rather, all these theories are welcome as evidence that man is part and parcel of nature, and there is nothing non-natural in his being. Man and his ecology are part of the system which we call Nature; and Nature is a dynamic system in which disturbances in one part very often cause disturbances in other parts, and mankind survives by (1) adjusting to these disturbances and (2) using knowledge to control or minimize disturbances. Since man and his technology are both products of nature, there can be problems of conflict (as between any subsystems), but there is no basic antagonism stemming from man being one kind of entity and technology being another.

Still, the idea that man's mind and consciousness is not a part of Nature, but a part of Nature's creator is a very old idea. It was even an old idea in Plato's time. It is an idea that is not going to die easily, even in 20th Century

America, the technological society. And it will always create tension in the "conceptual framework" of a person who holds it and who also is told that machines can be mind-like and that man and machine are both products of nature.

POWERFUL IDEAS: RESPONSIBILITY FOR TRUTHFUL INPUT

Neil Macdonald
Associate Publisher
Computers and Automation

A basic function of Multi-Access Forum in this magazine is to stir up ideas, to broaden the horizons of computer people with powerful ideas, to help them see all the panorama of ideas in the computer and information sciences.

This raises some interesting questions. Among them are:

- What is an idea?
- How do you measure the power of an idea?
- Where do good ideas come from?
- What are the ten (or hundred, or thousand) most important ideas in the computer field?

We can't of course answer all these questions here and now; but in Multi-Access Forum we hope to cover such questions as these from time to time.

An example of a really important idea in the computer field was the idea of the stored program, which the computer itself could modify by its computations. This idea was not present in the Harvard IBM Automatic Sequence Controlled Calculator, which started running in 1944, nor in the ENIAC, which started running in 1946. But today it is a common idea, yet still profoundly important.

Another important idea which is at present enjoying much fashionableness is the idea of the time-shared multi-access computer. This issue of *Computers and Automation* contains many articles relating to time-shared computing systems. The editors of *Computers and Automation* think that there is currently an overemphasis on time-sharing, that much emphasis should remain on batch processing, and that much emphasis should be placed on direct access to

computers — whereby a small computer (or even a large one) is used essentially by one person at a time who has intimate interaction with every part of the computer whenever he chooses to.

A third important idea that we want to nail down in these current remarks is this one:

1. Correct handling of information depends on correct data drawn from the world of physical facts and also the world of human facts, — of organizations, people, societies, newspapers, etc.
2. Therefore, computer people as information engineers have a responsibility for obtaining correct and truthful facts to put into computers.

Take, for example, the Arab-Israeli War of June 1967. When the Arabs were thoroughly defeated in four days, the Arab governments attributed their defeat to overwhelming aerial intervention by American and British planes helping Israel. This was a lie. This was a lie of enormous dimensions, for no American and British planes at all helped Israel. The lie was told to millions of Arabs; the lie was assiduously spread; the fantasy was cultivated; and today millions of Arabs have been convinced that their defeat did not occur from the Israelis but from an alliance of Israelis, Americans, and British.

Computers and Automation will take its stand resolutely against the telling of lies. Information processing cannot work correctly when lies are poured into the input.

TINY FLAWS IN MEDICAL DESIGN CAN KILL

(Based on a report in the September, 1967 edition of ELECTRONIC DESIGN, published by Hayden Publishing Co., Inc., 850 3rd Ave., New York, N.Y.)

A seemingly harmless current of 20 millivolts can kill a hospital patient under certain conditions — and there are reports that errant currents from faulty electronic equipment have imperiled patients in certain cases. In light of the fact that there are today no Federal, state or local standards to regulate the design, construction and electrical safety of equipment used in a hospital room or doctor's office, the potential for continuing this tragedy exists.

This is the picture painted by medical and engineering critics of some of today's electronic equipment. Two major flaws in equipment are turning up, according to these critics, as the field of medical electronics reaches out toward growing markets: (1) faulty components in instrumentation and monitoring devices; and (2) wiring systems that do not provide maximum protection for a patient.

A leading critic, Dr. Paul Stanley, Professor of Aeronautics, Astronautics and Engineering Sciences at Purdue University, Lafayette, Indiana, says that doctors are well aware that small electric currents applied to the body can be fatal, but that they are not fully aware that malfunctioning hospital

instruments can produce these currents. It is bad enough when a healthy person is subjected to such shocks, Dr. Stanley says, but the problem is drastically compounded when a hospital patient, especially one suffering from a heart problem, receives the shock from an electrical device attached to his body.

Efforts to set safety design standards are being pressed by such professional groups as the Safety Committee of the Instrument Society of America, the Corresponding Committee of the IEEE, and the Standards Committee of the Association for the Advancement of Medical Instrumentation. However, they report little headway toward achieving their goals.

To help fill the void, some manufacturers have begun to set their own standards. And in Congress a bill has been introduced in the House of Representatives to create a national commission that would study the quality controls and manufacturing procedures of companies that make medical instrumentation equipment. The bill, HR 6165, introduced last February by Rep. Ed Reinecke (R-Calif.), is still under study.

APPLICATIONS FOR 1968 EXAMINATION FOR DPMA'S CERTIFICATE IN DATA PROCESSING DUE NOV. 1, 1967

R. Calvin Elliott, Exec. Director
Data Processing Management Assoc.
505 Busse Hwy.
Park Ridge, Ill. 60068

The seventh annual examination for the "Certificate in Data Processing" (CDP) will be given February 24, 1968, at 100 test centers in the United States and Canada.

The three-hour examination is given at accredited colleges and universities, and is designed to test a wide area of data processing knowledge considered necessary for professional competence in the field. Any individual meeting the application requirements is eligible to sit for the examination; DPMA membership is not required.

Certification is granted to candidates who pass the examination, meet a three-year experience requirement in data processing, and fulfill the academic requirements which in-

clude a number of college level courses encompassing the fields of business and mathematics.

The examination consists of 220 multiple choice questions covering: automatic data processing techniques and equipment; computer programming and software systems; data processing systems concepts, design and implementation; and quantitative methods in data processing including accounting, mathematics and statistics.

A list of examination sites, study guides, and application forms for the 1968 examination are available free from the above address. The deadline for filing applications is November 1, 1967. All applications must be submitted to DPMA headquarters.

ACM TO HOLD PROFESSIONAL DEVELOPMENT SEMINARS ON COMPUTER GRAPHICS

James M. Adams, Jr.
Director of Education
Association for Computing Machinery
211 E. 43rd St.
New York, N.Y. 10017

A series of half-day seminars for programmers and analysts on "Computer Graphics" has been scheduled for five cities by the Professional Development Committee of the Association for Computing Machinery in cooperation with the Special Interest Committee on Graphics.

These introductory sessions will be held 1-6 P.M. in the following cities:

October 26	Denver, Colorado
October 27	San Francisco, California
October 30	Albuquerque, New Mexico
October 31	St. Louis, Missouri
November 1	New Orleans, Louisiana

The seminar is intended as a comprehensive overview of the role of computers in graphical data processing, particularly displays. Topics will include basic concepts and terminology, display hardware and software, data structures and applications.

Instructors will be Dr. Andries Van Dam, Assistant Professor, Brown University, and Samuel M. Matsa, Manager, New York Scientific Center, IBM Corp., New York, N. Y.

Requests for additional information and enrollment forms should be sent to me at the above address.

INDEXING OF DATA PROCESSING LITERATURE: AN INTERNATIONAL EFFORT

S. D. Duyverman
Chrmn. of ad-hoc Bd. of Directors
IFIP Administrative Data Processing Group
6, Stadhouderskade
Amsterdam W. 1, Netherlands

In response to the letter of Philip R. Bagley and your invitation on page 12 of the July issue of *Computers and Automation*, I am writing to draw the attention of your readers to the fact that there is a monthly abstracting and indexing periodical which goes a very long way toward meeting the requirements specified by Mr. Bagley and yourself.

This periodical, "Literature on Automation," has been published for over six years by the Netherlands Automatic Information Processing Research Centre and has recently

been taken under the banner of the new IFIP Administrative Data Processing Group.

In a few months time, the Group has received support in twenty countries. It will be developed in the United States by a special committee of AFIPS under the chairmanship of Mr. R. C. Cheek, Director of the Tele-Computer Centre of the Westinghouse Electric Corp., Pittsburgh, Pa.

We hope that this periodical will meet a long felt need for the exchange of information and experience on an international basis.

INDEX OF GOVERNMENT-SPONSORED COMPUTER PROJECTS IS COMPLETED

**National Bureau of Standards
Office of Tech. Inform. & Publications
U.S. Dept. of Commerce
Washington, D.C. 20234**

The National Bureau of Standards Center for Computer Sciences and Technology has completed the compilation of an automated index of government-sponsored research and development projects in the computer sciences. The index, which covers almost 2500 projects, was prepared with the assistance of the Defense Documentation Center.

The index is stored on computer tape; it will be available for such machine searches as the listing of all projects for which a particular investigator has responsibility, or the

determination of the amount of money spent by a certain agency on all projects in the computer sciences.

The index is available for study in the form of a computer printout at the Computer Center's Technical Information Exchange at the Gaithersburg, Maryland, laboratories of the National Bureau of Standards. The printout consists of two different listings. One is sequenced by 20 subject categories in the field of computer sciences and technology; the other is by sponsoring organization, and is further arranged by performing organization.

ANNUAL COMPUTER ART ISSUE — COMMENTS

**I. From William H. Harkins, Director
Automation Institute
Boston, Mass. 02116**

Your August issue with its annual computer art display is excellent. The creativity and diversity of output from a sophisticated plotter program should be of great interest to professionals and laymen alike.

As a new organization in Boston for EDP Training, we find that while interest in computers and systems is high, many young people still have fears about the entire idea of the computer field. In order to help eliminate these uncertainties about going into a new career, we spend considerable time with prospective students showing them our school and giving machine demonstrations.

It has occurred to me that an excellent example of the need for intelligent human minds behind every computer is the computer art material such as you have published in

your current and earlier issues. Would you permit us to photostatically reproduce this material for display use within our school? Full credits to C&A plus the individuals, would be given.

II. From the Editor

Thank you for your kind remarks about our computer art issue.

We are glad to give you permission to reproduce for display within your school computer art that we have published, with due acknowledgement to the individuals producing it and to *Computers and Automation*.

THE PAID CIRCULATION POLICY OF "COMPUTERS AND AUTOMATION"

**I. From Mary T. Berran
Technical Librarian
The Dikewood Corporation
Albuquerque, N. Mex. 87106**

We have a request from several members of the staff for issues of *Computers and Automation*, which we understand are free. Would you please place us on your distribution list as soon as possible?

Thank you for your kind and prompt attention.

**II. From Carl Heyel
Management Counsel
Manhasset, L.I., N.Y. 11030**

As a management consultant and currently special consultant to BEMA, am I qualified to get on your controlled circulation list? I am currently heavily concerned with BEMA in its presentation to the Federal Communications Commission relative to the latter's investigation of the computer industry, and receiving your publication here would be especially helpful over the ensuing months.

III. From the Editor

We have your letters asking us to send our magazine free. *Computers and Automation* is a paid circulation magazine, and we do not regularly have free or complimentary or controlled subscriptions.

Furthermore, we believe that a magazine should be supported chiefly by its readers, and not entirely by its advertisers, in order that the editorial information printed in its pages shall be less subject to control in the interests of advertisers. Such control can be direct in the form of suasion, or indirect in the form of fear of loss of advertising revenue, or in the form of restriction of the audience to whom the magazine may be sent, etc. He who pays the piper calls the tune.

We shall be glad to welcome anyone as a regular paid subscriber to our magazine if he so wishes.

(Please turn to page 67)

AN EVOLVING SPECIAL-PURPOSE TIME-SHARING SYSTEM

Paul A. Castleman
Bolt Beranek and Newman Inc.
Cambridge, Mass. 02138

"The biggest operational problem in an evolving special-purpose time-sharing system is reliability. Because the data attached to the system are important and also must be maintained for a long time, reliability is doubly crucial. Errors affecting the data base cannot only interrupt users' current procedures, but also jeopardize past work."

Like Caesar's Gaul, the class of time-sharing systems can be divided in three parts: special-purpose, general-purpose, and evolving special-purpose. The special-purpose systems perform many application functions, but no programming functions. Airline reservation systems and banking systems are representative of this class. To achieve the impression of many terminals using the computer at the same time, some special-purpose systems employ multiprogram time-sharing, that is, allowing each terminal to run a separate program that is swapped in and out of the computer periodically. Alternatively, these systems may use one program that resides in the computer but handles many transactions at the same time.

General time-sharing systems, like MIT's Project MAC, employ multiprogramming, are programmable from the terminals, but provide few if any application functions. Whereas users of special-purpose systems share application functions (e.g., checking a schedule), users of general systems share a computer (e.g., debugging a program).

Some of the more sophisticated application systems have incorporated capabilities of both special-purpose and general time-sharing systems. These evolving special-purpose systems perform specific application jobs for a real-life activity, but must also have the programming capability of general time-sharing systems to allow the system itself to be modified. There are three principal reasons why such systems need to evolve:

- It is difficult to specify in advance what the characteristics of a complex information system should be.
- Once an initial version of the system is running, automation can alter the way users perform their original jobs and thus precipitate secondary changes upon the system.
- Once a system is running, its users conceive of new applications.

Management information systems, hospital information systems, and administrative educational systems are examples of applications requiring the evolving special-purpose approach.

An evolving hospital time-sharing system was designed and implemented as part of the Hospital Computer Project,

Note: Work reported here was performed under contract PH43-62-850 with the National Institutes of Health, Public Health Service, U.S. Department of Health, Education, and Welfare.

a joint research program of Bolt Beranek and Newman, Inc. and the Massachusetts General Hospital. The experience of the Project has been that the evolutionary period for the system is not a brief initial phase but rather a prolonged process on the order of several years. On the basis of this experience, this paper discusses the problems of designing, constructing, and operating an evolving special-purpose time-sharing system. One solution to some of the problems is also proposed.

Problems of Design and Construction

Building one system that is both general and special-purpose is much more than twice as difficult as building both types separately. The Operating System must have general and special-purpose portions. (In the Hospital Computer System, these two parts of the Operating System are about the same size.) The problem of such an ambivalent Operating System is not just separating the two parts, but allowing each to work effectively in the presence of the other.

Including the general time-sharing portion of the Operating System, which handles the program swapping, tends to lower the efficiency of the special-purpose application programs. Because the design must include this general multiprogramming, the system contains the inefficiency of swapping overhead common to all general time-sharing systems. Thus two users performing similar functions may have to share time for multiple copies of the same application program. If the system design did not have to include the general time-sharing facility, resident application programs could probably be built to share time more effectively.

To combat this inefficiency, the Hospital Computer System upgraded some functions which were common to many application programs into resident system routines. These common routines constitute the special-purpose portion of the Operating System. They reside in the computer memory and function as an extension of the application programs, so that at least these common routines are not swapped and do not contribute to the system overhead. Examples of these special-purpose system functions are:

- a question-answer interpreter for maintaining interactive dialogues;
- verification routines for checking the syntax of user-typed responses; and

- routines for handling the special hospital file structure, which automatically update data indices and create special patient data items.

However, once these portions of application software are embedded in the special-purpose part of the Operating System, they become frozen to change and can thereafter evolve only at great cost, effort, and risk.

Distinguishing Between Function Capability and Computer Capability

The general time-sharing portion of the Operating System must be built to share function capability as well as computer capability, and further must distinguish the difference. The system cannot just run programming functions and application functions under time-sharing, but must handle them differently. For example, when an application program is running and is interrupted from the terminal, the Operating System transfers control to the interrupt-handling routine of the application program. However, if the same application program is interrupted while running under the debugging monitor program, the Operating System stops the program and restores control to the debugging monitor. Employing the debugging monitor, the user can then examine his core image and files to find out what is happening. In this case the user receives the use of the computer for programming purposes; in the former he receives the use of a specific function for application purposes.

A similar design consideration applies to the handling of program failures. When an application program crashes while being run by a hospital user, the Operating System must halt the program and release any I/O devices and files which the program had held. When a program run by a programmer under the debugging monitor crashes, the Operating System merely returns control to the debugging monitor.

How to Share Time

Another problem in designing the general part of the Operating System is how to share time. In the Hospital Computer System, the time-sharing queueing algorithm assigns time under the assumption that all programs are equal. The frequency with which a program is run is based only on that program's behavior. (Specifically, a program that communicates often with its terminal runs more often, but usually for a short time; a program that computes rather than communicates runs less often, but usually for a longer time.) Absent from this scheme is any "sense" of what the system's real priorities should be. There is no obvious way for a special-purpose program that is performing some critical service to supersede other programs for running time. Therefore a special priority system had to be designed, whereby external priorities could be superimposed over the queueing process. A high priority can then be assigned to a program to reflect its importance, and the program will run for a longer time within the queueing scheme, regardless of whether it computes or communicates.

Reliability

The primary objective of an evolving special-purpose time-sharing system is to provide a real service for people who are generally not computer programmers and furthermore depend on the system to perform their duties. Therefore the biggest operational problem is reliability. Because the data attached to special-purpose system are important and also must be maintained for a long time, reliability is doubly crucial, since errors affecting the data base cannot only interrupt users' current procedures but also jeopardize past work.

If the system is designed to handle both special-purpose functions and programming development, then why is reliability a problem? It is a problem because in a real operating environment some new "dangerous" programs cannot be tested on the system at the same time that service is in effect. As a result, new software must be checked out during off-hours, with two consequences. First, the system is not subjected to its usual daytime load during checkout time. It is a characteristic of time-shared programs that different "bugs" may appear depending on the conditions of the overall system activity. For example, the "time-sharing bug" of a program manipulating data incorrectly because another program processes the same data at virtually the same time would be unlikely on a lightly loaded system. Second, programmers must simulate at night their counterparts of laymen users. Unfortunately, these two types of people tend to use application programs differently and to make different types of errors; so program debugging is again limited. Therefore, because the same system is used for both service and development, programs checked as rigorously as possible can still cause system failures when they are installed during actual service hours.

Pressure for Smooth Service

Just as the evolution of the system can impair its reliability, the pressure for smooth service can also dampen the evolution of the system. Because of both risk and inconvenience, many developments are not attempted. While much creative programming has been done at night, it is difficult to revise whole systems, or even make seemingly simple additions of new hardware, on the night shift. For example the hospital system has been using the same patient-record file structure for over three years, even though significant improvements have been designed, because the logistics of installing a new structure are very complex and the risk to the reliability of affected application and system programs is very great.

System Loading

A third operational problem is system loading. Because development occurs concurrently with service, it degrades both the efficiency and predictability of response time for special-purpose functions. The scheme of program priorities attacks this problem, but does not solve it completely. The external priority assignments are essentially manual tinkering, and can only optimize the performance of the most important application programs.

The Dual Processor System

One type of evolving special-purpose time-sharing system which would solve many of the problems outlined above is the dual processor system. This system would have two distinct central processor units, CPU A and CPU B. The general and special-purpose portions of the single Operating System would be separated into two Operating Systems, one for CPU A and one for CPU B. With the special-purpose Operating System, CPU A would perform all the service functions, but not programming functions. CPU B, with a general time-sharing system, would handle developmental programming. The two processors and Operating Systems would share common peripherals.

To insure reliability, CPU B would have read-only access to the public file used by the special-purpose system, but would also have its own experimental files insulated from the service system. The two processors might also share a common communication concentrator for further efficiency. Figure 1(a) illustrates the configuration of a dual processor evolving special-purpose time-sharing system. Figure 1(b) shows the single processor system.

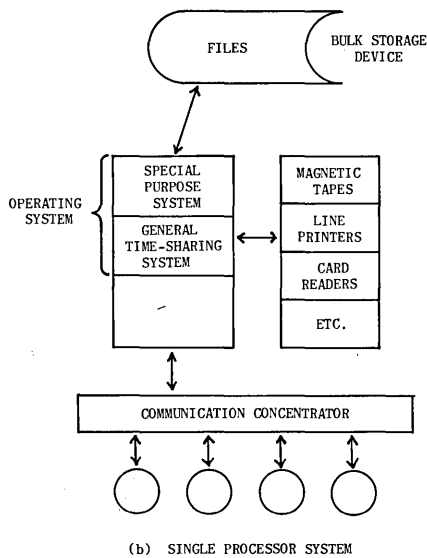
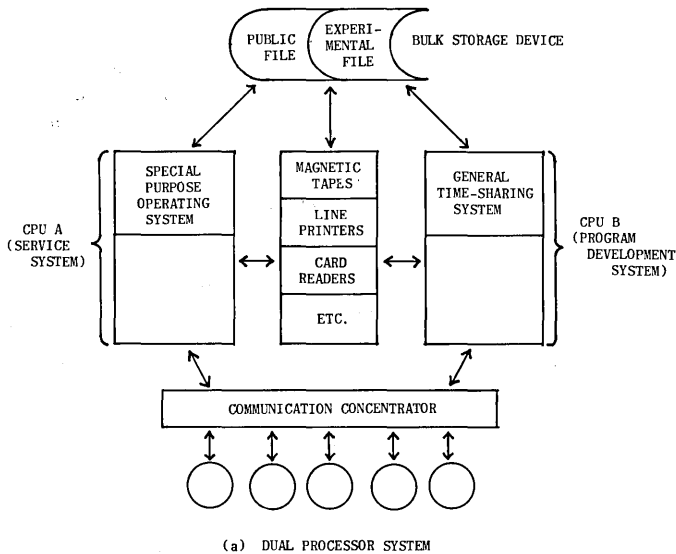


FIGURE 1. EVOLVING SPECIAL PURPOSE TIME-SHARING SYSTEMS

Greater Efficiency

Because each would be simpler, the two Operating Systems can be built more easily and cheaply, and because they can be built in parallel, more quickly. Also, each Operating System would be more efficient. The special-purpose system (CPU A) could be made more efficient because its special-purpose software, instead of being frozen into the Operating System, could be modified and tested on CPU B during regular service. Another alternative would be to design a resident special-purpose system for CPU A, eliminating the swapping overhead of the single system. The general system for developmental use on CPU B would be more efficient because it would run only the programming facility, with no special considerations for program type or priority. Such general time-sharing systems might be commercially available off-the-shelf from computer manufacturers.

The dual system could provide much closer control of reliability. New software can be tested on the development system during actual service hours and conditions. Thoroughly debugged programs can then be transferred directly to the service system with less danger of performance aberrations

Also, since the development system is separated from the service system, the loading problem vanishes.

The dual system further solves a reliability problem that was not even mentioned above: machine failure. In the event that CPU A malfunctions, CPU B is available as a backup processor for the service system. This simple problem has no solution in a one-processor time-sharing system, whether special- or general-purpose.

A Graphic Comparison

Figure 2 is a schematic time-picture that compares the evolution of a single-processor system with that of a dual processor. In the single-processor system (Figure 2(a)), the combined general and special-purpose Operating System must be developed first. (This time period was over two years for the Hospital Computer System.) Then the application programs are developed, and finally service begins concurrently with ongoing development.

In the dual processor system (Figure 2(b)), the special-purpose Operating System for CPU A is created at the same time the general time-sharing system for CPU B is being written or purchased. The completion of the development system for CPU B is followed by heavy development of application programs. An initial package of application software is transferred to the completed special-purpose system for initial service. Meanwhile application development continues on CPU B, followed by a bulk transfer of the full special-purpose system to CPU A. Thereafter, full service continues on CPU A concurrently with further development on CPU B. New software continues to be transferred from the development system to the service system, although the intervals between innovations tend to increase.

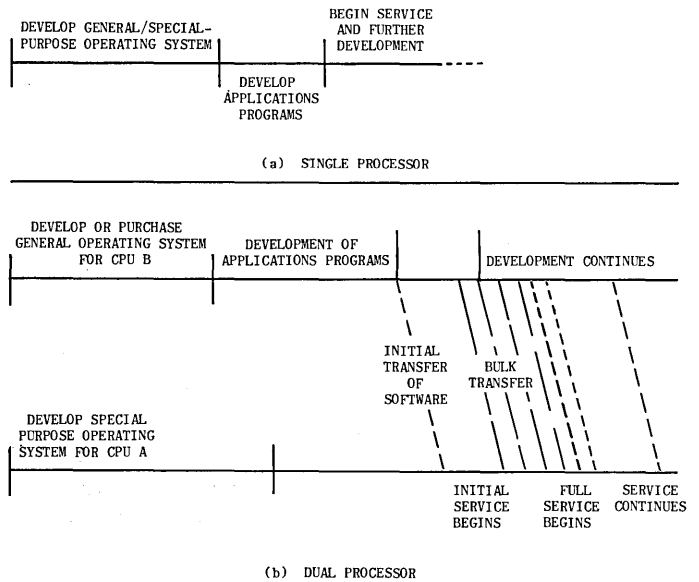
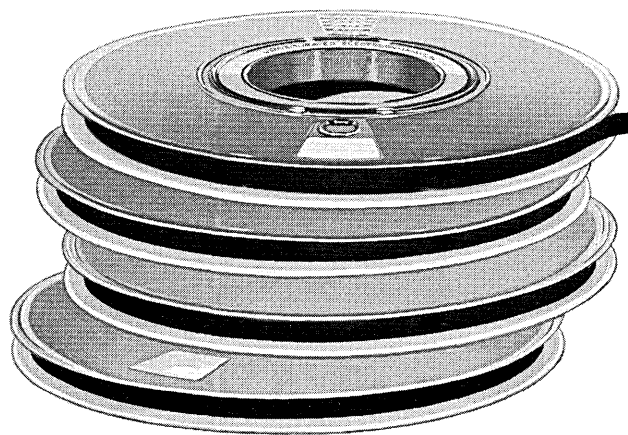


FIGURE 2. EVOLUTION OF TWO SPECIAL PURPOSE TIME-SHARING SYSTEMS

Conclusion

Many sophisticated application systems require both the efficiency of a special-purpose system and the flexibility of a general time-sharing system. These evolving special-purpose and time-sharing systems are subject to problems in design and operation. Some of the problems found in a single Operating System can be ameliorated by a configuration of dual processors and two Operating Systems.

Now there are four reliable computer tapes



(Delivery is another matter)

As you may surmise from the name at the bottom of this message, CEC is the new challenger in the computer tape field.

We would like to add that the performance of our tape is demonstrably superior to our three competitors'. But that would not be true. All four are well within allowable tolerances of the reference tape used by the computer industry. And all are certified "drop-out free" for the first pass, and remain so for many more.

Obviously, since CEC had no exclusive on excellence, we had to have a pretty compelling reason for climbing on the totem pole.

And we did.

Delivery.

From the time you place your order, you should receive your CEC computer tape within 24 hours — virtually anywhere in the United States.

If you're 100 miles somewhere west of Laramie, it might take a little longer. Perhaps as much as 48 hours.

Quite a difference, we suspect, from the delays you've become accustomed to.

This is no miraculous achievement on CEC's part. The advantage was already there. Namely, the largest established field force in the industry. Plus — the only warehousing facilities strategically located to serve the entire nation.

P.S. One more benefit: if you order CEC Analog Tape along with the new computer tape, you'll also realize some significant savings.

CEC/TECHNICAL SUPPLIES

 **BELL & HOWELL**

Technical Supplies Dept.
Consolidated Electrodynamics Corp.
360 No. Sierra Madre Villa, Pasadena, Calif. 91109
Please send me complete information about
CEC's new Computer Tape.
Bulletin Kit 332-X3.

NAME _____

ORGANIZATION _____

ADDRESS _____

CITY, STATE & ZIP _____

Designate No. 6 on Reader Service Card

THE ROCHESTER DIRECT-ACCESS TIME-SHARED SYSTEM

Kurt Enslein, Consultant, Rochester, New York

Anthony G. Lauck, Smithsonian Astrophysical Observatory, Cambridge, Massachusetts

Robert MacIntyre, Bausch & Lomb, Inc., Rochester, New York

Robert E. Hopkins, Tropel, Inc., Fairport, New York

"The idea of a group venture involving a direct-access remote terminal was most appealing. The prime considerations were: (1) Can such a system be brought to operational level soon enough to be worthwhile?; and (2) Which system would minimize the probable total cost over the period of the agreement of usage?"

We describe below a direct-access terminal from Rochester, New York, to a Control Data Corporation (CDC) 6400, located approximately 400 miles away in Cambridge, Massachusetts. The terminal is financed cooperatively by three concerns: Tropel, Inc., and Bausch & Lomb, Inc., designers of lens systems, and Kurt Enslein, an independent consultant. The system is predicated on very fast turnaround on a powerful multiprogramming computer. The sections below detail the evolution and present status of this system.

The Need

The three users have the following classes of problems:

1. Design of lenses with guidance from the designer, requiring good turnaround (1 hour maximum between trials). A large, fast computer is necessary for this purpose.
2. Program development, requiring rapid turnaround for reasonable time between debugging runs.
3. Large linear and nonlinear statistical analyses, requiring good turnaround because of the many possibilities for error, with many intervening steps involving human decision (somewhat like the lens design problem). A large, fast machine is needed because of the size of the matrices to be operated on.
4. Short routine jobs, such as sorting with a substantial amount of tape moving and disk usage but little computation. These jobs require good peripheral facilities but very little central processor (CPU) time.

Note that most of these requirements specify good turnaround.

Note: This work was supported in part by Grant No. NsG 87-60 from the National Aeronautics and Space Administration and by a grant from the Council for Tobacco Research.

Previous Solutions

A number of solutions were utilized:

1. Experience with many kinds of machines all around the country (IBM 7094, IBM 7044-7094, CDC 3600, etc.).
2. TWX connection from Rochester, New York, to New York City, using ASCII code, then punched tape to magnetic-tape conversion on a CDC 160A. Finally, the tape was used as input to a two-bank CDC 3600. The output was mailed back. The best turnaround was 24 hours, but usual turnaround was 48 hours, which sometimes deteriorated to 3 to 4 days, particularly on weekends.
3. Use of medium-sized local machines (IBM 360/50, IBM 7044, IBM 7074, SDS 930, etc.).

An additional drawback was that the simple sorting jobs were quite expensive on previously available equipment, owing to the fact that machine time would be charged while anything was being processed, even if the use of the central processor was not required. Neither a sufficient number of problems nor an adequate staff was available to justify a large-scale computer in the Rochester area, where there are no very large-scale computing facilities, for three users alone. Thus, many problems either were tackled with a relatively less desirable combination of medium-sized computers and manual intervention, or were left pending until better access to a large-scale computer would be available. In addition, future plans of Bausch & Lomb made it desirable for its computing staff to acquire experience in the field of remote computing without interfering with the normal processing flow at existing facilities.

In view of these needs, the idea of a group venture involving a direct-access remote terminal was most appealing. It would greatly reduce the fixed charges for each participant, even though the input/output requirements of three users would make it necessary to lease a somewhat more

expensive terminal computer than would be needed for a single user. The prime considerations were then reduced to: (1) Can such a system be brought to operational level soon enough to be worthwhile; and, (2) Which system would minimize the probable total cost over the period of the agreement of usage?

Evaluation of Various Systems

We evaluated the following possibilities: remote time-sharing, local direct-access, and remote direct-access systems.

1. *Remote Time-Sharing System.* The systems available at the time (and from all appearances, at this time as well) did not have adequate facilities: Core storage was too small; a sufficient number of tapedrives was not available to the user, if, indeed, any at all; only TWX-type terminals could be used, that is, no card readers or line printers. In addition, the CPU's on which the processing could be done were definitely second generation and did not have the cost advantages of later equipment.

2. *Local Direct-Access System.* We investigated several possibilities in this connection but found that the availability of new equipment was such that we could not hope for an operational system in much less than a year. In retrospect, even this was an optimistic estimate; 2 to 3 years would seem more reasonable at this time.

3. *Remote Direct-Access System.* The factors studied to determine the best of these systems included:

- a. Compilation and execution time for several benchmark programs.
- b. Hourly rates for CPU and peripheral.
- c. Minimum charge per job.
- d. Minimum annual guaranteed usage.
- e. Turnaround time.
- f. Cost and capabilities of terminal hardware.
- g. Cost and transfer rates of communication gear.
- h. Local hardware service and software support for terminal.
- i. Probable future updating of the system.
- j. Lead time to begin operation.
- k. Total annual expenditure, assuming various levels of computation.

We investigated the following possibilities:

1. *CDC 3600 in New York City to 160A in Rochester.* The cost per computation was too high, particularly for input-output limited jobs. The minimum charge per job was approximately \$6, which was also too high, because of a slow operating system.

2. *Univac 1108 in Baltimore, Maryland, or on Long Island to Univac 1004 in Rochester.* The cost per computation was excellent, and the compilation was very fast. A reasonable guarantee of prime shift time, however, was not available, and there was a \$10-per-job minimum charge, which would have been disastrous for short, routine jobs.

3. *GE 635-645.* The hardware would not be available in time.

4. *CDC 6400 in Cambridge, Massachusetts, to Honeywell 120 at Rochester.* This turned out to be the final choice because the cost per computation was reasonable; there was no minimum charge per job; there was a reasonable guarantee of prime shift time; there was only a 3- to 4-month delay before putting the system on-line; and the possibilities for good turnaround were excellent.

Description and Characteristics of Facilities from Rochester Standpoint

1. **Hardware** The Rochester terminal consists of a Honeywell 120 computer with a 4K core, a 400 card-per-minute

reader, and a 400 line-per-minute printer, connected first via simplex, and later by a full duplex line and a 201-B Bell System data set to the CDC 6400 in Cambridge. The telephone line is employed for this purpose only and, therefore, is not on the dial-up network; this permits data rates of 2400 bits per second.

2. **Software.** The software is such that the card reader and printer behave essentially like the card reader and printer at the central computer installation. The software has provisions for retransmission upon parity errors and various other simple recovery procedures. Like all software, it could be improved but does operate satisfactorily most of the time.

3. **Cost.** The computer hardware leases for approximately \$3000 a month and the communication system costs approximately \$1000 a month, for a total of approximately \$4000 a month. This is manifestly too large an expense for the provided hardware. We have investigated other terminals, but they are either more expensive or their facilities are not adequate for our purposes. Negotiations with several companies in progress indicate that such a terminal might be purchased for a cost of \$40,000 to \$60,000. So far, however, we have been unable to obtain firm commitments. It is also expected that the cost of the telephone system will drop to approximately \$850 in the near future, owing to changes in rates.

4. **Performance.** The card reading and printing rates are fundamentally limited by the capacity of the transmission line of 300 characters per second. There is hope that in the not too distant future, by means of Bell Telephone type 203 data sets, this rate could be doubled or tripled over essentially the same transmission line with slightly different line conditioning. With the full duplex line, both card reading and printing have approximately 10% overhead. Thus, about 210 full 80-column cards per minute or 400 40-column cards per minute can be transmitted, and about 120 full 132-character lines per minute or about 400 40-character lines per minute can be received when there are no transmission errors. Transmission errors do occur fairly frequently, particularly during periods of bad weather.

5. **Turnaround.** For short, small jobs, i.e., those estimated to take less than 1 minute and use less than 50,000 words of core, turnaround is generally a few minutes. For long jobs, say of 5 minutes, and large amounts of core storage, turnaround is between 15 minutes and 6 hours, sometimes with an overnight wait, depending upon load. The load is often severely affected by breakdowns, including power failures, which have occurred repeatedly in the Cambridge area. Under normal conditions we process 20 to 50 jobs a day from the terminal.

6. **Operating Schedules.** The facility operates from 10:00 A.M. to 7:00 A.M., 5 days a week, with a more restricted schedule on weekends.

7. **6400 Software Problems.** Fortran has its bugs, as does the operating system, but both are useful as they are. There are some restrictions at the moment to obtaining day files from the 6400 at the terminal, but these will be removed in the future.

8. **Telephone Problems.** There have been occasional failures, due to line repair or to thunderstorms, and small problems in the data-set hardware itself. We have had seven major interruptions (longer than a few minutes) in the first 3 months of operation.

Description of the System from the 6400 Standpoint

1. **Hardware.** 6400 terminal equipment includes a Bell System 201-B data set, CDC 311-B data-set adapter, 3266 communication controller, 6681 data-channel converter, and one 6400 data channel. When the data link is operating,

5000 60-bit words of main memory are used for buffering the system disk, and two of the ten 6400 peripheral processors are used to operate the link. An additional peripheral processor is used transiently for reading and writing the disk. The 3266 has provision for several 311-B data-set adapters, and a second is currently in use with a 301-B data set and short Telpak line to an H-200 a mile away.

2. **Software.** Software is split among two peripheral processors. One drives the communications equipment, handles error checking and recovery, and multiplexes several lines into short buffers in the main memory. The other reads these short buffers, handles blocking and unblocking and code conversion, supervises disk read/write operations, enters files into the input queue, and removes files from the output queue. All communication with the 6400 operating system is performed by this peripheral processor.

All transmission of alphanumeric data over the link is in standard ASCII code, and standard ASCII formats are employed for data and control blocks. To maximize line utilization and transmission of useful data, card-reading and line-printing data transmissions are variably blocked, with trailing-blank suppression. To allow convenient modification to the initiating, terminating, and error-recovery procedures during the development process, the communication scheme at the 6400 end is completely table driven.

Evolution of the System from a Technical Standpoint

1. *Early Efforts.* The requirement of flexibility at the 6400 end and the prospect of several data lines to the 6400

from different terminals determined the design of the system. Initial efforts involved modifying existing 6400 terminal software and writing appropriate Honeywell software to those specifications, but it soon became apparent that the quickest results would come from a completely new 6400 approach. A standard communications interface would be an ideal solution to the multivendor problem, and thus ASCII code was deemed essential. Fortunately, an existing H-120 program was available that used ASCII code. Modifications included adjusting blocking factors and adapting the start/stop procedures to the needs of the system, where the H-120 peripherals were to behave as much as possible as the local card reader and printer.

2. *Difficulties.* Most serious of all the difficulties of this early system involved errors in the data. Occasionally, data would be lost or garbled, or extraneous characters would be inserted into the card input or printout. When these situations occurred consistently, they were usually associated with code-conversion or data-blocking procedures. Because of the multiprogramming operating system at the 6400 and the asynchronous operation of the remote computer, these bugs were often confused with another kind of program difficulty, undetected line-transmission errors.

The specifications for the 201-B data sets allow an error rate of 1 in 10^5 bits, but the actual error rate fluctuated widely, depending, among other things, on the weather. Errors occurring at different parts of a data block or acknowledgement block could test different logic paths in the programs, and so were difficult to find and correct.

3. *Future Plans.* Currently, certain program conditions or repeated line errors necessitate reloading the H-120 or 6400 programs. This delays the operation, causes extra operator effort, and creates the possibility of losing an entire data file. A new communication scheme is being checked out to simplify initiation and termination of data runs, interruption of data transmission for telephone voice communication, and the transition between card reading and line printing.

Additional plans will allow for better monitoring of the operation on the 6400 display console, a necessity when additional terminals are connected to the central computer. Better program record keeping will check the failure rate of the telephone line and, when it exceeds specifications, allow early corrective action.

The software is being documented and the technical specifications for the telephone interface explicitly defined, so others can benefit from the development of this system. Ideally, a standard communication format and procedure would enable any small computer with suitable peripherals and a data-line facility to communicate with any large computer system, without extensive software development.

General Comments on Usage

The system became operational in May 1967, after having been decided upon in late February. It represents a radical change from our previous practices, and when it is operating well, that is, if there are no hardware or software problems anywhere along the line, we are very satisfied. The cost performance on the central processor has been very good, but we would like to operate with a lower overhead for the terminal; the prospects in this direction are good, although not excellent. We estimate that our cost per computation compared to the average of previous diverse arrangements has essentially dropped to one-half, although, as expected, we are spending more now than we ever did before, simply because we are capable of accomplishing more work.

FERRITE MEMORY TECHNICIAN

Opportunities with Simmonds Precision in Vermont

Located in the heart of Vermont's vacationland, Simmonds Precision, Middlebury Division, offers a ground-floor opportunity to a qualified electronic technician with 2-4 years' experience in setting up test programs and procedures for ferrite memory core planes and memory stacks.

Position will eventually involve customer-liaison as well as responsibility for all project test equipment.

Salary commensurate with background plus liberal company benefits including relocation costs.

To arrange a company-paid interview, contact the Industrial Relations Department of



SIMMONDS PRECISION
Middlebury Division

Maple Street, Middlebury, Vermont 05753

An Equal Opportunity Employer m/f

Designate No. 9 on Reader Service Card

COMPUTER TIME SHARING: ITS ORIGINS AND DEVELOPMENT

T. James Glauthier
Peat, Marwick and Livingston
Los Angeles, Calif.

"Six years ago the first experimental time-sharing system arose; three years ago eleven systems were counted; today they number more than 40. If this trend continues, the projection of 1,000 time-sharing systems installed and operating by 1971 may prove to have been conservative."

Just over five years ago, in late 1961, the first known general-purpose computer time-sharing system went into operation at the M.I.T. Computation Center. Two years ago there were only about 10 such systems in the United States. Today there are more than 40 of them, and if the trend witnessed over the last five years continues, 1971 will see our 1,000th time-sharing system installed and operating (see Figure 1). In the face of industry, estimates for world growth from the present 40,000-odd computer installations to nearly 70,000 in 1972, 1,000 general-purpose time-sharing systems may sound less than earthshaking. However, most such estimates are based upon expected needs for computer capabilities, and 1,000 time-sharing systems providing upwards of 30,000 terminals would have a great impact upon that. Furthermore, this projection of time-sharing systems does not begin to consider the airlines, inventory and numerous other special-purpose time-sharing systems already in wide use.

In this article I wish to look backward and to explore where the general-purpose time-sharing system came from, who developed it, and where general-purpose systems are operating today.

The Concept

The development of computer time-sharing has been compared to the development of electric power with thought-provoking results. The automobile has its own battery and generator to supply its own needs; most computers today are similarly installed in one organization to meet its computing needs. In its early days electricity was generated in central Edison plants and wired to homes which used it almost exclusively for a single task, lighting. Similarly the first computers serving more than a single operator simply performed the same task repeatedly for a great many operators, such as in the airlines reservation systems and inventory tallying systems. As men developed more and more applications for electricity, homes began to connect a variety of

devices to their electric wires — radios, toasters, heaters, etc. Today the computer industry is witnessing a similar phenomenon through computer time-sharing; men "connect" their consoles into the computer through telephone lines and use the computer for whatever purposes their situation dictates. Even the men who operate the computer are often unaware of just what is being done with it except in a general sense.

What Type of System?

The systems discussed may be divided into "special-purpose" or "general-purpose," depending upon whether the men who use them through their consoles are constrained to performing very well-defined tasks, or can "program" the computer to solve problems of a very wide variety. Another way to approach the question is whether or not the operator of the computer installation knows what tasks the users are performing at their consoles, as he would in a special-purpose system such as a reservation system.

Just as it would be difficult to identify one man or one group who first envisioned "general-purpose" electricity, it is difficult to single out a "father" of general-purpose time-sharing. While Jules Verne may have alluded to on-line computing as far back as 1889 in his "In the Year 2889," the concepts really began to take shape in the 1950's. Time-sharing (which I will use to mean general-purpose time-sharing) involves two concepts: remote computing; and computer sharing, both in real time. The concept of remote computing, off-line, was discussed in 1955 at the Eastern Joint Computer Conference by E. L. Fitzgerald of M.I.T.'s Graduate School of Industrial Management.¹ He reported that G.E.'s Steam Turbine Department in Lynn, Massachusetts, had been transmitting programs since 1953 over teletype lines to Evandale, Ohio, for processing on the Evandale IBM 701. The computer output at Evandale was later

¹Fitzgerald, E. L., "Computers with Remote Data Input," *Proc. Eastern Joint Computer Conf.*, November 1955, pp. 69-75.

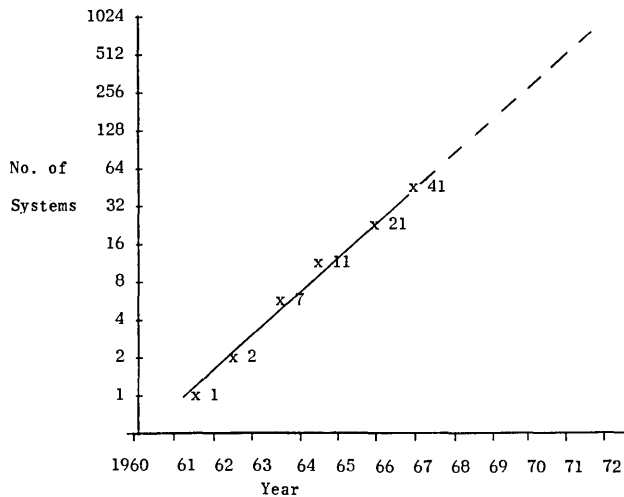


Figure 1. General-Purpose Time-Sharing Systems in the United States.

converted to punched paper tape and transmitted back to Lynn. The Steam Turbine Department had even gone so far as to try to measure the success of the remote programming and debugging against working locally. While this arrangement for computer access is not on-line remote computing, it is a landmark in the development of the concept of remote general-purpose access to a computer.

The concept of computer sharing developed from special-purpose systems in which each user performed the same operation and the computer itself was specifically designed for a special type of operation. The second stage of development was a multipurpose system on a special-purpose computer, and that gave way to special-purpose systems on general-purpose computers, systems which for the first time embodied remote access to computers which were capable of performing a variety of tasks.

It remained for the two concepts to be combined to yield the powerful time-sharing concepts abundant in today's literature. Christopher Strachey made this contribution in 1959 by writing the first paper on the subject of time-sharing and presenting it at UNESCO's International Conference on Information Processing. In a more general sense, the concept of computer time-sharing should be attributed to the M.I.T. — Lincoln Laboratory — SAGE community of the middle and late 1950's; from this community came the men who were instrumental in designing and developing the first operational systems.

Special-Purpose Systems on Special-Purpose Computers

In 1951 a Chicago mail-order house, the John Plain Company, contracted with a division of Remington Rand for the development of a tallying system for their orders and inventories. During the Christmas rush season of 1953 the newly installed Speed Tally system proved itself by maintaining 39,000 daily tally totals and simultaneously accepting 9,000 new entries per hour. The system was straightforward, consisting of a memory drum, 10 keyboard units resembling small calculators, and an allotting mechanism which they

described as similar to an automated telephone exchange. The system simply performed one operation for each keyed entry, and then looked for another entry awaiting it. Slightly preceding the Speed Tally system into operation, was the American Airlines reservation system which began operations in 1952. This system had a memory drum in New York City to which 100 inquiry devices at other ticket-selling offices were connected by private wire.

By 1955 these first efforts had been followed by the development of similar systems elsewhere. Eastern Airlines also acquired an on-line reservations system. Remington Rand extended the Speed Tally concept and marketed the "Tag-o-matic" system. Teleregister (later to become Bunker-Ramo) developed and installed the "Bid-Asked Register" for the Toronto Stock Exchange, where it reportedly served some 200 subscribers at the rate of $4\frac{1}{2}$ requests per second. In Britain, Rentix Ltd. was using an on-line system for viewing balances on remote cash registers.

SAGE: A Multipurpose System on a Special-Purpose Computer

By 1953 work had begun on the design of the SAGE (Semi-automatic Ground Environment) system at M.I.T.'s Lincoln Laboratory and the RAND Corporation (whose participating division was to become System Development Corp.). SAGE was to be the heart of this country's defenses, accepting inputs from all types of radar units throughout North America. It was to process all these various inputs, decide which warranted human attention and at what location, and then type out appropriate messages for its operators.

The design of the SAGE computer system was guided by Jay Forrester, the director of the Digital Computer Division at Lincoln Laboratory, and the man who was responsible for the construction of M.I.T.'s first high-speed digital computer, the Whirlwind I. Other men active in various phases of the project and whose names are familiar in time-sharing discussions today include Robert Fano, J. C. R. Licklider, George Miller, Marvin Minsky, and later, John McCarthy.

The first SAGE prototype unit was operated successfully in 1956 and was to be followed by over 100 other units. Each console was to be specially tailored to meet the needs of the different users; so the system had to accept many different types of input and perform many different functions depending upon the source of the input. The SAGE system is certainly an on-line system, and whether or not it was "really time-shared" does not seem as relevant as the fact that this was the first system to perform a variety of processing functions in response to remote demands on it.

Special-Purpose Systems on General-Purpose Computers

In a 1961 paper John McCarthy eloquently pointed out the special hardware characteristics which time-sharing demands of its computer. The five major requirements he listed are: a large primary core memory; an interrupt system including error traps and input-output functions; completely non-stop operation; some memory protection; and secondary storage large enough to maintain the users' files. No commercially available computer system satisfied those requirements until the fall of 1965 when the GE 265 and UNIVAC 491 systems were delivered ready for time-sharing use. However, reservations systems and many other special-purpose time-sharing applications require only two of McCarthy's five characteristics: non-stop operation; and large secondary storage. The first can be practically guaranteed by installing two computers, one for operation and the other as backup, as Teleregister did for Braniff International in 1957 when

that firm became the first airline company to computerize all reservations on all flights at a single location.

The IBM 305 RAMAC (Random-Access Memory Accounting Machine) computer system, which was announced in the summer of 1956, was the first reasonable solution for many applications to the need for large secondary storage. The RAMAC offered a very large memory and efficient access time for a rental of only \$3,200 per month. It was said to be capable of recording 10,000 line transactions per day, which implies a storage capacity of approximately 1 million characters.

Remington Rand developed a more ambitious computer system for large mass storage in their UNIVAC File Computer. Its storage consisted of from 1 to 10 drums of 180,000 alphanumeric characters each, giving a total of up to 1,800,000 characters. With special equipment its capacity could be extended to 6 million characters. The system could also handle up to 240 input-output devices. Whereas the 305 RAMAC rented for approximately \$3,000 per month, the UNIVAC File computer rented for about \$20,000 per month.

The UNIVAC File Computer was the first general-purpose computer to be used for time-sharing application. The occasion was the Eastern Airlines Reservation System which went into operation in 1958, and by December of that year was serving 135 ticket agents through 40 remote telegraph connections. The following year the File Computer was used by the Onoda Cement Company, Ltd. of Japan, to go on-line to its 72 branch offices. To illustrate the size of the File Computer system, the Onoda configuration consisted of 680 separate units worth \$1,250,000, and was attended by a staff of 150.

During the same period in which Remington Rand was becoming active in supplying computer systems for special-purpose time-sharing applications, a group of engineers spun off the SAGE Project at Lincoln Laboratory and established the Digital Equipment Corporation (DEC) to produce and sell computers of their own. Their first computer, the PDP-1, appeared in 1960 and rented for only \$3,000 per month. Because of the background of these men, the PDP-1 and succeeding Digital Equipment Corp. computers embodied design characteristics compatible with real-time system needs. It was probably only natural, then, that the PDP-1 would be used in several experimental time-sharing systems, especially those developed by people with ties at SAGE and M.I.T.

Communications Sets the Stage

The first remote on-line uses of computers, such as the Speed Tally and American Airlines systems, used special communications devices designed and built by the computer manufacturer or the users and operated over private wire. In the mid-1950's the use of punched paper tape and telegraph lines was becoming common for data transmission. In 1954 the Teletype Corporation announced a new punched paper tape unit which would operate at the rate of 60 characters per minute, as opposed to existing devices of 10 characters per minute. However, the new system was even less reliable than the slower devices, for which transmission errors were already a universal source of concern.

The IBM Transceiver, marketed as early as 1954, was the first communications device to embody what is now called parity checking, and thereby increased communications reliability substantially. But the Transceiver still required computer input and output to be recorded on some medium for transmission — punched paper tape, cards, or magnetic tape.

The first high-speed device which made direct machine communication possible without having to use punched paper tape or other intermediate medium was the Dataphone. The Dataphone was the single most significant communications development of the era, and came from the communications

industry itself, as the result of work at the Bell Laboratories. It is somewhat ironic that the Dataphone was announced by Frederick Kappel, president of AT&T at a dinner meeting of the Economic Club of New York rather than at a press conference, and that the *New York Times* devoted only its last two or three paragraphs on the meeting to the Dataphone. That announcement was on January 22, 1958, and two weeks later the New York Telephone Company conducted a demonstration of the device. The Dataphone was described as enabling one to transmit up to 800 items of information per minute by telephone at standard long-distance charges plus equipment rentals. It could transmit any information which could be recorded on magnetic tape or punched cards.

Two years after the Dataphone announcement came the announcement of IBM's 1009 Data Transmission Unit, which was capable of exchanging data and computing separately at the same time. In February, 1961, engineers at M.I.T. announced that they had developed a method for virtually eliminating transmission errors from communications lines carrying data to and from computers.

CTSS — A General-Purpose Time-Sharing System

M.I.T.'s Computation Center gave the first public demonstration of a general-purpose time-sharing system in November, 1961. Called the Compatible Time-Sharing System (CTSS), the system was begun on a PDP-1 and then actually implemented on an IBM 709, presumably for the latter's greater speed and storage capacity. F. J. Corbato, on the staffs of both the M.I.T. Department of Electrical Engineering and the M.I.T. Computation Center, seems to have played the central role in developing the CTSS system.

In the original paper describing the CTSS system, Corbato and his associates credit H. Teager and John McCarthy with much of the time-sharing philosophy. It was Teager's preliminary study committee at M.I.T. which provided much of the initial stimulus for the time-sharing system in its examination of the long-range computational needs of the Institute. John McCarthy chaired the subsequent M.I.T. computer working committee which oversaw the CTSS development. An important role was undoubtedly also played by Applied Science Cambridge, the IBM group which cooperated with M.I.T. in establishing and operating the M.I.T. Computational Center. Perhaps an additional factor behind the switch from the PDP-1 to the IBM 709 was the strong relationship with Applied Science Cambridge, which had only recently been headed by Martin Greenberger before he joined the M.I.T. faculty. Also significant in the CTSS development was the sponsorship of the work by ARPA, the Advanced Research Projects Agency of the Dept. of Defense, which was also to play an important role in sponsoring other time-sharing systems in the first years. In fact, of the first 12 systems developed, ARPA participated in the sponsorship of 6 of them.

The significance of the CTSS system to the computer industry can hardly be underestimated. As the first time-sharing system which permitted its users to write their own programs, it demonstrated the feasibility of the time-sharing concepts. Furthermore, it sparked numerous papers and articles about the design, use, and potential of time-sharing systems, which must be credited with giving a great boost to time-sharing thoughts and plans elsewhere.

The first time-sharing system to succeed CTSS came in September, 1962, almost one year later, at Bolt, Beranek & Newman (BBN) in Cambridge, Mass. The BBN system operated on a PDP-1 and served five stations, each equipped with a typewriter device. Two of the principals in the development of this system were J. C. R. Licklider, who had been at M.I.T. and Harvard until about 1959, and John

McCarthy, who had played an important role in the design and development of the CTSS system.

The BBN system had been developed largely to provide a faster, more efficient means of debugging programs. Work had been in progress at Lincoln Laboratory since 1957 and at BBN since 1961 in on-line debugging through the use of typewriters. Through the time-sharing system BBN hoped to make more efficient use of both its manpower and its computer by effectively giving each of five men "a computer of his own."

1963-64 — Ten Trial Systems

In May, 1963, the JOSS time-sharing system became operational at the RAND Corporation in California. Cliff Shaw is credited with the design of the system, which was also developed under ARPA sponsorship. The JOSS Language is specifically oriented toward the on-line solution of algebraic problems, and was so well written that BASIC at Dartmouth and CAL at the Univ. of California at Berkeley were both patterned after it. One unique aspect of the JOSS system is that it was developed almost as an afterthought, in order to make some use of the 1950 JOHNNIAC Computer for which RAND no longer had need. In late 1965 the JOHNNIAC was retired in favor of a PDP-6.

Also in May of 1963 the M.I.T. Department of Electrical Engineering put its time-sharing system into experimental operation on a PDP-1 with three terminals. Probably the major effort behind this system came from Robert Fano, on the E.E. staff and the staff of the M.I.T. Research Laboratory of Electronics. Fano is another computer scientist with a background at Lincoln Laboratory, having been a group leader there during World War II and later on their Radiation Laboratory staff.

Charles W. Adams left the M.I.T. faculty to form Adams Associates, Inc. about 1960 and in July 1963 announced his own time-sharing system on a PDP-4. The 8-station system was used at that time primarily for the acquisition and processing of data for some 40,000 claims in the Transiron stock mix-up. The system was apparently not used extensively after that until 1965, when it was converted to a UNIVAC 491 to give birth to Keydata, the country's first completely commercial time-sharing service.

System Development Corporation, which was spun off of RAND specifically to work on the SAGE Project, also put its time-sharing system into operation in July, 1963. Its old IBM Q-32 (7090) computer was the basis of the system and reportedly gave a 2-second response time when operating with 20 to 30 users on-line. Its system employed a PDP-1 as a satellite computer to handle the communications to and from the terminals.

In September, 1963, the M.I.T. Computation Center reappeared upon the scene with CTSS II on an IBM 7094. Robert Fano and F. J. Corbato guided this improvement of the original CTSS system, and came up with a system capable of serving 30 users simultaneously in truly general-purpose applications. The system has been used for scientific problem-solving, simulation, language study, report typing, and a host of other applications.

Project MAC was born in November, 1963, when CTSS II was implemented upon a second IBM 7094 at M.I.T. That has since been heralded by some as the birth of the "computer utility." There may be justification for that claim in MAC's 160 terminals scattered around the Institute, professor's homes, and cooperating universities, and its use of approximately 25 programming and problem-solving languages.

The year 1964 witnessed the entrance of time-sharing at four additional universities. May brought Dartmouth's time-sharing system to light, the first general-purpose system on

a G.E. computer, the GE-235. John Kemeny deserves the credit for the Dartmouth system and the BASIC language on it. July saw Alan Perlis bring up the Carnegie Tech system, and in the following month Stanford put their time-sharing system into operation. In December UCLA's Western Data Processing Center also joined the fraternity.

Acceptance — 1965 and Beyond

The year 1965 ushered in a new phase in the growth of time-sharing: acceptance and recognition. The concept was generally recognized as valuable and demonstrably feasible. New organizations and people began to announce their own time-sharing systems. At least 10 new systems were put into operation in that single year. Six of those were commercial systems and began to sell time on their systems to customers via teletype or similar terminals, dataphones and standard telephone lines. Theoretically at least, anyone with telephone service could add another \$100 per month worth of telephone equipment and subscribe to a time-sharing service. Perhaps the most significant thing about 1965 was that in that year time-sharing was recognized an important future area of activity for the computer manufacturers, for by the end of the year almost every major manufacturer had announced plans to make and sell a time-sharing system.

Another 21 general-purpose time-sharing systems were put into operation during 1966. At the close of the year U.S. time-sharing systems numbered approximately 40.

Figure 1, at the beginning of this paper, illustrates the rapid growth rate of time-sharing installations in the United States, and projects a tremendous proliferation of them in the next few years. In addition to the estimates of men in the industry that this kind of growth is possible, two factors lend credence to the projection. The first is the number of time-sharing computers now on order. A look at the computers, large and small, which have primarily or exclusively time-sharing applications in the "Monthly Computer Census" published in *Computers and Automation* reveals approximately 175 such systems on order as of November 10, 1966. Admittedly, not all will find their way into general-purpose systems, but many will, and at least two, the IBM 360/67 and GE 645 which alone account for 75 orders, are so large and expensive that they almost demand general-purpose environments. The second factor which supports the projection is IBM's recent announcement of a new software system, RACS (Remote Access Computing System), which they claim will enable any Model 30, 40 or 50 or the System/360 line to be time-shared. These developments attest to the fact that time-sharing demand is growing and time-sharing systems are becoming much more available.

Seven years ago Christopher Strachey's paper appeared; five years ago the first experimental system arose; two years ago eleven systems were counted, today they number more than 40. In five more years the projection of 1,000 time-sharing systems may prove to have been conservative.

Bibliography

- "Applied Logic Tele-Computing Center," *Computers and Automation*, December, 1965, p. 48.
- Berkeley, Edmund, "Dedication of the Keydata Service May Mark Beginning of New Growth Industry . . . But When Will Growth Begin?" (editorial), *Computers and Automation*, January 1966, p. 9.
- Berkeley, Edmund C. (ed.), "Monthly Computer Census," *Computers and Automation*, December 1966, p. 64-65.
- Byrnes, W. P., "Teletype High-Speed Tape Equipment and Systems," *Proc. Eastern Joint Computer Conf.*, December 1954, pp. 35-39.
- Coffman, E. G., Jr., J. I. Schwartz, and C. Weissman, "A General Purpose Time-Sharing System," *AFIPS Proc. 1964 SJCC*, pp. 397-411.

Corbato, F. J., M. Merwin-Daggett and Robert C. Daley, "An Experimental Time-Sharing System," *AFIPS Proc.*, Spring, 1962, pp. 335-344.

Daly, R. P., "Integrated Data Processing with the Univac File Computer," *Western Joint Computer Conf.*, February 1956, pp. 95-98.

David, Edward, Jr., "Sharing a Computer," *International Science and Technology*, June 1966, pp. 38-47, 120-122.

Desmonde, William H., *Computers and Their Uses*. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1964, pp. 183-223.

Everett, R. R., C. A. Zraket and H. D. Benington, "SAGE — A Data Processing System for Air Defense," *Proc. Eastern Computer Conf.*, December 1957, pp. 148-155.

Fano, R. M., and F. J. Corbato, "Time-Sharing on Computers," *Scientific American*, September 1966, pp. 128-140.

Fano, R. M., "The MAC System: The Computer Utility Approach," *IEEE Spectrum*, January 1965, pp. 56-64.

Fitzgerald, E. L., "Computers With Remote Data Input," *Proc. Eastern Joint Computer Conf.*, November 1955, pp. 69-75.

"Flight Reservations and Information System," *Computers and Automation*, May 1966, p. 37.

"GE Computer Department Now Offering Time-Sharing Service," *Computers and Automation*, December 1965, pp. 48-49.

Glaser, E. L., and F. J. Corbato, "Introduction to Time-Sharing," *Datamation*, November 1964, pp. 24-27.

Greenberger, Martin (ed.), "Biographical Notes," *Management and the Computer of the Future*. MIT Press, Cambridge, 1962, pp. xiii-xxiii.

Head, Robert V. *Real-Time Business Systems*. Holt, Rinehart and Winston, New York, 1964, pp. 3-28.

Hill, John L., "Design Features of the Remington Rand Speed Tally," *Proc. Western Computer Conf.*, February 1954, pp. 155-162.

Lesser, M. L., and J. W. Haanstra, "The RAMAC Data-Processing Machine: System Organization of the IBM 305," *Proc. Eastern Joint Computer Conf.*, December 1956, pp. 139-146.

Licklider, J. C. R., "Man-Computer Partnership," *International Science and Technology*, May 1965, pp. 18-26, 86-88.

McCarthy, John, "Time-Sharing Computer Systems," in M. Greenberger (ed.), *Management and the Computer of the Future*. MIT Press, Cambridge, 1962, pp. 221-236.

McCarthy, J., S. Boilen, E. Fredkin, and J. C. R. Licklider, "A Time-Sharing Debugging System for a Small Computer," *AFIPS Proc.*, Spring 1963, pp. 51-57.

"New Installations: Munitype, Inc.," *Computers and Automation*, November 1965, p. 44.

"New Installations: Univ. of Rochester," *Computers and Automation*, October 1965, p. 40.

"New Robots Chat Long Distance, Feed Each Other Data by Phone," *New York Times*, February 6, 1958, p. 39.

Parkhill, Douglas F. *The Challenge of the Computer Utility*. Addison-Wesley Publishing Co., Reading, Mass., 1966, pp. 19-120.

"Quiktran Datacenter," *Computers and Automation*, January 1966, p. 45.

"Remote On-Line Computing Service in Boston Area," *Computers and Automation*, October 1965, p. 42.

Riley, Wallace B., "Time-Sharing: One Machine Serving Many Masters," *Electronics*, November 29, 1965, pp. 72-78.

Sampson, D. K., V. E. Herzfeld and C. W. Fritze, "The UNIVAC Airlines Reservations System, A Special-Purpose Application of a General Purpose Computer," *Proc. Eastern Joint Computer Conf.*, December 1958, pp. 152-156.

Sass, Margo A., and William Wilkinson. *Computer Augmentation of Human Reasoning*. Spartan Books, Washington, D.C., 1965, pp. 89-104, 131-150.

"Time-Sharing Announced for Three Models of System/360," *Computers and Automation*, October 1966, p. 50.

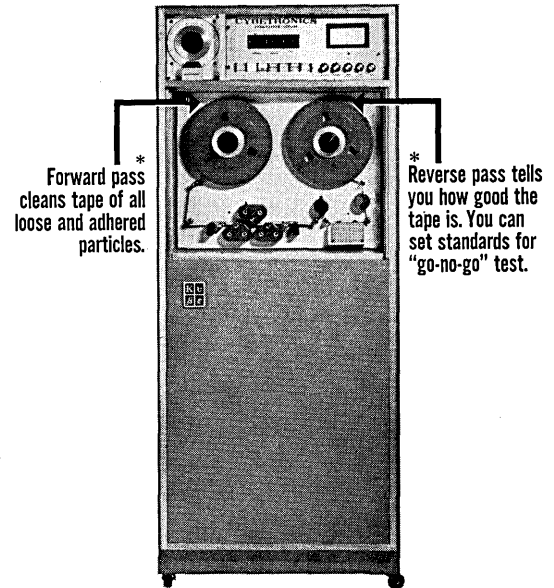
Time-Sharing System Scorecard, Computer Research Corporation, Nos. 1, 2, 3 and 4, Spring 1965 to Fall 1966.

Trumbull, Robert, "Japanese Concern Extends Use of Big Computer," *New York Times*, October 24, 1959, p. 25.

Witkin, Richard, "Schriever Thinks 'Space Man' Near," *New York Times*, January 22, 1958, p. 15 (Dataphone announcement).

See us at booth #214-215 FJCC, Anaheim

THE REAL PRICE OF MAGNETIC TAPE IS ITS FAILURE COSTS ON THE COMPUTER — NOT ITS PURCHASE PRICE.



INTRODUCING THE NEW CT-100

gets your tape as clean as possible — lets you know just how good it is. Here's what this revolutionary new system will do.

- *1. The Cybe-Tester can test simultaneously for signal dropouts — adjustable from 20 - 80% threshold.
2. Write skips — preset threshold at 32% — (computer operating level).
3. Skew errors — adjustable for proper density.
- *4. 7 channels, 556 bpi or 800 bpi.
5. 9 channels, 800 bpi or 3200 fci.
6. Full-surface (5/4 head) 800 bpi or 3200 fci.

The Cybe-Tester will indicate:

- *1. How many signal dropouts
2. How many write skips.
3. How many skew errors.
- *4. Location of each error.
- *5. Tape length in feet.

You determine the tape specifications.

1. How many errors are acceptable (error counter).
2. What channel format (7, 9, 5/4).
3. What density (556, 800, 3200).
4. What repairs to make (from chart and counter).
5. You take the proper action (tape OK — tape needs repair — replace tape).

*Basic machine.

Want more information? Write or call.

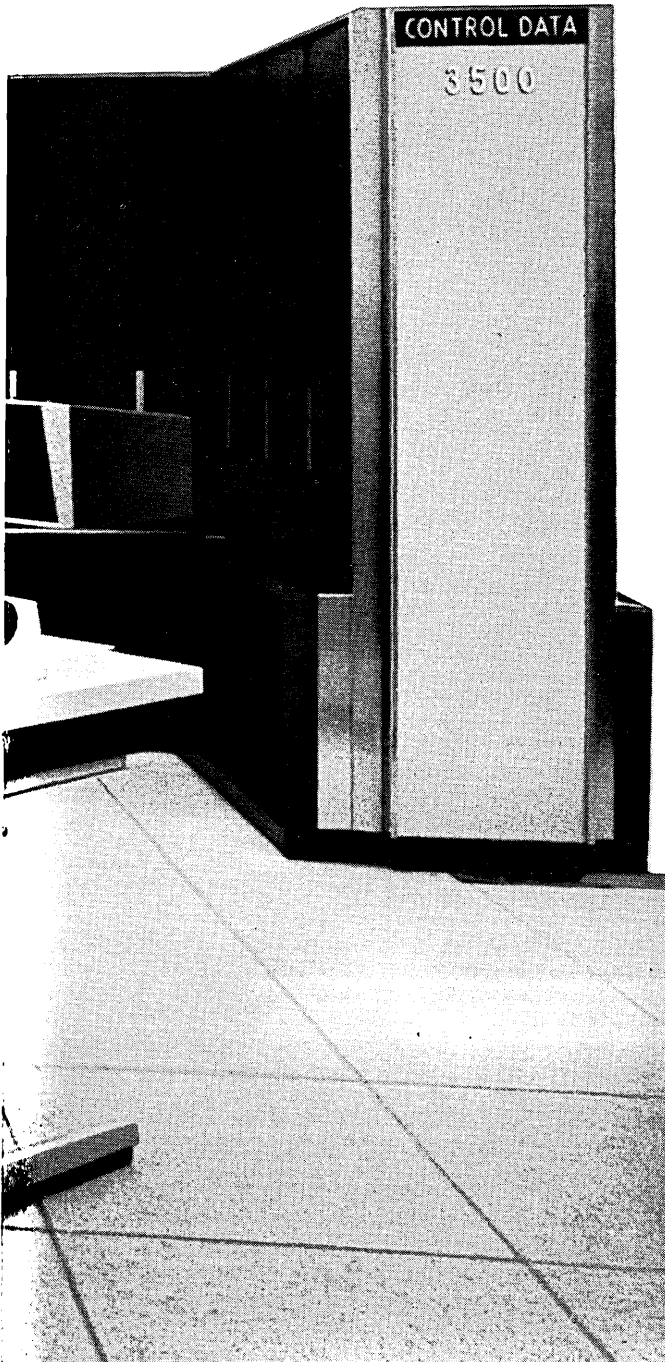


CYBETRONICS INC.
132 Calvary St., Waltham, Mass. (617) 899-0012

Really serious about a better information management system?



our new 3500 system is ready, if you are!



If you are looking for better ways to handle information, data communications, production control, scientific and engineering problems, you will want to know more about the new CONTROL DATA® 3500 computer system.

The CDC 3500 is a large-scale, multi-programming system designed for general purpose and time-sharing applications. It is the most advanced computer in our compatible family of systems that includes the 3100, 3150 and 3300 — hundreds of which are on the job throughout the world today. Each offers the advantage of fully computerized, automated information handling.



People-oriented peripherals

Along with the new 3500 computer system, Control Data gives you a wide choice of advanced peripheral products: Remote entry-and-display stations

provide direct communication with the computer system. DIGIGRAPHICS® light-pen systems make computer-aided designs a reality. Remote-processing terminals extend the capabilities of the 3500 to remote plants, laboratories, distribution facilities, etc.

All software is available now

Control Data's advanced operating system, known as MASTER (mass-storage oriented, multi-programming operating system), lets you efficiently handle mixed business/scientific work loads in your organization. Your costs are lower because MASTER makes maximum use of all hardware features. Software includes compilers, assemblers and job-oriented systems such as COBOL, MASS STORAGE SORT, FORTRAN, PERT/TIME, PERT/COST, ALGOL and COMPASS. All software is field-proven and available now.

INTEBRID circuitry

Specially developed by Control Data for use in the 3500, INTEBRID® circuitry combines the advantages of both monolithic-integrated and hybrid circuits. The results are higher speed, reduced space requirements and greater reliability.

If you are genuinely interested in a fully computerized information management system for your company, the coupon below will bring complete details.

Designate No. 18 on Reader Service Card

CONTROL DATA
CORPORATION

CONTROL DATA CORPORATION, DEPT. P-107
8100 34th Ave. So., Minneapolis, Minn. 55440

Please furnish us with full details concerning your new CDC 3500.

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

PROGRAMMING SELF-TAUGHT

*Hal B. Becker, Communications Specialist
Information Systems Marketing Operation
General Electric Company
Phoenix, Ariz.*



As Communications Specialist with General Electric, Hal B. Becker is responsible for analysis and development of communications applications, consultation on systems designs and hardware configurations, and analysis of competitive systems.

Mr. Becker joined General Electric in 1959 as a programming analyst. In 1963 he transferred to the Computer Department at Phoenix as Communications Analyst, specializing in the design of real-time software for various systems.

A native of Plymouth, Michigan, he attended Michigan State and Wayne State Universities. He is a member of the Association for Computing Machinery (ACM).

The increasing popularity and availability of time sharing has placed the computational power of centrally located information systems within the reach of many potential users who, for various reasons, such as cost, programming difficulty, and distance, might not otherwise seek the computer's aid in solving their problems.

While the "English-language" or higher-level types of programming languages usually associated with these systems are much easier to learn and apply than machine-level coding, some potential users are still reluctant to attempt to learn these languages and start writing their own programs without some kind of guidance or instruction. Some look upon programming as a black art of a sort, understood by an initiated few who talk among themselves in a language totally unintelligible to outsiders.

As an inducement to these uninitiated a series of programs was written in the BASIC language (the BASIC language was developed by Dartmouth College) in the form of self-teaching or programmed-learning lessons. These lessons were designed to lead the potential user through the fundamentals of BASIC programming.

The integration of programmed learning techniques with medium- to large-scale computers has progressed slowly until now. The evolution of time-sharing systems has provided the vehicle necessary to place the computers power in the hands of numerous remote users.

The following lessons were written primarily to uncover some of the more fundamental considerations involved in integrating programmed learning with computers. Obviously, to completely cover the subject, a much more thorough, complete series of lessons is required.

The lessons present statements and examples to the user in a carefully planned sequence, designed to illustrate fundamental programming functions such as the stored program concept, loops, subroutine usage, as well as the BASIC language itself. As each lesson proceeds, multiple-choice questions requiring a typed response from the user are asked at key points. The incorrect responses are carefully structured to catch users falling into well-recognized traps in their logical comprehension of the concepts presented in the

“Some potential computer users look upon programming as a black art of a sort, understood only by an initiated few who talk among themselves in a language totally unintelligible to outsiders. As an inducement to these uninitiated, a series of programs, designed to lead the potential user through the fundamentals of BASIC programming, was written in the form of self-teaching, or programmed-learning lessons.”

Getting Acquainted With the Computer

Prior to the first actual lesson itself, contact with the computer must be established and a brief “handshaking” procedure executed to establish the identity of the terminal and user and determine what the user wishes to do when granted access to the system. This procedure can be explained and executed in a few minutes and the typeout at the terminal appears as follows (User responses are underlined for clarity):

```
8*522-4665
TELETYPE NUMBER--29
ON AT 13:26 PX MON 02/06/67
USER NUMBER--Q88470
SYSTEM--BASIC
NEW OR OLD--OLD
OLD PROBLEM NAME--BASIC1
WAIT
READY
RUN
```

This relatively simple procedure, which requires that the user type in his user number, desired system, new or old and a name as asked for by the system, serves as an introduction to the conversational nature of time-sharing. The idea that simply typing in a word or number and depressing the return key will cause the computer to respond with intelligible, almost English language responses to someone who knows

nothing of the intricacies of programming seems psychologically reassuring and instills in many people an immediate feeling of “this isn’t so bad after all.”

Lesson 1

Following the typing of the word “RUN” by the user, the system responds with the name of the requested program, in this case “BASIC1,” the date, location of the time-sharing system itself and the local time at that location. Completing that function, the system proceeds to execute Lesson 1 which begins as follows.

```
LESSON 1 ***SELF TEACHING BASIC***
```

```
THIS PROGRAM IS A SELF TEACHING COURSE IN THE FUNDAMENTALS OF 'BASIC' PROGRAMMING. INFORMATION WILL BE PRESENTED AND A SERIES OF MULTIPLE CHOICE QUESTIONS ASKED AS YOU PROCEED. TO ANSWER A QUESTION, SIMPLY TYPE IN THE NUMBER OPPOSITE THE ANSWER OF YOUR CHOICE AND DEPRESS THE RETURN KEY AT THE RIGHT SIDE OF THE KEYBOARD...ARE YOU READY?
```

```
1 = YES, 0 = NO...YOUR ANSWER? 1
```

The student is given one more chance to stop, gracefully, if desired. Should he choose to do so, the system would respond by suggesting he read “Introduction to Basic programming” and try again later.

Assuming he has chosen to continue, and types in a ‘1’, as indicated above, the system responds with:

GOOD...LET'S BEGIN.

STATEMENT...

A 'BASIC' PROGRAM IS AN ORDERED SET OF STATEMENTS DESIGNED TO GUIDE THE
COMPUTER IN THE SOLUTION OF YOUR PROBLEM.

QUESTION...

WHAT WOULD YOU CONSIDER THE BEST METHOD OF DEFINING THE ORDER OF YOUR STATEMENTS?

1 = SUBMIT THE STATEMENTS IN THE DESIRED ORDER.

2 = PRECEDE EACH STATEMENT WITH A NUMBER AND SUBMIT THEM IN ANY SEQUENCE.

YOUR ANSWER?

The most immediate response to this statement is Answer 1. This answer is "suggested" by virtue of the fact that the word "order" appears in the "statement" above and answer Number 1. People with some programming experience will

almost always pick the correct answer, Number 2, but to people with no experience, the distinction is not so clear, and they are more open to the "suggestion."

The response to the incorrect answer is:

THAT WOULD CREATE A PROBLEM IF WE LEFT SOMETHING OUT IN THE BEGINNING OR WANTED TO MAKE A
CHANGE SOMEWHERE ELSE IN THE PROGRAM.

TRY AGAIN...

Since there are only two possible responses to the question, the second choice is fairly evident. However, there is some-

one in every group who will try "3" or "4" or "yes" as an answer. To this kind of activity the system responds with:

1 THROUGH 2 ONLY VALID ANSWER...

YOUR ANSWER...?

When the correct answer is finally given the system returns with:

GOOD...WE WILL THEN NUMBER EACH STATEMENT AND SUBMIT THEM IN ANY ORDER.

NOTE...A STATEMENT MUST BE CONTAINED ON A SINGLE TELETYPE LINE.

QUESTION...

DO YOU THINK THE STATEMENTS SHOULD BE NUMBERED CONSECUTIVELY SUCH AS 1, 2, 3, 4, ETC.?

1 = YES, 0 = NO...YOUR ANSWER?

As people, we often tend to group things into nice, neat packages where everything relates to everything else. If asked to assign sequence numbers to a series of items or events, we invariably number them 1, 2, 3, 4, etc. The

point is that, in programming, while we must relate everything to everything else, we don't have to do it so strictly that there is no room for change or expansion. Selecting "1" or yes to the above question results in:

THAT CREATES A PROBLEM IF WE WISH TO ADD SOMETHING BETWEEN, SAY, LINES 3 AND 4. WE WOULD HAVE TO RENUMBER ALL FOLLOWING STATEMENTS.

Selection of the "0" or no answer causes:

GOOD...WE WILL SPACE THE STATEMENTS BY 5 OR 10 TO ALLOW FOR ADDITIONS OR CHANGES.

NOW WE ARE READY TO DISCUSS THE 'BASIC' VERBS.

STATEMENT...

VERBS ARE ENGLISH WORDS USED TO DEFINE THE TYPE OF ACTION THE STATEMENT IS TO PERFORM.

THE FIRST VERB WE WILL USE IS THE 'PRINT' VERB.

STATEMENT...

THE 'PRINT' VERB IS USED TO PRINT A LITERAL EXPRESSION ENCLOSED IN QUOTES.

HERE IS A SAMPLE PROGRAM...

```
10 PRINT "THIS IS A SIMPLE PROGRAM"  
20 END
```

QUESTION...

WHAT DO YOU THINK THE PROGRAM WILL DO WHEN EXECUTED?

1 = PRINT '10 PRINT' THIS IS A SIMPLE PROGRAM

2 = PRINT 'THIS IS A SIMPLE PROGRAM' AND STOP

3 = PRINT 'THIS IS A SIMPLE PROGRAM' AND CONTINUE

Selection of Answer 1 indicates that the preceeding "statement" was not read carefully and the system responds with:

ONLY THE INFORMATION BETWEEN THE QUOTATION MARKS IS PRINTED WHEN THE

'PRINT' VERB IS USED LIKE THIS.

...SEE ABOVE STATEMENT...

TRY AGAIN...

Selection of Answer 2 or 3 results in:

GOOD...EITHER 2 OR 3 WOULD HAVE BEEN CORRECT. THE DATA BETWEEN THE QUOTES WOULD BE PRINTED

AND THE PROGRAM WOULD CONTINUE BUT, SINCE THE NEXT LINE SAYS 'END', THE PROGRAM WILL STOP,

...THEREFORE...

STATEMENT...

THE LAST, OR HIGHEST NUMBERED STATEMENT IN THE PROGRAM MUST BE THE WORD
'END'.

Several points are presented in this last exchange between the user and the system.

The use of verbs to define the action to be performed is presented simply and easily because it is a relatively simple concept. These are the words that, when compiled and executed, will cause the computer to perform the desired action.

The spacing of the line numbers by 5 or 10 to permit the insertion of changes and corrections is emphasized in the small two-line sample program. While many people don't yet really understand how a change or correction can be inserted without retyping the whole program, the reason given for the spacing is sufficiently logical and sound that they are willing to adopt the habit on the assumption that the understanding will come later.

The explanation given when Answer 2 or 3 is chosen for the last question indicates that, unless instructed to stop, the system will execute one line at a time and continue to the next. To tell the user that this is exactly the way that large-scale binary-sequential computers operate would serve no useful purpose at this point and would very probably rekindle his "black art of programming" image.

The point that the last or highest numbered line in the program must be the word 'END' is quietly made. The system must be told how or where to stop and what simpler way than the word 'END.'

At this point, Lesson 1 is terminated and the user is told:

END OF LESSON 1

YOU REQUIRED 6 TRIES TO CORRECTLY ANSWER
4 QUESTIONS FOR A 66.6667 PERCENT EFFEC-
TIVENESS...CONGRATULATIONS.

IF YOU ARE READY FOR LESSON 2 RUN PROGRAM
'BASIC2'.

TIME: 12 SECONDS

Grading

As indicated in the example above, the number of tries the user requires to answer the questions is accumulated and reported to him at the completion of the lesson. It appears that, to protect extremely reluctant people from embarrassment, the system should ask them, before beginning the lesson, whether or not they want to be graded and proceed accordingly.

The 12 second time-indication is given as the amount of central processor time required to execute Lesson 1.

Starting with Lesson 2, the user is asked to type in his score at the end of the preceding lesson. He is then given

his score for each individual lesson as he completes it and a cumulative or running score for all lessons completed to date.

Any number from zero through 100 is accepted as a score from the preceding lesson. Entry of negative or greater than 100 scores results in the system stating:

IMPOSSIBLE...TRY AGAIN

The 'LET' Verb

Lesson 2 proceeds with a discussion of the 'LET' verb which is used to define the equivalence or relationship between elements of an expression such as:

15 LET X = Y + Z

This is approached in terms of its similarity to elementary algebra and the user is shown that he can express relatively complex relationships through the use of the following arithmetic operators:

+ = ADDITION

- = SUBTRACTION

* = MULTIPLICATION

/ = DIVISION

() = PARENTHESIS -- (A + 3X)

↑ = EXPONENTIATION -- 2 ↑ 3 = 2 CUBED

The concept of a loop is presented by introducing the 'GO TO' verb. A small sample program is given to illustrate its use.

10 PRINT "SAMPLE PROGRAM TWO"

15 LET X = 1

20 LET X = X + X

25 GO TO 20

30 END

The user is asked to indicate what the program will do and where the results of the computation will be placed. By selecting the correct answers he is shown that the variable 'X' is given an initial value of 1 in Line 15 and is doubled every time through the loop between Lines 20 and 25.

Lesson 2 is terminated and the user is given his score for the lesson and his combined score for Lessons 1 and 2 and told to run program 'BASIC3' if he is ready to proceed.

The 'PRINT' Verb

Lesson 3, after asking for the user's combined score at the end of Lesson 2, begins by pointing out that a method of printing the results of the program calculations has not yet been described. To accomplish this, a variation of the 'PRINT' verb, described earlier to type literals, is presented through another sample program. In this program, the print verb is used to print variables, the result of calculations, as well as literals enclosed in quotes.

Example . . .

```
10 PRINT "POWERS OF TWO"
15 LET X = 0
20 LET Y = 2 ↑ X
25 PRINT "2 TO THE" X "POWER EQUALS" Y
30 LET X = X + 1
35 GO TO 20
40 END
```

Using this same sample program, the user is introduced to exponential notation, which the system uses when the generated numbers become very large or very small.

Stopping A Program

Since no means of stopping a program in execution has been introduced yet, the user is told that by typing in a letter "S" at any time, whether the program is outputting to him or not, the program will be stopped. An alternate to this, if the program is not outputting, is to type the word "STOP" and follow it with a carriage return.

These, obviously, are not the only ways to bring a running program to a halt. It seems reassuring to a user whose program is in an endless loop to know that he can halt it quickly and easily.

The 'IF-THEN' verb is the next one presented. Its use as a decision-making tool is defined. The user is also shown that changes or additions can easily be made by simply typing in the line number — either an existing one if he wishes to change or replace it, or a line number between two existing ones if he wishes to make an addition.

Three additional arithmetic operators, greater than, less than and equal to are described and the lesson is terminated.

Loops and Subroutines

Lesson 4 begins with the 'FOR-NEXT' verb and its use as a loop-building tool. The building of loops within loops or nested loops is touched on but not stressed.

A sample program using the 'FOR-NEXT' verb is presented. This includes another form of the 'PRINT' verb that can be used to space the Teletype paper upwards for formatting output.

The next verb discussed is the 'INPUT' verb. Its use as a means of allowing the program to ask the user for input data at execution time is discussed. The idea that the user can run several different sets of input data through the program without stopping and re-entering the data as constants is also pointed out.

Following the termination of Lesson 4, Lesson 5 presents the 'GOSUB' verb to be used to build subroutines that can be called or entered from anyplace in the program. Nesting of subroutines, like nested loops, is mentioned but not stressed.

For programs of an iterative nature, requiring more data than can be handled conveniently by the 'INPUT' verb, the 'READ-DATA' verb is outlined.

Lesson 6 is primarily a review of the preceding lessons. Rather than present new material, examples of the current material are given, and some slightly more complex combinations illustrated. Several possible programs that the user may write with the aid of the lesson material are suggested.

The six lessons described here were written primarily to explore programmed learning or self-teaching systems techniques; secondarily for actual use in teaching BASIC programming. The concept appears deceptively simple. In truth, however, there exist many areas requiring much study and development if computer technology is to be successfully applied to programmed learning.

How Many Subquestions Should Be Asked?

When the student selects a wrong answer, for example, how many levels of subquestions should he be asked before the initial question is re-asked? This can become very involved. If he continues to give wrong answers, putting too many questions to him obviously may lead him away from the concept under discussion. On the other hand, asking too few questions may never reveal to him why the correct answer actually is correct.

The length of the lessons in this series was fairly short due, primarily, to inherent storage limitations in the 'BASIC' system itself. The ideal lesson length is probably a function of many things, some of which are age, educational level, and experience with computers.

The level of the approach to a subject such as BASIC programming — as with any other subject for that matter — clearly is influenced by age, education and other like factors. This preferably should be worked out with an educator familiar with the age group in question, and having a good knowledge of programmed-learning concepts, as well as some understanding of basic computer technology.

What Kind of Terminals Are Best?

The development of terminals most suitable for use in this environment is also an important consideration. While the Teletype is the most readily available and least expensive terminal for this purpose available today, it certainly is not suited for use by students unable to read or by blind students. A terminal capable of cathode ray tube display, light pen and keyboard input, and voice explanation generated by the computer would appear to meet most of the requirements. While technically feasible today, this type of terminal is still far too expensive to be practical.

Furthermore, until a language is developed that will make it easy for educators to structure and generate their own lessons, the training of people to work with educators in developing programmed learning lessons will continue to be a problem.

The Future of Computer-Programmed Learning

It is evident, therefore, that whereas computer-programmed learning is potentially a very powerful tool, computer manufacturers and applications experts are going to have to work very closely with the educational community if the vast potential of the computer is to be applied sensibly and realistically to the constantly growing needs of education.

There's a cycle at work in the steel industry. It begins the moment a customer places an order.

When it ends is critical, because today quality in the steel industry is universally high. Prices are competitive. The big difference is customer service. The crucial question is: how fast can you deliver? The answer depends chiefly on how fast work begins on the customer's order.

Before computers came onto the scene, the order cycle took three weeks. (Often, time was lost just determining if and when room could be found for the customer's order.)

Today the sales division of one of the world's giants in the steel industry relies on a UNIVAC® 490 to shorten this cycle.

Now, in 85% of the cases, the three week wait has shrunk to a maximum of 48 hours.

Now data (and lots more data) can be accessible to remote locations on request. And when the requirements of a customer's order change, a lot of people who need to know about it will know about it simultaneously.

A hypothetical case: A customer needs his order of steel cable sooner than expected because progress on

Next time you order a

The crucial question in the steel industry is: how fast can you deliver?



the bridge he's building has been accelerated by a warm weather spell.

This means a shift in scheduling which affects plant availabilities, cost factors, date of shipment, and ultimately, invoicing.

The new data is fed into the UNIVAC 490, a real-time system. Information from then on is revised to be up-to-the-minute. Any outlying plant with a terminal device can have that information instantaneously.

This particular 490 has been in operation for 3½ years. It has been used twenty hours a day, five days a week and 16 hours on Saturday. During all that time

the machine has been "down" only once.

UNIVAC systems are at work at the major steel companies and throughout the entire metals industry.

They're working for countless other industries, for government, for education — here in the United States and throughout the world.

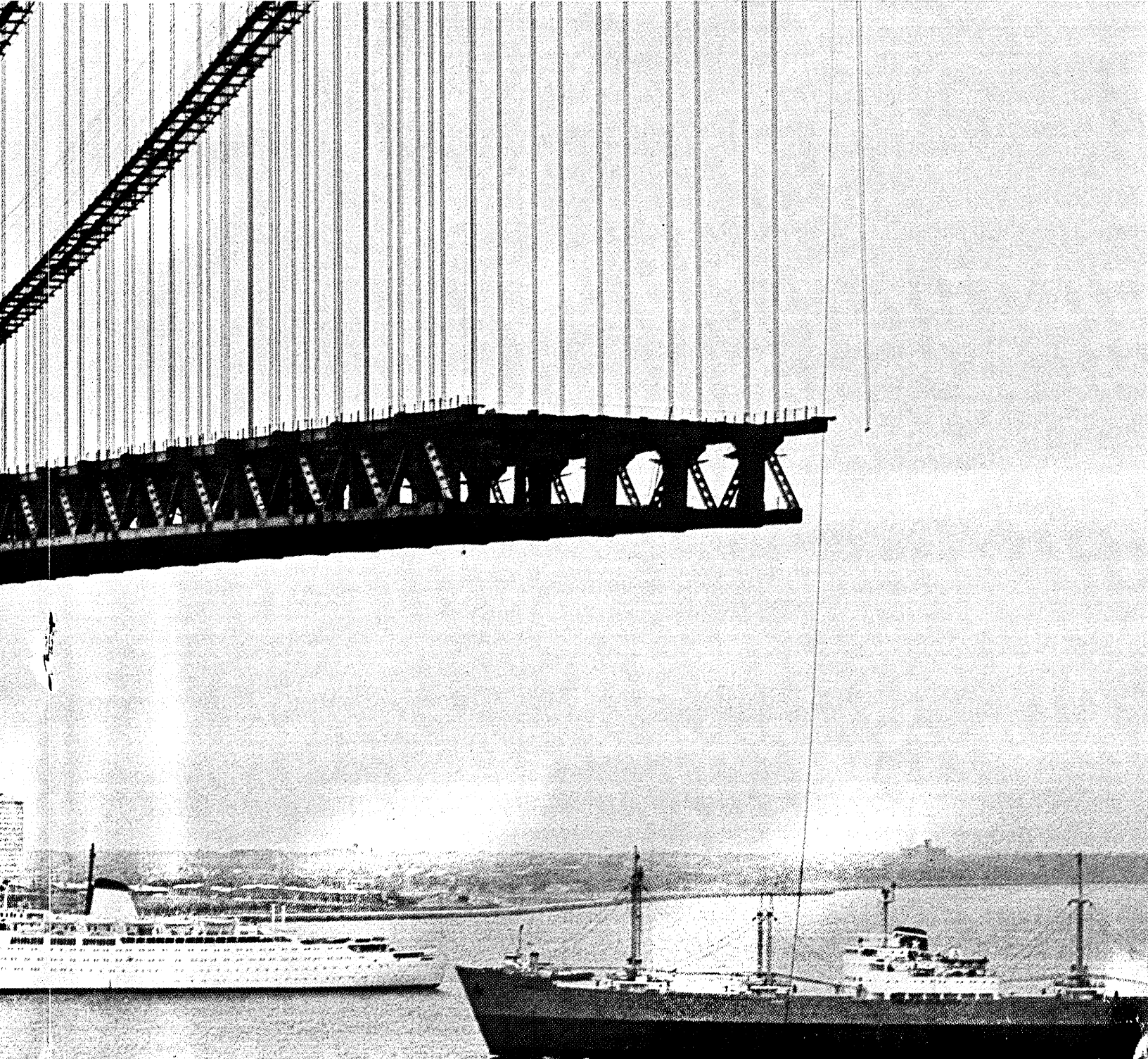
UNIVAC SPERRY RAND

Univac is saving a lot of people a lot of time.

Designate No. 4 on Reader Service Card

a bridge you'll get it faster.

The answer depends chiefly on how fast work begins on the customer's order.



COMPUTER TIME SHARING – A REVIEW

*Nicole Pointel and Daniel Cohen
Laboratoire Central de Telecommunications
Paris, France*

“The electronic computer has been used up to now either to relieve man of routine work or to carry out complex and lengthy computations. Time sharing is a big step toward the improvement of man-machine relations; it permits undelayed conversation between man and machine.”

1. Introduction

This article reviews time-sharing, a recent way of using computers in which a given information processing power is made available to several remote users. First, time-sharing, its present services and its future ones, will be defined. Then, the main hardware and software features of a time-sharing computer will be pointed out. Features which are desirable but not essential will also be mentioned.

Engineers and programmers have solved the most urgent problems in time-sharing. The use of a time-sharing system in fields other than scientific computation and management data processing has not yet been envisaged. Nevertheless, the results obtained to date in these two fields will facilitate the approach to new fields of application: industrial process control and telephone network control.

2. General Presentation

2.1 DEFINITION

Time-sharing is the simultaneous employment of a computer by several users; each one has the illusion of being the only person using the machine. In a typical time-sharing system, the users communicate with a central computer by means of remote consoles. The users can run and debug their programs on-line as they would with a conventional computer. Debugging is the process of testing, correcting, and simplifying

the operating instructions or program for solving the particular problem presented to the computer.

The time-sharing system shares computer time among all the programs; each program has control over the processor in turn for a specified quantum of time Q . At the end of this time slice, the running program is stopped and, if necessary, stored on an auxiliary memory; the next program is loaded into core memory if it is not already there and runs for time Q , et cetera. Multiprogramming is made possible by the interrupt system, which enables the interruption of a running program and the switch-over of processor control to another program, according to predetermined priority criteria. In this way, tasks of the same nature and length assigned to the computer by several users at approximately the same time will be finished almost simultaneously.

It should be noted that multiprogramming can be used in a classical computer center with only one input access point to the computer. The main purpose then is to provide better use of computer time. The computer can in fact execute program $P2$ while it is awaiting completion of an input-output operation requested by program $P1$.

2.2 SERVICES PROVIDED BY A TIME-SHARING SYSTEM

Time-sharing provides for many simultaneous users, improves man-machine communication, provides better solutions to present problems, and enables an approach to new fields.

2.2.1 Many Simultaneous Users

One of the advantages of time-sharing is the number of simultaneous users possible. For instance in the Compatible-Time-Sharing System (CTSS) of the Massachusetts Institute of Technology, 110 consoles are connected to an International Business Machines Corporation computer, *IBM 7094*, and 30 of them can be used simultaneously. In Machine-Aided Cognition or Multiple-Access Computer (Project *MAC*), now being implemented on a General Electric computer, *GE 645*, about 500 consoles will be available of which 150 to 200 will be able to operate simultaneously.

Thus a time-sharing system can provide direct assistance to a large number of engineers, research workers, students, et cetera.

2.2.2 Improvement in Man-Machine Communication

In a classical system, the programmer writes a program on paper. The program is punched on cards or paper tape and is then written (by the computer) on a magnetic tape. Sometimes it is loaded on a magnetic drum before being compiled or assembled. These various stages usually require several days rather than a few hours; in fact, the problems raised by the organization of data processing centers are often inadequately solved. In this way, the programmer loses precious time before he can even start debugging.

Moreover, when the machine is saturated, the programmer may often be allowed only one debugging run per day, which entails exceedingly long waiting times.

Time-sharing considerably improves the whole operation by enabling direct conversation with the computers. This conversation is carried out simultaneously with several users, and the computer then becomes a practical tool quickly accessible to all users.

Mme. Nicole Pointel was born in Amiens, France, on 4 December 1939. She received the Licencié ès Sciences degree from the Faculty of Sciences of Lille in 1961.

After 4 years with the Bull—General Electric Company, she joined the Laboratoire Central de Télécommunications in 1965, where she is working in the Programming Group on the programming of telephone exchanges.

2.2.3 Better Solutions to Present Problems

Time-sharing improves the running of programs that require frequent interventions by the user.

2.2.3.1 Scientific Problems

Time-sharing provides scientists, research workers, and engineers with a tool which has the capabilities of both a desk calculator and a computer.

These users want to be able to write their programs easily; they can do so by using a problem-oriented language such as FORTRAN. They want also to interact with the computer (stop a program under execution after a few results have been obtained, modify a parameter value and run the program again, et cetera). A time-sharing console is readily adapted to their needs.

2.2.3.2 Debugging

Whatever the kind of programs to be debugged, only time-sharing offers the capabilities of speed and efficiency. In fact, the programmer need not use intermediate means, and numerous errors can thus be avoided. The program is directly introduced using a typewriter; typing and syntax errors can be corrected immediately. Errors are no longer detected and corrected with the help of comprehensive printouts. On the contrary, printouts of some memory areas and some registers are asked for, and corrections are then typed and sent to the core memory.

In this way, step by step, but quickly, the programmer debugs his program.

2.2.3.3 Business Data Processing

If a company has several branches, each one generally uses a small computer for its own needs. A time-sharing system using a large

Daniel Cohen was born in Casablanca, Morocco, on 13 March 1938. He received the Licencié ès Sciences degree in Physics and Mathematics in 1958, and the Engineer diploma in electronics and radioelectricity from the École Supérieure d'Électricité in 1960.

Mr. Cohen joined the Laboratoire Central de Télécommunications in 1960, where he participated in various studies on system design. He is at present head of the Programming Group within the Telephone System Research Department.

central computer can handle the data processing for the entire company. Each branch can have access to its own files (inventories, personnel lists, et cetera) or to common files (documentation, for instance) independently of the other branches by sending commands through the consoles.

2.2.4 *New Capabilities*

2.2.4.1 *Information Retrieval*

The main feature of an information retrieval system is a bulky master file that must be scanned quickly to answer an inquiry. Time-sharing makes use of mass memories that can be controlled directly from the consoles. Therefore, time-sharing offers a real solution to these problems. Moreover, oscilloscope displays enable on-line reading of documents.

2.2.4.2 *Text Editing*

A user can type a text on a console typewriter. Then, with the help of a few commands, he can modify this text, add a word or line, substitute one word for another, or delete a complete paragraph. Finally, he can ask that the amended version of his text be printed out on the typewriter.

This capability to edit text helps in the actual writing of programs.

2.2.4.3 *Education*

Teaching programming is more efficient with a time-sharing system. As the student receives a quick answer from the computer, he can ascertain his errors more rapidly and therefore learn more quickly.

This way of teaching is also applicable to other fields, such as foreign languages, mathematics, or physics. The computer asks the student a question and he must choose from several answers; the answer given is stored and the correct answer shown.

Experiments of this sort have been performed at the Massachusetts Institute of Technology.

2.2.4.4 *Graphic Data Processing*

The invention of new peripheral devices and the establishment of some special programs give invaluable aid to engineers and research workers.

Since drawings are generally far more explicit than text, it is advantageous to be able to use them as inputs to or outputs from a computer.

Thus graphic data processing is a useful new field.

With a peripheral device such as Sketchpad (Section 3.3.3), the user can draw a diagram (an electrical network, for instance) on a screen with a light pen. A special program stores the drawing in memory. The user can call back on the screen parts of the drawing and modify them. He can then call the complete amended drawing back on the screen. As numerical values can be introduced, another special program can effect computations and display the results on the drawing; for example, the values of the current in the various branches of the electrical network can be displayed. Viewing the results, the user if necessary can modify some parameter values or even the network structure itself. In this way many solutions can be examined quickly.

These new programs and peripheral devices improve communication with an ordinary computer system. They are all-the-more attractive in a time-sharing system, as the same capability is provided for several users simultaneously.

2.2.5 *Response Time*

The higher the number of simultaneous users the system can accommodate, the greater the efficiency. However, this number should not be so high as to increase waiting time considerably. In particular, short computations should not take longer on a time-sharing console than on a desk calculator.

The response time for a given command, issued by a particular user, depends on the length of the program that corresponds to the required service, the number of other active users, and the length of their programs. But above all, the response time depends on the method employed for the allocation of computer time to the various users. To our knowledge, no general study of this question has been carried out. At present, computer time allocation is experimentally adjusted according to users' reactions.

3. **Hardware Necessary for Time-Sharing**

3.1 **ESSENTIAL FEATURES**

A computer intended for use in a time-sharing system should include the following features.

(A) Memory protection is necessary since the users' programs should neither disturb each other nor destroy the supervisory program (the program in charge of the general management of the machine).

(B) Interruption of the program under execution must be possible each time the supervisory program has to carry out a specific job (request from a console, end of an input-output operation, error, et cetera).

(C) A built-in clock enables automatic interruption of the program under execution after a time Q has elapsed and switchover of control to the next program.

(D) Dynamic program relocation is necessary. To give quick service, several programs or program segments are stored simultaneously in core memory. When one of them has been completely executed, it must be stored in another medium; the memory area thus released becomes immediately available for new programs or program segments. It should be possible to load a program in any memory area.

(E) Auxiliary stores are necessary. Parts of the supervisory program and programs interrupted during execution that cannot remain permanently in core memory must be transferred to an auxiliary memory with very short access time. Users' files and programs, library programs, and some infrequently used supervisory subroutines must be stored in a bulky mass memory.

(F) Consoles equipped at least with a typewriter must be connected to the computer through telephone lines and data transmission terminals at both ends.

3.2 IMPLEMENTATION OF ESSENTIAL FEATURES

Machines recently designed for time-sharing have all the above features. However, implementation differs among manufacturers.

3.2.1 Memory Protection

3.2.1.1 Protection of Users' Programs

It is necessary to prevent any user program from altering core memory areas outside its own limits. Several methods are available.

(A) Lower-limit and upper-limit registers. The *IBM 7030* computer uses two limit registers, loaded by the supervisory program, that define the memory area allotted to a program. On execution of any instruction involving memory reference, the address is automatically and simultaneously compared with the contents of both registers by a hardware device.

The General Electric 600 series computers use a single reference register, the base address register, which contains the location address of

the program and its length. As before, the address comparison is automatic. This register is also used for program relocation in the *GE 625* and *GE 635* computers.

(B) Assignment of a protection key to each program. A protection key is also associated with each memory block; before reading or writing in a memory block, the protection key of the program is automatically compared with that of the block. The block can be used only if the two keys are identical.

This technique is used on the *IBM 360-67* computer.

(C) Programmed protection. In a user program, it is possible to include a subroutine to ensure memory protection by comparing each address with the bounds of the memory area assigned to the program. The execution time is obviously much longer, and this solution can be envisaged only for program debugging.

3.2.1.2 Two Modes of Operation

The computer operates in two modes. In the master mode the supervisory program has access to the entire memory, whereas in the slave mode any user program has access only to the area assigned to it.

3.2.2 Interrupt System

The interrupt system enables the processor and the peripheral devices to obtain any needed service from the supervisory program. Types of interrupts include the following.

(A) Input-output interrupts occur as soon as a call from a console or an input-output command has been initiated, and also when a peripheral device has completed its task or when it is out of order.

(B) Interrupts due to incidents occur when a user program tries to obtain access to a core memory area that has not been allotted to it or to use instructions of the master mode.

(C) End-of-job and end-of-allotted-time interrupts are indispensable in time-sharing systems. However, it is also useful that incidents such as overflow, parity error, et cetera, be signaled through an interrupt.

Interrupts are transmitted through suitable circuits to a register having one bit per interrupt type. The supervisory program then determines the action required.

3.2.3 Clock

The processor must have a clock which issues an interrupt at the end of a given time interval. This clock generally has a register the contents of which are decreased by one at regular intervals. When the register contains zero, the clock issues an interrupt and the supervisory program reloads the register. In this way, a clock interrupt is issued at the end of the time interval allotted to each program. This ensures the actual sharing of processor time and permits the system accounting to be done.

In some time-sharing systems, a clock interrupt order is issued at regular intervals to permit the system to detect and take charge of calls originated by the consoles.

3.2.4 Dynamic Program Relocation

When several programs are stored simultaneously in core memory, it should be possible to load them starting at any address. The programs are therefore written with relative addresses. When the execution of a particular program ends (end of job or end of allotted time), the memory space it occupies is available for loading new programs.

Dynamic program relocation is effected by means of either of two devices described hereafter.

3.2.4.1 Base Address Register

The base address register contains the starting address of the program under execution. Addresses are automatically incremented with the contents of that register at execution time. When execution of a program is complete, the other programs are "packed" to regroup the available memory space in a single area.

After packing has taken place, only the starting addresses of the programs must be modified. It is the "allocator" part of the supervisory program which manages the memory allocation table.

This system is used in the *GE 625* and *GE 635* computers.

3.2.4.2 Page-Turning System

In the system described above, the processor carries out program packing, which entails a delay in the actual execution of users' programs. A hardware device called a page-turning system avoids this loss of processor time.

A special logic unit splits the programs into fixed-length segments called pages. A table in the memory contains the addresses of all pages of each program. This allows the various pages of a program to be scattered in the memory (see Figure 1).

A logic unit automatically looks up the table of pages to find the locations of the pages of a program, thus enabling that program to be run. This table look-up is made without any loss of time since it does not call upon the processor. If the table indicates that a particular page is not in core memory, a logic unit issues a request to the supervisory program, which will then look for the missing page in the auxiliary memories.

Referring to Figure 1, after page 3 of program 2 has been executed, the next instructions to be executed will be those on page 4; page 3 can be replaced by page 6 of program 2 (not at present in core memory) or by a page from another program. Thus, instead of packing programs, the system operates through page replacement. The programmer need not take care of paging. This solution is costly in hardware as it needs 11 specialized registers in the *GE 645* computer, 16 registers in the *IBM 360-67*, and 32 registers in the *Atlas* computer.

Although it is more costly than the base address register, the page-turning system is attractive as it avoids physical displacement of programs in core memory. Moreover, memory allocation is simplified and lengthy programs can be run without the programmer being concerned with calls to the various pages.

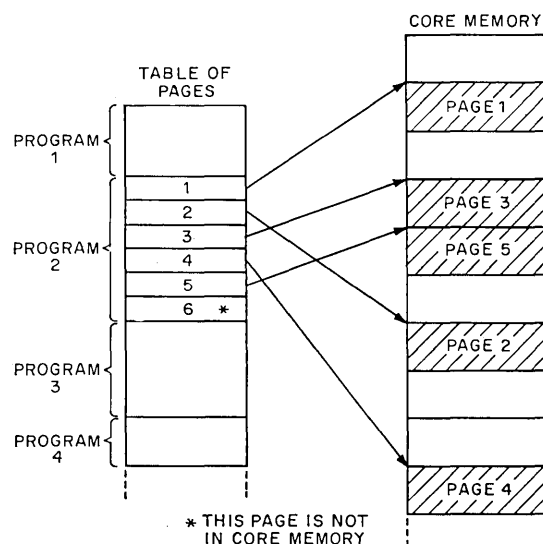


Figure 1—Page-turning system.

3.2.5 *Auxiliary Memories*

In time-sharing systems, active users are numerous and all programs cannot be stored simultaneously in core memory. An auxiliary memory with a very short access time is therefore necessary. Moreover, users' files and programs should be quickly accessible, and a large direct-access memory should be connected to the system.

3.2.5.1 *Auxiliary Memory with Short Access Time*

The memory used at present is a magnetic drum. Programs interrupted during execution are transferred from core memory to drum, and programs to be executed are loaded from the drum to the core memory. This double operation is called "swapping." The drum is thus considered as a direct extension of core memory.

An interesting example is the General Electric "fire-hose drum" with capacity of 4-million 36-bit words and average access time of 8.5 milliseconds. This drum is directly connected to the core memory of the *GE 645* computer.

3.2.5.2 *Large-Capacity Direct-Access Memories*

Large-capacity disc units are used. Their direct-access feature shortens the waiting time involved in file searching.

In the Compatible-Time-Sharing System, the *IBM 1301* disc unit is the "heart" of the system, for it contains all useful files and programs.

3.2.6 *Consoles and Data Transmission Terminals*

Communication with the machine is effected through a console usually equipped with a typewriter. The user sends commands and introduces programs and data by means of the typewriter. By the same means, he receives the results and also messages from the supervisory program.

Each console is connected to the computer through a telephone line. The computer is not interrupted on reception of each character. At the computer end, as one of its functions, the data transmission terminal assembles characters in messages. When a message is complete an interrupt is sent to the computer, which can then process the whole message.

3.3 COMPLEMENTARY FEATURES

The features described in Sections 3.1 and 3.2 are essential to a computer used in a time-sharing system. Other features, although of a less peremptory nature, add to the efficiency of the system.

3.3.1 *Large Core Memory and Fast Processor*

The extensive time-sharing supervisory program must be stored entirely or in greater part in core memory; for instance, the supervisory program of the Compatible-Time-Sharing System occupies 32 000 words in the *IBM 7094* core memory.

Moreover, it is attractive to store as many programs as possible simultaneously in core memory to reduce interrupts caused by swapping. Therefore, the larger the core memory the better the service provided.

For a given number of users, the faster the processor, the shorter the response time.

3.3.2 *Large-Capacity Auxiliary Memories*

Magnetic cards are attractive in time-sharing systems for storing infrequently used files and programs. Their capacity varies between 1×10^8 and 6×10^9 characters, and their average access time is between 100 and 500 milliseconds. The cost per character is low.

3.3.3 *Special Peripherals*

The manifold capabilities of these peripherals provide a new type of user-machine conversation.

Curve plotters permit graphs, schematics, maps, et cetera, to be obtained directly from the computer. Cathode-ray tubes provide for an immediate display of results. Sketchpad (developed at the Massachusetts Institute of Technology) permits the user to draw a graph on a cathode-ray tube with the use of a light pen, then to store the drawing in memory, call it back, modify it, et cetera.

For example, to draw the arc of a circle, the user points the light pen to the center and presses the "circle center" button. The user then chooses, by means of the light pen, one of the ends of the arc (which has the effect of defining the radius) and presses the "draw" button; the final position of the light pen defines the other end of the arc.

Various buttons enable drawings to be rotated, translated, magnified, erased, et cetera.

A description of the drawing that appears on the screen is stored in core memory; it can be transferred to an auxiliary memory. A library of drawings can thus be accumulated; a complex drawing can be composed by means of elementary drawings existing in the library.

These peripherals offer a new field of application for time-sharing. They will be very useful in the numerous cases in which an exchange of graphic information simplifies the conversation between user and machine.

4. Time-Sharing Software

4.1 ESSENTIAL FEATURES

The software of a time-sharing system should include at least the following.

(A) Supervisory program for the allocation of memory space and processor time to each program and for machine management in general.

(B) A command language employed by the user to give general commands to the system (independently of any specific user program).

(C) A debugging language to enable on-line program debugging from the consoles.

(D) A symbolic programming language to simplify program writing.

Library programs included in classical systems are also part of time-sharing software.

4.2 SOFTWARE ITEMS

4.2.1 Supervisory Program

4.2.1.1 Memory Space Allocation

Programs are written with relative addresses so that they can be loaded anywhere in core memory. The supervisory program must manage the memory allocation table that contains the starting address of each program; it must decide which programs to transfer to the magnetic drum when a new program is loaded in core memory; and finally, it must manage the table for allocation of drum areas intended for program swapping.

4.2.1.2 Processor Time Allocation

When a program is loaded in core memory for execution, a maximum running time is assigned to it so that the processor time will be shared among all users.

The supervisory program loads the clock register with the time allotted to each program. Two

situations may arise: Either the same time Q is allotted to each program and the supervisory program switches processor control from one program to another every Q seconds, or the time allotted depends on the priority level of the program. Priority assignment can itself be a function of several factors (program length, author, et cetera). The active programs are then distributed over a number of queues, each queue corresponding to a different priority level. The supervisory program is responsible for priority computation and queue management.

4.2.1.3 Interrupt Servicing

Each interrupt must be controlled by the supervisory program, which first stores the state of the interrupted program—that is, the contents of various registers (instruction counter, accumulator, index registers, et cetera). It then looks for the nature of the interrupt (clock, peripheral unit, or fault) and finally determines the action required depending on the nature of the interrupt.

A clock interrupt is issued every Q seconds. The supervisory program looks for calls coming from the consoles. If there are none, the interrupted program is restarted. Otherwise the messages received are decoded and analyzed.

If the message is a user command to the system, the priority of the corresponding program is determined and its identification is introduced into a queue. If the message was intended for the user's program, no action is taken; the message will be read by the user program.

After the messages have been analyzed, the interrupted program is started again unless another program with a higher priority has been introduced by one of the commands, in which case the latter is executed.

An input-output interrupt occurs in one of the three cases that follow.

(A) When the program under execution issues an input-output request, this request causes an interrupt. The supervisory program sends out the request and transfers control to the next program, for the processor should not stay idle while a peripheral device is working. The program interrupted is not taken in charge by the supervisory program before completion of the input-output operation (also signaled by an interrupt); it is taken from the queue.

(B) When an input-output operation is complete, the supervisory program reintroduces the program into a queue, where it again becomes ready for execution.

(C) When an incident occurs in a peripheral unit, an interrupt is issued. The supervisory program determines the identity of the peripheral device and the cause of the incident (parity error, mechanical failure, et cetera) and sends a message to the operator who will carry out the action required.

An interrupt is issued when an incident occurs in the computer (for example, overflow, parity error, or attempt to go outside allotted memory area). The supervisory program determines the nature of the incident and transfers control to the corresponding servicing subroutine.

Interrupt servicing subroutines are part of the repertoire of the supervisory program; these subroutines are run quickly since they should never significantly slow down the execution of users' programs.

4.2.1.4 Peripheral-Device Allocation

When a read or write instruction appears in a program, the peripheral device used is designated by its logic identity. The allocator subroutine of the supervisory program allocates the peripheral devices needed by the program and establishes the correspondence between logic identity and physical identity. It also allocates an area of an auxiliary memory to each user for storing files and programs.

4.2.1.5 File Management

In the following, the word "file" refers to both programs and data.

The users' files have various utilization rates. It would be too expensive to store them all in rapid-access auxiliary memories. The files used less frequently can be stored in slower (and cheaper) auxiliary memories. A hierarchy is thus established among files based on file utilization rate and among memories based on the storage cost per character.

For instance, memories can be ranked as follows: magnetic discs, magnetic cards, magnetic tapes, and files—according to the date of their latest use. The supervisory program will have to check regularly that auxiliary memories are adequately used and to initiate file moving if necessary. A file requested by a user should be found quickly regardless of its present place in the memory hierarchy. For this purpose, the supervisory program will have to maintain a file directory for each user.

The distribution of files over the various hierarchy levels should not be such that savings

made on memories are offset by the cost of lengthy processing; a compromise must be found by experiment.

4.2.1.6 Checking Functions

When a user requests access to a particular file, the supervisory program must check that the user is allowed to read, write, or both read and write in that file.

The supervisory program must also check the condition of auxiliary memories. A daily copy of the contents of the disc memory is usually maintained on a magnetic tape. When the supervisory program detects an error in the disc memory, it may initiate partial or complete reloading of this memory from the magnetic tape.

4.2.2 Command Language

The following commands (with examples from Compatible-Time-Sharing System) should be available to the user.

(A) A command for entry to and another for exit from the system (for example, *log in* α, β and *log out*, where α is problem name or number and β is user name or number). The first command identifies the problem and the user; the second one tells the system that the user has completed his intervention—his files must be closed, the directory updated, and the time used logged.

(B) A load command and a start command that allow the user to load a program and start program execution (for example, *load* $\alpha_1, \alpha_2, \dots, \alpha_n$, where $\alpha_1, \alpha_2, \dots, \alpha_n$ are file names or numbers, and *start*).

(C) An input command that permits the user to introduce a program directly from a console.

(D) A start compilation command (for example, *mad* α , which will initiate the translation of program α by the *MAD* compiler).

(E) A temporary stop command which allows the user to stop execution of his program when he wants to modify it or the data, or to reflect on the results obtained.

4.2.3 Debugging Language

A number of commands should be available to the user for program debugging.

It should be possible to modify a line in a program, to delete lines, and to insert new ones. It should be possible to stop a program under

execution and ask for printout of the contents of some registers or memory areas. It should also be possible to modify these contents.

4.2.4 Symbolic Language

A symbolic programming language should be available to the user for a time-sharing system to be of practical use. This language should be an assembly language at least (a language in which mnemonics are used for instruction codes and symbolic names for addresses).

On the other hand, such high-level languages as FORTRAN, ALGOL, and COBOL are obviously highly desirable.

4.3 COMPLEMENTARY FEATURES

The following features of time-sharing software are not strictly necessary but add to the service provided or increase the system efficiency to the user.

(A) A command for indication of processor time used.

(B) A command for printout of the user's file directory with such indications as file names, memory space used, and memory space available.

(C) A command for printout of the user's files themselves.

(D) Interconsole messages that permit users to communicate among themselves. This facility could be very useful when several people are working on different parts of the same project.

(E) Special problem-oriented programming languages such as LISP, COMIT, and IPL for non-numerical information-processing problems, GPSS, SIMSCRIPT, and SIMULA for simulation problems, and STRESS and COGO for civil-engineering problems.

5. Conclusion

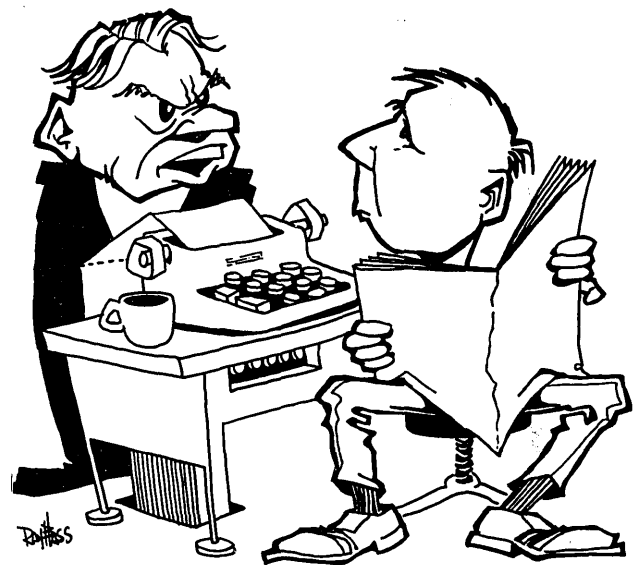
Time-sharing is a big step toward the improvement of man-machine relations; it permits undelayed conversation between man and machine.

The electronic computer has been used up to now either to relieve man of routine work or to carry out complex and lengthy computations. In a time-sharing system, the computer can be used as an assistant to the engineer or the research worker in his creative work, as it enables him to scan a large number of solutions quickly.

We noted earlier that the improvement of man-machine communication, not the equipment cost and efficiency, has been the prime concern of designers. It is quite clear that the internal operation of a time-sharing system requires a great deal of management, which uses up memory space and processing time.

Some problems have apparently been solved in an empirical or experimental fashion. For instance, we know of no theoretical studies on methods of allocation of processor time to various programs or on the optimization of information storage in memories with various hierarchy levels.

Finally, because of the very nature of time-sharing, it should be possible to apply it to real-time problems such as the control and checking of industrial processes or the control of a telephone network. The same computer could control several industrial processes or several telephone exchanges. To our knowledge, no theoretical or practical study of the effects of real-time constraints on a time-sharing system has been made.



"AND JUST EXACTLY WHOSE TIME DO YOU THINK YOU'RE SHARING?"

WORLD REPORT — GREAT BRITAIN

Brilliant summer notwithstanding, there has been no holiday in the hot war for the British computer market. Major U.S. makers are pressing hard for the big jobs while Britain's ICT and English Electric organisations are "pulling out all the stops" to get their biggest machines through testing and en route to customers.

GE Launches Time Sharing in UK

General Electric, through its De La Rue Bull company in Britain 75 per cent owned, has launched a time-shared 265 service with more than 20 terminals already taken. It's clear that GE really means business now after abortive attempts to have the 600 series made in Britain and comparatively little success in selling machines from the other ranges, apart from the nimble Gamma 10.

Vic Casebolt, head of the UK venture, told me that it is expected that a second, and probably a third 265 system will be set up in Britain. This is confidence indeed, since three of these machines could serve 450 engineering and other clients (120 of them simultaneously).

IBM Foresees Gold Mine in Communications

Not to be outdone in advanced techniques, IBM has inaugurated a pepped-up international internal communications system working from Hursley House, Winchester.

It will have its own 360/50, and as a starter it will handle orders for IBM World Trade, which now has 14 factories outside the US, each with specific product responsibilities.

Management services are a natural corollary, but it seems that plans far more ambitious than these, which will involve leasing channels in a satellite, have already been formulated.

A new company, IBM Information Systems, has been set up to handle the work, and it is not sheer coincidence that Jacques Maisonrange, President of WTC, is the first chairman. Some observers in Britain see this move as portending an IBM attempt to corner communication networks which will have an increasingly large element of computer control. Others see in it preparations to sell access to data banks anywhere. Whatever the real reason, one thing is certain — IBM management foresees a mine of dollars in communications.

First CDC 6600 in UK

The first CDC 6600 (fourth in Europe) has been placed in Britain. Freeman, Fox, Wilbur Smith, consulting engineers in London, are the catalyst. But the same group that is operating the SCAN, on-line, real-time broker service to London Stock Exchange operators, is behind the deal and is planning to load this big machine with some of the complicated seismic problems resulting from the North Sea natural gas research.

Through another linked company, these real-time experts are to get twin Univac 1108 machines and they will use the drum storage of this equipment with the 6600.

British industry is not asleep. As this was written, the news came that two second generation IBM machines and two others at the nuclear reactor design headquarters of the UK Atomic Energy Authority were to be thrown out next year in favour of a single English Electric System 4-70.

This may well be direct government influence, but it speaks volumes for the capacity of this £2 million machine, that it is capable of taking all the work from a 7040, a 1401, a PACE analog and an old Ferranti Mercury.

Who Will Develop Government "Number-Cruncher"?

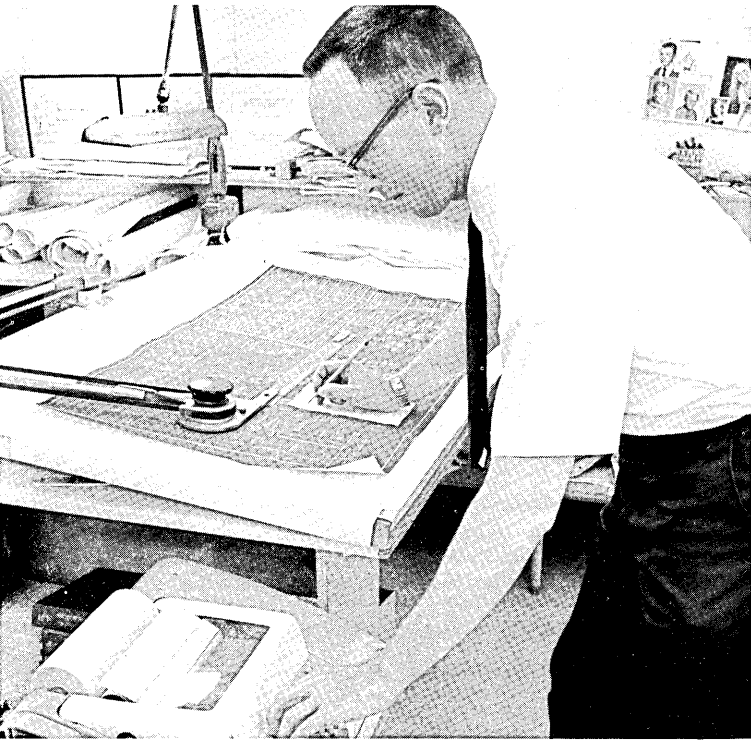
By the time these lines are read, it is likely that the Government will have made up its mind as to who shall do the development work on the big "number-cruncher." It seems that, on balance, it should be International Computers and Tabulators. The main reason is that the other UK company, English Electric Computers — recently merged with Elliott-Automation — still has its hands full with its present design. This is one up on RCA's Spectra 70 in that the whole range is "micro-min" and is in the same position of playing piggy-back with IBM. While this may be wise in the US where there are many 360's to replace, it is not so wise in Britain — even less so when it is remembered that English Electric seems to have forgotten the European market.

Small computers are in the news again. It seems the ubiquitous Ministry of Technology has decided that there should be only two makers of small (process-control) computers. The elect are Ferranti and English Electric. Sufferers included Plessey, who were told not to come out with the XL-12, a machine akin to the PDP-8.

But all the work on the XL-12 circuits and its design has been funded by the Ministry, a fact overlooked by Plessey. So the XL-12, reputed to be cheaper than the PDP, is still alive — but only barely.



Ted Schoeters
Stanmore
Middlesex
England



THE MANY NEW USES OF TIME SHARING

*Thomas J. O'Rourke, President
Tymshare Inc.
Los Altos, Calif.*

"The fact that an individual literally has a giant computer at his fingertips will open up a whole new dimension of applications for him that will be limited only by his creativity and imagination — in essence he possesses the Aladdin's lamp of the computer age."

When we started in the time-sharing business two years ago, most of the industry considered it a passing fad with little practical application outside the academic world. It is gratifying to see how quickly acceptance has grown. One of the factors in this growth was the transformation of the time-sharing research project "Genie" at the University of California at Berkeley to a profitable commercial time-sharing operation. This was the result of 1½ years of programming effort culminating in a software package delivered to Scientific Data Systems which has become the standard offering on their 940 line.

This program development work was painfully intermixed with a lengthy hardware debugging and modification program in cooperation with the SDS engineers in the Palo Alto Computer Center of Tymshare Inc.

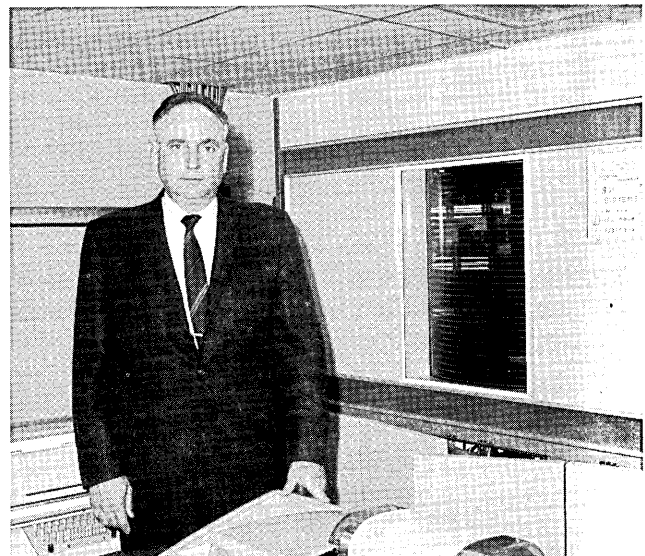
Reactions From Users

Now that the development phase is behind us, we are concentrating on expanding the versatility of the system and the uses to which time sharing can be put.

What are some of these uses?

For a banking executive, "Time sharing is a meaningful response to an investment problem so complex that you don't know what questions to ask until you start getting some answers." An engineer sees the system as an electronic slide rule. For a computer novice, it's a teaching machine. For a software professional, "It's the most efficient approach to program debugging ever conceived." These are the reactions of just four users of time sharing. Already the uses have grown beyond the small engineering problem that most people felt was the only practical use for time sharing.

In less than two years, over 1000 subscribers have tapped into the Tymshare computer facilities in either Northern or Southern California. Each evaluates the purpose and importance of time sharing from a different point of view.



T. J. O'Rourke, standing beside the first SDS 940 system to be delivered.

What then is time sharing? Already it's beginning to sound a little like the proverbial description of an elephant by the six blind men. Yet isn't that what one would expect from a service that is flexible and truly user-oriented? Unlike electric power with a standard voltage and frequency that requires a wide variety of special devices to convert it to use, it's a service that depends only on the needs and ingenuity of its user to produce useful work.

Technically speaking, however, time sharing is a technique that allows many simultaneous users to work directly with a computer over standard communication lines on a dial-up and use-as-needed basis.

Tymshare users represent a cross-section of business, industry, commerce, government and education. Some are experienced programmers; others are interacting with a computer for the first time.

A Case History

In some respects, Douglas Laidlaw, co-owner of L.A. Lithograph Co., Inc., El Segundo, Calif., typifies the new breed of novice users attracted to time sharing. Before connecting on-line to the Tymshare computer, he had no previous experience with any type of computer operation. What he saw in time sharing was a streamlined bidding system unmatched by any other printing house on the West Coast. Time sharing has become an integral part of his business.

"Cost estimating," says Laidlaw, "is the key to competitive bidding, making or losing a profit once the job is won, and maintaining an even flow of work for employees and plant facilities.

"Speed, accuracy, and consistency are the essential characteristics of a good printing bid. To obtain fast bids, some printers often sacrifice the two other characteristics. If the resulting estimate is too high, the printer will probably be underbid and lose the job. If the quote is too low, then he wins the contract at the expense of his profit. And if the bids reflect inconsistency in pricing over the long duration, customers may lose confidence in him and cut off requests for bids altogether.

"Estimating is also a time-consuming process involving numerous variables; e.g., quantity, number of pages and colors, paper weight and grade, man-machine hours, etc. Frequently, after considering all the fine details, the human brain completely overlooks paper costs or some other very obvious factor."

Laidlaw and his assistant, neither of whom had ever programmed a computer, came to Tymshare's Inglewood computer center for a day of orientation. They learned how to use the software and experimented with the classroom terminal keyboard. Then they went back to their plant and proceeded to write their own program in CAL, Conversational Algebraic Language. This is a highly simplified source language using English-like statements and algebraic formulas. It includes standard arithmetic operations, logical decisions, trigonometric functions, with key words such as DEMAND and DISPLAY for input-output.

The Impact

Laidlaw now describes the impact of the new system on his business: "Time sharing has added an invaluable competitive edge to our bidding. When an ad agency or ad manager is unable to pin down firm requirements, the computer can generate a wide range of pricing alternatives as an aid to decision making. Or when the specifications for a brochure or catalogue change after bids have been submitted, we can come back immediately with a new cost breakdown.

"Time sharing has also provided a way to keep on top of the fluctuating price of materials. Paper costs, for example, change continually. Frequently, price change notices are overlooked by human beings before a bid goes out. But now accuracy is machine-enforced. Once we have entered the necessary rate changes in our central program, we know the correct amount will be figured into the quotes automatically.

"Even the glamour of time sharing itself has exerted a strong influence on our business. Normally, the printer is expected to appear at the convenience and location of his customers. Many of our clients, however, are so impressed with computer bidding that they come to our office for a demonstration. We've even attracted some large printing contracts from back East."

Several years ago, L.A. Lithograph felt that the staff would have to be expanded to accommodate increased estimating requirements. "Today," says Laidlaw, "we are handling a higher volume of bidding than ever before and without increasing the size of our staff. Our estimates are faster and more precise. In less than a half-hour on the terminal, we can estimate a complex printing job which previously would have required two full working days. And in addition to estimating, we are now considering billing, subscription maintenance, and several other applications for future implementation."

Time Sharing vs. Direct Access

An aerospace executive has compared time sharing with batch processing, service bureaus, in-house computing, or any other form of computer usage, from personal experience. Asked about direct access to a small computer, he felt that there were many hidden costs and problems which could be avoided by time sharing. The monthly lease price of a



Douglas Laidlaw (left), co-owner of a Los Angeles printing firm, feels that time sharing has given his firm an invaluable edge in competitive bidding. In less than one-half hour, he now can estimate a complex, multi-color job formerly requiring two full working days. His firm is now printing five editions of TV Guide.

small-scale machine may be as little as \$1000, but program maintenance, debugging and support operations are expensive. Output formatting and data file manipulation create problems, he added.

"Immediate response" and "conversational mode" are two features mentioned by users who have tried both time sharing and batch processing. The carry-in, carry-out of computer batch processing stretches out the time required between problem statement and computed data. But one time-sharing subscriber has pointed out that the computer result itself is quite different with the interactive system. "Sometimes," he said, "you don't know what you're looking for when you start; you browse a little, check the feedback, and gradually the answer begins to emerge."

A government agency came up with a new twist to conversational time sharing. They are using the interactive environment of a time-shared computer as an automatic checkout system for diagnosing electronic equipment and components. To check out a circuit module, for example, the user applies a testing procedure according to machine instructions and reports the results on-site by terminal. In effect, the central program contains a decision tree. In the course of testing, the system may ask if the indicator light went on as a result of the last step. Upon a positive response from the user, the program sequences to a new step. A negative response causes the program to branch off to another set of checkout procedures.

Problem Orientation

Problem orientation is another feature attracting some converts to time sharing. One user said that it was almost



Engineer Richard Foy and wife, Nancy, tap into their time sharing terminal from their boat. Dick first started using the terminal as a design aid. Later his wife saw possibilities for a programming service firm and proceeded to launch what may be the world's first floating software house. By connecting Tymshare's data transceiver to their home phone, their children also use time sharing to do school assignments.

impossible to get non-computer personnel interested in the machine-oriented demands of most small computers. With time sharing, he has already succeeded in training 80 intra-company people to use the terminal keyboard. More than one user claims that his children do their homework on the system, using a portable unit and an audio magnetic data transceiver.

A modern time-sharing service can offer a wide range of software. CAL, the Conversational Algebraic Language, can be learned in less than a day. BASIC, a Basic Algebraic Symbolic Interpretive Compiler, is another widely-used and easily-learned language for Tymshare subscribers. For the more sophisticated, FORTRAN II and IV and a powerful text editor, QED, are available.

The Economics of Time Sharing

The economics of time sharing is really based on cost sharing. It places a million-dollar computer into your hands for a few hundred dollars per month. One time-sharing bureau, for example, offers its services for as little as \$13.00 per hour of connected time.

The remote terminal, which is a standard teletype unit, is available from the local phone company for as little as \$50 a month. In addition, an Audio Magnetic Data Transceiver allows you to operate from any standard telephone connection. The purchase price of this unit is \$475.00.

A typical subscriber can get good use out of the system for under \$200 a month, including terminal, data transmission costs and program storage. The latter cost may be \$3 a month for each 3000 byte unit over a 60,000 byte no-charge block. One user, with a 100,000-word data base, said that he can justify the cost of extra storage whenever he uses an on-site data file more than once a week.

Some users are even beginning to broker time on the system themselves, either as a service to customers or as a profit-making enterprise. One subscriber, in the San Francisco Bay Area, allows his customers to have direct access to the time-shared computer. So instead of sending an inquiry to an application engineer, this company's customers can put their request on-line. The computer program will then respond by matching up a complete tailor-made system with appropriate model numbers and modifications fitted to specification.

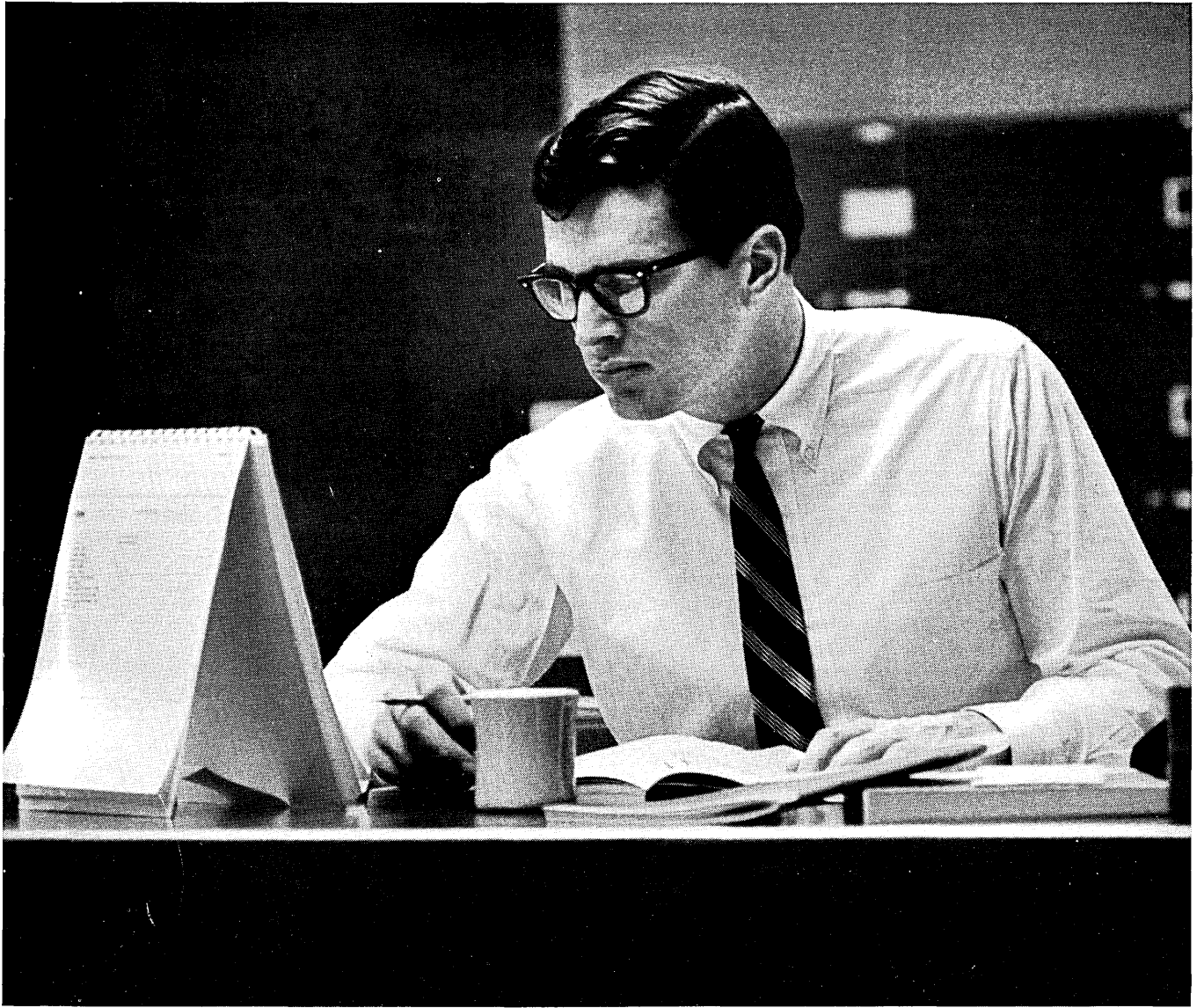
Concap Computing Systems of Berkeley, California, has established a spin-off business, offering a proprietary program stored in the Tymshare computer as a service to civil and structural engineers. Users have a faster and improved method of calculating stresses, strains, and structural dimensions without use of slide rule or customary data tables. With a breakdown of usage as clocked by the computer, Concap converts the monthly itemization into invoices and sends them on to their clients.

The Future: Aladdin's Lamp

All of these time-sharers — and hundreds more — are continuing to find new ways of using time sharing in research labs, hospitals, software houses, aerospace firms, banks, universities, manufacturing plants, and many other organizations.

What then is the future of time sharing?

It seems evident that we have hardly scratched the surface of uses for time sharing. The fact that an individual literally has a giant computer at his fingertips will open up a whole new dimension of applications for him that will be limited only by his creativity and imagination — in essence he possesses the Aladdin's lamp of the computer age.



The 20-minute education break.

For busy people who need to know.

Maybe you have a programmer who needs to brush up on COBOL, or a tab operator who needs to know about the IBM 85 Collator. Or you may know a junior executive who just wants to learn a little bit about data processing. IBM has an easy way to teach them.

It's called programmed instruction—P.I. for short.

P.I. is an approach to self-study that guides a student through the required material at the student's own pace, a step at a time. He can breeze through five or ten pages whenever there's some time to spare—at home or on the job.

Last year, some 100,000 students took IBM programmed instruction courses. And the results were gratifying. Students learned faster—27% faster on the average—and scored higher than did those in conventional lecture-discussion classes.

Right now there are 29 P.I. courses available to IBM customers covering punched card systems, computer fundamentals and computer programming. More are being developed.

But programmed instruction won't replace your local IBM Education Center. Some subjects are just too complex or too specialized to be taught by P.I. So we'll continue to operate our school system—providing a comprehensive curriculum for everyone from key punch operators to board chairmen.

Either way—sending the student to school or the school to the student—IBM education helps you and your people learn how to get the most productive work from your IBM system.

IBM Education: it's there when you need it. Just like the rest of IBM's services.

IBM®

ACROSS THE EDITOR'S DESK

Computing and Data Processing Newsletter

TABLE OF CONTENTS

Applications	52	Software	58
Organization News	54	Data Transmitters and A/D	
Education News	56	Converters	58
New Products		Input/Output	58
Digital	56	Data Processing	
Analog	56	Accessories	60
Memories	57	Business News	61

APPLICATIONS

COMPUTER CREATES PICTURES SEEN IN THREE DIMENSIONS

A computer at Brown University (Providence, R.I.) is creating pictures — as simple as a cube and as complex as a refinery pipeline — that can be seen in three dimensions. The 3D project has been undertaken by Charles M. Strauss, a graduate student, and Dr. Andries van Dam, assistant professor of applied mathematics, who is supervising this doctorate work in the Division of Applied Mathematics.

Mr. Strauss has created a program for the university's System/360 Model 50 which enables the computer to construct a pair of images, differing slightly in perspective, side by side on a television-like screen. When viewed through the stereoscope mounted in front of the IBM 2250 display screen, a person sees the two images merged into one with the added dimension of depth.



The images, geometric models stored in the computer's memory, can be manipulated on the screen

— enlarged, reduced, moved up or down or rotated — by pressing various keys on the display unit. In addition, a person can draw or alter the pictures generated by the computer through the use of a light pen.

Dr. Walter Freiburger, professor of applied mathematics and director of Brown's computing center, says that the use of a computer to create three-dimensional pictures has great potential for industry. "The petroleum industry, for instance, Right now scale models are constructed to check that the thousands of pipelines required for a modern refinery don't run into one another. It may be possible to do the same job — at a great saving in time and money — by giving the data in architectural plans to a computer and then inspecting the three-dimensional results on the screen."

BUSINESS FIRMS SEND DATA TO IRS ON MAGNETIC TAPE

More than 450 business firms used magnetic tape, rather than paper, in furnishing the Internal Revenue Service 28 million reports on 1966 payment of wages, interest, dividends, and other types of income, the IRS has reported. IRS said that information returns will be accepted either on magnetic tape or on paper. Previously returns were acceptable only in the form of paper documents.

By submitting reports on tape, these firms not only realize finan-

cial savings in data processing costs, but also in their shipping and paper costs, IRS said. IRS prefers magnetic tape reporting because it makes it easier to match the reported payments with amounts appearing on individual income tax returns. Tape reporting also reduces IRS handling costs.

The tape reporting program covers Forms W-2 for wages, withholding tax, and other types of income; Forms 1099 for interest, dividends, and certain other payments, and Forms 1087 for payments of interest and dividends by nominees. These forms are used by employers, banks, and corporations.

The magnetic tape reporting program does not change the existing requirement for companies to provide individuals with information of wages, interest, or dividends paid or tax withheld. It also has no effect on the requirement that a copy of the Form W-2 be attached to the individual income tax returns. Detailed information about reporting on tape appears in Revenue Procedure 67-31, which can be obtained from any IRS service center or district office.

PLOTTING SYSTEM CHARTS INVESTMENT DATA

Equipment similar to that being used to track our satellites and missiles now provides investment analysts with up-to-date charts of financial data. Waddell and Reed, Inc. (Kansas City), one of the largest mutual fund investment corporations

in the U.S., has installed a Milgo DPS-6 Digital Plotting System to provide them with graphs of the financial data handled by their two IBM 360 computers.

The Milgo Plotting System, manufactured by Milgo Electronic Corp., Miami, Fla., draws each graph, including the printing of numerals and written material, in less than five minutes on either sheets or rolls of paper. It provides a fast, hard-copy record for immediate use, as well as a permanent document for future reference. The graphs can be easily duplicated by any reproduction technique. All graphs are drawn to the same basic scale so that various types of information, charted at different times can be easily compared.

The Kansas City firm uses their DPS-6 Plotting System to produce graphs of comparative financial data for more than 600 companies, plus information on a number of basic industries. The graphs show stock trends and performance by company and by industry, as well as comparisons of factors such as relative earnings and price/earnings ratios. With the addition of the Milgo DPS-6, graphic data as current as the information fed into the computers is available for evaluation and analysis.

BODY RESPONSE TO NEW DRUGS PREDICTED BY COMPUTER AND GRAPHIC DISPLAY TERMINAL

A computer and a graphic display terminal are aiding researchers at The Upjohn Company (Kalamazoo, Mich.) in predicting how the body will respond to a new drug before it is given to volunteers on an experimental basis. Upjohn's laboratory computer is an IBM System/360 Model 30 which is linked to an IBM 2250 graphic display unit. Its "light pen" draws on the face of the tube and alters displayed data or enters new information into the computer.

Simulated study of the body is made possible by mathematical "road maps" or models of the body programmed into the computer. In addition, results of hundreds of experimental tests using many kinds of drugs also are programmed into the computer. These serve as the directional signs to suggest what course the new drugs will take once in the body. Drawing on this bank of information, researchers can predict when a new drug will reach

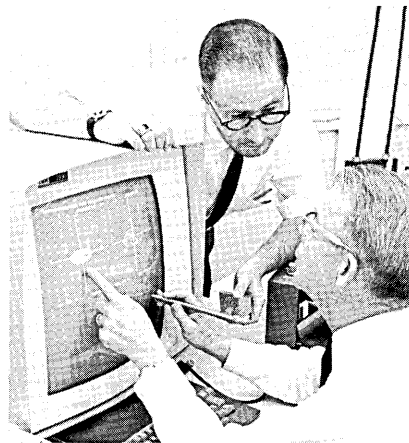
the digestive tract, when it will be absorbed into the blood stream, how long it will stay in the body and when it will be excreted.

If tests prove that a new drug's characteristics are not exactly what had been hoped for, mathematical changes are made and further testing is done on the computer to see if the alterations will achieve the desired results. Dr. John J. Woodward, Upjohn's Research Computer Center Manager, explained that the slightest alteration in the basic ingredients of a drug can result in a significant change in its characteristics.

"Before a drug is introduced on the market, an average of 20 million pieces of related information will have been recorded, retrieved and evaluated. Computer processing of this information is greatly reducing the span between discovery and introduction," Dr. Woodward said.

BECKMAN ENGINEERS DESIGN OPTICAL SYSTEMS WITH IBM 2250

The IBM 2250 display device, which is connected to a System/360 Model 40, allows engineers at Beckman Instruments, Inc. (Fullerton, Calif.) to experiment with different designs in an optical system and



immediately see the results. James L. Malakoff, left, chief of mathematical analysis at Beckman, and Dr. William S. Gallaway, senior scientist, are using the IBM 2250 to design the optical system of the infrared spectrophotometer shown on the right. The equipment also is being used to design instruments for the Nimbus D weather satellite. The patterns on the cathode ray tube of the 2250 represent the changes in focal qualities that would result

by making modifications to mirrors, lenses and prisms in an optical system.

IBM MICROFILMS MAINTENANCE DATA FOR BETTER SYSTEM/360 SERVICE

Detailed maintenance documents have been shrunk to microfilm size by IBM Corporation to help its customer engineers provide better service for System/360 customers. The company has cut extensive service reference data down to punched card sized sheets of microfilm — called microfiche — for its Field Engineering Division customer engineers who install and service IBM information-handling products.

Stored on the microfiche is detailed maintenance information including theory of operations, parts listings, fault locating tests, diagnostic listings, and programming maintenance data. To read the microfiche, the customer engineer simply inserts it in a mobile IBM document viewer. The viewer, which is marketed by the company, has indexing dials to make it easy to quickly locate any of the information contained on a single microfiche.

In addition to quick access to data, the advantages of microfiche to the customer engineer include reduced storage space and easy updating of information. In a typical System/360 Model 30 installation, a 3/4" stack of microfiche replaces a stack of service reference material 4 feet high. Each card contains up to ninety pages (8 1/2" x 11") of maintenance data. Weekly mailings of up-to-date information keep the reference material current. The customer engineer has only to replace four to ten microfiche a month, instead of inserting hundreds of single new pages into manuals.

Customer engineers now are using the service aid in more than half of the System/360 installations. By the end of the year, the company plans to have it in use at all such installations.

COMPUTER REPORTS TO AID REDSKINS

Players on the Washington Redskins have achieved one of the newest management status symbols in the executive big leagues — management reports produced via com-

puters. C-E-I-R, Inc., Washington, D.C., has been commissioned by the Redskins to produce weekly reports on game opponents. These will show the correlation between field situations and the plays called on offense and defense by their opponents.

The reports are geared primarily to give information on probability. For example, in a 3rd - and -2 - situation on its own 25 yard line in the second quarter and with the score even — is a foe likely to gamble and throw a bomb, or will it try to earn the two yards in a cloud of dust with a fullback plunge? How often may its linebackers be expected to blitz, and under what circumstances? The percentages on questions like these can be compiled to a close degree by a computer processing and calculating play inputs from previous games.

The end result is a printout handed to each player, his to study and absorb, which gives him the scoop on what Sunday's Foe may be expected to do. The computer printout includes formations on both offense and defense, pin pointing player location. The laws of probability have been calculated to a fine point by computer men. However, they concede that they cannot fully account for the squirrely quarterback who decides to pitch and pray from his own one yard line on the opening play of the game.

HOUSTON ARCHITECTURAL FIRM AIDED BY COMPUTERIZED IBM MICROFILM SYSTEM

A Texas architectural firm, Caudill Rowlett Scott, has developed a computerized microfilm file system enabling architects to stop "reinventing the wheel". By converting drawings and file material to IBM micro records, needed information can be retrieved and displayed, or reproduced, in a few minutes.

In the past, CRS, like other large architectural firms, was constantly redesigning many common construction features such as ships ladders, flashings and curbing. The only alternative was the even more time consuming task of retrieving a particular drawing from the company's file of completed projects (bins containing all records pertaining to the completed project) — located in a distant warehouse. Since there is no statute of limitations on the responsibility of architects in Texas, the firm retains its files permanently. In

addition to the time consumed, the usual results were frustrating failure.

CRS's system employs both aperture cards and microfiche. Aperture cards are standard sized punch cards with a film frame mounted in a window on the card. The CRS microfiche are sheets of microfilm containing up to 90 images. Projected data, reduced to microfilm, will be readily available in an area adjacent to the computer room.



If the architect wants to study the drawing, he drops the aperture card into a viewer. If he wants a hard copy, one can be produced in thirty seconds for him to study at his desk.

Under its developing program, CRS also is analyzing all of its design functions, coding them and entering the data into an IBM 1130 computer. When completed, the computer will contain references to projects by design elements. An architect seeking to learn how a particular problem was solved in the past will cite the factor and the 1130 will list the projects containing that particular element.

ORGANIZATION NEWS

TECHNICAL SERVICES EDUCATION CENTER BEING CONSTRUCTED BY NCR

The National Cash Register Company (Dayton, Ohio) has announced that construction will get underway this fall on its \$8-million Technical Services Educational Center south of Dayton. The facility is to be used to train worldwide NCR personnel in the maintenance and servicing of computer systems and other advanced electronic equip-

ment, and also to train personnel from the central part of the United States in the servicing of non-electronic NCR machines.

Plans call for an initial 14-building complex connected by all-weather walk-ways. Focal point of the campus-type facility will be three buildings housing 120 classrooms. Around these will be spaced seven residence halls, an auditorium and administration building, and a dining hall. Two of the classrooms will be three-story, consisting of lecture and laboratory space. The third will be a one-story structure containing classrooms and a computer center. Some 329,000 square feet of floor space will be involved in the project, which has been designed to permit possible future expansion.

Approximately 1200 students including some technical personnel from overseas countries, will be accommodated by the NCR school. They will be taught by a permanent faculty of 100.

\$85 MILLION FINANCING FOR DIEBOLD COMPUTER LEASING COMPANY

The formation and private financing of Diebold Computer Leasing, Inc. was announced by Mr. Ralph Weindling, President of John Diebold Incorporated and Chairman of the Executive Committee of the new company. He stated that the company "is believed to have the largest single credit lines — \$75 million — that a firm of this type has received from one credit source."

Three corporations — Commercial Credit Company, Bankers Leasing Corporation (a wholly owned subsidiary of the Southern Pacific Company) and The Diebold Group, Inc. (a wholly owned subsidiary of John Diebold Incorporated) — have participated in the development of Diebold Computer Leasing, Inc., a new company which has been formed to lease data processing and peripheral equipment. The new firm will specialize in the leasing of third generation computer equipment to businesses located throughout the United States and Europe.

Kuhn, Loeb & Co. and White, Weld & Co. arranged a private placement of \$6 million principal amount of Convertible Subordinated Notes due 1977 and 810,000 shares of Common Stock, for a total of \$10 million. In addition, a subsidiary of the Commercial Credit Company has

made available for the U.S. operations \$75 million in the form of a revolving credit.

The marketing and administration of the lease programs will be performed by Bankers Leasing Corp., Boston, Mass., a subsidiary of Southern Pacific Company.

ACME VISIBLE PURCHASES ASSETS OF AUTOGRAPHIC BUSINESS FORMS AND AUTOGRAPHIC REGISTER

Acme Visible, Crozet, Va., announce the closing of the purchase of the major part of the assets of Autographic Business Forms, Inc., and its subsidiary, the Autographic Register Company, with plants in South Hackensack, N.J., and Waynesburg, Pa. The total consideration involved more than \$3,000,000, paid to the sellers in cash and by assumption of indebtedness by the purchaser. No purchase of goodwill was involved.

The new acquisitions will be operated as separate subsidiary companies. Acme Datagraphic Business Systems, Inc., will succeed to the business at So. Hackensack, formerly conducted by Autographic Business Forms, Inc., and will specialize principally in the computer forms field. Dataflow Autographic Register, Inc., will succeed to the business at Waynesburg, formerly conducted by the Autographic Register Co. and will be geared to the production of multiple copy business forms.

DU PONT TO EXCHANGE INFORMATION WITH TOKYO FIRM

The Du Pont Company of Wilmington, Del., and the Sony Corporation of Tokyo, Japan, have agreed to an exchange of certain technical information and patent rights in the magnetic tape field.

Under the agreement, Sony will be licensed by Du Pont to manufacture in Japan video tape based on a chromium dioxide process developed by Du Pont. Du Pont will receive from Sony certain know-how and patent rights involving the manufacture of magnetic tape.

No other details were announced by the companies.

DATATRON, INC. — NEW MANUFACTURING COMPANY

A new manufacturing company, Datatron, Inc., has been formed to produce low cost, high performance digital data products, systems, timing instrumentation, and data transmission systems. Arthur L. Purcilly, formerly chief engineer at Astrodata, Inc., Anaheim, has been named president of the new firm headquartered in Santa Ana, Calif.

Work is underway on the company's initial contracts, a data-coupler to connect a digital tape recorder with a Bell or Western Union telephone data set and an analog data recording system complete with timing instrumentation.

Datatron will focus initially on two fields, data systems and products plus timing instrumentation. The third product area, data transmission is in research and development stages.

APPLIED DATA RESEARCH ACQUIRES MASSACHUSETTS COMPUTER ASSOCIATES

Applied Data Research, Inc. (Princeton, N.J.), a computer software and service company, has acquired Massachusetts Computer Associates, Inc., an advanced research and development company, it has been announced by Richard C. Jones, president, Applied Data Research, and Thomas E. Cheatham, Jr., president, Massachusetts Computer Associates.

Under the terms of the agreement, ADR acquired Massachusetts Computer Associates, a privately held company, in exchange for 72,000 shares of ADR common stock. Massachusetts Computer Associates, with headquarters in Wakefield, Mass., was founded six years ago, and has branch offices in New York and Washington, D.C. The company will operate as a wholly-owned subsidiary of ADR.

DATA PRODUCTS ACQUIRES REDCOR

Erwin Tomash, president of Data Products Corp., Culver City, Calif., has announced that agreement in principle has been reached to acquire Redcor Corporation, Canoga Park, an electronics computer peripheral manufacturer.

The transaction is subject to approval by the customary regulatory agencies and by the shareholders of Redcor Corporation. It would involve the exchange of two shares of Data Products common stock for each share of Redcor common stock. Based upon the 305,000 Redcor shares of common stock outstanding, the transaction is valued at approximately \$8,500,000.

Data Products Corporation is a major supplier to the data processing industry, both through its hardware divisions and through its software subsidiary, Informatics, Inc.

FARRINGTON MFG. CO. EXPANDING INTO VOICE IDENTIFICATION FIELD

The Farrington Manufacturing Company, New York, N.Y., a leading producer of Optical Character Readers, is expanding into the voice identification field by agreement to purchase Voiceprint Laboratories, Inc., Norville E. White, Chairman and President of Farrington, has announced. The agreement provides that Voiceprint Laboratories, with headquarters in Somerville, N.J., will be operated as a Farrington subsidiary.

Voiceprint identification is a method of identifying individuals by a spectrographic examination of their voices which is nearly as accurate as fingerprint identification. Mr. White said that Voiceprint identification "will become a useful and valuable tool in the data processing field. In addition to use in credit verification systems, it is expected that during the next few years voice identification will be used for direct communication between depositors and a bank's computers via telephone."

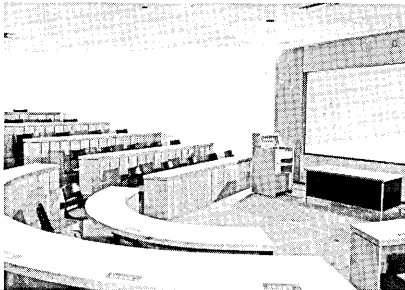
The acquisition involves transfer of common stock. It will not have significant short term effect on Farrington's sales or per share earnings, Mr. White said.

EDUCATION NEWS

STUDENT RESPONSE SYSTEM BEING USED AT SYRACUSE

New insights into the learning process in large classrooms are provided by a Student Response System installed in an advanced teaching facility at Syracuse University, Syracuse, N.Y., by the General Electric Research and Development Center. Each student in the 97-seat classroom has an input unit, which enables the student to respond to five-part, multiple-choice questions projected on a screen by the instructor. Each response panel consists of five pushbuttons, plus a sixth button that permits canceling and changing a response.

The percentage of students making each of the five multiple-choice selections is immediately displayed to the instructor. As a result, the instructor has a rapid and capable tool for measuring the effectiveness of his presentation — as he makes it. He knows whether to continue the pace and content of his lecture, to backtrack and review previously presented material, or to accelerate the pace.



The responses also can be automatically fed through telephone lines to the Center's GE-265 computer in Schenectady, N.Y., where they are analyzed and information about individual student performance is transmitted back to the instructor via teletype. Thus the instructor, with detailed information about individual student performance, is able to identify and assist students who are having problems.

The Student Response System at Syracuse University is being tested in courses in religion, sociology, psychology, statistics, education, and instructional communications.

WORKSHOP SERIES ON EDUCATIONAL TECHNOLOGY

A Workshop Series on Educational Technology is being sponsored by the Association for Educational Data Systems (AEDS). The current workshop series is an extension of the series begun in 1966. It consists of 14 workshops which began September 25th in Washington D.C. and will continue through April 1968 in cities from Florida to California.

These are designed to meet an increasing need for detailed information about educational technology. Specialists from education and industry present in-depth discussions on a variety of topics. Attendance is open to all interested in Educational Technology, with registration on a limited basis.

The Association for Educational Data Systems (AEDS) is a private, non-profit professional education association composed of individuals interested in the exchange of information in the area of educational data processing. More information on this workshop series may be obtained by writing or calling the Association for Educational Data Systems, 1201 Sixteenth St., N.W., Washington, D.C. 20036.

NEW PRODUCTS

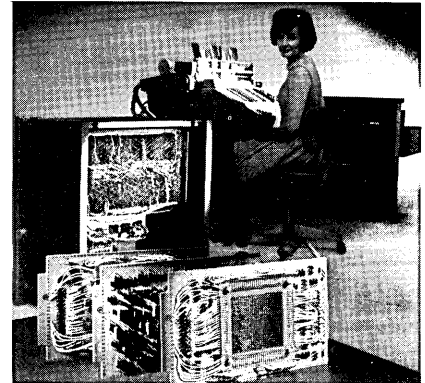
Digital

BURROUGHS ANNOUNCES E3000 ELECTRONIC ACCOUNTING SYSTEMS

Burroughs Corporation (Detroit, Mich.) has announced the new E3000 Electronic Accounting Systems. The most powerful of the family, the E3500, combines the advantages of solid state electronics, four-function arithmetic, the information storage ability of magnetic striped ledger cards, and expandable, electronic core memory. The E3500's solid state electronics permits handling of data in thousandths of a second.

Basic units of the system are an operator's control console with an alphanumeric keyboard, control keys, communications lights, a printer, and a transistorized electronic processor which contains the options

of 30, 50, 80 or 100 words of core memory. Optional peripheral units include an electronic ledger card reader, and either a card or paper tape punch.



— Magnetic core memory in options of 30, 50, 80 and 100 words, are features of E3000 Systems.

Data is entered into the system through magnetic striped ledger cards, the alphanumeric keyboard, the electronic ledger reader, or any combination. Processed information is produced on punched cards or paper tape, ledger cards and journals. The punched cards or paper tape produced by the system can be used as input to a larger computer.

The E3500, like other Burroughs systems, is pre-programmed to do the jobs specified by the customer. The system is delivered ready to plug in and go to work. A lower priced member of the new family, the E3200, includes all the features of the E3500 except the capability for handling magnetic striped ledger cards. These two systems are the first of a series of systems to be announced in the E3000 family. (For more information, designate #41 on the Readers Service Card.)

Analog

FEED FORMULATION COMPUTER

A special-purpose analog computing system which can provide savings of 50 cents to \$4 per ton of feed mix now is available from Electronic Associates, Inc., West Long Branch, N.J. The system, designated the Feed Formulation Computer (FFC), enables firms to optimize feed formulas automatically.

The specially engineered system, designed with speed and ease of operation as the prime considerations, provides immediate access to the knobs and switches which control the variables in the matrix blending problem — raw material, nutrient content, restrictions and cost. As many as 20 formulae can be updated in an hour allowing the user to keep pace with, for instance, rapidly changing market conditions of raw materials. The effects of changing the many variables in a mix are instantly and simultaneously indicated on a numerical readout device and can be printed out on command.

Users need no prior experience in operating computers to use the FFC. Experience in Europe, where the FFC has been marketed by EAI since last year, has shown that nutritionists and others involved in feed formulation can become expert in operating the system in less than a week. (For more information, designate #42 on the Readers Service Card.)

Memories

SECOND SERIES OF MAGNETOSTRICTIVE SERIAL MEMORIES FROM ANDERSEN

A new series of magnetostrictive serial memories, designated Type 3790, has been introduced by Andersen Laboratories, Inc., Bloomfield, Conn. The new series are designed for video display application in computer terminal or peripheral equipment. In video display, the new devices are intended to function as CRT refresh memories for the storage of graphics and data.

Type 3790 Andersen Serial Memories are self-contained packages including complete electronics. The memories operate well under wide environmental conditions including shock vibration, low or high temperatures and high altitudes. The casing consists of an aluminum casting fitted with a cold rolled steel cover, fully gasket sealed. Since terminals are arranged on one side only, a series of Type 3790 serial memories may be stacked.

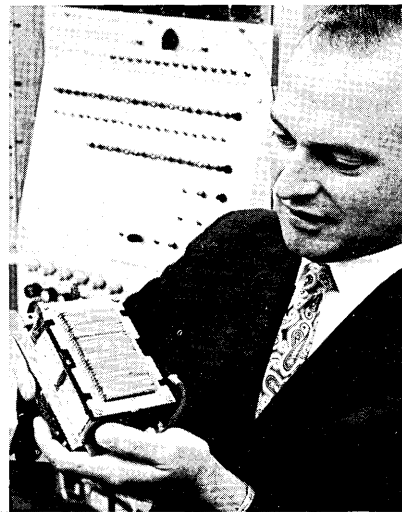
The new series is intended for commercial or non-military use. This concept, plus a high level of production has made possible the

achievement of a per bit storage cost of approximately 1 cent. (For more information, designate #43 on the Readers Service Card.)

SPERRY RAND'S UNIVAC DEVELOPS NEW MAGNETIC THIN-FILM MEMORY

Announcement has been made of the successful development of a magnetic thin-film memory which will be competitive in cost and superior in performance to core memories in the speed range of 200 to 400 nano-second cycle time. The new memory was disclosed by Gerald G. Probst, Vice President and General Manager of the UNIVAC Federal Systems Division of the Sperry Rand Corporation. The memory, now in pilot production, is planned for broad application as the standard memory in the UNIVAC Division's next generation of advanced militarized computers.

Special features of the new memory derive from its three-dimensional construction which provides for smaller stack size and form factor comparable to the latest ferrite-core stack designs. The design also reduces the number of electrical connections over typical word-organized plane, stack designs, and conventional core memories, thus providing greater reliability and lower manufacturing cost.



— Supervisory engineer holds a new magnetic thin-film memory stack, two inches thick by five inches long and 3½ inches wide.

The length of the word lines has been reduced by a factor of eight over past designs, thus facilitating high speed performance.

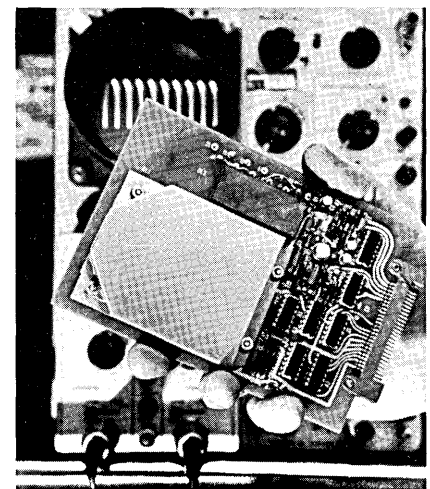
Stack construction is modular at the plane level. Word length is readily variable and requires no design change for the stack components.

The magnetic storage element employed in the new design is a modified version of UNIVAC'S MATED-FILM[®] element used in the UNIVAC 1230 computer. The MATED-FILM storage element requires much less digit drive and has significantly greater signal output than conventional film-memory designs.

The first production units are of the destructive-readout memory type and are being used for ground, sea or airborne applications meeting all applicable military specifications. Basic module size is 16,376 words. Non-destructive readout configuration of the SOLID-STACK memory is under final development for use in missiles, aircraft, and other applications which utilize the NDRO feature. (For more information, designate #44 on the Readers Service Card.)

GLASS DIGITAL MEMORY MODULES

Six new glass digital memory modules are available from Corning Glass Works, Corning, N.Y. These modules combine delay lines and integrated circuitry in one compact package. Interface problems associated with designing circuitry for delay lines are eliminated by the module concept.



The modules are carried on glass-epoxy circuit boards with edge card type connectors, ready for simple plug-in to standard logic circuitry. Data rate of the six modules ranges from 2.5 to 10 megabits, bit storage is up to 2500, and delay time ranges from 50 to

Newsletter

350 microseconds. Corning Glass memories are made of "zero TC" glass. The material has a nominal temperature coefficient of time delay of zero.

Applications for Corning memory modules are varied. They include computer displays, teletype and communications buffers, high speed printer and plotter buffers, and computer shift registers and scratch pad memories. They also can be utilized in small special purpose computers that control numerical control machine tools, communications message switching, and missile guidance and weapons systems.

(For more information, designate #45 on the Readers Service Card.)

Software

6000 SERIES COBOL / Control Data Corporation, Minneapolis, Minn. / Statements can be converted to machine language at a rate of six thousand statements per central memory minute. It also has the ability to read tapes not created on 6000 Series Computers. Features include levels of diagnostics, mass storage input and output, and the SORT verb. Data sharing by separately compiled programs through a COMMON STORAGE section also is possible. 6000 Series COBOL is upward compatible with 3600/3800 COBOL. (For more information, designate #46 on the Readers Service Card.)

COTRAN / Software Resources Corp., Los Angeles, Calif. / Converts source language COBOL statements for older machines into IBM System/360 E level COBOL; has high percentage of translation effectiveness. In addition to translated source statements, output includes comparison of old and new statements, documented with over 25 different explanatory flags. Translation packages are provided for IBM 1410/7010, 7090/7044, 7070/7074, 7080 and 7090/7094 equipment. COTRAN will run on any IBM System/360 Model 30 with a 32K byte memory or larger. (For more information, designate #47 on the Readers Service Card.)

RAX (Remote Access Computing System) / IBM Corporation, White Plains, N.Y. / Program enables many persons in an organization to work simultaneously on individ-

ual projects with help of central computer (System/360 Models 30, 40 or 50). Users communicate with computer through either an IBM 1050 data communications system, or the IBM 2260 visual display station; programming language is FORTRAN. RAX is available to System/360 users through the IBM program library in Hawthorne, N.Y. (For more information, designate #48 on the Readers Service Card.)

Data Transmitters and A/D Converters

MULTI-PURPOSE REMOTE DATA TERMINAL

The DLC-08 is a Remote Data Terminal, manufactured by Digital Logic Corporation, Anaheim, Calif., which uses a small computer as the basic I/O controller, and transmits data via DATA-PHONE. The overall system consists of an I/O Processor Unit, a small general purpose computer with 4096 words of core memory and an ASR-33 Teletypewriter.

This System, used as a remote data terminal, can control data transfers for up to seven input/output devices. Each device is assigned a fixed priority level within the I/O Processor Unit. The I/O Processor Unit provides control for data transfers into and out of computer memory. I/O transfers have priority over the computer and are interweaved with other active programs.

Of importance to the multi-purpose user, there are only three instructions required to initiate a data transfer. These are: TEST INTERRUPT, RESET INTERRUPT and EXECUTE OPERATION. All control circuits, current address, and word count registers for each device are an integral part of the System. No additional interface electronics between the terminal and a device is required.

Utilization of a general-purpose computer in the System provides extended capability for diversified data processing uses. However, for Remote Data Terminal applications, the computer is used primarily to control the I/O Processor and provide a data-storage buffer between terminals. It also performs data check-summing, and can be used for code conversion, logging or other pre-processing computation. (For more information, designate #49 on the Readers Service Card.)

Input-Output

CONTROL DATA 200 USER TERMINAL

Control Data Corp., Minneapolis, Minn., has introduced a new input-output terminal for use in remote batch and real-time data processing applications. The new device, designated Control Data® 200 User terminal, consists of a visual entry-display station (CRT display with keyboard input), a card reader, and a line printer (or an automatic typewriter). A large number of 200 User Terminals may share a single computer system over common carrier lines.

The CDC® 200 User Terminal can operate in two separate modes — "block mode" and "line mode". Block mode provides conventional batch data processing capability. Line mode offers conversational interaction between the remote user and the central computer.

**RANDOLPH
COMPUTER
CORPORATION**

**Leasing specialists,
IBM System/360.**

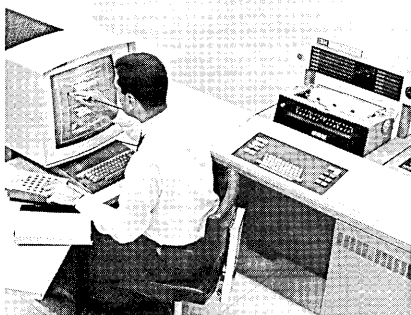
**Pan-Am Building,
New York, N.Y. 10017
212 YU 6-4722**

The 200 User Terminal has a 1000 character buffer for each display, card reader and line printer. The unit also has error detection and automatic retransmission, printing speed of up to 300 lines per minute (80 or 136 columns), full 63-character print and read set, unattended printing, blanks and zeros suppressed on print transmission, card reading speed of 100 cards per minute, and continuous reader checking.

A controller for the visual entry-display station in the 200 User Terminal is mounted in the station's base. Interface between the terminal and the central computer is provided by a Bell System data set. (For more information, designate #51 on the Readers Service Card.)

SMALLEST IBM COMPUTER GETS GRAPHICS DISPLAY

This new model of the IBM 2250 graphics display unit permits users to exchange visual information with IBM's lowest-cost computing system, the desk-sized IBM 1130 (right). The new equipment was developed especially for scientists, engineers and designers who need fingertip access to their computers. The display enables them to work with diagrams, charts, drawings, or printed letters and numbers directly on the face of a television-like screen.



With a "light pen", a user can revise images, add or delete lines, modify curves, or change dimensions. He also can change information and images on the screen through the 1130 and 2250 keyboards. When the user wants a more powerful computer, he can link his combined 1130/2250 system to a larger IBM System/360 through standard communications lines. (For more information, designate #54 on the Readers Service Card.)

FRIDEN INTRODUCES THE 7100 CONVERSATIONAL MODE TERMINAL

A keyboard/prINTER data communications terminal which provides on-line access to a computer has been announced by Friden, the business machines division of The Singer Company, San Leandro, Calif. The new Friden 7100 Conversational Mode Terminal (CMT) is designed for use in time-shared computer systems of all types and may be used for on-line programming, information retrieval, documentation, and scientific analysis.

The 7100 CMT incorporates the USASCII (United States of America Standard Code for Information Interchange) language and operates at 12.2 characters per second. It is self-contained, portable, and has integrated circuit logic for maximum reliability and minimum downtime.

Other features include an automatic color ribbon shift which allows the operator to print in red and the computer's response to print in black; upper and lower case; a 13 inch writing line; and a full 128 character USASCII typewriter-like keyboard.

The new Friden 7100 Conversational Mode Terminal will be available for delivery in the fourth quarter of this year. (For more information, designate #50 on the Readers Service Card.)

DATA ENTRY KEYBOARD FEEDS INFORMATION TO COMPUTERS FROM THE SOURCE

Colorado Instruments, Inc., Broomfield, Colo., has introduced a new computer data entry keyboard, called C-Dek®, for simplified source data entry. The new device is designed for custom applications in recording systems requiring the entry of raw data into computers by persons unfamiliar with data processing equipment. The desk-top C-Dek instrument is built to customer specifications from standard modules.

Each C-Dek is usually designed around an already-existing format provided by the user. This may be nothing more complicated than the printed form the C-Dek will replace. This format is actually superimposed over the keyboard by use of an overlay. Thus the equipment is transformed from an anonymous array of keys into an order form, parts

requisition, or some other meaningful pattern with which the operator is familiar. The result is complete compatibility with the present systems and a minimum of confusion.



— C-Dek® data entry keyboard being used to record aircraft maintenance accounting information.

The C-Dek unit can be built to produce any code level output (5-, 6-, 7-, or 8-level) for true compatibility with existing data processing systems. Recording speed is limited only by the speed of the receiving device. Thus, speeds can be from 10 characters per second to 400 or more for on-line computer readout. The keyboard operates on 115-volt 60 Hz AC power.

The C-Dek keyboard is designed to be used in such diverse applications as production data recording, maintenance shop parts accounting, inventory control, order processing, labor accounting, and payroll preparation. Maximum application adaptability is accomplished by the modular construction of the C-Dek itself and the use of accessory output components (when needed) to produce printed records, punched tape, or a direct line output. (For more information, designate #52 on the Readers Service Card.)

OPTICAL SCANNER READS 4000 LINES A MINUTE

Farrington Manufacturing Company, New York, N.Y., has introduced a new multifold optical character reading machine capable of reading up to 4000 lines a minute of printed data from cash register, accounting and adding machine tape. The new Model 3040 Journal Tape Reader automatically converts the data it reads into magnetic tape for automatic data processing.

Desired data is stored in the reader memory for later transfer to

the computer. Data can be stored in unit records of any length up to 40 characters for each document. Unit records can be combined into a block of up to 1024 characters. Transfer of data to the computer is automatic and occurs when the reader storage reaches its pre-programmed capacity. If the computer is capable of accepting characters from the reader at any rate over 15,000 characters per second, there is no delay in the reader's operation.

Reading rates over 4000 lines a minute are possible with the new Farrington equipment depending on line length and spacing. Printing zone is a band parallel to the edge of the tape. Characters may be printed on the tape at a density up to 10 characters per inch. Lines can be spaced on the tape at 6, 5, 3, 2½, or 2 lines to the inch.

Multifont reading capability enables the new Model 3040 to be used with a wide range of equipment producing tape in a variety of fonts including Farrington 12 F and 12 L, NCR National Optical Font, IBM 1428, USA Standard - A and B.

A slightly modified "on-line" version of the 3040 can be supplied that can transfer optically read data directly into a computer system. (For more information, designate #55 on the Readers Service Card.)

DEVICES DEMONSTRATE COMPUTER PRINCIPLES

A series of animated "Computer Demonstration Devices" have been developed by Lester Associates, Inc., Thornwood, N.Y. Lights and simple numerical readouts graphically explain the theory and working principles of computers. After an instructor has explained and demonstrated a computer principle or function through the use of one of the devices, students, trainees or executives can flip switches or push buttons themselves to get a clear and concise picture of just what would be happening in the computer.

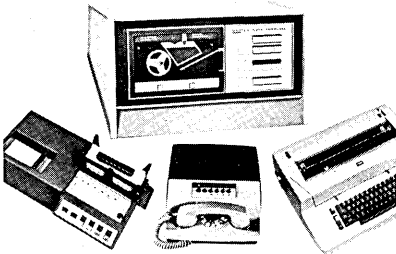
The subjects covered by the devices are: Binary Numerical Principles, Bistable Logic Building Blocks, Computer Logic Principles, Four Digit Adders, Flip Flop, Shift Register Principles, Memory Access, Computer Control, Program Cycle Principles and Computer Operation. The ten 2' x 3' x 4" units are stur-

dily constructed of wood, plastic and metal. (For more information, designate #53 on the Readers Service Card.)

DATA TERMINAL ANNOUNCED

The Dartex Division of Tally Corporation, Seattle, Wash., has announced the availability of a new low cost input/output data terminal. The device, called the Dartex Data Terminal, can convert keyboard, punched card, or paper tape data onto magnetic tape for data transmission or high speed computer entry.

When interfaced to a data phone, the terminal can send or receive data over ordinary telephone lines at 1200 words per minute. It also offers unattended operation and automatic retransmission of data received in error.



A typewriter option to the terminal provides both data entry and hard copy print-out. A card reader option converts punched card data to magnetic tape at 75 cards per minute. The terminal also converts paper tape data to magnetic tape.

The Dartex Data Terminal can record or reproduce data at 1600 characters per second for high speed computer input/output. Most common application for this feature is an interface to the IBM 360 for data entry using the 360 multiplex channel. (For more information, designate #56 on the Readers Service Card.)

Data Processing Accessories

CYBE-TESTER, A COMBINATION MAGNETIC TAPE CLEANER/TESTER

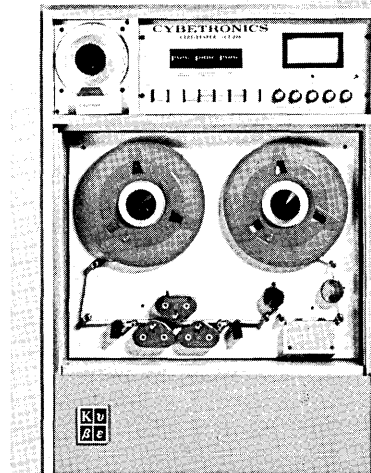
A new Magnetic Tape Cleaner/Tester combination is available from Cybetronics, Inc., Waltham, Mass.

The newsystem can identify any bad tapes — eliminating failure during computer operation. It may also be used to evaluate new tapes before they are accepted as perfect.

The Cybe-Tester Model CT-100 is a simple-to-operate, self-contained machine which is adjustable to any tape standards. The operator selects the density and tape format (7 channel, 9 channel, full-surface testing) and loads the tape. During the forward pass the tape is cleaned. At the completion of the forward cleaning pass, the system reverses and tape testing automatically begins.

The forward cleaning pass takes 3 minutes; the reverse testing pass takes 7 minutes for a total of 10 minutes for a 2400 foot reel. The Cybe-Tester may be stopped at the end of the first pass to clean or replace the tape reel, if required.

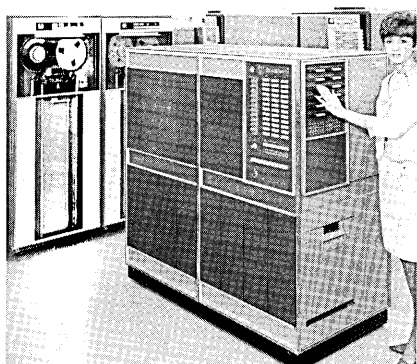
The device will count the number of computer "write skip" dropouts, hypercritical or marginal signal dropouts at a higher threshold and the number of skew errors. Tape footage and error locations also are displayed.



Applications of the Cybe-Tester include (1) Vendor Analysis of new tape, (2) Quality assurance controls for new tape, (3) Real time or other critical computer uses where failure cannot be tolerated, (4) Regular preventive maintenance testing of tapes, and (5) retention of new tape allowance for trade-in by in-house testing. (For more information, designate #57 on the Readers Service Card.)

COMPUTER PERFORMANCE MEASURED BY EXPERIMENTAL MACHINE

An experimental machine which monitors the performance of complex computer systems was described at the 20th National Conference of the Association of Computing Machinery, by Franklin D. Schulman, of IBM's Systems Development Laboratory, Kingston, N.Y. The device, called a performance recorder, can measure 256 operating conditions at one time. It is fast enough to perform several operations between the execution of two instructions of a computer (each operation as fast as 150 billionths of a second).



The performance recorder collects data on some computer conditions which never before have been measurable as well as measuring others more accurately. "The performance recorder will pinpoint those areas of the system which are inefficient and allow us to correct them," Mr. Schulman said.

The computer monitor provides "electronic stopwatches" for checking millions of operations every second. It will give information on almost any operation or state which can be timed or counted or detected. As more elaborate programs are developed, the computer — with the performance recorder — will be able to take a more active part in directing its own analysis while continuing normal operations (in "real time"). (For more information, designate #58 on the Readers Service Card.)

BUSINESS NEWS

CONTROL DATA REPORTS ON PROGRESS FOR FISCAL 1967

Sales, rentals and service income of Control Data Corporation and its subsidiaries amounted to

\$245,170,627 for the year ended June 30, 1967, an increase of 43% compared to \$171,272,946 reported in the same period last year. Net earnings for the year ended June 30, 1967 were \$8,405,792, as compared with a loss last year of \$1,677,586. After preferred stock dividends, the earnings per share, based on average shares outstanding, were \$0.98 versus \$0.36 per share loss last year.

William C. Norris, Chairman of the Board and President of Control Data Corporation said that the past year had been one of the most successful in the Company's history. Revenues, he added, reached new highs as Control Data continued its worldwide growth.

SOFTWARE SYSTEMS, INC. SHOWS PROFIT IN FIRST YEAR OF OPERATIONS

In the first annual report to stockholders, Dr. Harry J. Older, president of Software Systems, Inc., Falls Church, Va., disclosed that the company showed a net profit after taxes of \$7,673 on net sales of \$375,646, during its first fiscal year of operation, ending June 30, 1967.

The firm, formed originally in Washington, D.C. in March 1966, moved to Virginia in July, 1967, where 30 employees now are engaged in a wide variety of computer programming and system analysis work.

A special feature of the fiscal 1967 operations has been the work in analyzing and processing test data arising from applied research in the social sciences, particularly in the field of education.

SYSTEMS ENGINEERING LABORATORIES, INC. REPORTS SALES UP FOR FISCAL 1967

Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., reports sales of \$8,026,579 for the fiscal year ended June 30, 1967, up 30% from the preceding year and net income of \$303,508. For the previous fiscal year, the company reported sales of \$6,163,267, and a net loss of \$403,053. Orders secured for systems and products during the fiscal year were \$11,022,000, as compared with \$6,593,000 for the previous year. The backlog at June 30, 1967 was over \$7,500,000, a new high for the company.

PLANNING RESEARCH REPORTS RECORD PROFITS FOR YEAR

After-tax earnings of Planning Research Corp. (Amex & PCSE) for fiscal 1967 increased 38% to a record \$931,573 compared with \$676,068 a year earlier. Earnings per share were \$1.25 compared with 94 cents per share the previous year.

Revenues and earnings do not include two recently announced acquisitions, Alan M. Voorhees & Associates of Washington, D.C. and Behavior Science Corp., Los Angeles. The acquisitions have not yet been legally finalized. The consolidated figures will add several cents per share to earnings.

GAINS REPORTED BY BECKMAN INSTRUMENTS

Beckman Instruments Inc. of Fullerton, Calif., has reported a 26% gain in earnings on a 14% increase in sales for the fiscal year ended June 30. Earnings for the year were \$6,088,446, on sales of \$129,854,364, compared with earnings of \$4,827,772 on sales of \$113,771,543 a year ago.

The 1967 earnings and sales figures are new records for the company.

UNIVERSAL DATA PROCESSING REPORTS RECORD RESULTS FOR FISCAL 1967

Universal Data Processing Corp. (UTC), Los Angeles, Calif., had a consolidated net income of \$139,012 for the fiscal year ended June 30, 1967, as compared with \$101,746 for fiscal 1966. Sales for the year were \$2,120,267 as compared with \$1,550,286 a year earlier.

William C. Clauer, president, said the earnings gain was achieved in spite of the fact that fiscal 1967 earnings were subject to federal income taxes. No taxes were paid in 1966 due to availability of an operating loss carryforward. Fiscal 1967 taxes were reduced by an investment credit carryforward, however.

Earnings before taxes were \$171,512, for fiscal 1967, an increase of 67% over pre-tax earnings of \$101,746 for the previous year.

NEW CONTRACTS

TO	FROM	FOR	AMOUNT
URS Corporation, San Mateo, Calif.	U.S. Army Engineer Research and Development Laboratories	Continued development of an automatic data processing system for use by the Army field forces	\$3,700,000
Sperry Rand Corp., UNIVAC Division, Philadelphia, Pa.	Naval Ordnance Systems Command, Washington, D.C.	Computer equipment and programming for the digital fire control system adopted by the U.S. Navy for its Talos surface-to-air missile system	over \$2 million
	Selenia Electronic Associates (S.P.A.), Rome, Italy	Computing equipment for the Italian Navy to implement its future defensive mission in the North Atlantic Treaty organization	\$1,681,990
Planning Research Corp., Los Angeles, Calif.	U.S. Navy	Two data processing studies under contracts providing for the continuation of studies for advanced automatic data processing systems for the Naval Command Systems Support Activity	about \$1,600,000
Control Data Corp., Military Systems Div., Washington, D.C.	Defense Supply Service	Development of a computer software system for the Department of the Army	combination total of over \$1 million
	Marine Engineering Laboratory, Department of the Navy	Indexing and abstracting information from studies made on amphibious landing craft to implement a library information retrieval system within the Marine Engineering Laboratory	
Data Products Corp., Culver City, Calif.	Cubic Corp., San Diego, Calif.	More than 35 Data Products LINE/PRINTERS and high-speed punched card readers, manufactured by Uptime Corp., a subsidiary of Data Products. Equipment will be incorporated into major computer peripheral systems Cubic is producing for the NATO Air Defense Ground Environment system (NADGE)	over \$1 million
Electronic Associates, Inc., West Long Branch, N.J.	NASA's Ames Research Center	Preliminary analysis and final model development of complex systems in the aerospace, science, bio-medical, engineering and statistical technologies — services provided will include application investigation, programming, software development and maintenance	\$990,000
Computer Applications Inc., New York, N.Y.	Naval Ships Systems Command, Department of the Navy	Support and analysis software for the AN/SQS 26 (SN-2) sonar data acquisition system	over \$750,000
Standard Telephones and Cables Ltd., a subsidiary of ITT, London, England	British Post Office	Equipment to be used in the British computer-data transmission network	\$700,000
Sanders Associates Inc., Nashua, N.H.	Kaiser Foundation Hospital, San Francisco, Calif.	CLINI-CALL [®] Data Management System to speed up patient admissions, medical treatment and discharge — equipment will include computers, data display terminals, hard copy printers and related equipment	\$500,000
Itek Corp., Bedford, Mass.	U.S. Air Force, Aeronautical Systems Div., Wright-Patterson AFB	Twenty-three special Reader-Printer units for shipboard naval reconnaissance use	\$291,000
The Franklin Institute Research Laboratories, Philadelphia, Pa.	National Highway Safety Agency, U.S. Department of Transportation	A study to see how present emergency medical care systems for saving lives may be reorganized and augmented by space-age technology and recent battlefield experience in Korea and Vietnam	\$260,000
The Bunker-Ramo Corp., Defense Systems Div., Canoga Park, Calif.	U.S. Army Engineers Research and Development Laboratory	Digital computer equipment for use in the Rapid Combat Mapping System (RACOMS)	\$250,000
Adams Associates, Bedford, Mass.	M.I.T. Lincoln Laboratory	Extension contract for assisting the Laboratory in its continuing research and further development of graphic systems for the Laboratory's TX-2 computer	\$245,000
Computing and Software, Inc. (CES), Data Systems Division, Panorama City, Calif.	National Aeronautics and Space Administration	Conducting research and development in the area of flight physiology data reduction and analysis at NASA's Flight Research Center, Edwards, Calif.	over \$200,000
Computer Sciences Corp., El Segundo, Calif.	U.S. Air Force	Development of a computer-based model to simulate the Air Defense Command's satellite-tracking system	\$175,000
Brandon Applied Systems, Inc., New York, N.Y.	National Library of Medicine	One-year contract to modify, refine and maintain computer programs for NLM's MEDLARS system, a central medical information service	\$111,000
Scientific Data Systems, Santa Monica, Calif.	Recognition Equipment Inc., Dallas, Texas	Ten SDS 910 computers for use as Programmed Controllers in Recognition Equipment's Electronic Retina Computing Readers	—
Planning Research Corp., Los Angeles, Calif.	Office of the Assistant Secretary of Defense (Systems Analysis)	Designing, programming, implementing, testing, and documenting an Airlift Simulation Model	—
Computer Usage Company (CUC), Mt. Kisco, N.Y.	Florists Transworld Delivery Association	Providing all data processing for the Complete Billing Service system of FTD	—

NEW INSTALLATIONS

<u>OF</u>	<u>AT</u>	<u>FOR</u>
Control Data 3300 computer system	Memorial Hospital, Long Beach, Calif.	Applying new information processing techniques to hospital operations
Control Data 6400 computer system	University of Arizona, Tucson, Ariz.	Academic research, teaching, and processing the University's business-type problems
GE-425 computer	Abbott Laboratories, Chicago, Ill.	A variety of business and scientific tasks, including customer accounting, production control, and pharmaceutical research
Honeywell DDP-416 computer	U.S. Atomic Energy Commission, Health and Safety Laboratory, New York, N.Y.	Use in on-line experiments designed to provide new methods of identifying the source and type of radioactive samples
IBM System/360	Milwaukee Road, Chicago, Ill.	Updating "Carscope", the Milwaukee Road car reporting center
IBM System/360 Model 44	C-E-I-R, Inc., San Francisco, Calif.	Supplementing service already available on IBM 360/65 and 360/30 computers; will be used primarily as a FORTRAN program processor
IBM System/360 Model 65	Matrix Corp., El Segundo, Calif.	Faster, more economical computer utility to Matrix customers; the computer service center is heavily committed to the time-sharing concept
	ITT Data Services, Western Regional Computer Center, El Segundo, Calif.	Increasing the center's capabilities to meet the complete data processing requirements of any computer user, ranging from the solution of complicated scientific problems to simple payroll processing
IBM 1130 computer system	William Ferrel, Inc., Toledo, Ohio	Helping stabilize the company's normally cyclical mechanical contracting business; will be used for new project planning and sales and market analysis
NCR 315 computer system	L. S. Heath & Sons, Inc., Robinson, Ill.	Handling customer accounting, inventory, payroll and specialized applications
NCR 315 RMC computer system	Pennsylvania Liquor Control Board, Harrisburg, Pa.	Cutting costs and improving retail service to the public; improving the efficiency of the board's statewide operations
NCR 500 computer system	Richards and Wallington (Plant Hire) Ltd., Birmingham, England	Helping management control the profitable employment of several hundred units, ranging from tractors to 100-ton cranes; also will handle general accounting
SDS Sigma system (includes a Sigma 7 and a Sigma 2)	Albert Einstein College of Medicine of Yeshiva University, Bronx, N.Y.	Serving as the nucleus for a physiological research computer center; when in full operation, research laboratories throughout the College of Medicine will be simultaneously connected directly to the Sigma 7
UNIVAC 418 computer	Woodward Iron Co., Woodward, Ala.	Initial use in inventory control, order writing and general accounting; also for blast furnace burden calculation for determining an economical ore mix
UNIVAC 490 computer system	Italsider S.p.A., Cornigliano, Italy (Italy's largest steelmaking concern)	Production control, order acceptance, programming and control of shipments, physical control of inventories, raw materials, semi-finished products, work in progress and finished products, cost control, research studies and other applications
UNIVAC 492 computer	Union Bank of Switzerland, Geneva and Zurich (2 computers)	Batch processing of deposit and current accounts, savings accounts, handling of stock exchange and foreign exchange transactions, and in billing tasks for such customer organizations as doctors' associations etc.
UNIVAC 494 computer system	British European Airways, London, England (2 systems)	Replacement of two 490 systems which have been operating the airline's electronic reservations system; additionally, the new systems will comprise part of a total system called BEACON (BEA Computerized Office Network) (systems valued at more than \$3.5 million)
	State of Louisiana, Division of Administration, Baton Rouge, La.	Availability to all state agencies on a time-sharing basis with each agency retaining complete autonomy and absolute control over its own input and over usage made of computer output from its own records (system valued at \$2.7 million)
UNIVAC 9200 computer system	Woodward Iron Company divisions: Western Foundry Co., Tyler, Texas; Golden Foundry Co., Columbus, Ind.; Alabama Pipe Co., and Anniston Foundry Co., both in Anniston, Ala. (5 systems — one location to be determined later)	Invoicing and payroll processing; data communication links will tie in with the central computer at Woodward
	Western Standard Life Insurance Co., Amarillo, Texas	Handling claims and general accounting, calculating agents' commissions and premium billing
	Ocean Science & Engineering, Inc., Bethesda, Md.	Providing management and engineering planning information and also for general accounting purposes
UNIVAC 9300 computer system	Fuller & Dees Marketing Group, The Favorite Recipes Press Division, Montgomery, Ala.	Accounts receivable, accounts payable, marketing and sales analysis, and book club accounting
	United States Jaycees, Tulsa, Okla.	Maintaining mailing files, chapter rosters, membership dues billing, inventory control and supplies invoicing; also aid in distribution of two national monthly magazines with circulation of 340,000 copies

MONTHLY COMPUTER CENSUS

The number of electronic computer systems installed or on order changes rapidly. The following is a summary made by "Computers and Automation" of reports and estimates of the number of general purpose electronic digital computers manufactured by companies based in the United States. These figures include installations and unfilled orders inside and outside of the United States. These figures are mailed to the individual computer manufacturers from time to time for their information and review and for any updating or comments they may care to make. Our readers are also invited to submit information that would help make these figures as accurate and complete as possible.

From the start of our magazine in 1951, our policy has been to publish "factual, useful, and understandable" information -- with emphasis on "factual". It has become increasingly difficult to substantiate the research performed by "Computers and Automation" to confirm

figures we desire to publish in our Monthly Computer Census. As soon as we have the necessary cooperation from certain manufacturers, we hope to return to publishing additional data on computer installations by type of computer.

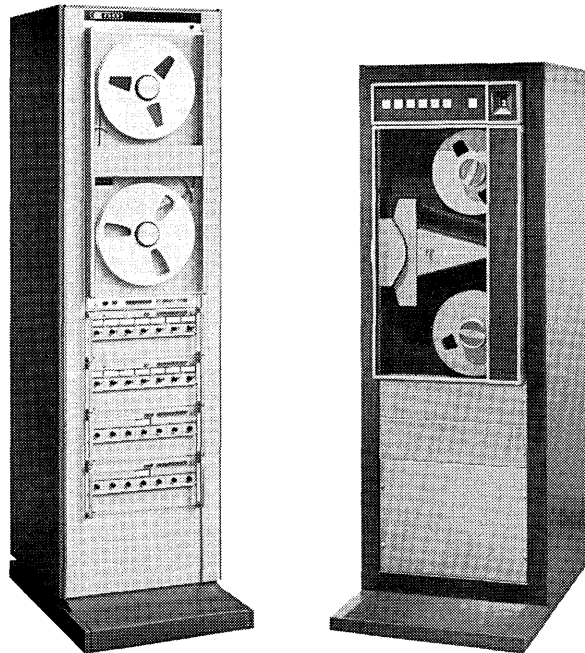
The following abbreviations apply:

- (R) - figures derived in part from information released directly or indirectly by the manufacturer or from reports by other sources likely to be informed
- (N) - manufacturer refuses to give any figures, and refuses to comment in any way on the figures stated here beyond saying that they are not correct
- X - no longer in production
- C - figure is combined in a total -- see below
- E - figure estimated by "Computers and Automation"

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	MANUFACTURER'S TOTAL INSTALLATIONS	NUMBER OF UNFILLED ORDERS	MANUFACTURER'S TOTAL ORDERS
Autonetics (R)	RECOMP II	11/58	30		X	
	RECOMP III	6/61	6	36	X	0
Bunker-Ramo Corp. (R)	BR-130	10/61	160		X	
	BR-133	5/64	62		X	
	BR-230	8/63	15		X	
	BR-300	3/59	18		X	
	BR-330	12/60	23		X	
	BR-340	12/63	19	297	X	X
Burroughs (R)	205	1/54	38		X	
	220	10/58	31		X	
	B200 Series, B100	11/61	790		31	
	B300 Series	7/65	292		150	
	B2500	2/67	7		45	
	B3500	5/67	2		50	
	B5500	3/63	71		19	
	B6500	2/68	0		6	
	B8500	8/67	0	1230 E	4	310 E
	Control Data Corp. (R)	G-15	7/55	285		X
G-20		4/61	23		X	
LGP-21		12/62	159		X	
LGP-30		9/56	322		X	
RPC-4000		1/61	73		X	
046/136/636		-	28		C	
160*/8090 Series		5/60	594		X	
924/924A		8/61	30		X	
1604/A/B		1/60	59		X	
1700		5/66	48		C	
3100/3150		12/64	87		C	
3200/3300		5/64	132		X	
3400		11/64	20		C	
3600/3800		6/63	57		X	
6400/6500/6600		8/64	49		X	
6800	6/67	0	1938 (as of June 30)	C	320 E	
Digital Equipment Corp. (R)	PDP-1	11/60	59		X	
	PDP-4	8/62	55		X	
	PDP-5	9/63	114		X	
	PDP-6	10/64	22		X	
	PDP-7	11/64	165		C	
	PDP-8	4/65	795		C	
	PDP-8S	9/66	300		C	
	PDP-9	12/66	24		C	
	PDP-10	7/67	0	1534	C	600 E
	8400	6/65	21	21	7	7
Electronic Associates, Inc. (R)	AST 210	4/62	26		X	
	AST 2100	12/63	7		X	
	ADVANCE 6020	4/65	14		11	
	ADVANCE 6040	7/65	7		3	
	ADVANCE 6050	2/66	18		8	
	ADVANCE 6070	10/66	7		2	
	ADVANCE 6130	8/67	5		32	
	All			84	56	
General Electric (N)	All			1330 E	850 E	
Honeywell (R)	DDP-24	5/63	85		X	
	DDP-116	4/65	172		41	
	DDP-124	3/66	38		33	
	DDP-224	3/65	50		8	
	DDP-516	9/66	49		154	
	H-120	1/66	535		242	
	H-200	3/64	1115		87	
	H-400	12/61	120		X	
	H-800	12/60	89		X	
	H-1200	2/66	132		94	
	H-1400	1/64	12		X	
	H-1800	1/64	21		1	
	H-2200	1/66	45		64	
	H-4200	6/67	0		15	
	H-8200	4/68	0	2460 E	5	740 E
	IBM (N)	All			31500 E	
National Cash Register Co. (R)	NCR-304	1/60	24		X	
	NCR-310	5/61	14		X	
	NCR-315	5/62	563		150	
	NCR-315-RMC	9/65	52		50	
	NCR-390	5/61	600		6	
	NCR-500	10/65	1400	2650 E	580	790 E
	All					
Philco (R)	1000	6/63	16		X	
	2000-210,211	10/58	16		X	
	2000-212	1/63	12	44	X	X

MAGNETIC TAPE RECORDERS?

ask Hewlett-Packard



ANALOG or DIGITAL...

Reliability, ease of use, flexibility...these are the built-in extras you get with Hewlett-Packard magnetic tape recorders: today's most dependable tape transport; sturdy mechanical construction permitting long-term performance that can't be matched by more expensive recorders; electronics that are easy to adapt to your specific application; minimum maintenance. And, Hewlett-Packard service is only a phone call away. All this makes the low HP prices even more attractive.

For complete information on analog or digital magnetic tape recorders, call your local HP field engineer or write Hewlett-Packard, 690 Middlefield Road, Mountain View, California 94040; Europe: 54 Route des Acacias, Geneva.

ANALOG RECORDERS

IRIG compatible
7 or 14 tracks
½" or 1" tape
Direct and FM recording
Bandwidths to 1.5 MHz
Price: \$10,000 to \$20,000

DIGITAL RECORDERS

IBM compatible
7 or 9 tracks
3 standard densities
½" tape
Choice of tape speed
to 75 ips
Read and write
Price: \$5000 to \$15,000

HEWLETT  PACKARD

MAGNETIC RECORDERS

Designate No. 12 on Reader Service Card

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	MANUFACTURER'S TOTAL INSTALLATIONS	NUMBER OF UNFILLED ORDERS	MANUFACTURER'S TOTAL ORDERS
Radio Corp. of America (R)	RCA 301	2/61	635		X	
	RCA 3301	7/64	75		X	
	RCA 501	6/59	96		X	
	RCA 601	11/62	3		X	
	Spectra 70/15	9/65	122		125	
	Spectra 70/25	9/65	72		57	
	Spectra 70/35	1/67	34		135	
	Spectra 70/45	11/65	68		107	
	Spectra 70/55	11/66	5	1110 E	14	420 E
Raytheon (R)	250	12/60	175		X	
	440	3/64	20		0	
	520	10/65	27		1	
	703	10/67	0	222	20	21
Remington-Rand UNIVAC (R)	I & II	3/51 & 11/57	23		X	
	III	8/62	67		X	
	File Computers	8/56	13		X	
	Solid-State 80 I, II, 90 I, II & Step	8/58	222		X	
	418	6/63	118		33	
	490 Series	12/61	160		58	
	1004	2/63	3195		40	
	1005	4/66	740		200	
	1050	9/63	285		16	
	1100 Series (except 1107 & 1108)	12/50	9		X	
	1107	10/62	33		X	
	1108	9/65	58		75	
	9200	6/67	2		1100	
	9300	7/67	0		650	
	LARC	5/60	2	4930 E	X	2170 E
Scientific Control Corp. (R)	650	5/66	15		13	
	655	10/66	1		2	
	660	10/65	2		1	
	670	5/66	1		2	
	6700	10/67	0	19	1	19
Scientific Data Systems (N)	All			830 E		500 E
Systems Engineering Labs (R)	810	9/65	24		X	
	810A	8/66	28		21	
	840	11/65	4		X	
	840A	8/66	14		25	
	840 MP	-	0	70	5	51
Varian Data Machines (R)	620	11/65	70		5	
	620I	6/67	8	78	67	72
TOTALS				50,400 E		26,400 E

BOOKS AND OTHER PUBLICATIONS

Neil Macdonald Assistant Editor Computers and Automation

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

Reviews

Wiberg, K. B. / *Computer Programming for Chemists* / W. A. Benjamin, Inc., 1 Park Ave., New York, N.Y. 10016 / 1965, hardbound, 269 pp., \$13.75

This book is for chemists, whom the author feels need a working knowledge of computers in order to complete long computations quickly and with minimum error. Chapters are: "Input-Output and Simple Arithmetic," "Matrices and Arrays," "Iterative Operations and Branching Tests," "Subroutines and Function

Statements," "Further Programming Details," "Summary of FORTRAN Statements," "Computer Programming Using the FAP and MAP Assembly Programs" and "Examples of Computer Programs." Problems for the student are included and the answers are given in the appendix.

The virtue of this book is that it is written in a simple way for persons who are informed in another field.

Duffin, R. J., E. C. Peterson, and C. M. Zener / *Geometric Programming: Theory and Application* / John Wiley and Sons, Inc., 605 Third Ave., New York, N.Y. 10016 / 1967, hardbound, 278 pp., \$12.50

"Geometric Programming" is an outgrowth of "linear programming and convex programming" and is offered as a major, new method for engineering design.

This book presents geometric programming and its application in engineering. Chapters are: "A Preview of Geometric Programming," "Linear and Convex Programming," "Basic Concepts and Techniques of Geometric Programming," "The Duality Theory of Geometric Programming by Way of Lagrange Multipliers," "Engineering Design by Geometric Programming," "A Refined Dual-

ty Theory," and "Extended Geometric Programming." There are four appendices: the chapters contain exercises and problems and their solutions.

Haight, Frank A. / *Handbook of the Poisson Distribution* / John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016 / 1967, hardbound, 168 pp., \$9.50

This handbook deals with all of the information that has been published on the Poisson distribution and process. Chapters are: "Elementary Properties," "Models Leading to the Poisson Distribution," "Generalizations of the Poisson Distribution," "Further Properties," "Statistical Estimation," "Statistical Testing," "Applications," "Tables and Computer Programs," and "Historical Remarks." Many formulas and theorems are included and there is a subject index and an extensive bibliography.

Archibald, R. D., and R. C. Villoria / *Network-Based Management Systems (PERT/CPM)* / John Wiley and Sons, Inc., 605 Third Ave., New York, N.Y. 10016 / 1967, hardbound, 508 pp., \$16.00

This book contains 5 parts: "Network Planning: What It Is — How It Works," "Implementing the System," "Case Studies," "Pitfalls and Potentials," and the appendices, which include a glossary of terms, a bibliography, and a selected course outline.

GE TIME SHARING SERVICES — CORRECTION

From J. P. Sweeney
General Electric Company
777 14th St. N.W.
Washington, D.C. 20005

I have reviewed part of your comprehensive "Computer Directory and Buyers' Guide, 1967," your June issue. While I'm sure your staff spent many long hours sourcing and preparing information for the Directory, they somehow did not get an accurate report of General Electric's commercial time-sharing service business.

The Roster of Organizations on page 22 should have shown time sharing service as a product of the Information Service Department, 7735 Old Georgetown Road, Bethesda, Maryland.

The Roster of Commercial Time-Sharing Computer Services should have listed GE services available in the following 31 metropolitan areas:

- | | |
|----------------------|----------------------|
| Atlanta, Ga. | Philadelphia, Pa. |
| Boston (Metro Area) | Phoenix, Ariz. |
| Chicago (Metro Area) | Pittsburgh, Pa. |
| Cincinnati, Ohio | Portland, Oregon |
| Cleveland, Ohio | Rochester, N. Y. |
| Dallas, Texas | San Diego, Calif. |
| Dayton, Ohio | San Francisco |
| Denver, Colo. | (Metro Area) |
| Detroit, Mich. | Schenectady, N. Y. |
| Hartford, Conn. | Seattle, Wash. |
| Houston, Texas | St. Louis, Mo. |
| Los Angeles | Syosett, Long Island |
| (Metro Area) | Syracuse, N. Y. |
| New Haven, Conn. | Teaneck, N. J. |
| New York City | Tulsa, Okla. |
| (Metro Area) | Washington, D.C. |
| Orlando, Fla. | (Metro Area) |
| Palo Alto, Calif. | |

ARTIST IN COMPUTER ART — CORRECTION

Lloyd Sumner
Computer Creations
Charlottesville, Va. 22903

Thank you very much for including two of my computer drawings in the August, 1967, issue of *Computers and Automation*.

I would also like to congratulate you for the excellent work you are doing in promoting computer art.

I am a little disturbed, however, by the title published with my name in your magazine. I am not the "Artist in Residence" at the University of Virginia, nor have I ever been. The unofficial title of "Artist in Residence" at the Computer Science Center at the University was given to me at the Center as a sort of joke, because I was always drawing pictures with the computer instead of doing some more worthwhile work. It was never intended that this "title" be published in anything other than the newsletter of the Computer Science Center of the Univ. of Virginia. In fact, at present, I hold no position at the University, other than being a recent alumnus.

Would you please publish this correction?

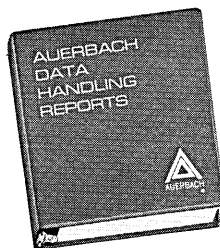
How to avoid your first data handling mistake.

And then your second.

Mistake one: plowing through stack upon stack of manufacturers' literature trying to evaluate and compare equipment for your EDP installation.

Mistake two: making a decision on the basis of the incomplete—and necessarily biased—information that you accumulated during mistake one.

Avoid both mistakes. Invest \$325 in AUERBACH Data Handling Reports.



This complete two-volume reference service provides detailed reports on the characteristics, performance, prices, application—and limitations—of all the equipment you need for the care and feeding of a computer: equipment for data recording, input preparation, data transmission, unit records, and forms handling, plus a complete section on input/output media such as magnetic tape, cards, and forms.

Authoritative, accurate. These data have been collected, edited, and verified by some of the best men in the business—every one of whom has had actual hands-on experience with data handling equipment.

Objective. AUERBACH has no hardware to sell, no axe to grind.

Current. Updated quarterly to maintain current-awareness value.

Granted, you could gather all this information yourself and keep it current. But it would cost you considerably more than the \$325 cost of AUERBACH Data Handling Reports.

What it comes down to is this: the best way to get the right computer support equipment for your application is to go by the book. And the best way to do that is go buy the right books: AUERBACH Data Handling Reports. Two volumes, plus quarterly updates, just \$325. For more information, including a sample report, or for a trial order, use the coupon.

AUERBACH Info, Inc.
121 N. Broad Street, Philadelphia, Pa. 19107



Gentlemen:

- Please send me more data about AUERBACH Data Handling Reports, including a free sample report.
- Enclosed is a check for \$20. Send me a set. If I don't like it, I'll send it back three weeks after I receive it. If I do like it, I'll keep it and you may bill me for the rest of the \$325.
- I'm not that worried about data handling right now. Tell me how to solve my problems in
- Data communications Software Computer systems

Name _____
 Title _____
 Company _____
 Street _____
 City _____ State _____ Zip _____

Mail this coupon today.

CALENDAR OF COMING EVENTS

- Oct. 12-14, 1967: Computer Fundamentals Workshop, The Univ. of Mich., North Campus, Ann Arbor, Mich.; contact Haldon L. Smith, Industrial Development Div., The Univ. of Mich., P.O. Box 618, Ann Arbor, Mich. 48107
- Oct. 16-19, 1967: UAIDE (Users of Automatic Information Display Equipment), Statler Hilton Hotel, Washington, D.C.; contact George E. Perez, Box 6749, Fort Davis Station, Washington, D.C. 20020
- Oct. 18-20, 1967: Eighth Annual Symposium on Switching and Automata Theory, University of Texas, Austin, Tex.; contact Prof. C. L. Coates, Room 520, Engineering Sci. Bldg., Univ. of Tex., Austin, Tex. 79712
- Oct. 18-20, 1967: International Electron Devices Meeting, Sheraton Park Hotel, Washington, D.C.; contact William S. Patton, Litton Industries, 960 Industrial Way, San Carlos, Calif. 94070
- Oct. 19-20, 1967: The Association of Data Processing Service Organizations (ADAPSO), Fairmont Hotel, San Francisco, Calif.; contact Stan Stetson, Data II, Oakland, Calif.
- Oct. 22-26, 1967: Annual Convention, American Documentation Institute, New York Hilton, New York, N.Y.; contact Steven E. Furth, IBM Corp., 112 E. Post Rd., White Plains, N.Y.
- Oct. 23-25, 1967: National Electronics Conference and Exhibit, International Amphitheatre, Chicago, Ill.; contact IEEE, 345 E. 47th St., New York, N.Y. 10017
- Oct. 23-25, 1967: SWAP 13 — for CDC Small & Medium Scale Computer Users, Somerset Hotel, 400 Commonwealth Ave., Boston, Mass.; contact George Catuna, Conference Registration Chairman, c/o MIT Lincoln Labs., P.O. Box 73, Lexington, Mass. 02173
- Oct. 26-27, 1967: American Society for Cybernetics, National Bureau of Standards Auditorium, Gaithersburg, Md.; contact Dr. Carl Hammer, UNIVAC Div., Sperry Rand Corp., 2121 Wisconsin Ave., N.W., Washington, D.C. 20007
- Nov. 1-3, 1967: 32nd National Meeting of the Operations Research Society of America, Sheraton-Chicago Hotel, Chicago, Ill.; contact ORSA, Mt. Royal and Guilford Aves., Baltimore, Md. 21202
- Nov. 1-3, 1967: Northeast Research & Engineering Meeting, Boston-Sheraton Hotel, Boston, Mass.; contact IEEE, Boston Office, 31 Channing St., Newton, Mass.
- Nov. 6-8, 1967: Computer Graphics Conference, Univ. of Ill., Urbana, Ill.; contact L. J. Brightbill, Dept. of Architectural Engineering, Univ. of Ill., Urbana, Ill. 61801
- Nov. 10, 1967: ACM Symposium on the Application of Computers to the Problems of Urban Society, New York Hilton Hotel, New York, N.Y.; contact Dr. E. S. Savas, New York Scientific Center, IBM Corp., 590 Madison Ave., New York, N.Y. 10022
- Nov. 14-16, 1967: Fall Joint Computer Conference, Anaheim Convention Center, Anaheim, Calif.; contact AFIPS Headquarters, 211 E. 43rd St., New York, N.Y. 10017
- March 18-21, 1968: IEEE International Convention & Exhibition, Coliseum & New York Hilton Hotel, New York, N.Y.; contact J. M. Kinn, IEEE, 345 E. 47th St., New York, N.Y. 10017
- Apr. 30-May 2, 1968: Spring Joint Computer Conference, Atlantic City Convention Hall, Atlantic City, N.J.; contact American Federation for Information Processing, 211 East 43rd St., New York, N.Y. 10017
- June 25-27, 1968: Second Annual IEEE Computer Conference, International Hotel, Los Angeles, Calif.; contact John L. Kirkley, 9660 Casaba Ave., Chatsworth, Calif. 91311
- Aug. 5-10, 1968: IFIP (International Federation for Information Processing) Congress 68, Edinburgh, Scotland; contact John Fowlers & Partners, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2, England

C&A

PROBLEM CORNER

Walter Penney, CDP
Problem Editor
Computers and Automation

Problem 6710: Computing Without a Computer

"This program was written by a student in my last class who seems to have lost interest in it," Claude Liffey said, pointing to a somewhat crumpled Fortran sheet. "Now I'm trying to figure out what it would compute."

John Lawthorne picked it up and smoothed it out a bit. It read:

"Shouldn't be much work to punch up a few cards and run it."

"That's the coward's way out," said Claude. "I'm trying to do this by using what little mathematics I still remember."

John looked up from studying the program. "It's really quite simple," he said.

What does the program compute?

Solution to Problem 679: Are Two Heads Better Than One?

Bob and Charlie would get $.9 (1/4 + 1/5)$ of the job done in one hour, so that it would take 200/81 or approximately 2.47 hours to finish the program.

Our thanks go to Stephen L. Robinson, Applied Data Research, Inc., Princeton, N. J., MSG Charles A. Johnson, Carlisle Barracks, Pa. 17013 and Duane A. Higgins, Campaign County Court House, Urbana, Ill., for sending us correct solutions to Problem 678, "A Fascinating Flow-chart That Doesn't Work."

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

NEW PATENTS

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

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

July 4, 1967

- 3,329,835 / Michael V. D'Agostino, Flemington, N. J. / Radio Corporation of America, a corporation of Delaware / Logic arrangement.
- 3,329,944 / Merton C. Leinberger, Inglewood, Cecil H. Burns, Palo Verdes, and Robert A. Melnick, Los Angeles, Calif. / The National Cash Register Company, Dayton, Ohio / Sequential Access data store.

July 11, 1967

- 3,330,971 / Teddy R. Thomas, Dallas, Tex. / Sperry Rand Corporation, Great Neck, N. Y. / Nor-Nand logic circuit using tunnel diodes.
- 3,331,057 / William C. Hill, Phoenix, Ariz. / General Electric Company, a corporation of New York / Data processing system employing logic for distinguishing between information and extraneous signals.
- 3,331,061 / Mitchell P. Marcus,inghamton, N. Y. / International Business Machines Corp., N. Y. / Drive-Sense arrangement for data storage unit.
- 3,331,063 / Hartmut P. Kallmann, New York, N. Y., Bernard Kramer, Bergenfield, N. J., and Eric Weissman, New York, N. Y. / New York University, New York, N. Y. / Light producing and memory means.

July 18, 1967

- 3,332,062 / Toshio Ando, Tokyo, Japan / Nippon Electric Co. Inc., Tokyo, Japan / Multiple frequency selecting signal storage control circuit.
- 3,332,063 / Carmi Ariel, Hollywood, Calif. / Clary Corporation, San Gabriel, Calif. / Comparison circuit.
- 3,332,066 / William E. Burns, Los Gatos, and Quentin E. Correll, San Jose, Calif. / International Business Machines Corp., New York, N. Y. / Core storage device.
- 3,332,069 / Earl C. Joseph, Minneapolis, Albert Kaplan, St. Paul, and Samuel K. Poppleton, Savage, Minn. / Sperry Rand Corp., New York, N. Y. / Search memory.

- 3,332,073 / Fred G. Hewitt, St. Paul, Minn. / Sperry Rand Corp., New York, N. Y. / Magnetic storage elements and method for storing discrete levels of data.
- 3,332,075 / John Presper Eckert, Jr., Gladwynne, Pa. / Sperry Rand Corp., New York, N. Y. / Nondestructive readout thin film memory array.

July 25, 1967

- 3,333,116 / Thomas M. Lo Casale, Warminster, Pa. / Sperry Rand Corporation, New York, N. Y. / Tunnel diode to transistor interface circuit for interconnecting high speed circuitry to relatively slower speed circuitry.
- 3,333,249 / Genung L. Clapper, Vestal, N. Y. / International Business Machines Corporation, New York, N. Y. / Adaptive logic system with random selection, for conditioning, of two or more memory banks per output condition, and utilizing non-linear weighting of memory unit outputs.
- 3,333,255 / David Loev, Plymouth Meeting, Pa. / Burroughs Corporation, Detroit, Mich. / High speed magnetic shift register.

August 1, 1967

- 3,334,181 / William F. Bartlett, Rochester, and Barrie Brightman, Webster, N. Y. / General Dynamics Corp., Rochester, N. Y. / Parallel to serial character converter apparatus.
- 3,334,333 / Robert O. Gunderson and Sidney L. Valentine, Torrance, and George L. Foster, Hawthorne, Calif. / The National Cash Register Co., Dayton, Ohio / Memory sharing between computer and peripheral units.
- 3,334,334 / George N. Halpin, Newport, England / General Electric Co., a corp. of New York / Signal change detector for process control computer.
- 3,334,335 / Donald B. Brick and George G. Pick, Lexington, Mass. / Sylvania Electric Products Inc., a corp. of Delaware / Electronic data processing.
- 3,334,336 / Ralph J. Koerner, Canoga Park, and Samuel Nissim, Pacific Palisades, Calif. / by mesne assignments to The Bunker-Ramo Corp., Stamford, Conn. / Memory system.
- 3,334,337 / Paul Mallery, Murray Hill, N. J. / Bell Telephone Laboratories, Inc., N. Y. / Information storage and transfer system.
- 3,334,338 / William F. Bartlett, Rochester, and Barrie Brightman, Webster, N. Y. / General Dynamics Corp., Rochester, N. Y. / Rapid access recording system.

August 8, 1967

- 3,335,222 / Claude G. Davis, Colts Neck, and Lewis C. Thomas, North Plainfield, N. J. / Bell Telephone Laboratories, Inc., N. Y. / Binary data rate reconstruction.

INFORMATION & SYSTEMS INSTITUTE

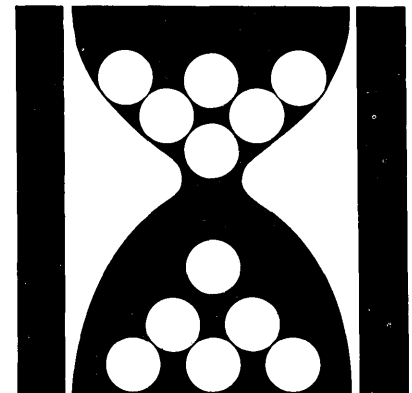
INTEGRATED CURRICULUM IN
INFORMATION PROCESSING

COURSE T-25

REAL-TIME SYSTEMS DESIGN

BOSTON MASS

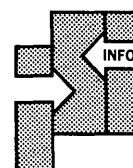
DECEMBER 4-8



An in-depth course on the practical design of real-time systems. Emphasis is on design / development of types of systems most frequently implemented. Both software design and hardware considerations which interact with programming are covered.

APPLICANTS MUST QUALIFY.

**For information and application,
Write now -**



INFORMATION & SYSTEMS INSTITUTE, INC.
14 CONCORD LANE
CAMBRIDGE, MASSACHUSETTS 02138

Designate No. 20 on Reader Service Card

Cover Story:

TIME SHARING IN ACTION

John G. Atwood, Vice President
Director of Research, Optical Group
Perkin-Elmer Corp.
Norwalk, Conn.

An increasing number of our scientists, engineers and programmers, while remaining right in their offices, are getting more computer time with less waiting. This became possible when we introduced what we believe is the first fully general-purpose time-sharing system designed, developed and implemented by any industrial company.

The system is designed to provide interactive computing to as many of our engineers and scientists as possible. Our goal is to increase the productivity of our professional staff by making powerful computer-aided engineering programs available to them on a conversational, hands-on, basis. The system presently permits up to 16 simultaneous users.

Optical design, scientific research, and program development are currently being carried out. Additional applications are anticipated.

The system was conceived at Perkin-Elmer, and carried out as an in-house project. It required about ten man years of effort over the last three years, with some of the software designed and implemented by firms under contract to us. The system utilizes Scientific Data Systems' SDS 9300 and SDS 930 processors. Each user has available 22,528 words of main memory for execution of his programs. Overlay of programs allows programs of essentially unlimited size to be run. A full range of processing languages and features is available to each time-shar-

ing terminal user, the same as if he used a standard SDS 9300 by himself. The maximum response time of the system to a simple inquiry is less than five seconds.

One of the most important features of our system is that a program may be worked on, or run, either from a remote terminal, or as a batch job, with no modification. To accomplish this result, one of the 16 users, called the "central" user, has special status: he has direct access to the fast peripherals, such as magnetic tape, card readers, and line printers. Ordinary batch processing is run through the "central user" with the control sequences, languages, and files available identical to those of a remote terminal.

The system has proved extremely valuable in the development of large complex programs. Here compilation from the central user enables listing on the high speed printer, and then provides the ability to "massage" and debug the identical programs with the text editor from a remote terminal, recompiling from the terminal as frequently as is desired.

The company developed its own internal time-shared system rather than buying access to a commercial time-sharing system for two reasons. First, we had proved the value of an open-shop, hands-on, computing facility. And second, we could provide better service for our users at a lower cost.

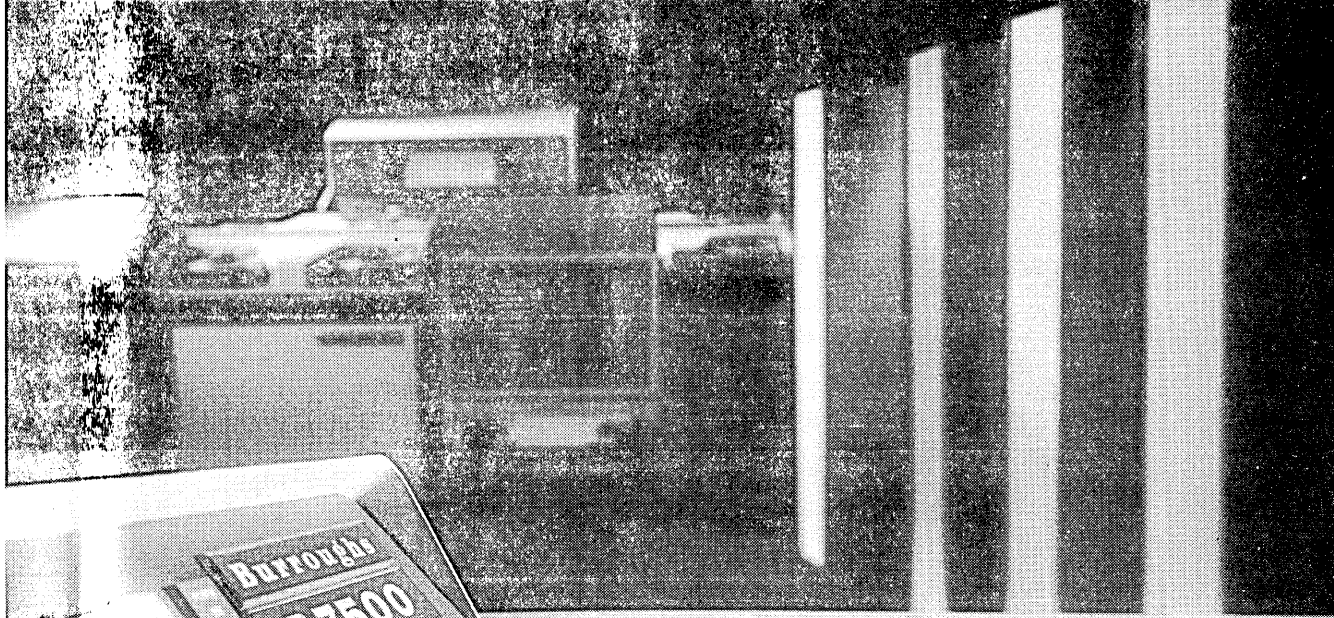
ADVERTISING INDEX

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

American Telephone & Telegraph Co., 195 Broadway,
New York, N. Y. 10007 / Page 2 / N. W. Ayer & Son
Auerbach Corporation, 121 N. Broad St., Philadelphia,
Pa. 19107 / Page 67 / Schaefer Advertising Inc.
Burroughs Corporation, 6071 Second Blvd., Detroit,
Mich. 48232 / Page 71 / Campbell-Ewald Co.
Consolidated Electrodynamics Corp. (Tech. Supplies),
360 Sierra Madre Villa, Pasadena, Calif. 91109 /
Page 19 / Hixson & Jorgensen, Inc.
Control Data Corp., 8100 34th Ave. So., Minneapolis,
Minn. 55440 / Pages 28, 29 / Klau-Van Pietersom-
Dunlap, Inc.
Cybetronics, Inc., 132 Calvary St., Waltham, Mass.
02154 / Page 27 / Stan Radler
Digital Equipment Corp., 146 Main St., Maynard, Mass.
01754 / Page 4 / Kalb & Schneider Inc.
Graham Magnetics Inc., Graham, Tex. 76046 / Page
72 / Witherspoon and Associates
Hewlett Packard Corp., 1501 Page Mill Rd., Palo Alto,

Calif. 94304 / Page 65 / Lennen & Newell, Inc.
Information & Systems Institute, Inc., 183 Harvard St.,
Cambridge, Mass. 02139 / Page 68 / --
International Business Machines Corp., Data Processing
Div., White Plains, N. Y. / Page 51 / Marsteller Inc.
Memorex Corp., 213 Memorex Park, Santa Clara,
Calif. 95050 / Pages 8, 9 / Hoefler, Dieterich & Brown
Inc.
Randolph Computer Corp., 200 Park Ave., New York,
N. Y. 10017 / Page 58 / Albert A. Kohler Co., Inc.
Scientific Data Systems, 1649 17th St., Santa Monica,
Calif. / Page 3 / Doyle, Dane, Bernbach, Inc.
Simmonds Precision, Maple St., Middlebury, Vt. 05753
/ Page 22 / Allied Advertising Agency Inc.
Univac, Div. of Sperry Rand, 1290 Avenue of the
Americas, New York, N. Y. 10019 / Pages 36, 37 /
Daniel and Charles, Inc.
Varian Data Machines, 1590 Monrovia Ave., Newport
Beach, Calif. / Page 6 / Durel Advertising

**A brand-new computer
with years of experience!**



The large-scale B 7500

Fast—Powerful—Proven. The B 7500 gives you:

- 10 megacycle processor. Or processors.**
- 3 million-plus bytes of high speed core or 600 nanosecond thin film memory.**
- 19 billion bytes of 20 to 60 millisecond access disk storage.**
- 2,000-plus remote lines and eight individual communications processors.**
- 20 simultaneous I/O operations; 12.8 million cps.**

Master Control Program—the only fully proven automatic op system available.

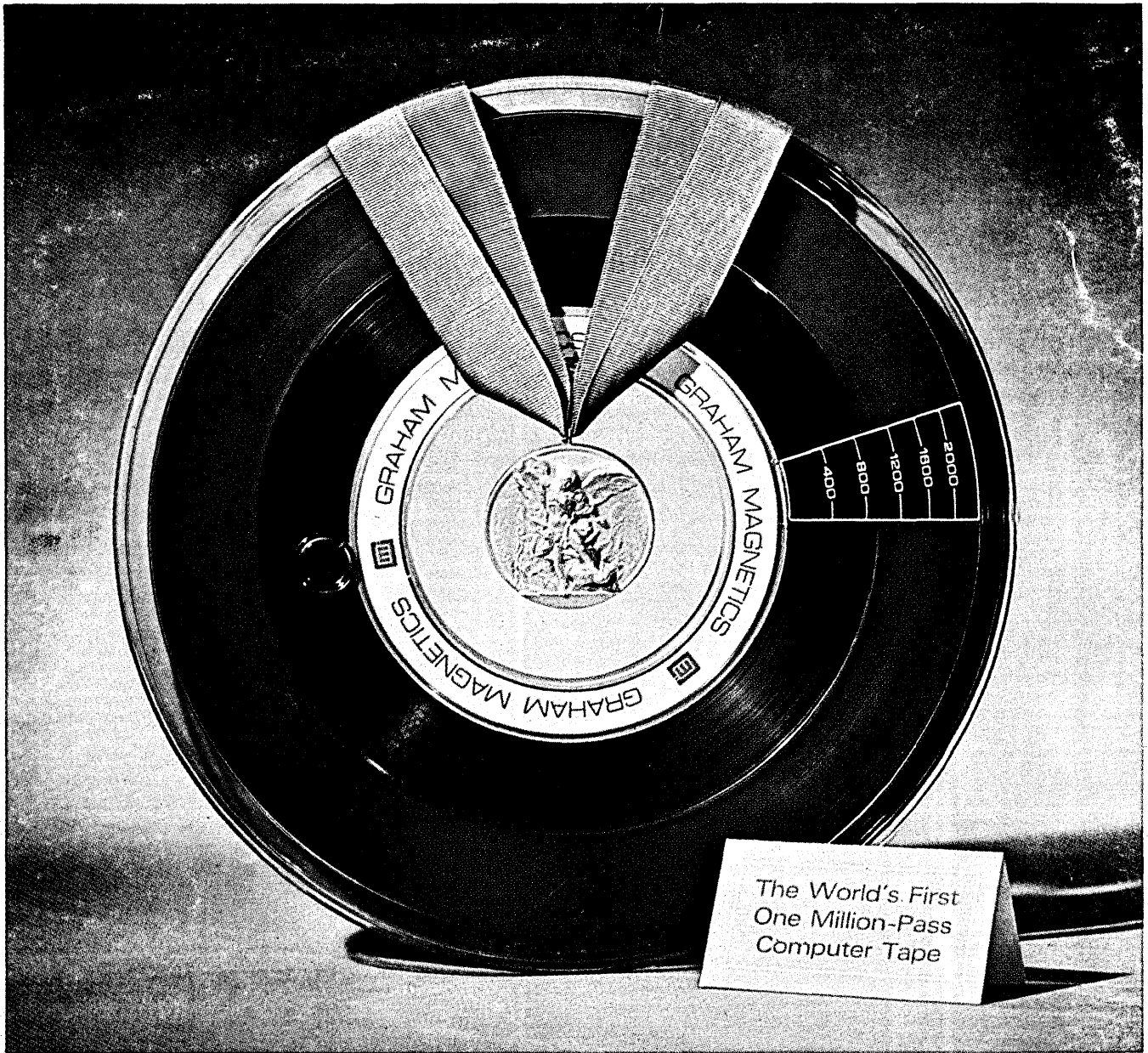
Program compatibility with the B 5500, B 6500, B 8500, or any other B 7500.

An evolutionary system. The B 7500 is built on hardware/software concepts developed by Burroughs and proven in use with the B 5500. Result—the new B 7500 offers a vastly greater capability for business and scientific computing, for on-line communications, for large-scale management information and control operations.

Ask your Burroughs representative for the impressive details.

Burroughs 

DETROIT, MICHIGAN 48232



Meet the first million-pass computer tape.

When we developed our new Zero Defects digital computer tape, with the new, more sophisticated polymers, we produced a binder system that made all other binder systems obsolete. The result was a full magnitude increase in durability, lower head wear, and no troublesome rub-off.

Until our Z-D tape exceeded one million passes in durability tests on CDC 680 certifiers with no permanent errors, we didn't know just how really great it was. But don't take our word for it, let your own computer prove it. Contact your nearest GMI Sales representative or contact us direct.



GRAHAM MAGNETICS INCORPORATED
Graham, Texas 76046 Telephone 817-549-3211

Manufacturers of Zero Defects Magnetic Computer Tape

Designate No. 3 on Reader Service Card