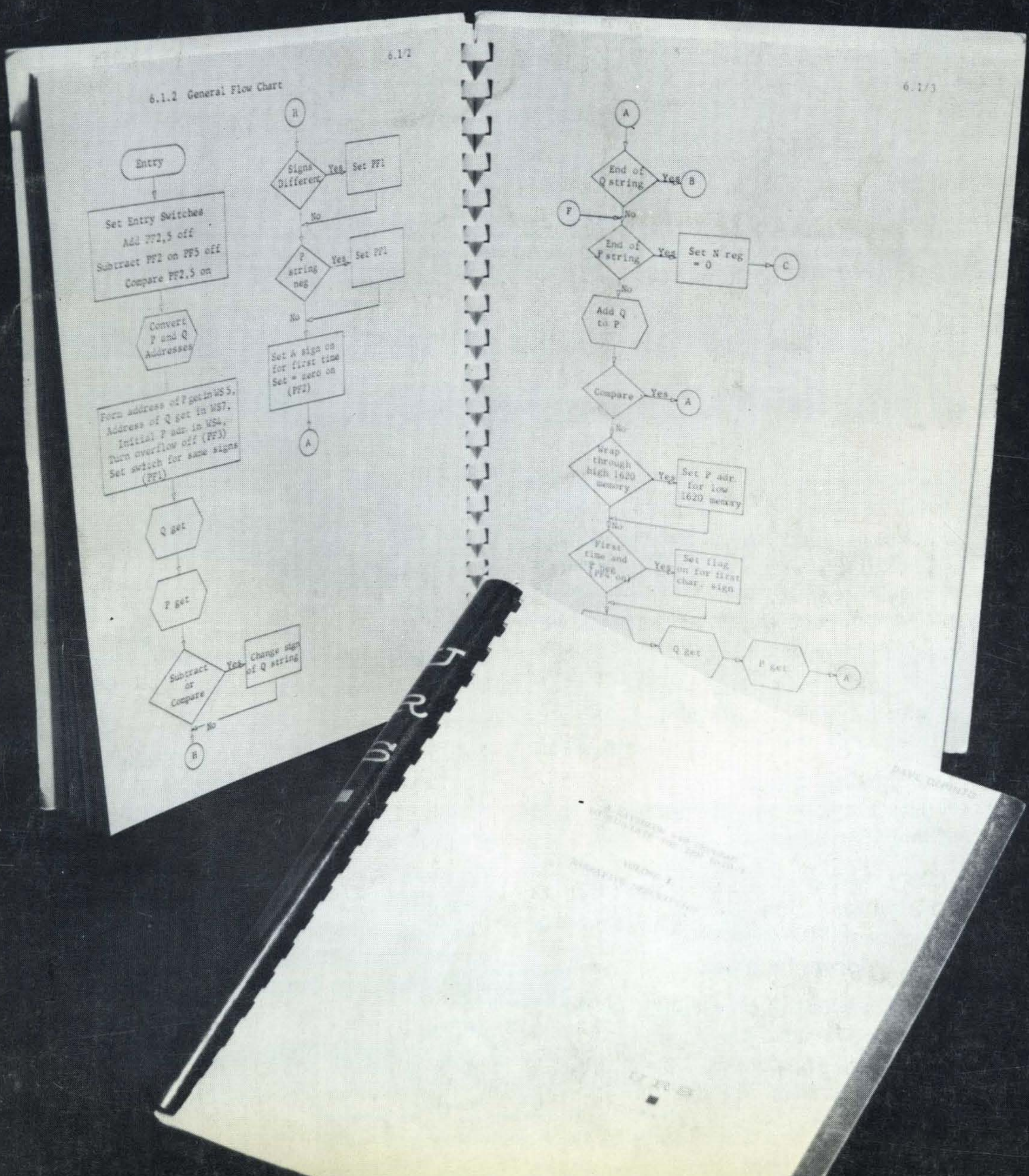
February, 1966

computers and automation

Programming, Software, and Future Developments: Special Feature



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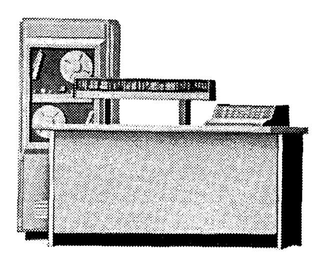
NCR



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Ever have days when you get this sinking feeling? Tape problems — transport problems — dropout problems?

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Of course, many people have solved their data recording problems simply by switching to Computape.

In any case, we are at your service. For advice, application assistance, problem solving, or just a reel of tape, call your nearest Computron office.

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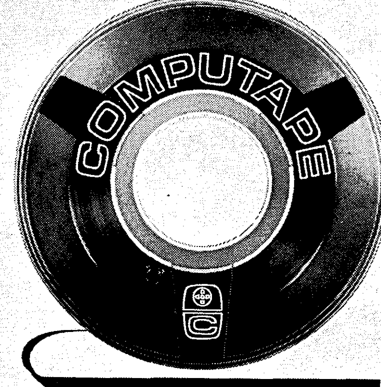

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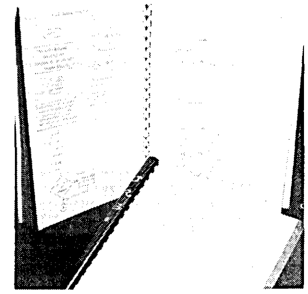
The front cover, alluding to the special feature in this issue, shows some software documentation produced systematically — by people, not computers! For more information, see page 42.



computers and automation

FEBRUARY, 1966 Vol. 15, No. 2

In This Issue

Special Feature:
Software, Programming, and Future Developments

In Every Issue

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 50c 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.

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Programming, Software, and Future Developments

As a special feature in this issue of "Computers and Automation," we have chosen the subject of programming, software, and future developments. Why?

A central proposition in this field nowadays, it seems to me, is this:

> The hardware of computers, as machines for handling information, has gone a long way — but, the software, the techniques for easily and flexibly instructing machines to handle information as we desire, is becoming the critical area for further progress, and many advances need to be found and worked out.

In "SDC Magazine" for August 1965, published by System Development Corporation, Santa Monica, California, appear some interesting remarks:

> At SDC a family of user-oriented programs and systems is being developed that will make possible a valuable dialogue between the computer and its users. These programs and systems aim at bringing the user . . . into communication with the computer without the need for a translation by a programmer. The goal is to make it possible for him to:
>
> — question the computer;
> — get responses in a language resembling English;
> — build his program as he goes along;
> — permit him to do this while other users are sharing the same machine; and
> — receive the responding information in any format that seems best.

Clearly, it is desirable for the computer also to recognize natural English. Steps in this direction have also been taken. In his Ph.D. thesis "Natural Language Input for a Computer Problem-Solving System" which Dr. Daniel G. Bobrow submitted to Mass. Inst. of Technology in September 1964, a computer program called STUDENT is defined, which is able to accept for example a problem like the following:

> Bill is one half his father's age 4 years ago. In 20 years he will be 2 years older than his father is now. How old are Bill and his father?

The problem in this very form is accepted by the program STUDENT, and the answer produced by STUDENT is:

> BILL S AGE IS 14. BILL S FATHER S AGE IS 32.

This is of course the correct answer, and expressed in satisfactory English as well. Only the grammatical apostrophes for the possessive case are missing, a trivial defect which would not have occurred if an expanded set of characters had been available in the computer system in which STUDENT was run.

Along with the development of direct personal questions and answers in a dialogue with a computer, is increased interaction of computer programming with mathematics and logic.

For example, problem-oriented computer programming languages enlarge our conception of mathematical objects. In prior centuries men became accustomed to noticing as interesting mathematical objects: numbers; points and lines; the magnitudes and directions of forces; sequences of numbers, usually infinite and usually constructed with fairly simple rules, such as 1, 1/2, 1/4, 1/8, 1/16 . . . ; and so on. Now with the development of problem-oriented programming languages, we take into mathematics a great variety of new structures (such as lists), and a mathematical expression of processes of effectively computing with them (such as recursion). For example, a recursive definition of the function FACTORIAL (for whole numbers) is that the factorial of zero is one, and that the factorial of any number N is equal to N times the preceding factorial. This is not a circular definition because the recursion stops at the initial case, and so the function can be computed from this definition. The expansion of the nature of mathematical objects because of problem-oriented computer programming languages is important and exciting.

We can safely predict that the next 20 years will show remarkable developments in computer programming languages, to such an extent that the barriers between user and computer nowadays will seem like prehistoric times to those of us still working in the computer field.

By then in fact it is very likely that computers will converse and discuss with human beings, using ordinary language and handling ideas appropriately, — as well as being able to draw within seconds on vast quantities of recorded knowledge, and perform within seconds reasoning and calculation far beyond human powers.

Edmund C. Berkeley

EDITOR

THE JOURNAL OF COMPUTER AND SYSTEMS SCIENCES

Academic Press
New York, N. Y.

We should like to inform your readers that we will soon be publishing the JOURNAL OF COMPUTER AND SYSTEMS SCIENCES. A new journal, to be issued quarterly, it will be devoted to the newly emerging interdisciplinary area of Computer and Systems Sciences. It will feature papers on computers and computer-like information processing systems; on the general theory of systems whether they be discrete (such as automata) or continuous, whether deterministic or stochastic, and including biological systems; and on optimization theory of such systems, whether for information systems or control systems, in which the emphasis is on computational methods and algorithms. The papers, largely theoretical in character with no compromise in mathematical rigor, will deal with problems that may arise in diverse disciplines but will involve the computer or computer-based technology in an essential way.

The editors of JOURNAL OF COMPUTER AND SYSTEMS SCIENCES will be Professor A. V. Balakrishnan, University of California, Los Angeles; Professor E. K. Blum, Wesleyan University; Dr. R. W. Hamming, Bell Telephone Laboratories; Professor P. D. Lax, New York University; and Professor L. A. Zadeh, University of California, Berkeley. They will be assisted by an international editorial board representing the U.S.S.R., Israel, England, France, and Japan.

AIAA TECHNICAL SUBCOMMITTEE ON COMPUTERS

Barry Boehm
Chairman, AIAA TSC
Computer Sciences Department
The Rand Corp.
1700 Main St.
Santa Monica, Calif. 90406

The American Institute of Aeronautics and Astronautics — the nation's primary aerospace professional organization, with about 40,000 members — has recently established a Technical Subcommittee on Computers.

The purpose of the subcommittee is to facilitate technical advances and reduce duplication of effort by stimulating information transfer in the interface area between the aerospace sciences and the computer sciences. Some of the proposed means of doing this include compiling a catalogue of aerospace computer programs, sponsoring sessions of technical papers on computer applications at AIAA meetings, coordinating with relevant professional organizations in the computer sciences, and disseminating information on problems and progress in the computer sciences to aerospace scientists and vice versa.

Any suggestions on these or other possible useful activities will be welcomed by the subcommittee.

DATA PROCESSING MANAGEMENT ASSOCIATION ANNOUNCES RESEARCH GRANTS

The Data Processing Management Association will sponsor a program to assist and promote Ph.D. level university research in data processing. Beginning in September, 1966, a number of individual grants of $2,000 each will be made to selected doctoral candidates who will perform the necessary research and prepare dissertations in the field of data processing systems and management. The research should be directed toward methods of management planning, control, organization, and decision-making with regard to automatic data processing technology.

The grant funds will be disbursed in two parts: (a) the first $1,000 at the rate of $125 per month for eight months during which time the candidate pursues his research, and (b) the final payment of $1,000 upon completion of the study and its acceptance by the university as a dissertation that partially fulfills the requirements for a doctoral degree. A copy of the accepted manuscript, suitable for publication, will be provided the Association which will have first option to publish.

Applicants must be doctoral candidates at accredited graduate schools. The doctoral committee must have already been appointed by the university and the proposed research, including content and methodology, must have been approved.

Applications for 1966-1967 grants must be received at DPMA International Headquarters no later than March 15. Additional information and application forms are available from DPMA International Headquarters, 505 Busse Highway, Park Ridge, Illinois.

THE DIGITAL MONA LISA — ACKNOWLEDGEMENT

The front cover of our December 1965 issue was a copy of "the digital Mona Lisa," made by a computer and a plotter. Our account of it (on page 13) mentioned the maker of the computer, but did not mention the maker of the plotter — information which we did not have at that time.

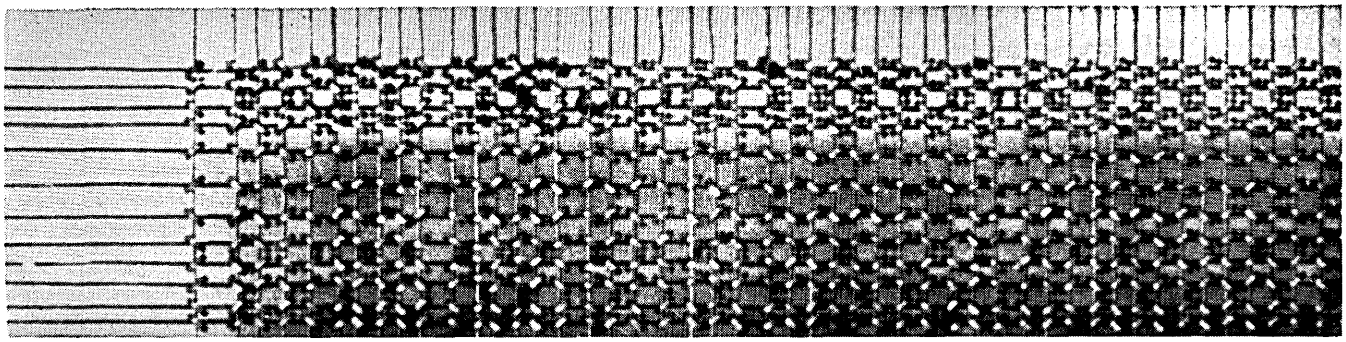
The maker of the plotter was California Computer Products, of Anaheim, California. Certainly, the remarkable accomplishment of the device that plotted the information produced by the computer should have been acknowledged in our December issue. We regret this omission.

FORMATION OF THE AUSTRALIAN COMPUTER SOCIETY

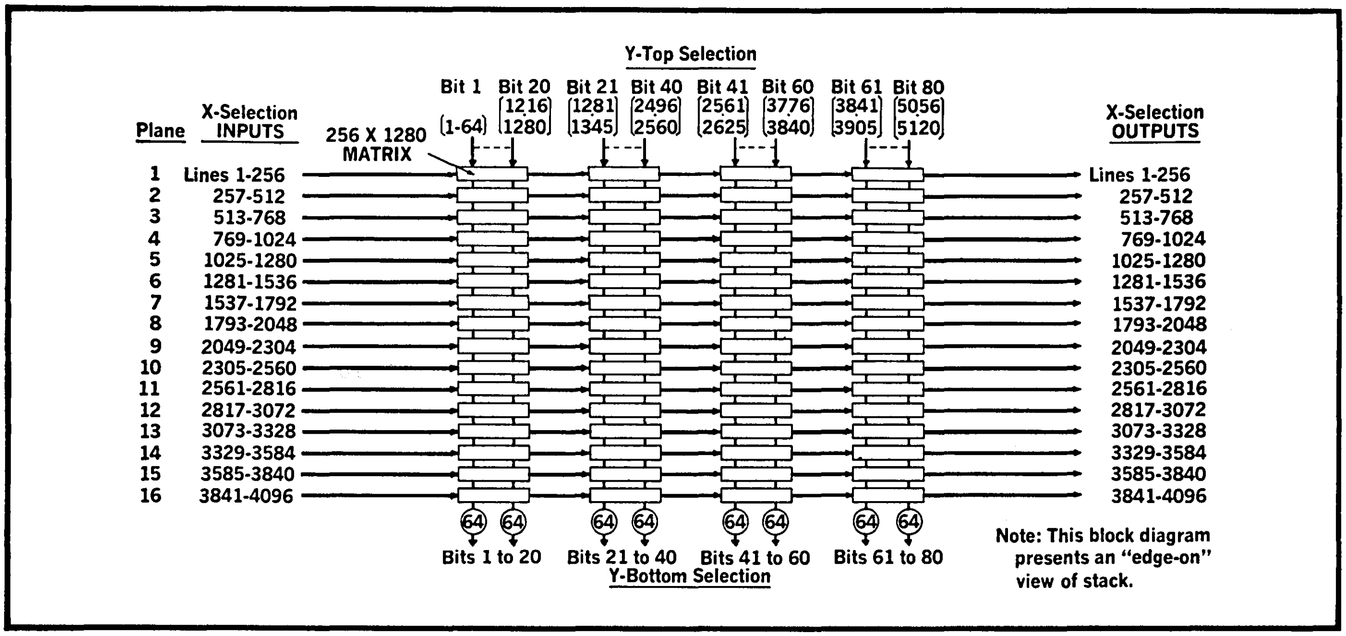
The five existing computer societies in Australia, namely, the Canberra Computer Society, the N.S.W. Computer Society, the Queensland Computer Society, the South Australian Computer Society, and the Victorian Computer Society, have agreed to join together to form a single society, to be called "The Australian Computer Society." This Society came into existence on January 1, 1966.

(Please turn to page 18)

A 20-million-bit mass core memory can be economical, reliable, and fast! Here's how:



Coincident-current versatility with only two wires!
(Cross-section of Fabri-Tek's simple and reliable orthogonal mass core memory plane.)



Here is the road-map to reliability!
(Core-selection block diagram for Fabri-Tek's mass core memory stack.)

In extremely large capacity core memory systems such as Fabri-Tek's new Series MT mass core memory, the stack and core selection circuit costs become the major system cost consideration. The illustrations above show the key factors which make the Series MT a truly practical mass core memory.

A simple and reliable orthogonal array uses only X and Y wires to reduce the stack stringing cost and to reduce X and Y drive line soldered connections by a ratio of more than 4:1.

The core-selection block diagram shows how a 20-million-bit array is divided into 4,096 X lines and 5,120 Y lines. A total of 327,680 cores is wired into each frame.

If conventional 128 X 128 matrices were used, a total of 1,280 frames would be required instead of 64. This would mean a total of 655,360 X and Y-line to frame connections compared to the 196,608 connections used in this Fabri-Tek memory.

Special Fabri-Tek circuit techniques, using all-silicon semiconductors, give reliable memory speeds of 4 to 8 microseconds. Interface is compatible with discrete or integrated circuitry.

If you'd like more interesting facts about the Fabri-Tek mass core memory, write, call, or wire Fabri-Tek Incorporated, Amery, Wisconsin. Phone: 715-268-7155. TWX: 510-376-1710.

FABRI-TEK
INCORPORATED

c & a MARKET REPORT

MORE COMPUTERS = MORE PROFITS, NEW RESEARCH STUDY INDICATES

The profitability of major sectors of business enterprise shows a close relationship to the size of their investment in computer use. This is one of the key findings of an extensive market research study of computer use in the United States, recently conducted by the International Data Corporation (IDC).

The table below summarizes the results of the study.

Finance, insurance, and real estate firms, which as a group rank first in business profitability (their profit equaled over 18% of gross receipts), also rank first in computer investment per firm. They show an overall investment of $27 in computer hardware per thousand dollars of business receipts. Transportation, communications and public utilities come next in industry profitability with profit at 14.1% of gross receipts and they were also second in computer investment with $9 in computers for every thousand dollars of business receipts.

Following these economic sectors were manufacturing firms with profit equal to 6.4% of gross receipts and an investment in computers of $6.38 per thousand dollars of business receipts. Trailing were the construction and mining firms, wholesale and retail trades, and agricultural, forestry and fishery firms with profits less than 4% of gross receipts and investments in computers of less than $3 per thousand dollars of business receipts.

The IDC research project included a study of computer use in firms with annual sales in excess of $100,000, whether sole proprietorships, partnerships or corporations.

"The density of computers in the industries studied is still very light," a spokesman for IDC commented. "It ranges from one computer per 18 organizations for financial firms to one computer per 975 organizations for agricultural, forestry and fishery firms." He pointed to these high ratios as indications of the massive potential market still available in the computer industry in the United States. He also said that at the current time, the benefits of direct computer use are being received by less than 1% of the business enterprises in the United States with annual sales of over $100,000.

COMPUTER USE BY SOLE PROPRIETORSHIPS, PARTNERSHIPS, AND CORPORATIONS IN THE UNITED STATES WITH ANNUAL SALES OVER $100,000

Industry Group	Number of Organizations	Number of Organizations/ Installed Computers	Total Business Receipts (millions)	Net Profit (millions)	Percent Net Profit/ Business Receipts	Value of Computers Installed/ Business Receipts x 1000
Agriculture, Forestry, and Fisheries	39,000	975	$ 12,534	$ 478	3.8	.87
Mining and Contract Construction	105,000	233	64,430	2,362	3.7	2.73
Durable and Non-Durable Products Manufacturing	153,000	20	407,061	26,150	6.4	6.38
Transportation, Communication, and Other Public Utilities	29,000	16	71,872	8,125	14.1	9.25
Wholesale and Retail Trades	545,000	361	365,012	8,814	2.4	1.11
Finance, Insurance, and Real Estate	64,000	18	46,715	8,535	18.3	27.22

Prepared by: International Data Corporation, Newton, Massachusetts 02160, December 1, 1965.

Source: Business Statistics from "Statistical Abstract of the United States, 1965," Table 670, p. 489, published by the U.S. Department of Commerce, Bureau of the Census. Computer use statistics from analysis of IDC Computer Installation Data File.

NEW DEMANDS ON SOFTWARE

Dr. Thomas E. Kurtz, Director
Computation Center
Dartmouth College
Hanover, N.H.

Computers are getting bigger and better, and at a faster rate. In the short space of 15 years computation has progressed from the card programmed calculator (CPC) stage, with its two or three operations per second, to the place where submicrosecond machines are no longer status symbols. While it would be heresy within the computing world to suggest that this is a bad thing, I would contend that the tremendous advance in hardware has been a mixed blessing. So much re-programming effort has been needed for these frequent, easily justified, equipment changes that little energy was left to improve the software situation on existing (now obsolete) computers. As computers get bigger and faster and approach the speed of light, it is becoming clear that the development of software to match has not proceeded as well as it should.

The appearance of several time-sharing computer systems has caused us to take a closer look at software. This closer look, besides leading us to conclude that the software situation is not as good as it ought to be, has suggested some remedies. We can obtain some perspective by reviewing the present controversy about the value of time-sharing. The perspective becomes clearer if we look at the past history of software development.

A Brief Historical Trace

The first computers following the CPC were relatively fast compared with their input-output. In those days most computer programming was done directly in *machine language*. A person labeled as a computer programmer was indeed a highly skilled expert in conversing with the computer in this mysterious and exotic tongue.

As more efficient means of input and output were developed, we noted the increased use of special languages, though it is not being claimed that there is any correlation between these two trends. In any case, *symbolic assemblers* made it more convenient for programmers to program. Then came the revolutionary development of algebraic, user-oriented languages of which FORTRAN was one of the pioneers. The job of programming now suddenly became somewhat simpler; it is obviously simpler to teach an algebraic language than it is to teach a machine language if your purpose is to perform numerical calculations.

About this time there entered on the scene a new type of software, the so-called monitor. It permitted the user to specify what was to be done with his problems in a special code language punched on "control cards." Thus was born the batch processing system now in extremely heavy use the country over. In a batch processing system each submitted problem is run to completion. Usually each such run will require several different components in the software system to be retrieved and used consecutively. (Actually, the term batch processing is now a misnomer. Originally, when input and output were slow, it was convenient to batch together all jobs requiring, say, an assembler. After the batched assemblies, each of these jobs would then be continued at a later time. A more appropriate term for the present mode of operation might be sequential processing.)

The conventional batch-processing monitor initiates and performs such tasks as reading and writing tapes, searching for and reading in compilers, and printing or punching accounting information. Human operators still perform the tasks of scheduling the work load, handling the accounting information, overseeing the running of the problem including adherence to time limits, and carrying boxes of cards and magnetic tapes from point to point within the computing center.

Time-Sharing vs. Batch Processing

The once common and often vociferous controversy between batch-processors and time-sharers has by now subsided to a whisper. What is left of the controversy is largely abstract and not related to the current directions of computer development. One suspects that there was a liberal sprinkling of good-old-day-ism mixed with the usual throughput-per-dollar reasons presented in favor of the status quo. I would like to draw one point from the controversy, however. The most common pro-batch processing argument is that the hardware and software overhead for a time-sharing system is costly. This is of course true. The standard counter-argument, with which I agree, is that time-sharing provides a completely different, much more valuable service, well worth the additional cost. But a *crucial point* is often overlooked: namely, that batch processing software systems also require a considerable amount of overhead. Some might require up to twenty per cent of the central processor operating time for tape operations, including a search for the proper software systems, and in some cases for manual operations such as tape mounting or operator intervention for debugging purposes. The conclusion we can draw is that conventional batch processing software must still be considered primitive. While present time-sharing systems represent only the beginning, experience with them has served to identify areas for considerable software improvement in batch-processing systems as well.

There are, of course, good batch-processing monitors. Many installations are making improvements to better utilize existing hardware without dropping the basic concepts of batch processing. But in the fast-moving computer world today it is usually easier for an organization to convince its management that it needs a more powerful set of hardware. (Indeed, it may even be true that a newer, faster computer can often do the same job at a lower cost.) The net result is that not nearly enough thought and effort is being put into the improvement of software systems. If the improvement in hardware were to suddenly cease (perish the thought), we would undoubtedly find the computer world working harder to improve present software, reduce overhead, and improve service.

It should be pointed out that the emphasis on improved hardware over improved software is probably economically justified. When you can get it, good software is expensive. More often than not, you can't get it. There just aren't enough systems programmers to go around, especially ones that can be assigned the job of going after that additional 10 or 20 per cent of saving.

The Time-Sharing Legacy

The principal side effect of the introduction of time-sharing systems has been the necessity to re-examine the whole question of software: its design, construction, growth, and maintenance. Since poor service in a time-sharing system is something that every customer is immediately aware of, there is much more direct pressure to come up with better supervisory systems and compilers. The computer center staff can no longer hide behind the jargon of unfamiliar words that has kept the computer-using public docile.

To be truly effective, a time-sharing system must be designed for the load and job mix that it actually receives. In an educational or engineering environment, for instance, the multitude of small, quick jobs dictates the availability of small, quick compiler systems. Where file maintenance and interrogation are important, special attention must be given to the software that performs the file functions. Poor service is easily recognized by the user and complaints just as easily initiated. But all too often, in conventional batch processing systems serving predominantly a load of small problems the clumsy, memory-filling compiler is unlimbered and dragged in for every such problem. (What user knows enough to complain?) All too few installations now are using small resident compilers for their many short problems.

Another side effect, traceable to considerations of multi-programming as well as time-sharing, suggests quite strongly that most of the bookkeeping and manual operations previously performed by human beings ought to be managed by the computer itself. The most obvious example is that the computer should schedule its own work. Even if we retain the fundamental batch-processing concept of a single input-output channel, it is still common sense that the computer should be able to interrupt its own work when a very short, quick job is submitted to it. In a commercial situation, if a customer is willing to pay more for a quicker turn-around, the software ought to be able to serve his request, whether it be oriented more towards batch-processing or towards time-sharing.

Like the term batch-processing, the term time-sharing is also a slight misnomer. All but the smallest computers are time-shared, that is, their users share their time. But what is usually meant by the term "time-sharing" today is a system whereby many small input-output consoles operate simultaneously. Perhaps a better term would be a *multiple-console* system. In any case, the fundamental characteristics of what we usually call a time-sharing system are these:

1. Multiple input-output consoles.
2. A software system that lets the consoles operate simultaneously, schedules the use of the computer so that all console users receive equally good service, and maintains the user files.

We argue that a batch-processing software system ought to supply the functions under item 2, with the exception that there may be only one input-output channel, or that multiple channels if they exist receive only delayed service. We admit that many applications are better served by a system that employs the philosophy of a batch-processing run to completion, but we insist that this is no reason not to have sophisticated software.

The Problem of the Evolution of Software

The main problem therefore is that the development of computer hardware has outstripped the evolution of software. If our utilization of computers is to keep pace with the development of hardware, then new efforts must be invested in software. Software must be engineered with the applications in mind. The relatively infrequent application requiring special treatment need not receive the same service as the frequent applications.

As an example, in an educational environment, the many small problems from students should receive super-fast service from a software system especially designed for them. The relatively less frequent problem requiring a longer run or more sophisticated use of memories would require a different software system. This more elaborate system would be brought into play only when needed. As a result, the overhead associated with the more elaborate software system would be generated much less frequently. It does not make sense to have the more elaborate software system on hand at all times.

Another reason why more effort must be put into the development of software is that software must assume more of the bookkeeping and data-transfer functions now performed by human beings. Whether in a time-sharing or batch-processing environment, we can no longer permit a computer system used by many, many persons to be slowed down to the speed of human operators in changing problems.

In a time-sharing or a multi-programming system the more widely used software components must be reentrant: that is, they must be able to be used in common by several different users, and be interruptible.

(Please turn to page 54)

THE INTERACTION OF HARDWARE, SOFTWARE, AND FUTURE DEVELOPMENTS AT TRW SYSTEMS

H. D. Greif, Manager
Data Systems Department
TRW Systems
Redondo Beach, Calif.

In the summer of 1965 TRW Systems decided to replace their existing computers with GE 600's. This replacement is scheduled to take place in the latter half of 1966. Why did we decide to take this step?

Basically, there are two prime reasons. One is economic: the computers to be replaced lease for about $3.5 million per year, compared to the equivalent capability on the new configuration renting for approximately $1.1 million annually. The other reason for replacement is technical capability: the new computers will permit rendering new or improved services in many areas. It is the purpose of this paper to outline the new and improved capabilities of the new configuration compared to our existing computer complex and how we expect to take advantage of them.

Present Computing Facilities

Since the spring of 1963 our computer complex has consisted primarily of two integrated[1] (or shared file) IBM 7094/1301/1410 systems configured as shown in Fig. 1. In contrast to most other large computer installations of that time period, our "integrated system" has permitted input/output functions to be performed on-line to the main computer (7094) by direct tie-in of a peripheral processor (1410) via a large, shared disk file (1301). In addition, we have also employed small RCA and Honeywell computers for accounting, etc.; furthermore, a third IBM 7094 computer was added in 1965 to cope with the increased computing load.

What Is Faulty With the Existing System

Other than its relatively high cost compared to newer computer offerings, what is wrong with TRW's existing computer complex? It is certainly a relatively efficient installation and gives excellent turn-around time (as long as the load does not exceed system capacity); set-up time is very low compared to industry standards because of the sophisticated scheduling that is handled by the computer itself; furthermore, many of the tape and file-service problems of other batch-processing installations have been eliminated.

In discussing the shortcomings of our existing computer complex, we may talk about two areas: those that are primarily of concern to the professional computer programmer or analyst; and those that primarily concern the man with a problem to be solved, e.g., the engineer, physicist, or accountant. Some of the shortcomings of concern to the former include

- limited core space (32K* words on the 7094)
- no common data base between the various computers
- lack of memory protection
- competition between 7094 and 1410 for disk accesses

*$K = 2^{10} = 1024$

The shortcomings of concern to the latter are primarily the poor accessibility of the computer and the lack of immediate man/machine communication. TRW Systems currently has seven large buildings at its main 100-acre facility, and people being inherently lazy, there are loud and frequent objections to the 10-minute walk to the computing center. Also, TRW Systems has several outlying buildings and facilities in the Los Angeles area, some 1-5 miles distant, others up to 75 miles from the main plant, and Southern California's freeway system notwithstanding, computer input-output has been a real bottleneck for those not in close physical proximity of the computing center. Furthermore, the lack of immediate man-machine communication causes certain delays; regardless of how small the problem, the services of a professional programmer are required to initially translate the problem into computer language, and since the programmer is only human, generally several runs on the computer are required before useful answers are obtained.

Hence, in summary, what is wrong with the present system is that on the one hand there are certain limitations in terms of core space, etc., that primarily handicap the solution of the ever-more-complex large problems, e.g. space mission analysis; on the other hand there are different limitations in terms of access that prevent the optimum employment of a computer for the myriad of small problems that crop up daily. It is our goal to alleviate these shortcomings with the new computing complex which will be described next.

What Will the New Hardware Offer?

The new hardware equipment[2] selected to meet our requirements is shown in Fig. 2. Note first of all that it is a memory-centered system, with initially 128K words (36-bit) of 1 microsecond core storage and provisions for expansion up to 256K words. This large memory will allow the efficient solution of complex problems, and yet provide for multi-programming, i.e., the ability to accommodate several programs, both large and small, in core simultaneously. Multi-programming permits switching a processor from one program to another whenever a processor encounters a condition where it would become idle due to having to wait on some input-output, and hence multiprogramming is an important feature from the point-of-view of keeping the computer resources usefully occupied a large percentage of the time. Furthermore, multiprogramming as well as a powerful interrupt system are essential if large programs requiring minutes of computer time are to be frequently interrupted by small programs requiring of the order of a second of computing with essentially instantaneous response. To make multiprogramming practical, the new memory includes the following features:

- Memory Protection — Hardware provisions to prevent any program from accessing memory outside of its assigned boundaries. This is achieved by a register holding the upper program limit and a comparator checking every memory access to see that the address is less than this upper limit, and if greater, to cause a fault trap.
- Relative Addressing — Hardware provisions to allow all programs to be written as though they would be loaded into core starting at location zero. This is achieved by a register holding the address of the first memory location assigned to the program, and adding the contents of this register to the address specified in the program to obtain the absolute address to be accessed.

Any part of the core memory is accessible from either one of the two independent processor units, as well as from any of the devices connected to the input-output-controller (IOC). Secondary memory connected to the system via the IOC will initially consist of a hierarchy of 6 million characters of drum memory, 200 million characters of disk memory, and 16 magnetic tape drives; plans call for considerable expansion of the disk capacity in the future. The accessibility of all memory from either processor results in the highly desirable common data base which we currently lack.

All the traditional unit record devices, e.g. card readers, card punch, and printers, are on-line as in our present configuration to give fast turn-around. Furthermore, we plan to add plotting capability on-line in the future.

A data-communication processor rounds out the new computing complex; this is a small-scale computer with 16K word (18-bit) core memory, primarily designed to facilitate servicing a large number of remote terminals via communication lines. It is capable of accommodating a variety of

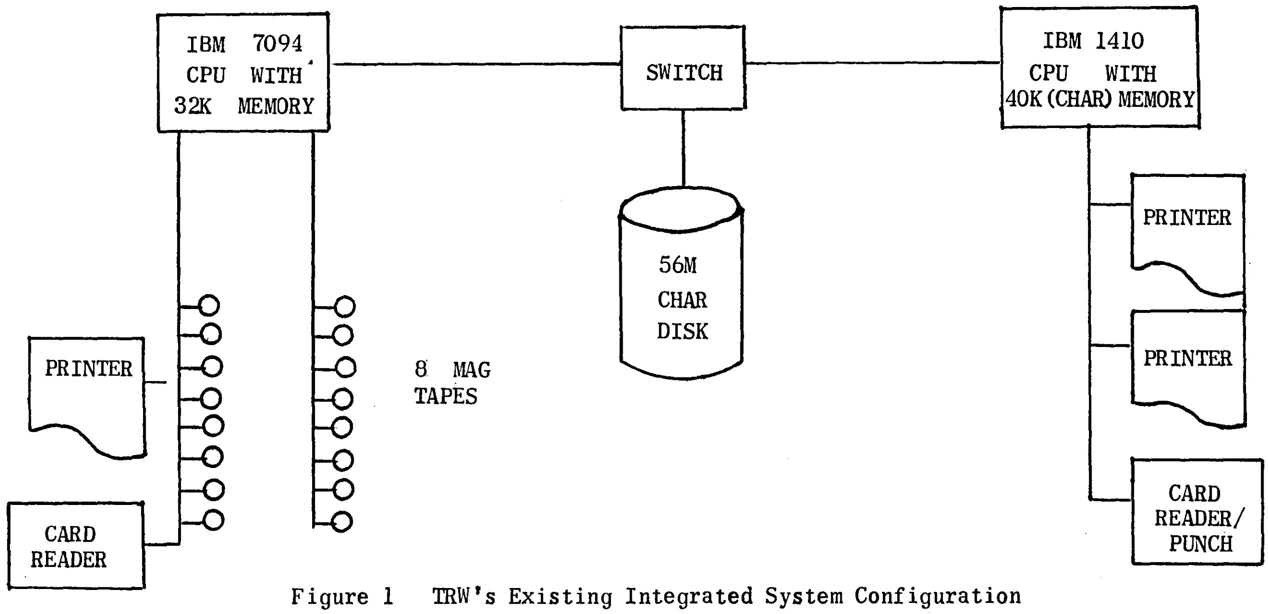


Figure 1 TRW's Existing Integrated System Configuration

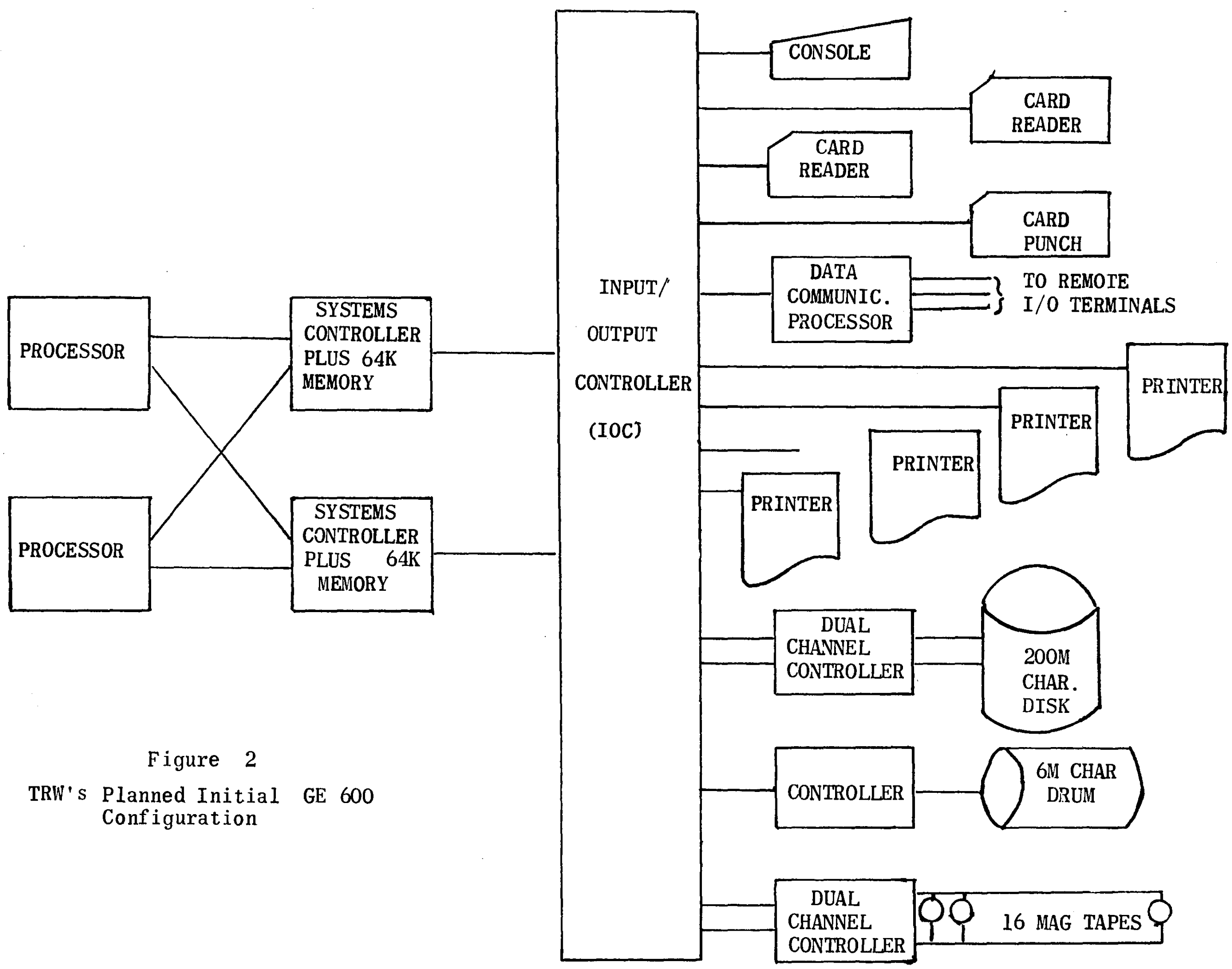


Figure 2
TRW's Planned Initial GE 600
Configuration

terminals via either direct lines or telephone switching circuits. The number and types of terminals to be installed at our various facilities is still unsettled; however, it appears likely that by 1967 there will be a total of about 30 Teletype or equivalent devices, plus about 15 CRT/Keyboard stations, plus a small number of satellite computers, test data collection and display terminals, etc.

Now that we have outlined the most pertinent features of the hardware TRW expects to install, and indicated how both large "batch-processing" programs and small, real-time on-line programs can live side-by-side, let us next look at the required software.

What About Software?

Hardware without software is rather like a man without a woman, of little use. To employ today's complex hardware at all efficiently requires equally complex software.

The following discussion on software is confined to the basic operating system, and the extensions to give the remote user the tools to solve his small problems; compilers, assemblers, applications programs, etc. will not be described.

The manufacturer has developed a comprehensive Operating Supervisor called GECOS II for the GE 600.[3] This software package is primarily intended for efficiently handling the traditional batch processing of jobs, with no provisions for real-time, conversational on-line facilities. We are developing fairly extensive additions to GECOS II to provide the required real-time, conversational on-line facilities.

Let us first give a brief description of the functions GECOS II performs:

- Input Media Conversion — Entering jobs into a job stack from the card reader or other input device; intercepting and interpreting certain control cards, and generating input control tables; and recording the input data on the drum or disk memory.
- Allocation — As jobs are completed, looking at the input control tables and selecting the job to be processed next on the basis of available resources, priorities, etc.; compacting the programs in core, if necessary, to allow the new program to be fitted into the memory; issuing instructions to the operator, if required, for tape mounting, etc.; updating the input control tables and initiating the new program.
- Execution — Overseeing the execution of each activity; interpreting fault conditions; supervising all input/output requests; collecting accounting data; etc.
- Termination — Generating the accounting record; closing systems output file; producing a post mortem dump if the termination was not normal; communicating with the operator, if required; reallocating memory and peripherals; etc.
- Output Media Conversion — Initiating and controlling the movement of data to output devices, e.g., card punch, printers, etc.

Thus, it can be seen that GECOS II completely performs the control functions required to process the traditional batch processing jobs. We shall next describe how we intend to extend by additional software the capability so that remote-terminal, real-time users can also be accommodated on the new computer complex.

Remote Operations Supervisor

First, we are currently developing a Remote Operations Supervisor (ROS) which, for simplicity, can be considered the highest priority applications program which may obtain up to 25% of the processor time. Parts of ROS, like GECOS II, are always resident in the core memory. ROS is essentially a second-level control program that performs many of the functions of GECOS, i.e., scheduling, accounting, relocations, etc., but only for the numerous remote terminal jobs. ROS is being structured "open-ended," so as to be able to accommodate a variety of specialized software packages as required to provide different services for the remote users.

Other Software

Initially, two specialized software packages are being developed to run under ROS, one a "small problem service" for solving fairly simple mathematical equations, the other for an on-line information update-and-retrieval system. A number of other software packages are in various planning stages. The following is a brief description of these remote-terminal, real-time packages.

- Small Problem Service — This package is essentially a copy of Dartmouth's BASIC,[4] but structured for operation under ROS. It will give the user at his terminal a powerful tool for finding numerical solutions to fairly sophisticated mathematical equations. Included are facilities for most of the common mathematical functions, capability for looping and branching, storage of the program for future recall, etc. This facility is expected to be heavily used, primarily by engineers, physicists, etc., for solving a host of day-to-day problems in the various scientific disciplines.
- Information Update-and-Retrieval System — This package is intended to give the administrative and management personnel ready access to the latest possible information, without having to search through voluminous reports. The initial system will be primarily used for purchasing, receiving, inventory control, quality assurance, etc.; however, plans call for other data bases to similarly allow on-line information update-and-retrieval in other fields.

In addition to the above packages currently under development, other packages currently under consideration for future implementation include:

- Text Editing — This package would permit the submission of textual material for storage on disk or tape. Once stored, additions, deletions, or corrections could readily be accomplished and clean copy prepared at any time. As such it is of prime value in the preparation of proposals, technical manuals, etc.
- Program Debugging — This package would allow a computer programmer to correct errors on-line to help speed up the development and checkout of software.
- Culler-Fried System — This package would make the Culler-Fried capability[5] available on the GE 600. This would be a powerful tool for solving problems which do not have a known or well-formulated solution, primarily as found in the field of classical mathematics.
- Computer-Aided Design — This package would permit the on-line, computer-aided design of mechanical parts, electrical circuits, structures, etc.
- Other — Computer-aided training, computer-aided testing of spacecraft and other devices, etc., are among many possible future extensions.

Thus, by extensions to the software supplied with the equipment, we expect to bring a host of new services to the users at remote terminals.

Conclusion

Our plans, in other words, are to combine the "best of two worlds" on a single state-of-the-art computing system. On the one hand, we expect to service large batch-processing problems, i.e., trajectory, matrix, APT, etc., in a very efficient and economical way. At the same time, we expect to "steal" small amounts of time in a multiprogrammed or time-sharing environment for solving a host of problems that are most effectively handled using remote terminals and man-machine interaction.

We fully expect that as time goes on, further improvements in computer hardware and software will bring about systems that together will approach a true computer utility, and which will once again make obsolete the computing system described here.

REFERENCES

1. M. Kory and P. Berning, "The STL Integrated Computer Operating System," ACM Proceedings, August, 1964
2. GE 635 Systems Manual, G.E. Computer Dept., July 1964
3. GE 625/635 Comprehensive Operating Supervisor, G.E. Computer Dept., July 1964
4. BASIC Manual, Dartmouth College, Hanover, N.H., Oct. 1964
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READERS' AND EDITOR'S FORUM

(Continued from page 8)

The Society will have objects similar to those of the state computer societies, these being described in the constitution as:

1. To extend among members the knowledge and appreciation of digital and analog computers, automatic data processing systems, and computer-based automatic control systems, and of theory related thereto;
2. To establish and maintain the professional standing of members by developing a code of ethics and defining standards of knowledge in the fields referred to above; and
3. To foster an informed public opinion regarding computation and computing machinery and techniques related thereto.

Its initial membership will be approximately 1,300.

SOCIAL RESPONSIBILITIES OF COMPUTER PEOPLE — MORE COMMENTS

I. From Stanley W. Mechlin

Data Systems Consultant
Pet Milk Co.
St. Louis, Mo.

I read your October editorial on social responsibilities of computer people, and I enjoyed it very much. I agree with the responsibilities and areas you have set forth.

Nevertheless, I believe you omitted several non-economic areas of responsibility. Perhaps the difference in our thinking results from the fact that I equate "Computer People" with "Systems Designers" . . . and this equating may not be acceptable to you.

Nevertheless, I believe you omitted several non-economic areas of responsibility. Perhaps the difference in our thinking results from the fact that I equate "Computer People" with "Systems Designers" . . . and this equating may not be acceptable to you.

Perhaps my forecasts are biased because of my business position, but I see computer-related systems design as being used primarily for optimization of *economic* systems. This optimizing is coming at a fantastic, accelerating pace.

But economic needs are only one part of human needs, and the economic sub-system is only a part of the total social system. As all systems designers have painfully discovered, optimizing a sub-system out of context can play the devil with the overall system. In fact, the new sub-system thus designed can easily make a *smaller* contribution to overall system performance than the "old" sub-system being replaced.

We already have seen examples of the danger of optimizing economic sub-systems. Partial optimizing of Production produced non-economic stresses that resulted in communism, trade-unionism, and strikes. Our economically abundant society has produced pollution of air and water, urban and highway blight, the television wasteland, etc., etc.

And the degree of optimization that has been achieved so far is just a tiny part of what is possible, through the use of computer-based systems, in the very near future.

Although it is difficult to predict the specific, non-economic results of this economic optimization, I think it is likely that dire consequences will follow. One possibility is a form of non-material communism, where the government is forced to take over the economic sub-system in order to relegate it to its place within Man's total needs.

None of this is meant to imply that using computers for economic optimization is bad. Nor could we slow down this progress even if we wanted to. Therefore, there seem to me to be two general areas of social responsibility for the systems designer.

First is the general area covered by the six items in your editorial, which I would sum up by saying, "Promote the use of computers for optimizing non-economic systems" . . . health, education, public welfare, law enforcement, etc.

The second area of responsibility covers providing for non-economic needs in the design of economic systems. In addition to the needs mentioned above (health, education, etc.), some of these non-economic needs might be described as follows: the need for freedom, the need for human companionship, the need for challenge and sense of accomplishment, and the need to feel needed.

I see quite a challenge to systems designers in both of these areas of responsibility. In general, the areas covered in your editorial imply public, avocational activities on the part of computer people.

The second set of responsibilities often produce on-the-job conflicts for the systems designer. How is he to meet the basic economic requirements for which he receives a salary, and still take into consideration in systems design the human need for freedom, sociability, etc.? It is much easier to turn one's back on such responsibilities.

Thanks for a provoking editorial and a good publication.

II. From William Eastman

Mass. Inst. of Technology
Instrumentation Laboratory
Cambridge, Mass. 02139

It would be as preposterous to oppose your "position paper" (C&A, October 1965) as to oppose motherhood or Christmas. No doubt

All men should be responsible citizens.

(Please turn to page 54)

LOGICAL DESIGN TO IMPROVE SOFTWARE DEBUGGING – A PROPOSAL

Dr. Ned Chapin
Menlo Park, Calif.

Logical designers of computers have given much attention to making computers efficient for data manipulation and computation operations. But they have given little attention to making computers efficient for program debugging.

Computers keep getting faster and more complex. Applications keep becoming more extensive, more intricate, and more time-critical. As a result, the programer faces an increasingly harder job in debugging. In point of fact, all of the programer's job has been growing in complexity. He must work now with machines that are inherently more complicated to program. He must prepare more lengthy and more logically complex programs. He must sometimes prepare programs for use in real time environments. He must sometimes prepare programs for use in environments where small undetected errors in programs may jeopardize large investments in equipment, or jeopardize life. All of these factors contribute to the cost of finding and correcting program bugs.

Proposals have been made for software to allow debugging work to be done in the same language in which the programer wrote the program. With few exceptions these proponents have never seen their ideas carried to the point of implementation; none have been carried to the degree they envisioned. The result is disappointing. No major computer today, and no major programing language today, has a comprehensive symbolic debugging software package with it. The best known debugging packages today are probably DDT and AUTOTEST.

Software packages such as these are far better than nothing, but they leave much still be be desired. In trying to strike a reasonable balance between convenience of use, amount of storage used, cost of programing, and speed of execution, the programers who prepare these symbolic debugging packages have found themselves at a considerable loss. Most hardware does not provide convenient features for debugging.

This is not to say that nothing has ever been done by the logical designer to help debugging. On the contrary, to cite two examples from history, the IBM-650 provided an address stop, and the IBM-1401 provided a line at a time dump. Features such as these however are of little use to the programer who attempts to prepare a symbolic debug package. Other features, as for example, interrupt traps and easy relocatability such as are available on some computers, actually contribute more. Consider the task of writing a trace routine for an IBM-1400 series machine. This is a difficult task but it can be done. However, the amounts of storage used by routines thus far devised are so large as to render the routines essentially useless. If a computer incorporated as part of the hardware some features convenient for debugging, then comprehensive and useful symbolic debugging software could be prepared.

A Proposal

To remedy this situation to some extent, I would like to propose a hardware feature that would facilitate debugging. The proposal is given in two forms. The "bare-bones" form is proposed as a minimum; the "full" form, as a possibly desirable trade of hardware for software.

The "bare-bones" proposal is to add two additional commands to the command repertoire of a computer. For their association value, one of these can be termed an Auto-MonitoR command (AMR), and the other can be termed a Snap Shot Dump command (SSD). How each of these commands might operate is discussed below.

The AMR Command

The AMR command (see Figure 1) would have two effective operands, the first naming an address in storage, the second a tape, disk, or other equivalent unit. In execution,

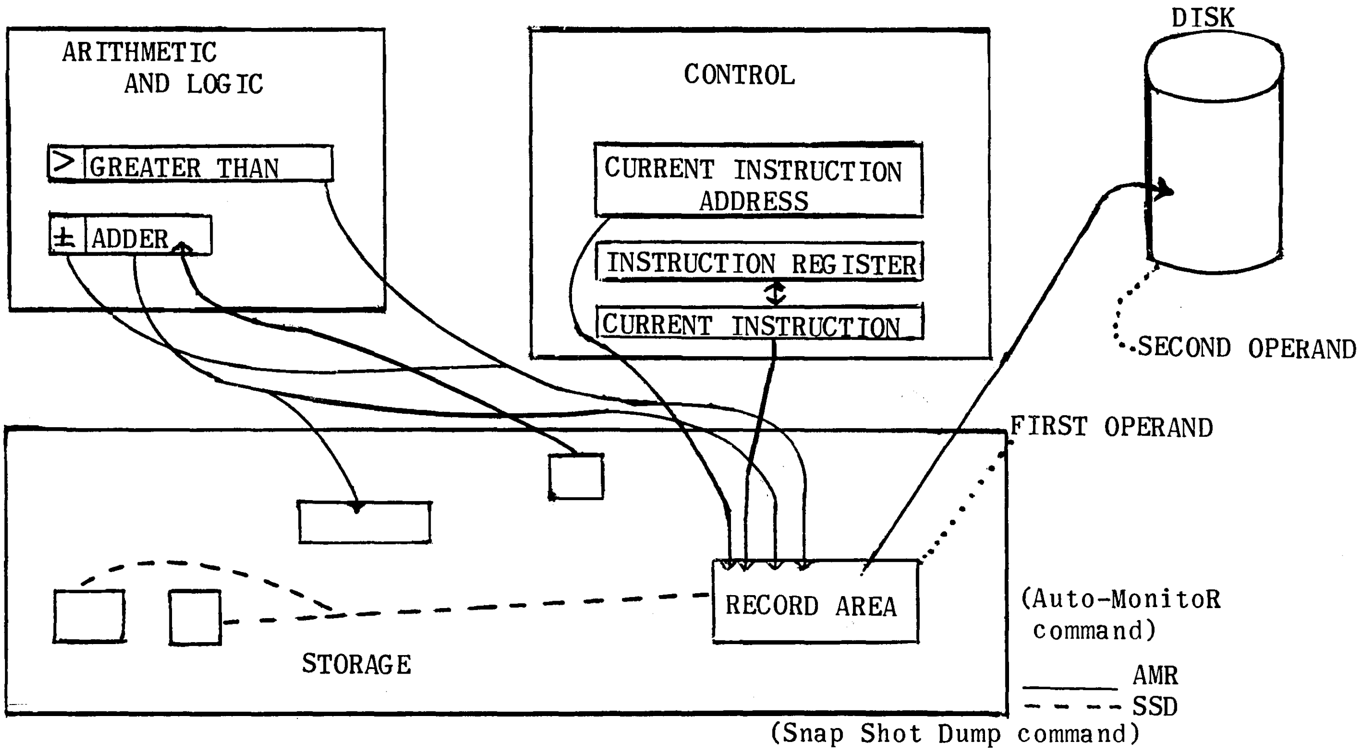

Figure 1 SKETCH OF FUNCTIONS

the AMR command would place into successive storage locations starting at the first operand address, data ("the record") indicating for each subsequent instruction that the computer executed: 1 — the effective instruction address, 2 — the effective instruction, 3 — part (say eight or ten characters) of the contents of the receiving operand after execution, 4 — a count of the number of words, bytes, characters, or digits of data altered by the operation, and 5 — the new status of any altered testable indicators. Periodically and automatically as needed the area in storage receiving these data ("the record") would be copied on the device named as the second operand of the AMR, and the area in storage then reused. In multiprogram environments, an additional operand might indicate whether one or all programs are to be included in the record.

The actual current instruction address is more useful than the anticipated next instruction address for debugging work. Since both are handled by the circuitry of the computer but at different times, the one can be recorded about as well as the other. The effective instruction in full is more difficult if higher level addressing or indexing are being used. The address data to be recorded are the addresses that result from the application of any indexing or multi-level addressing. The circuitry of the computer must go through the calculation of the effective addresses. These can be recorded at the time they are calculated. The count of the data altered is also always known to the computer circuitry because it is either fixed, or is calculated in each case. In those computers that increment or decrement an address successively, the amounts could be accumulated (summed) by circuitry to yield a count.

The operand data (contents of a word, field, or register) to be recorded are those data which the circuitry of the computer uses to replace existing data, such as the contents of a receiving area in a move operation, or of a sum in an addition operation. The essence of the proposal here is that the part of the data that are going to be set down somewhere in the computer anyway also be set down (copied) in the special storage area. In order to be economical about it, the amount of data to be copied should be about the equivalent of one or two words at the most. The record of any change in the status of a testable indicator could be given in a very condensed form, as one character to the combinations of the indicator identification and the status.

The SSD Command

The SSD command would have three effective operands. The first two would function in the same manner as the operands of the AMR. The third operand would list one or several addresses from which the dump would be made. Only the equivalent of one or two words (8 or 10 characters) of data would be dumped. While the dump was being made all other data movement operations in the central processing unit should be *halted*. In either case, ideally the execution time for SSD should be made as short as possible.

The SSD command is needed for two main reasons. One is that the AMR command would result in slowing computer operation. This would subvert the time relationship in the sequence of the computer's operations, rendering the recording unrealistic. This would be most noticeable in the slower, serial computer, and for programs designed for use in real-time environments. Second, a major problem that programers face is correcting timing difficulties arising from data arriving later or earlier than expected. A realistic diagnosis requires "on-the-fly" knowledge of data availability without slowing computer operations or altering time relationships in the action taken by the computer. The SSD command must operate within the normal timing "stop" or tolerance in a program. Also, the SSD command obviously would not be necessary if it were possible to implement the AMR command at no increase in effective execution time for all of the other commands in the repertoire.

The "Full" Proposal

A "full" or more luxurious proposal would refine the computer action and reduce the amount of programing needed to prepare a symbolic debug package. This full proposal alters the AMR command but leaves unchanged the SSD command.

The AMR command would include an additional or substitute operand naming a control field or word. This would indicate the circumstances needed to trigger the AMR function. That is, the AMR command, once it has been sensed by the computer, would produce no record in storage and seemingly remain a latent capability until the computer circuitry sensed a particular combination of circumstances. At that time and only at that time would a record be provided in storage, and that record would be a selective one produced only as needed rather than always for every instruction executed.

The circumstances that would be most helpful would be these: 1 — the effective instruction address, either in specific form or within inclusive limits; 2 — any effective operand address, either in specific form or within inclusive limits; 3 — any resulting effective operand content, in length up to the equivalent of about one or two words (8 or 10 characters), with the content specified either in specific form or within inclusive limits; 4 — the effective command; 5 — the activation of any specific peripheral device; 6 — the reference to set or test any specified indicator or condition that can be used for a conditional transfer of control; and 7 — the sensing of any illegal operation.

The record would be produced only when the circumstances were met, and then either be produced in full thereafter or produced only when the circumstances re-occur. The contents of the receiving operand before alteration could be included in the record. For completeness in the selective record, the breaks in the control sequence should be recorded. The net effect of this selective operation would be to reduce the amount of data recorded and hence to reduce the frequency of peripheral copying of the record.

Use of the Recorded Data

The availability of the recorded data noted above could make more easily possible an effective and efficient symbolic debug package. The input would come from three sources (see Figure 2). One of these would be a selective listing by the programer of some symbolic names and data contents expected for the test case being run. Second would be the symbol table produced by the compiler program. The third would be the record produced by the SSD and AMR operations. As to output, one tradition-clinging form would be a list of the steps showing how the areas the programer named got to have the contents they do. All symbols used by the programer in the original program would be retained and used in the output. The fact that programers do not have such information available today is evidence of the difficulty of producing it with present hardware.

This proposal has been brief and from a software writer's point of view. Perhaps it may stimulate thought about what can be done in logical design to cut down the growing burden of debugging.

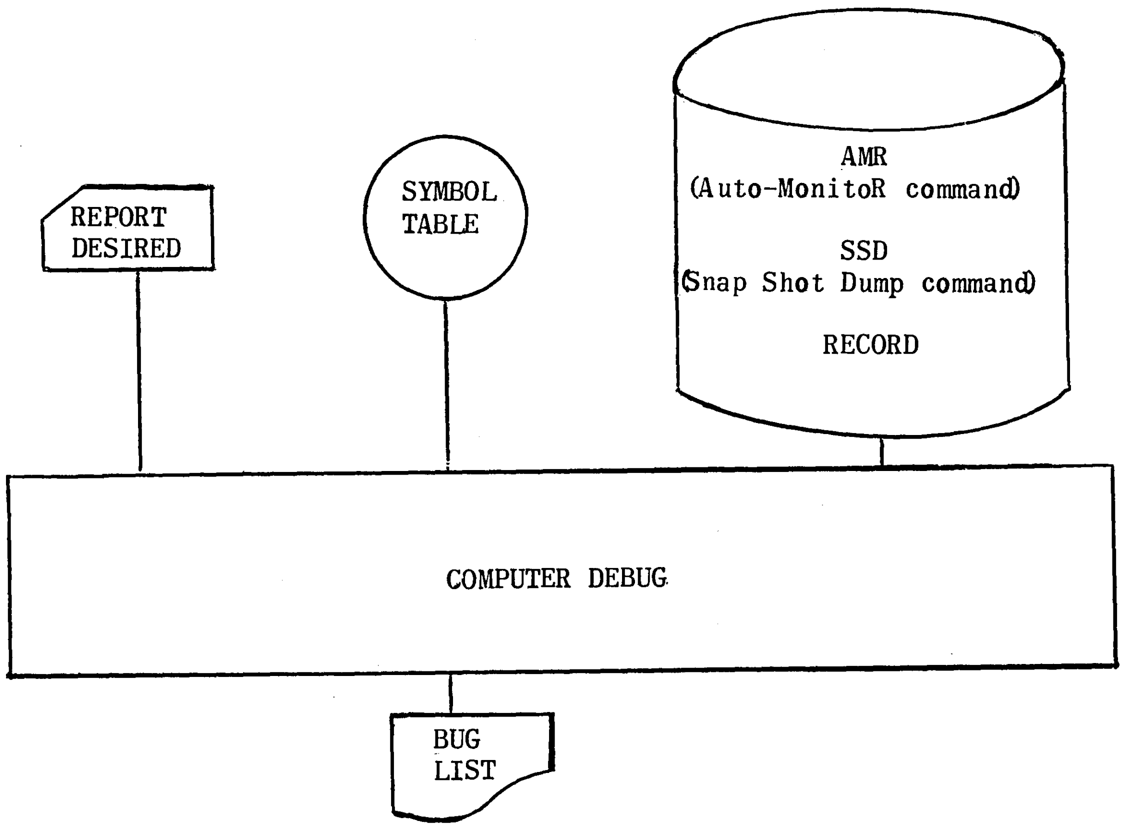

Figure 2 SYSTEM DIAGRAM

"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

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APPLICATIONS

$4 MILLION COMPUTER NETWORK AIDS TRUCKING INDUSTRY

Stanley J. Auwers, vice president and controller of Interstate Motor Freight System (Grand Rapids, Mich.) has revealed details of a computer-based management information system which "promises to revolutionize the truck transport industry". The $4 million computer network, completing its final stages of implementation, will give Interstate management the ability to: (a) instantly trace the location and status of any shipment; (b) give up-to-the-minute reports to destination and intermediate terminals on the composition of all loads dispatched to them; (c) centrally rate and automatically bill each shipment; and (d) simulate certain operating conditions on the computer to increase utilization, service and profits.

The center of the network, an IBM 1410 computer located in Grand Rapids, is linked by telephone lines to tele-processing units in each of Interstate's 64 terminals. When a request for a shipment of goods is received at a terminal, it is sent by an IBM 1050 data transmission device to Grand Rapids. There, it is picked up by a 7740 communications control unit which logs incoming messages and then feeds them to the central computer for processing. The 1410 automatically rates the shipment, prints a customer invoice, stores the updated data in a central disk file, and prepares a copy of each bill for transmission to the tele-processing unit at the destination terminal.

When the shipment leaves the originating terminal, a dispatch message is prepared showing the tractor, trailer, driver, destination of the load and individual freight bills aboard. This manifest is sent to headquarters and stored in the master file. Intermediate transfer terminals along the trailer's route and the destination terminal continue to update the master manifest as goods are loaded or unloaded.

"We will be able to track the movement of more than 8,000 daily customer shipments in more than 3,500 vehicles criss-crossing the United States on 4,000 separate traffic routes," Mr. Auwers said.

COMPUTER-BASED CREDIT AUTHORIZATION SYSTEM

Carson Pirie Scott & Co., a Chicago, Ill., department store, has announced the operation of a computer-based credit authorization system in which an IBM audio response device gives sales personnel credit information in the form of spoken words. The computerized communications system permits sales clerks to get authorization on credit purchases by telephone — in less than 30 seconds.

The new credit authorization operation is built around an IBM 7770 audio response device and an IBM 1440 computer, both installed in early November 1965. The sales clerk simply "taps in" on the Touch-Tone phone the computer's extension number along with the customer's account number and amount of purchase. Within a few seconds, the audio response unit gives a verbal answer authorizing the sale — or if for any reason the sale is not approved, the computer will give the clerk instructions on what procedure to follow.

Key to the voice answer back service is the audio response device which is linked to the computer. When a query is introduced into the computer via Touch-Tone telephone, the computer searches its memory for the answer and then directs the audio response device to assemble a verbal answer from its stored English-language vocabulary.

At present, 60 telephones in the main store are hooked to the central computer, and are requiring only four per cent of the computer's time. In the near future, all telephones on the sales floor and in the 11 branch stores (totaling nearly 1000) will have direct access to the system.

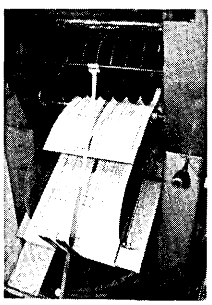
CARBONLESS PAPER USED IN CONTROL DATA CORPORATION'S PROCESSING CONTROL FORM

Use of a carbonless paper in their processing control form at the Operations Department of the Twin Cities Data Center, not only eliminates numerous problems associated with carbon-interleaved sets in the handling operation but also saves Control Data Corporation's in-plant print shop some 50 per cent in form preparation time.

The process control form is used to control all processing performed by the Data Center. The forms are printed in the company's Graphic Arts Department on pre-collated "Action" Brand Carbonless Paper.

The carbonless stock, produced by the 3M Company (St. Paul, Minn.), is unique in its field because it has the ink built right into the paper. The simple strike of a typewriter or business machine key or pressure of a stylus triggers a chemical reaction within the paper, producing an instant image. Images on the "Action" paper copies are uniformly sharp, clear and completely smudge-resistant. The color-coded carbonless copies are as easy to read as the original.

The paper comes already collated in three-part sets consisting of a white bond top sheet and canary and pink "Action" paper. It is run through the press in order (see photo, upper left).



The finished stack is then taken to a padding station (photo, upper right) where a special penetrating adhesive is applied and the forms are allowed to dry. Then the padded stack is fanned apart (bottom) into unit sets with the simple flick of a thumb down the side of the padded stack. Forms are produced with the pre-collated paper in half the time it takes to make carbon-interleaved forms for approximately the same cost. (For more information, designate #41 on the Readers Service Card.)

COMPUTERS TALK CENTS

Talking computers have begun giving long-distance telephone operators split-second information on the cost of calling any of the more than 30,000 possible toll centers in the United States and Canada. The new computerized toll rating system uses two computers, a matched pair of Honeywell 200's installed at the Northwestern Bell Telephone Co., Omaha, Neb., to insure 24-hour-a-day, seven-day-a-week operation. (The electrical power supply also is duplexed to insure against a failure of the normal power supply.)

The new system — to be used by long-distance operators in Iowa, Minnesota, Nebraska, North Dakota and South Dakota — is designed primarily to calculate rates on the thousands of long-distance calls made each day from public telephones, motels and hotels. It is expected to handle as many as 5000 requests an hour from operators throughout the five-state region.

Each computer has a 24,576-character main memory, a random access "drum" memory capable of storing 2.6 million characters of information, a communications control unit and a time-of-day clock which enables the computer to determine the correct rates, taking into consideration the appropriate time zone and day-of-week.

The geographical coordinates of the more than 30,000 central office locations in the U.S. and Canada are stored in the system's memory. The computer uses the coordinates to calculate the distances, and the resulting charge, referring to rate tables which also are kept in memory.

When intercity charges are needed by an operator — who may be situated anywhere within Northwestern Bell Telephone Company's territory — she queries the computers by using a keyset that is part of her standard operating station. The computer receiving the toll rate request consults the "drum" memory (under instruction of the main memory) for the basic information, performs the necessary calculations, and activates its audio response unit to give the correct reply. The computer automatically selects the phrases it needs from the appropriate audio response tracks and then, effectively, "speaks" to the operator.

CIRCUIT TESTING IN TELEPHONE SWITCHING EQUIPMENT AIDED BY COMPUTER

Testing and repairing circuit deviations in electronic telephone switching equipment being manufactured at Automatic Electric Company has become faster and easier through use of a computer and special equipment designed and built at the company. The time required to test circuits — in the maze of wiring that makes up the electronic control circuits in the matrix cabinets of the electronic switching centers — has been reduced from an average of seven hours to about 15 minutes. Formerly, these tests were made manually.

An IBM 1710 computer provides three kinds of information that help reduce necessary repair time for each wiring error to approximately two minutes: instructional messages are given that guide the operator in his functions; procedural messages are printed out to indicate what stage of testing is taking place, and diagnostic messages are issued that pinpoint the exact locations of the detected error.

D. E. Schuster, supervisor of test facilities, sketched the operation of the new computer program. "The computer has stored in its 'memory' the wiring arrangement of each unit. Working in conjunction with the special Automatic Electric equipment, the computer checks the accuracy of the circuitry against the pattern in its memory. If a deviation exists, the computer prints out on a typewriter the nature of the error and its exact location. A shop operator then can make the necessary correction in a matter of minutes."

COMPUTER CONTROL SYSTEM FOR PETROLEUM REFINING

Working in conjunction with the Foxboro Company, Foxboro, Mass., Esso Research and Engineering Co. and Esso Petroleum Co. Ltd. of the United Kingdom have designed the world's largest computer control system for petroleum refining. Spokesmen at Esso Research's engineering center, Florham Park, N.J., described the system, known as direct digital control or DDC, as the most advanced in the petroleum and petrochemical process industries. The system, which will be installed next summer at Esso Petroleum's refinery in Fawley, England, represents an initial investment of $1.2 million. It is expected to be operational by October.

Highlight of the system is what engineers call multilevel computer control, meaning that one computer will supervise a number of subordinate computers. The supervisory computer will make some of the decisions refinery operators make in less advanced systems, including the setting of such important manufacturing factors as temperatures, flow rates, and pressures. The subordinate computers in turn will maintain these conditions at desired levels, sending instructions directly to more than 400 control valves throughout the refinery.

The computers will control more refinery manufacturing conditions than any other known system. They will direct more than a dozen complex petroleum refining processes spread over an area larger than 50 football fields. The units to be controlled by the system turn crude oil into such finished products as gasoline, home heating oil, diesel fuels, industrial fuel oil, and jet fuels.

EDICT — ENGINEERING DOCUMENT INFORMATION COLLECTION TECHNIQUE

Engineers at the Space Division of North American Aviation, Inc., Downey, Calif., soon will have immediate telephone access to an IBM computer system which will contain up-to-the-second reports on the engineering design status of NASA's Apollo spacecraft and the second stage of the Saturn V moon rocket. The reports will be available by dialing the computer directly from any of North American's 42,000 telephones, information coming from the computer in the form of spoken words. Similar audio response systems currently in use, use touch-tone or push-button telephones to reach the computer. The Space Division uses regular dial telephones which make verbal replies readily available at almost any desk.

The new approach, called Engineering Document Information Collection Technique, or EDICT, was developed by the Space Division with the assistance of IBM Corporation and the General Telephone Company. EDICT will provide engineers, manufacturing personnel, scientists, inspectors and managers at the Space Division's widely-dispersed locations with immediate information on changes or revisions to engineering documents which may affect work underway in their areas. The computer system, containing 35,000 Saturn II and 40,000 Apollo drawings and specifications, will permit North American to keep track of all segments of both space programs.

To make use of EDICT, a Space Division foreman, for example, dials a special code number and is connected with the General Telephone trunk circuit leading to the computer. He dials the appropriate drawing number and the IBM 1460 computer checks for current information in its disk storage devices. The computer selects elements from the vocabulary stored in a magnetic drum of the IBM 7770 audio response unit, forms the proper response message and directs the reply to the correct telephone.

EDICT can handle eight telephone calls simultaneously while still processing incoming data. An engineer who dials EDICT just as new information on the drawing is being added to the computer's memory will receive that data before his call is completed.

AD DATA COMPUTERIZED BY SCHENLEY

Any of 13 key Schenley Industries' sales executives, at the punch of a few buttons, now are able to have projected instantly on a video screen on his desk, Schenley advertising expenditures — monthly or annually — for any brand in any region of the country on any medium. On the same projections, the selected data will be compared with the corresponding figures for that month a year earlier, or for the previous year. The Schenley innovation, a "first" for the advertising as well as the distilling industry, was described by Bernard Goldberg, president of Affiliated Distillers Brands Corp., Schenley's marketing subsidiary.

This past fall, Schenley installed a two-way, instant-access computerized data reporting system — with equipment made by The Bunker-Ramo Corp., and with the data stored on a computer's memory drum at Bunker-Ramo's downtown Telecenter. The stored and available information until recently was limited to sales and inventory. Price data and order information have been added.

The computerized system has a small transmitter-receiver desk console similar to the devices used by airlines for ticket information and by brokers for stock market information. Each console contains a keyboard and small video screen. By means of a keyed code, the user punches his query onto the keyboard and in less than a second the requested information begins to appear in easily read digits and letters on his screen.

"We will be measuring millions of dollars by pennies," Mr. Goldberg said. "For each of Schenley's many brands, we will be able to learn in a matter of seconds how much we spend for advertising and promotion in each market down to the last penny."

NEW CONTRACTS

FROM	TO	FOR	AMOUNT
United Air Lines, New York, N.Y.	UNIVAC Division of Sperry Rand Corp., New York, N.Y.	The design and building of an on-line computerized information system to provide United with a nationwide totally integrated reservations, operations and management data processing system. Contract calls for delivery of equipment during 1967 and for the system to "go on the air" early in 1968	$56 million
Japan National Railway	Honeywell Electronic Data Processing	Seven H-200 data processing systems; four have been installed at branch offices in Niigata, Seibu, Kansai and Chubu; the additional three will be at the railway's Shikoku, Hokkaido and Tohoku offices. The systems are worth $2.5 million	$50,000/month
The Dow Chemical Company, Midland, Mich.	Control Data Corporation	The design and building of a multi-computer integrated data processing communications system, which will include a Control Data 3600 computer supported by two Control Data 3200's	—
National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Ala.	Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla.	A SEL Model 810 digital computer and peripheral equipment to be used in a high pressure pneumatic test facility	$109,648
Boeing Company	Computer Control Co., Inc., Framingham, Mass.	One DDP-24 and three DDP-24 Van Mounted computers to be designed for use in a trainer system for launch control officer procedures on Air Force Minuteman weapons systems	over $500,000
Douglas Aircraft Co., Aircraft Group, Long Beach, Calif.	Planning Research Corp., Los Angeles, Calif.	A study of worldwide air passenger capacity in 1965	—
Aeronautical Chart Intelligence Center, St. Louis, Mo.	Planning Research Corp., Los Angeles, Calif.	A system design study	$400,000
NASA, Computation Laboratory, Marshall Space Flight Center, Huntsville, Ala.	Computer Control Company, Inc., Framingham, Mass.	An input/output system that will collect data from four analog computers	$295,000
Southwire Company, Carrollton, Ga.	General Electric Co.	A total information system which includes a G-E 415 computer, a printer, card reader, card punch and four magnetic tape units, scheduled for spring delivery; addition of the direct access package, random disc storage device, and communication control assemblage will complete system in the fall	—
Navy Oceanographic Office	Discon Corporation, Fort Lauderdale, Fla.	A Semi-Automatic Tracing Digital Coordinate Reader to be used in connection with scientific studies of contour maps and charts	about $200,000
Range Systems Division, LTV Aerospace Corporation, a subsidiary of Ling-Temco-Vought, Inc.	The Bunker-Ramo Corporation, Canoga Park, Calif.	A digital computer system and associated services. The computer equipment is part of a system being supplied by Ling-Temco-Vought to the U.S. Navy's Bureau of Ships	$339,443
Headquarters of the 3121st U.S. Air Force Logistical Control Group (ATLANTIC), Brooklyn, N.Y.	Itek Corporation, Special Equipments Division, Burlington, Mass.	Five special film viewers to be used by the Air Force photointerpreters to examine projected enlargements of aerial photography	$125,000

NEW INSTALLATIONS

AT	OF	FOR	FROM	AMOUNT
Sun Oil Company, Philadelphia, Pa.	GE-635 computer system	Use as heart of Sun Oil's central computing system located at Center City, Pa., and consolidation of company's business operations	General Electric Co., Phoenix, Ariz.	over $2.5 million
Sisters of Saint Casimir, Chicago, Ill.	IBM 1440	Patient accounting and billing at two Chicago hospitals owned and operated by the Order; later, student accounting/reporting at Maria High School, and primary accounting for Antelope Memorial Hospital, Neligh, Nebr. and for the Mother House	IBM Corporation, New York, N.Y.	—
Broken Hill Proprietary Co. Ltd., Newcastle, Australia	Honeywell 200 system	Payroll processing, inventory control, scientific and engineering calculation and statistical reports	Honeywell EDP, Newhouse, Scotland	$300,000
Wisconsin Telephone Co., Oshkosh, Wisc.	System/360 Model 30	Processing customer accounts	IBM Corproation, New York, N.Y.	—

AT	OF	FOR	FROM	AMOUNT
United Air Lines, Chicago, Ill.	Multi-computer flight planning system includes two Control Data 3100 computers, 30 Control Data 211 Display units	Automatic flight planning and monitoring system (AFPAM)	Control Data Corp., Minneapolis, Minn.	30-month lease, about $1.5 million, option to buy
M.D. Anderson Hospital and Tumor Institute, Houston, Texas	SDS 930 computer	Research aimed at safer surgical cures of cancer; in many cases working on-line, monitoring surgical operations	Scientific Data Systems, Santa Monica, Calif.	—
Lockheed Missiles and Space Co., Sunnyvale, Calif.	UNIVAC 1108 data processing system	Use primarily in data reduction and FORTRAN	Sperry Rand Corp., UNIVAC Division, New York, N.Y.	—
U.S. Navy, Oakland, Calif.	Honeywell 200 system	Maintenance of fleet inventories of repair supplies — supply operations assistance program (SOAP)	Honeywell EDP, Wellesley Hills, Mass.	about $6000/month
National Blank Book Co., Holyoke, Mass.	IBM System/360 Model 30	Streamlining telecommunications network between 6 branch offices and developing integrated system of management controls	IBM Corporation, New York, N.Y.	over $500,000
Cox Broadcasting Corp., Atlanta, Ga.	Honeywell 120 computer	Data management and information control for the home office	Honeywell EDP, Wellesley Hills, Mass.	—
County Auditor's Office, Franklin County, Ohio	IBM 1401 computer	Processing of real estate taxes and assessments due; payroll vouchers and warrants for entire county payroll	IBM Corporation, New York, N.Y.	—
NASA-Goddard Space Flight Center, Greenbelt, Md.	SDS 930 computer system	Check out of NASA Orbiting Astronomical Observatory (OAO) experiments prior to launch from Cape Kennedy	Scientific Data Systems, Santa Monica, Calif.	$400,000
New York Shipping Association and 13 Waterfront Commission Hiring Centers, N.Y.	A central computer consisting of dual IBM System/360 Model 40's and 56 IBM 1031-1053 terminals	Ensuring longshoremen prompt, accurate payments of annual income guarantee negotiated last year; first time a computer has been used to facilitate hiring of longshoremen and ensure adequate labor supply in Port of New York; becomes operational in April	IBM Corporation, New York, N.Y.	about $1.3 million in first year of operation
Ludwigsburg Bank, Baden-Wurttemberg, West Germany	H-200 system	Processing and maintaining 22,700 accounts and handling bookkeeping for main office, 8 branch offices and 62 smaller offices throughout the region	Honeywell EDP, Newhouse, Scotland	—
Roosevelt Savings Bank, Brooklyn, N.Y.	NCR 315-100 computer system	On-line data processing of savings accounts and a variety of other bank business off-line	National Cash Register Company, Dayton, Ohio	—
E. I. du Pont de Nemours & Co.	PACE (Precision Analytical Computing Equipment) Computing System	Automatic processing of analytical data from gas chromatographs	Electronic Associates, Inc., West Long Branch, N.J.	—
Mayne Nickless, Ltd., South Melbourne, Australia	H-200 computer system	Preparing over 22,000 monthly bills initially; other accounting and administrative tasks being phased into the trucking firm's system	Honeywell EDP, Newhouse, Scotland	—
New Era Data Systems, Inc., New York, N.Y.	Card-Tape System	Further expansion of data-converting operations without tying up New Era's computers	Ampex Corp., Redwood City, Calif.	—
Mayo Foundation, Rochester, Minn.	Control Data 3200 computer system	Analyzing large amounts of data from bio-medical experiments	Control Data Corp., Minneapolis, Minn.	—
Halliburton Co., Duncan, Okla.	IBM System/360 Model 30	Development of a toal management information system. The company provides oil field services in 34 countries on six continents	IBM Corporation, New York, N.Y.	—
Bambergers-New Jersey, a division of R. H. Macy and Company, Inc., Newark, N.J.	NCR 315-100 system	Converting optical-font tape produced by 450 NCR sales registers into magnetic tape for input into larger computer	National Cash Register Company, Dayton, Ohio	—
Chevron Oil Company, Geophysical Division, Houston, Texas	SDS 930 computer	Use in searching for oil	Scientific Data Systems, Santa Monica, Calif.	—
Computer Sciences Corp., Los Angeles, Calif.	IBM System/360 Model 40	Solving both commercial and scientific problems	IBM Corporation, New York, N.Y.	—
Philippine Air Lines (PAL), Manila	NCR 315 computer system	Eventually integrating all aspects of line's operations; initially for inventory control, aircraft maintenance scheduling and passenger-load analysis	National Cash Register Co., Dayton, Ohio	—
School Department, Dayton, Ohio	NCR 315 computer	Classroom scheduling of 11 high schools (elementary schools to be added later); also other student recordkeeping and administrative and accounting tasks	National Cash Register Company, Dayton, Ohio	—

ORGANIZATION NEWS

IBM & BSC ISSUE JOINT STATEMENT

In a joint statement, IBM Corporation and Business Supplies Corporation of America announced that an action previously instituted by Business Supplies Corporation of America against IBM Corporation and a counterclaim asserted by IBM against BSC, both for alleged violations of the antitrust laws, have been settled by a mutual withdrawal of claims, provision for cross-licensing under certain patents relating to the record media field and reimbursement by IBM of a portion of BSC's counsel fees.

HONEYWELL WILL BORROW $20 MILLION IN EUROPE

Honeywell Inc. announced plans (December 28, 1965) to offer a $20 million debenture bond issue in Europe in late January to raise money for the financing of its international operations.

Honeywell International Finance Company S.A., a wholly-owned subsidiary recently formed in Luxembourg, planned to make the offer through an international syndicate of underwriters headed by White, Weld & Co. and Eastman Dillon, Union Securities & Co.

The company described the bonds as guaranteed sinking fund debentures due in 1981. Other terms of the offering, including interest rate and offering price, were not available. The debentures will not be offered in the United States and will not be available for purchase by U.S. citizens or persons normally resident in the U.S.

Honeywell said this plan of borrowing outside of the U.S. will enable it to meet the capital requirements of its foreign affiliated companies and, at the same time, make a contribution toward improving the balance of payment position of the U.S. This will be the first time the company has raised a substantial sum outside of the U.S.

NCR TO ESTABLISH INSTITUTE OF TECHNOLOGY IN JAPAN

An NCR Institute of Technology will be established in Sagamihara, Japan, it has been announced by the National Cash Register Company. Sagamihara is located approximately 30 miles east of Tokyo.

The new institute, scheduled for completion next fall, will consolidate six of the company's present technical training schools located in the cities of Kamata, Tameike and Shinjuku. In addition to technical training for sales and service personnel, the institute also will provide seminars for NCR customers on modern merchandising methods and electronic data processing. It may also serve as a data processing center at a future date, the company said.

EDUCATION NEWS

AFRICAN STUDENTS COMPLETE IBM TRAINING IN NIGERIA

An education program, designed to help bring the techniques of data processing to Africa, was completed last December at the University of Ibadan, in Nigeria. At graduation ceremonies, 28 students from four African nations (Nigeria, Kenya, Ethiopia and Zambia) received their diplomas from the IBM World Trade African Education Center. (A first class of 23 from Nigeria, Ghana and Liberia took their diplomas last August.)

All graduates, originally selected from over 5000 applicants, were on a full scholarship financed by IBM; it included tuition, room and board, living and travelling expenses. The 18-month educational program was comparable to a normal three-year degree course. In addition to 2000 hours of computer training, the course included 500 hours of business administration and liberal arts. Graduates of both classes have returned to their own countries to work in government and commercial data processing installations.

The major objective of the program was to stimulate the training of Africans in managerial and technical skills needed to utilize modern data processing methods. The University of Ibadan, in cooperation with IBM World Trade Corporation, will continue certain courses in data processing and also will utilize the Center's facilities to develop a computing center for academic research.

NEW PRODUCTS

Digital

SCS ANNOUNCES NEW, LOW-COST COMPUTER

Scientific Control Systems, Inc., Dallas, Texas, has announced the Model SCS 650-2 Computer — "the newest, most powerful, 12-bit word length computer in the industry at a sales price of $14,800". The extensive instruction repertoire, comparable to larger machines, permits a wide variety of applications which include process controls, on-line data collection and reduction, and scientific computation.

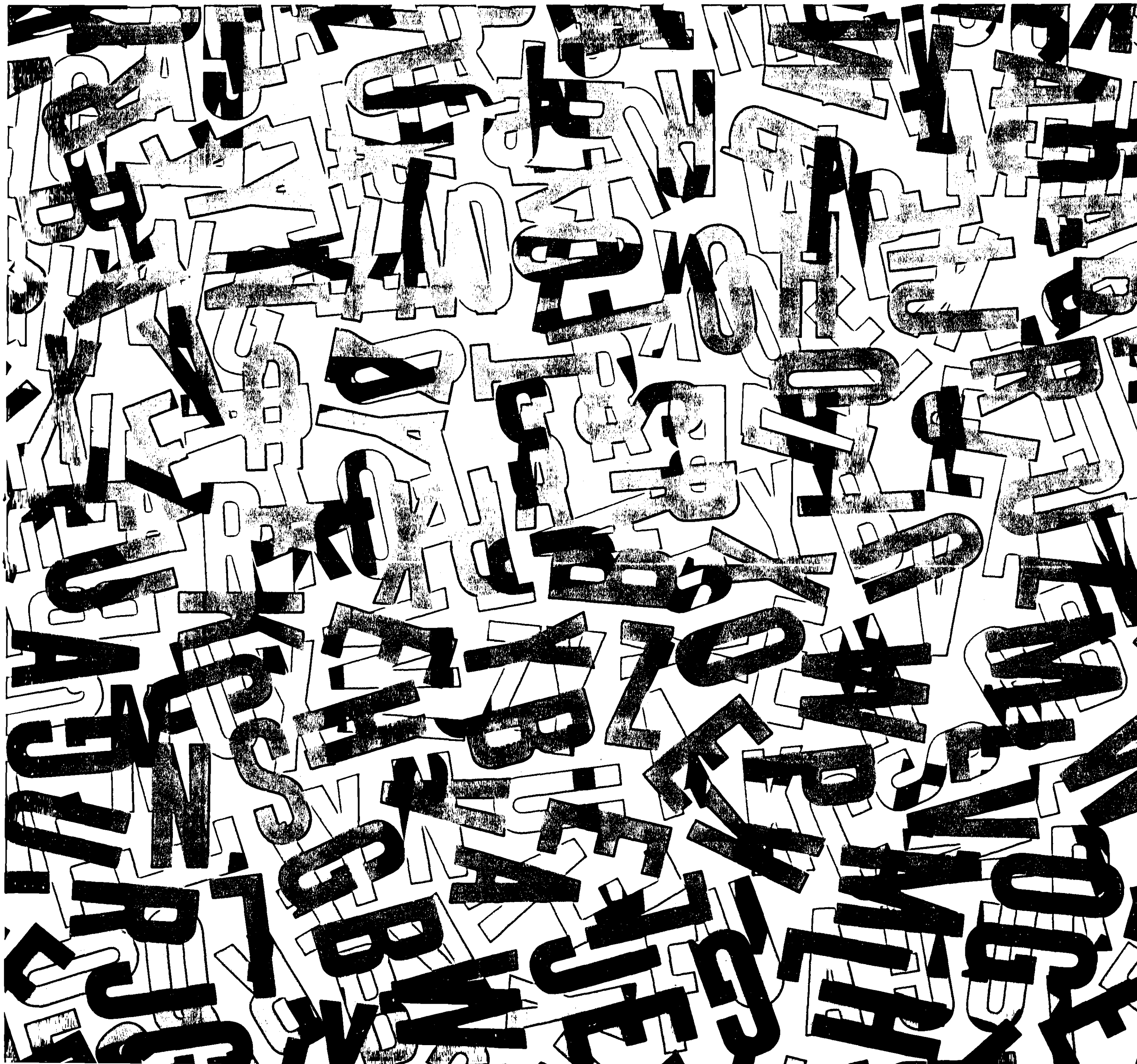
The basic SCS 650-2 includes a full size, coincident-current, ferrite-core, random-access, 4096 word memory with a 2-microsecond cycle time. The internal storage capacity is expandable to 32,768 12-bit, directly addressable words. The modular design of the system permits the use of a wide variety of peripheral equipment and/or special control devices. A complete software package is supplied with each hardware system.

Special emphasis has been placed on developing a computer which can be adapted in the field to meet the customer's changing requirements.
(For more information, designate #42 on the Readers Service Card.)

One of a series on topics of importance to data processing management

Honeywell report on COBOL

COBOL, the collaborative effort by the computer user and manufacturer to develop a standard programming medium for business data processing, has come of age. It has evolved as a precise, well defined and fully mature data processing language. This report discusses the major factors behind the growing importance of COBOL, indicates the cost and performance areas management must take into account when evaluating COBOL, and



briefly describes Honeywell's efforts to provide the best possible COBOL systems for its users.

Composed essentially of familiar business terms, COBOL can be learned more easily by new programmers and help them become more productive sooner. As a standard language, it aids communication between projects and between programmers and management.

When properly implemented, COBOL simplifies the problem of exchanging programs among various makes of computers and eases the transition to newer, more powerful models.

COBOL as a system minimizes program checkout and debugging, provides disciplined documentation, and simplifies program maintenance.

COBOL — A TOOL FOR MANAGEMENT

Many of the nation's largest users have adopted COBOL as their standard programming language. More and more prospective users are making COBOL a pivotal issue in their computer selection process. As a result, COBOL has been, or is being, implemented for virtually every major computer model or family of models.

More than a common business-oriented language, COBOL is a powerful management tool that can provide definite and precise answers to problems in the six major decision areas shown below. In each of these areas, COBOL's contribution to effective computer utilization can be measured directly in terms of time and money saved.

DECISION AREA	HOW COBOL HELPS
1 **INTERSYSTEM COMPATIBILITY** . . . the effect of computer hardware differences on program and systems conversion requirements.	Machine independence of COBOL language offers a substantial reduction in programming costs.
2 **INTRAPROJECT COMMUNICATION** . . . the organization and cooperation of project personnel.	Provides a communication medium that offers a common base for data nomenclature, flow charting and programming conventions.
3 **STANDARDIZATION** . . . the universality of a precisely defined programming language.	Standards within the language lead to standards within the application area.
4 **PROGRAM TESTING** . . . the cost of nonproductive debugging time.	COBOL compilers always produce mechanically correct code. Clerical mistakes and logical errors are quickly pinpointed and eliminated, usually with only one recompilation.
5 **PROGRAMMER TRAINING** . . . the time it takes a programmer to become productive.	Programmers need be concerned with only a finite number of familiar terms, not the inner workings of the computer.
6 **PROGRAM DOCUMENTATION** . . . the basis for program maintenance and modification.	Close relationship between statement of problem and COBOL solution to problem. Compiler automatically provides comprehensive program documentation.

Consider the benefit of being able to move from one computer to another without a major reprogramming effort. As COBOL language is not dependent on the logic of any particular computer, any reprogramming effort is mainly a clerical one. Moreover, one of the design features of Honeywell's Series 200 COBOL compilers makes it possible for the compiler itself to perform much of this clerical function.

The following example, based on an actual benchmark situation, demonstrates how COBOL can minimize program conversion time. The program in the example was, by comparison to the average COBOL program, very large: 2,100 statements. It was originally written to be run on a computer with 192,000 characters of memory. The program was converted to run on a much smaller computer, a Honeywell Model 200 with 32,000 characters of memory. The following timetable gives a breakdown of the total conversion time to create an executable object program from the original source program:

1. Preprocessing of 2100-statement COBOL program (A special feature to assist the conversion process)	10 min.
2. Programmer time to make all manual changes indicated by preprocessing	60 min.
3. First compilation (produced object code greater than 32K char.)	6 min.
4. Programmer time to change program file blocking descriptions	10 min.
5. Second compilation (produced object program executable in available memory)	6 min.
Total conversion time to create executable object program	1 hr. 32 min.

It is estimated that had the program been written in the assembly language of the original computer, reprogramming time would have been measured not in hours, or even days, but months.

COBOL EFFICIENCY IS A FUNCTION OF MANUFACTURER KNOW-HOW

A major feature of COBOL is that it shifts much of the responsibility for the production of a program from the user's programming staff to the computer manufacturer's COBOL programming staff. In effect, the experience and capabilities of the manufacturer's staff are placed at the disposal of the user via the COBOL compiler. The quality of the translation from source COBOL statements to machine codes depends very heavily on the quality of the manufacturer's implementation of COBOL.

HONEYWELL'S COBOL CREDENTIALS

Honeywell's record of achievement in the implementation of COBOL indicates the extensive background necessary to create a high-performance product.

For example:

Honeywell has been an active member of the CODASYL committee since the committee's inception.

Honeywell COBOL has been acclaimed as offering the fastest compilation speeds at the lowest costs.

Honeywell produced one of the first operational Syntax-directed COBOL compilers.

Honeywell COBOL offers the most comprehensive set of implementations of DOD COBOL language elements.

Honeywell Series 200 COBOL D offers the greatest number of DOD COBOL language elements in a compiler requiring only 16,000 characters of memory.

Honeywell Series 200 COBOL B offers a compact compiler capable of operating in as few as 8,000 characters of memory, yet using a fully compatible language subset.

And Honeywell is continually reinvesting its COBOL experience in the design of new compilers as well as in the upgrading of existing Honeywell COBOL systems.

COBOL IS MORE THAN A LANGUAGE AND A COMPILER

Many computer users tend to associate the term COBOL with just two elements — a manufacturer's selection of COBOL language elements and the compiler provided for translating a COBOL program into its machine-language equivalent. Actually these two elements are only a small part of what might be called a total COBOL system. The major portion of the total COBOL system cannot be appreciated by evaluating just the language and the compiler. In effect, the language and compiler can be all but useless if an extensive array of features is not provided to assist in the production, maintenance and usage of COBOL programs. Conversely the value of the total system can be diminished by a limited language or poorly designed compiler.

Granted that the compiler is a key element in the overall system, a logical question would be, "What makes a good compiler?" or "Are there differences in compilers?"

The answer comes from evaluating how well the compiler stacks up in the following areas:

1. Language Implemented — This includes not only the number of language elements but the overall power or richness of the language. Does it include time-saving coding tools, such as the copy verb or automatic segmentation of the object program?
2. Compile Time — An important consideration, since compilation is a parasitic operation using valuable machine time for nonproduction work. A compiler must offer optimum balance between a high compilation rate and efficient object code. A high-speed compiler makes it economically feasible to operate completely in source language for even the most trivial changes in the program. No machine-language patches are required.
3. Object Code Efficiency — How does the code produced by the compiler compare with the code produced by the computer's assembly system?
4. Reliability — How reliable is the compiler? Does it work when you want it to? Does the compiler introduce undetected errors into the object code?

The summary table on the last page shows the capabilities of the Honeywell Series 200 COBOL D compiler in these important areas.

Now take a look beyond the compiler, at the total COBOL system. The depth of coverage in this area is a measure of the manufacturer's commitment to COBOL. This is where the impact of COBOL really lies. This is where the manufacturer provides the tools for the preparation, maintenance and execution of COBOL programs.

More specifically, the following is a list of system features that are all-important in the efficient application of COBOL, yet have had all too little recognition in its overall evaluation.

Program Preparation

- Source-language file maintenance
- Library copy facilities
- Batch compilation
- Load-and-go facility
- Fast diagnostic scan
- Composite program listing with imbedded diagnostics
- Monitor control
- Environmental adaptability

Program Execution and Maintenance

- Object program file maintenance
- Job-oriented testing
- Monitor control
- Debugging facilities
- Object-time file relocation
- Dynamic control of I/O channels

In short, any attempt to evaluate COBOL on the basis of compiler speed and language implementation alone is like judging a cake solely by its frosting.

HONEYWELL SERIES 200 COBOL

Honeywell in implementing COBOL for Series 200 has taken a modular approach consistent with its operating system design concept. Series 200 COBOL consists of five levels, each identified by its minimum memory requirements. The five levels are: 8,000, 16,000, 32,000, 65,000, and 131,000 characters of memory, *including operating system memory requirements.*

Each level affords a rich and powerful implementation of the COBOL language and a fast and efficient compiler. Moreover, all levels incorporate the program preparation, execution and maintenance capabilities that distinguish a total system from just a compiler.

Make Your Own Comparison

The following table lists the characteristics of Honeywell Series 200 COBOL D (16K level). You can compare the superior capabilities of Honeywell COBOL D with those of any competitive system of similar design level simply by filling in the blank column in the table.

CHECK LIST OF COBOL SYSTEM FEATURES

	Honeywell COBOL D	Other
Core Memory Required	16K	______
Memory Required for Compiler	14K	______
Operating System Overhead	2K	______
Language Elements	270	______
Minimum Peripheral Configuration	4 tapes	______
	card reader	______
	card punch	______
	printer	______
Compile Time for Typical COBOL Programs:		
500 statements	1.7 min.	______
1000 statements	2.9 min.	______
Compilation Cost Per 100 Statements	19 cents	______
Object Code Efficiency	85-90%	______
System Features:		
Stacked-job Operation?	Yes	______
Composite Program Listing?	Yes	______
Fast Diagnostic Scan?	Yes	______
Library Copy Facilities?	Yes	______
Job-Oriented Testing?	Yes	______
Operating System Controlled?	Yes	______
Environmental Adaptability?	Yes	______
Load-and-go?	Yes	______
Extensive Debugging Facilities?	Yes	______

WRITE FOR MORE ON HONEYWELL COBOL

For in-depth coverage of the points discussed in this report, send for the Honeywell publication entitled "COBOL Orientation for Management." This booklet includes a description of all levels of Honeywell Series 200 COBOL.

Honeywell

ELECTRONIC DATA PROCESSING

A B C D E F G

TO: Honeywell EDP
60 Walnut Street
Wellesley Hills, Mass. 02181
Attention: Information Services

Please send me your publication entitled "COBOL Orientation for Management."

Name ______________________________

Title ______________________________

Company ______________________________

Address ______________________________

City ______________ State ____________ Zip Code ________

Memories

TWO-MICROSECOND INTEGRATED CIRCUIT MEMORY SYSTEM

An integrated circuit, core memory system with full-cycle time of two microseconds is the most recent addition to the Fabri-Tek product line.

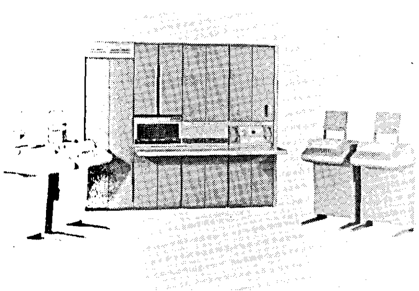
The system, designated the Series MUA, employs Fabri-Tek's "standardized" design concept, thus permitting a broad choice of configurations without sacrificing overall reliability and economy. The MUA is supplied in any of four access modes: Random; Sequential; Random/Sequential; and Sequential-interlaced. In addition, the user can select from a variety of interface circuits and optional features such as address register, power supply and self-test.

Half-cycle time is 1.25 microseconds and access time is 950 nanoseconds. Word capacities range from 64 to 4,096, with two to 30 bits per word.
(For more information, designate #43 on the Readers Service Card.)

Data Transmitters and A/D Converters

TYPE 680 DATA COMMUNICATION SYSTEM

An economical new switching system controlled by a small, fast computer has been introduced by Digital Equipment Corporation, Maynard, Mass., for use in communication systems and computation centers. Digital's Type 680 Data Communication System can function independently as a complete line scanning control or it can serve as a peripheral device to bunch inputs and outputs for most efficient use of large central processors.



— Serial communication systems with as few as seven lines can be serviced economically by the new 680 Data Communication System.

The new 680 is built around Digital's PDP-8 computer, a 1.5-microsecond, general-purpose machine. In the message switching function, the computer scans up to 128 lines — sequentially or in a commanded order — accepting incoming messages one bit at a time, assembling the bits into characters, sorting the characters, and routing them — again one bit at a time — to their destinations.

The basic difference between the 680 and other systems is in their methods of buffering characters. Other systems have used active registers — flip flops — for this function, while the 680 System uses the magnetic core registers in the memory of the PDP-8 computer.
(For more information, designate #44 on the Readers Service Card.)

Information Retrieval

TELECREDIT-100

A new low-cost, high-speed electronic information retrieval system that enables bank tellers or supermarket cashiers to verify a customer's check cashing credit status in 1/10 of a second has been introduced by Telecredit, Inc., Los Angeles, Calif., designers of the system. The new system, built for Telecredit by General Precision Inc.'s Librascope Group, can be completely contained within the user store or bank.

The compact system, called the Telecredit-100, can instantly report the credit on up to 100,000 check-cashers. It consists of a small, high-speed, magnetic memory disc device, up to 32 key-board-operated inquiry stations, and a master programming panel for updating data in the memory system. An optional unit includes a punched-card reader for automatic input of information. There are two models of the new system, the Model T-100 designed for use in supermarkets and the T-200 designed for banks.

Robert Foldman, Telecredit chairman and designer of the Telecredit-100 explained that the system is operated by a teller or cashier who merely "keys-in" the account number of a check-casher

— Nance Angel holds an inquiry station which would be used by a cashier to obtain reports from the compact electronic memory disc device in the background.

on the push-button inquiry device on which she receives a status report by way of color-coded lights in less than a second. Also the system allows a telephone operator at one bank branch to completely handle a check verification by telephone from another branch and place a hold on the account automatically all in less than 15 seconds.

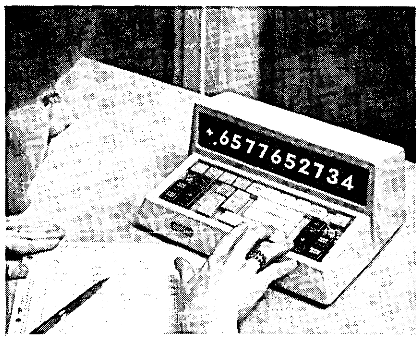
In supermarket use, the cashier enters the customer's identification card number. The signal travels over communication lines from the terminal to the memory disc storage device which has been pre-programmed to maintain and update its files on store customers. (Each check cashing transaction is recorded in the memory unit which continually updates customer status.) The unit searches its memory for the particular customer account, checks the status and sends the report back to the requesting station in 1/10 of a second.

Systems will rent for as little as $75 a month and sell for $3600 and up. Telecredit, patent holder of the new system, plans to initiate national distribution of the system this year. The firm reports that production of all units through March, 1966, have already been leased or sold.
(For more information, designate #45 on the Readers Service Card.)

Input-Output

DESK-TOP ELECTRONIC CALCULATOR SAID TO BE WORLD'S FASTEST

A new solid-state electronic device, believed to be the world's smallest and fastest desk-top calculator, has been introduced by the manufacturer, Wang Laboratories, Inc., Tewksbury, Mass. Able to perform all normal arithmetic computations in a fraction of a second, the Model 300 has a keyboard/display console scarcely larger than a telephone.



The device is noiseless. Answers are displayed instantaneously on the console, in clear, lighted characters 5/8" high, against a dark background. The automatic floating decimal point instantly finds its correct place every time, without presetting. An exclusive "Phantom Touch" keyboard design (in which the keys are depressed only 2/1000 of an inch to enter a number or perform an operation) permits considerably more rapid keying, and operators report virtually no fatigue, even after hours of steady use.

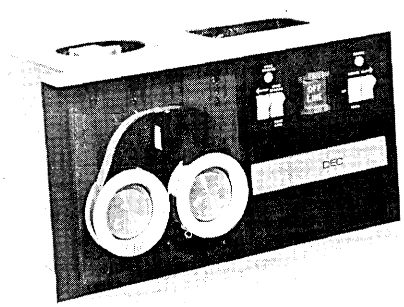
Because it functions on a unique logarithmic principle, the Model 300 is able to provide unusual computational flexibility. Many complex operations, such as duplex product and entry accumulation, are performed easily and quickly. Two independent, but interconnected, addition/subtraction sections are available and serve as storage registers for the accumulation of sums and products. A third section handles multiplication and division. Entry and recall from any of the registers is performed by a single keystroke.

Two models are available: the Model 300 which provides for all normal arithmetic functions; and the Model 310 which includes two additional keys providing instantaneous display of Squares and Square Roots, respectively.
(For more information, designate #46 on the Readers Service Card.)

SOLID-STATE TAPE TRANSPORT IS DEVELOPED FOR PDP COMPUTERS

A simple, solid-state magnetic tape drive for use with the PDP-7 and PDP-8 computers has been developed by Digital Equipment Corp., Maynard, Mass. The DECtape Type TU55 Transport has a reliability figure of less than one transient error per 10^{10} characters. The TU55 differs from earlier DECtape transports in two major respects: replacement of relay control components by solid-state devices, and elimination of one of the usual two transports.

The new transport, like earlier DECtape models, is designed for use with a control unit which segments computer words before recording them and reassembles them when reading back to the computer. Recording density is 350 ± 55 bits per inch, and read-record speed, in either direction, is 97 ± 14 in inches per second. Total information capacity per reel is 2.7 x 10^6 bits, arranged in duplexed three-bit characters. (The transport uses the same 4-inch reels containing 260 feet of 3/4-inch Mylar sandwich tape.)



— TU55 DECtape Transport

A principal application for the new transport is serving as economical bulk storage of data and programs in small computer systems lacking disc, drum, or conventional magnetic tape subsystems.
(For more information, designate #50 on the Readers Service Card.)

MODEL 835 ELECTRONIC DIGITAL PLOTTING SYSTEM

A new cathode ray tube/microfilm plotting system, that plots approximately 300 times faster than a standard CalComp Model 565 ink-on-paper digital incremental plotter, has been developed by California Computer Products, Inc., Anaheim, Calif. A complex manloading chart that would require several hours to produce manually and four minutes with a CalComp Model 565, can be plotted and recorded on microfilm with a Model 835 in less than one second.

Fully compatible with existing CalComp systems and software, the Model 835 is all solid-state except CRT. It produces, with 15 times magnification, a plot 11x17 inches. Accuracy is 1% of full scale stability ±.5% drift in eight hours.

Model 835 is designed for off-line operation with CalComp's magnetic tape unit Models 760, 770 and 780. Plotting is accomplished with the tape unit in the search mode, at a tape speed of 60 inches per second. It can plot a complete 2400-foot reel of tape in eight minutes. CalComp Plotter Controllers are used with the Model 835 in on-line operation. The plotting system may be used in a time-shared configuration with other on-line requirements, and is capable of accepting input commands at rates up to 100,000 characters per second.
(For more information, designate #47 on the Readers Service Card.)

CONTROL DATA 602 MAGNETIC TAPE TRANSPORT

Control Data Corporation, Minneapolis, Minn., is now marketing a new, low-cost magnetic tape transport. The CONTROL DATA 602 Magnetic Tape Transport moves tape at the rate of 37.5 inches per second. Vacuum buffer columns, photoelectric monitors and a newly developed drive mechanism insure minimum tape tension at all times.

The 602, which uses half-inch tape, offers 7 recording channels. Recording densities include 200, 556 and 800 bits of information per inch, providing data transfer rates of 7.5 KC, 20.85 KC and 30 KC, respectively.

Basic features of the 602 include high-speed rewind, separate manual control panels for operation and maintenance testing, and full computer control with no program-

ming restrictions. An important feature of the new Control Data transport is its ability to read tape in either direction. Dual-gap head construction also provides read-after-write capabilities. The 602's format is completely compatible with existing Control Data transports.
(For more information, designate #48 on the Readers Service Card.)

MODEL PI-1167 INCREMENTAL RECORDER

A new incremental digital recorder, which accpets randomly occurring digital data at rates from zero to 200 steps per second for the automatic preparation of 200-bit per inch magnetic tapes of computer compatible format, is in full production at Precision Instrument Co., Palo Alto, Calif. With solid-state electronics, the compact recorder also can record digital characters received synchronously at 500 steps per second.

The PI-1167 uses 10½-inch reels of standard one-half inch computer tape to produce a seven-channel NRZ format digital tape immediately compatible with most computer transports. Internal electronics automatically generate inter-record gaps, parity check characters, end-of-file gap and tape mark. An optical pick-off provides end-of-tape sensing to signal external equipment. Another signal occurs if the tape is broken or improperly loaded on the drive.

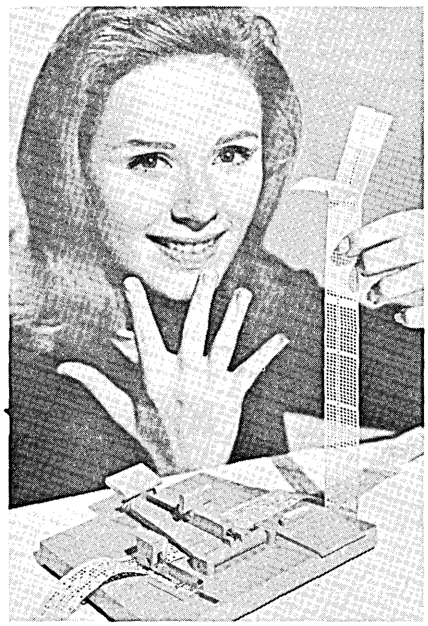
With selectable odd or even parity generation, the PI-1167's logic circuitry converts, for even parity, BCD-0 data to BCD-10, thus producing a fully compatible tape without further programming.

Price of the new model PI-1167, as announced by William C. Bennett, vice president - marketing, is $3,650. "Previous digital recorders with this performance cost approximately $6,000 or more," Bennett commented.
(For more information, designate #49 on the Readers Service Card.)

NEW METHOD OF SPLICING AND CORRECTING PAPER TAPE

Data-link Corporation has announced a new type of punched splicing tape called "Splice & Correct Tape". Paul Becking, President of Data-link Corporation, Los Altos, Calif., stated, "In developing this new approach, we wanted a product that would not only splice punched paper tape but permit the correction of punched tape and still be thin and flexible enough to follow punched tape drives without catching in the tape guides."

"Splice & Correct Tape" is self-adhering. It has a tear-off backing strip which can easily be applied to form tape loops or splice torn tapes. It includes one blank code level in four individual positions, and 2, 3, 4 and



5 blank code levels in different positions. The blank code level, or levels, can be placed over improper codes, or spliced into position, and the desired codes punched. Many tapes that have to be repunched a second or third time can be corrected in this manner.

The new tape may be used for splicing 7 and 8 channel tape. It can also be used to reinforce and correct edge punched cards.
(For more information, designate #52 on the Readers Service Card.)

DR-3000 DIGITAL MAGNETIC-TAPE SERIES

Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co., Pasadena, Calif., has introduced a new digital magnetic-tape system that offers versatility and performance at a lower cost than comparable instrumentation. The DR-3000 Digital Magnetic-Tape Series has flexibility of formats with a wide selection of input/output logic levels which makes the system suited to a variety of commercial and laboratory data processing applications.

The company reports that the new recorder is the only low-cost transport on the market with absolute straight-line loading for optimum operator convenience. The whole operation takes less than 10 seconds.

The transport of the DR-3000 operates at 200, 556, or 800 bits per inch, and a high-density, 1600-bpi format is optionally available. Other features include dual capstans with positive drive; air bearings; and all-metal-surface heads for extra-long head life.
(For more information, designate #51 on the Readers Service Card.)

Components

NO-FAIL POWER SYSTEM

A unique electronically-controlled "No-Fail Power System" that instantaneously — without the loss of even a thousandth of a second — "takes over" the moment commercial power begins to fail, has been developed by the Fermont Division of Dynamics Corporation of America and now is in commercial production. Designed especially to prevent even momentary "blackouts" of critical electronic equipment — computers, teletype and other data communications, automated manufacturing processes, aircraft landing systems, radar, electronic hospital devices, etc. — the new No-Fail systems will be produced commercially in varied sizes ranging from 10 kilowatts to 250 kilowatts.

The Fermont No-Fail Power System essentially consists of a motor-alternator, a diesel engine and a stored energy source all assembled as a total energy package. Ordinarily, the system uses commercial power to supply closely regulated voltage and frequency power to a critical load.

When commercial power fails or becomes irregular beyond preset limits, the following sequence occurs: 1) a frequency sensor in an all-solid state electronic control console senses the deviation at the alternator output and immediately activates a constant speed servomechanism; 2) the servomechanism in turn instantaneously releases a stored energy charge of pressurized hydraulic fluid to a hydraulic motor at a closely controlled rate, which maintains the alternator at synchronous speed; 3) simultaneously a diesel engine (which is constantly held in start-readiness) is started. When the diesel engine attains operating speed, it is automatically coupled to the motor-alternator shaft by means of an overrunning clutch. The diesel engine now supplies rotating power for the alternator as long as the power failure may last.

During the period of diesel engine operation the condition of commercial power is continually checked by means of a monitoring circuit. When commercial power is found to be stable over an adjustable period of time (15-60 minutes) a synchronization circuit adjusts diesel engine speed, synchronizing it with commercial power frequency. When synchronization is achieved the commercial power breaker is closed and the diesel engine shut down. The entire system is now in standby should another power interruption occur.
(For more information, designate #53 on the Readers Service Card.)

RCA INTEGRATED CIRCUITS

RCA's recently announced line of monolithic integrated circuits represents the third generation of electronic components, following in the footsteps of the electron tube and the transistor. Each of the new RCA integrated circuits is priced to compete with solid-state circuits using conventional transistors, diodes, resistors and capacitors, according to John B. Farese, Division Vice President, RCA Electronic Components and Devices. While other integrated circuit manufacturers have concentrated on the development of digital circuits, RCA offers a broad line of linear integrated circuits in addition to three families of digital circuits.

The new RCA linear circuits, which cover the frequency spectrum from DC to 100 Mc/s, utilize a basic differential amplifier circuit configuration with a built-in controlled constant-current source — a versatile approach to many applications in communications, instrumentation, industrial and military equipment.

RCA digital integrated circuits are aimed specifically at the growing number of applications (primarily in the computer field) that require either extremely high-speed switching or extremely low power dissipation. All RCA digital integrated circuits are mounted in 14-lead ceramic and metal flat packs.
(For more information, designate #54 on the Readers Service Card.)

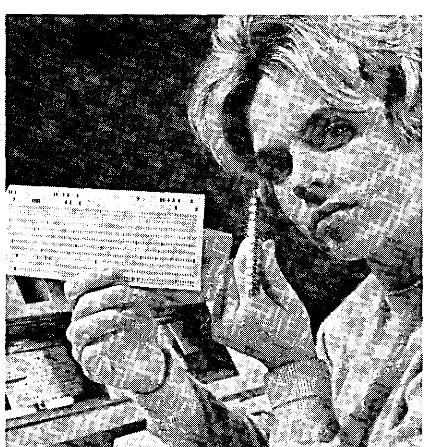
DATA-MAILER

A new packaging convenience for mailing or carrying computer tapes between data processing centers has been placed on the market by Ampex Corporation, Redwood City, Calif.

The Ampex Data-Mailer consists of a weather-proof "zip-lip" plastic bag, which holds a 200-foot reel of Ampex 839 magnetic computer tape, and a reuseable self-mailer package. Data-Mailers are available in 12-reel lots only.
(For more information, designate #55 on the Readers Service Card.)

FIBER OPTICS TECHNOLOGY EMPLOYED BY IBM

Light, which normally travels only in straight lines, now is being curved around corners by IBM Corporation to read and check the accuracy of punched cards and to scan documents. Tiny beams of light — curved around corners and projected by devices such as the one shown in the photo — now are being used in four different IBM machines. The machines incorporate "fiber optics", an advanced technology which enables light to be bent in any direction through flexible tubes of glass fibers.



Fiber optics tubes — called "bundles" — contain hundreds of extremely fine glass fibers, each several feet long but far thinner than a human hair. Acting as tiny pipes, the fibers carry beams of light which activate photosensitive elements and register the data scanned.

The two machines incorporating fiber optics and already at work in customers' offices are the IBM 1442 card reader and the IBM 59 verifier. Deliveries of the other two machines — the IBM 1231 and 1232 optical mark page readers — were scheduled for the first quarter of this year.
(For more information, designate #56 on the Readers Service Card.)

PEOPLE OF NOTE

SHE OPERATES COMPUTER BY BRAILLE

Jackie Cummings operates a computer by Braille. Her part-time job at Bowling Green State University's computer center consists of programming instructions for computers. She does it by writing the computer programs in Braille. Then she key punches them from it. To check if her work is correct, the young housewife, blind since she was 12, has a program card that translates the computers alphabetic information back into Braille.

Jackie says she has few problems with her job. One problem when she first went to work was learning her way around the center. Several times she got off on the wrong floor. Also, in order to know if the lights are on or off, she uses a hand-sized light probe which converts light waves into buzzing sounds.

Computers are not her only specialty. She also runs a card sorter, a key punch machine, and a variety of accounting devices. Before getting the job at Bowling Green, she had taken extensive training at the University of Cincinnati's Medical Computer center. Richard C. Neumann, Bowling Green State's center director said, "Jackie won the job over other applicants because of her training and after only a few days of orientation she began working as efficiently as other employees.

NEW LITERATURE

"PROFILE OF A SYSTEMS MAN"

"Profile of a Systems Man," an up-to-date survey of salary ranges, educational backgrounds and other data on personnel in the systems field, is now for sale by the Systems and Procedures Association.

The study, based on confidential data supplied by SPA members, outlines the systems man of today — his age, educational background, experience, salary, where and for whom he works, and other valuable data. It also compares 1965 levels to similar studies in 1959 and 1955 to provide a comprehensive picture.

While the study covers SPA members only, the information can be applied to the systems field in general. Companies with systems groups, or those planning such installations, will find the booklet an invaluable reference piece. Single copies of the 32-chart booklet are available at a price of $3.50 for non-members of SPA and $2.00 for members. Orders should be sent to Systems and Procedures Association, 7890 Brookside Drive, Cleveland, Ohio, 44138.

LOS ANGELES ACM GROUP TO PUBLISH A PL/I BULLETIN

Working Group 4 on PL/I of the Special Interest Group on Programming Languages of the Los Angeles Chapter of the Association for Computing Machinery was organized in Los Angeles about a year ago to promote the study and evaluation of the language then known as NPL. The Working Group, feeling that the importance of the new language to the programming community was great enough to warrant the step, decided at a recent meeting to extend its goals to include the general dissemination of knowledge relating to PL/I. The Group plans to begin publication of a PL/I Bulletin this year.

BROCHURE OFFERED BY DA-PEX

DA-PEX Computer Brokers is offering a brochure "The New Look in the Used Computer Market Since October 1, 1965". This information on the used equipment market for computers and punched card machines, valuable in the light of recent developments in this market, may be obtained by writing to DA-PEX Inc., 366 Francis Building, Louisville, Ky. 40202.

MEETING NEWS

ADAPSO SCHEDULES SAN DIEGO MEETING

ADAPSO, the Association of D Data Processing Service Organizations, Inc., will holds its 14th semi-annual management conference at the Stardust Motor Hotel, San Diego, Calif., on February 17 and 18, 1966. The conference will feature discussions of eight subjects of current interest to data processing service companies, including new approaches to public data processing, data communications and trends in service bureau activities. ADAPSO is the trade association of the computer service bureau industry, with members in 300 locations throughout the U.S., Canada and overseas.

8TH SYMPOSIUM ON PROCESS AUTOMATION

The 8th Symposium on Process Automation will be held from April 18 to 20, 1966, at the Newporter Inn, Newport Beach, Calif., according to Symposium Chairman William R. Biles, Coordinator, Process Computing, Houston Research Laboratory, Shell Oil Company. The Symposium is sponsored by four Southern California companies active in the manufacture of instruments, computers, and systems: Beckman Instruments, Inc., La Habra; Consolidated Electrodynamics Corp., Pasadena; Control Data Corp., La Jolla; and SDS Data Systems (formerly Consolidated Systems Corp.), Pomona. Symposium Director is Paul L. McMath, Manager of Industrial Systems Applications, SDS Data Systems.

The objective of the series of sessions is to provide an opportunity for representatives of process companies to exchange experience on instrumentation and control problems. To assure close adherence to this objective, Dr. Biles said, all papers will be individually invited. Also, attendance is limited to about 200 engineers and technical managers, not more than five from any one company.

BUSINESS NEWS

3C SALES RISE, PROFITS DROP

Computer Control Co. reports earnings of $388,123 on sales of $23.7 million for the year ending October 30th. Earnings dropped 26% from the $525,907 reported for the same period last year although sales rose 25% from $19 million last year.

A 3C spokesman attributed the lower earnings to new product introductions during the year, high initial manufacturing costs, and limited shipping rates on new products in the first two-thirds of the fiscal year.

CALCOMP SALES UP 20% IN QUARTER

California Computer Products reports income of $57,739 on sales of $1 million for the quarter ending October 3rd. Earnings were lower than the $107,307 reported for the same period last year, but sales were up from the previous $830,000.

A Calcomp spokesman said sales of digital plotters and plotting systems during the quarter increased 50% over the same period last year.

MAI INCREASES FINANCING FOR DP EQUIPMENT PURCHASES

Management Assistance, Inc. has filed a statement with the Security Exchange Commission seeking registration of $10 million worth of 6½% subordinated debentures, due 1980 and 215,000 shares of common stock to be offered through White, Weld, & Co. of New York. Proceeds of the offerings will be added to general funds primarily for the purchase of additional EDP equipment, including equipment to be located in foreign countries.

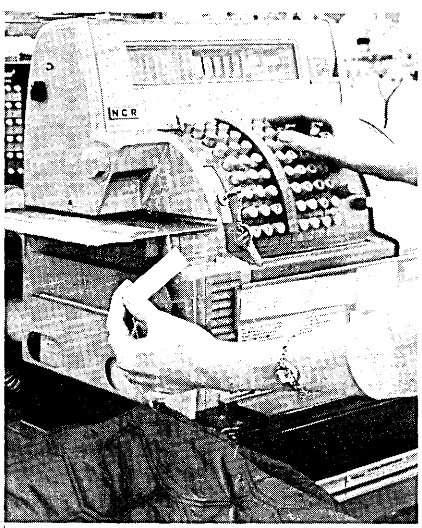
Management Assistance offers purchase-lease-back arrangements on computers and punched card equipment.

RETAIL AUTOMATION SYSTEM

A new retail automation system, designed to give shoppers a fresher, wider choice of merchandise and at the same time provide substantial cost savings to stores, has been announced by the National Cash Register Company. Charles L. Keenoy, NCR marketing vice president, said the new sales register and computer-controlled system, called REACT (Register Enforced Automated Control Technique), is based on the facility to capture precise merchandise descriptions in code at the point of sale. The system provides merchandising reports that eliminate laborious inventory counts, uninformed buying decision, and various manual methods of store control.

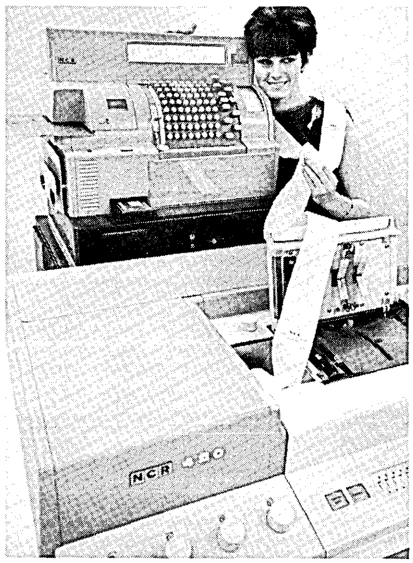
Key to the REACT system is a sales register which captures the necessary merchandise information as a by-product of ringing up the sale in the regular way. Each item of merchandise is described by code number as well as price. The code numbers are processed by computer and end up as high-speed, timely and reliable reports to store management on inventory levels and stock turnover — with every item accounted for.

Merchandise is first classified by code number within each department. For further information, such as color and size of a sweater, additional code numbers are used. The code numbers are printed on the most simplified type of price tag suitable to the merchandise. The coding system can easily be adapted to any merchandise and information requirements, NCR says. Up to 10,000 items can be specifically identified within each store department.



— A check-out clerk reads class information from a simple string tag for entry into the register.

The information can be recorded by the sales register in either punched paper tape or slightly stylized figures on a sales journal which can be read by an electronic scanning device. A computer then automatically produces sales records, stock reports, open-to-buy reports, purchase journals, on-order reports and other retailing information. According to Mr. Keenoy, the REACT program is so sophisticated that the computer can automatically print out vendor orders for additional items when stock reaches a certain level — without waiting for a manager or buyer to appraise the computer reports and make individual decisions



— New retail automation system — REACT — links familiar cash register with edp equipment. Young lady holds tape from register which is "read" by optical scanner (foreground) for computer processing.

The vital element of the REACT system is the large volume of information captured by the registers for automatic processing. "The sales register for the first time serves as a completely versatile data input device," said Mr. Keenoy. "It not only records the information needed for merchandise control, but also can capture all other data pertaining to the sale. This becomes computer input for the automatic preparation of monthly bills and the calculation of sales commissions."
(For more information, designate #58 on the Readers Service Card.)

COMPUTERS "BUILT-INTO" COMMUNITY HEALTH PROGRAM

An electronic computer is being used for the first time to help an entire class of college-bound high school seniors choose colleges to which to apply. Some 450 college-oriented students each have filled out a comprehensive questionnaire, which is matched in an IBM computer against 18 of the most important characteristics of every accredited four-year college or university in the United States to yield a list of schools which best fulfills each student's preferences and financial requirements.

The experiment is being conducted jointly by Pittsfield High School (Mass.) and Computer College Selection Service, Inc., also of Pittsfield, Mass. In 1965, Pittsfield High School had 16 National Merit Scholarship finalists, the greatest number of any public high school in the state. "Our goal of preparation for college is clearly a first-priority one," Superintendent of Schools, James P. Reynolds said.

Some objectives include: determining how many schools not previously considered by students are recommended by the computer as logical choices; finding out how helpful the program can be in getting high school students to consider in orderly fashion the number of choices that face them in selecting a college; determining whether to introduce such a program in the junior year (which would allow students ample time to study relevant college catalogs and seriously consider all questions which would affect their final choice of a college); and, finding out whether the computer's recommendations could help students get maximum benefit from counseling by the guidance department.

Computer College Selection Service, organized last year in Pittsfield under the direction of Milton A. Kolodkin, has been helping individual students throughout the country to choose colleges to which they should apply. A staff of experts spent nearly two years on the necessary research. The program contains 230,000 pieces of data on nearly 1200 accredited four-year colleges and is updated as new information is received. Taken into account are such diverse factors as cost, subject majors, geographical area, academic admission requirements, College Entrance Examination Board scores, size of school and college community, ROTC, class rank, etc.

Actual programming of the IBM computer at the Service Center of the Berkshire Bank and Trust Company, (whose facilities are being used by C.C.S.S.) was under the direction of Alan M. Falk, the bank's manager of data processing, who worked closely with Computer College Selection Service and its consultants.
(For more information, designate #57 on the Readers Service Card.)

Change in the United Kingdom

The United Kingdom has lagged considerably in the past in per capita use of computer systems. While the United States rate grew at a rapid pace, the United Kingdom rate (with one quarter the United States population) has only recently begun to climb:

	United States	*United Kingdom*	*Ratio*
1955	400	12	33
1959	3000	150	20
1963	12000	750	18
1965	23000	1100	20

Many industry leasers have expressed concern over the disparity, especially since West Germany and France are ahead today. At the same time, the United Kingdom is the only major country with an active independent computer industry: I.C.T.; English Electric-Leo-Marconi, Ltd.; Elliott Automation; and DeLa Rue Bull (now offering G. E. equipment) are all companies native to Great Britain. As a result, the distribution of vendors shares is different from the United States; the following table reflects percentages based on 1136 installed systems and 567 on-order systems:

IBM	31%	
I.C.T.	29%	
EELM	9%	
Elliott*	9%	
NCR*	6%	
Honeywell	4%	
DeLa Rue Bull	3%	
Others	9%	(Univac, Burroughs, CDC, etc.)

*Currently marketing together.

The country now faces a dilemma. The majority party is Labour, which has played an active role in establishing a Ministry of Technology, to advance the role of technology in industry and government. Nonetheless, the Government only has 50 computers installed, representing 5% of the total; by contrast the United States Government's 2400 systems represent 10% of the total, with at least another 5% performing Government-sponsored work.

Action is therefore required, and it appears as if increased Government support is necessary. Most business leaders, however, oppose Government control and oppose the Labour Party. They must decide, therefore, whether or not to support the Labour party's active program, wait for a possible election, or allow the computer industry to continue lagging.

The Labour Party's program has been heavily criticized so far, although principally on political grounds. Major elements of the program are

- — an increased policy of "Buy British" in Government computer acquisition,
- — a grant of £5,000,000 ($14,000,000) to I.C.T. for research into computers matched on a 3 for 1 basis by I.C.T.
- — the establishment of a National Computing Centre, announced in December.

The National Computing Centre is the most recent target of the Opposition. It has been established to provide

- — a Government-owned service center
- — a National Library of programs
- — a consulting service for "industry and Government to aid in use and selection of computers."

The questions which have been raised by the Conservative Party, and by United Kingdom computer experts, include

- — Where will the Centre get the necessary staff, considering the British shortage?
- — How can Centre personnel be objective in selection if the Centre is going to operate *one* computer system (presumably an ICT 1900 series system, according to informed sources)?
- — How does the Government intend to compete with established consultants, and how will the Centre charge for its service?
- — How will the Centre compensate its personnel? On a Civil Service scale it cannot compete for qualified analysts and programmers; on an industry scale it will be criticized by other scientists and engineers currently on Civil Service.

Mr. Cousins, Minister of Technology, will have to answer these questions before getting the active support of the industry. Without this support the Centre will not live up to its promise.

Dick H. Brandon

Dick H. Brandon
Contributing Editor

The Project Workbook for Software Documentation

Dave De Pinto
URS Corporation
Burlingame, Calif. 94011

In the processing of data, the computer is not always the central item. For software and its documentation, we have used the Project Workbook concept with highly satisfactory results.

This concept consists of an evolving workbook in many copies that progresses to final form along with work on the project. Advantages of this procedure include the following:

(1) Continuity of the project is maintained even when people working on the project are temporarily absent or permanently transferred.

(2) A current file is continuously available to each member of the project, providing ready access to all relevant information, such as extracts of applicable manuals, addenda, standards, programming practices, specifications, etc.

(3) Information on the progress of the project is readily available for progress reports.

(4) Upon completion of the project, a continuously updated project history is available for preparing additional documentation.

The procedure for using the Project Workbook is essentially as follows:

Each staff member assigned to the project has a copy of the Workbook, and each contributes inputs as appropriate. These inputs may be ideas, rough notes, questions, computer printouts, or detailed observations. Copies of all inputs are distributed to all other members of the project. In this way the Project Workbook is kept up to date with problem identification, analysis, design, and programming. So only a small amount of organizing, editing, and typing is needed to produce a final document at the end of the project.

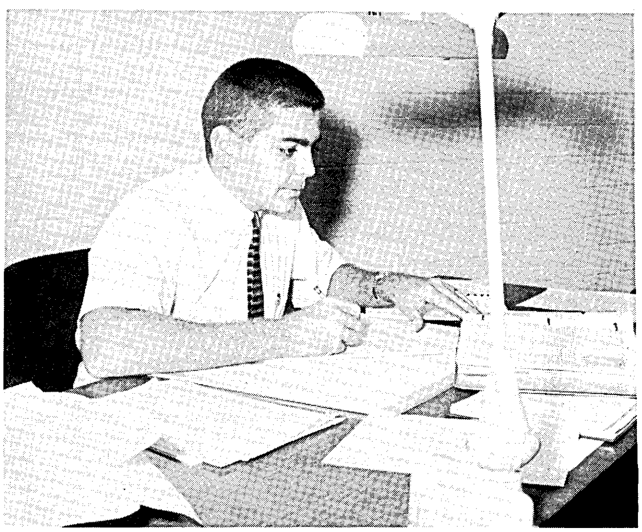


Figure 1 - Individual efforts relative to analysis, design, flow charts, coding, etc., are not kept only in project members' minds and desks; as soon as they are written down, they are made available via the Project Workbook to the other staff members of the project.

Figure 2 (below) - Each project member has the duty of arranging for preparing, reproducing, and distributing copies of pertinent material for inclusion in the Project Workbook, so that other staff members will know of his work as the project progresses. These inputs may be based on (and in some cases include) results obtained directly from the computer.

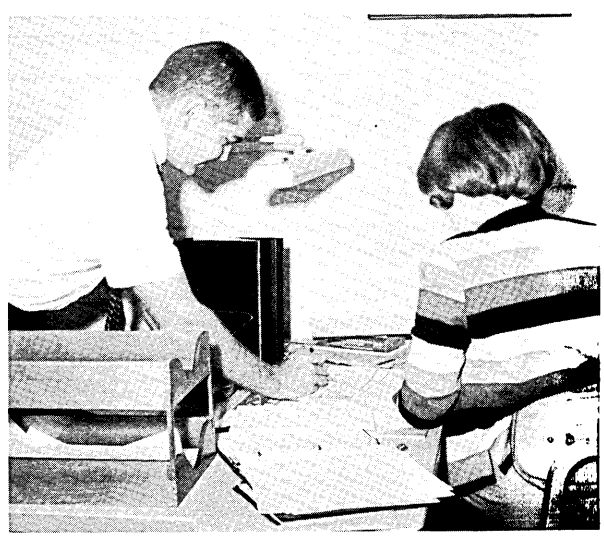


Figure 3 - Draft copies of progress reports can be made up quite directly from the Project Workbook by giving instructions to a typist. The progress reports can be substantiated as necessary with printouts, etc., from the computer.

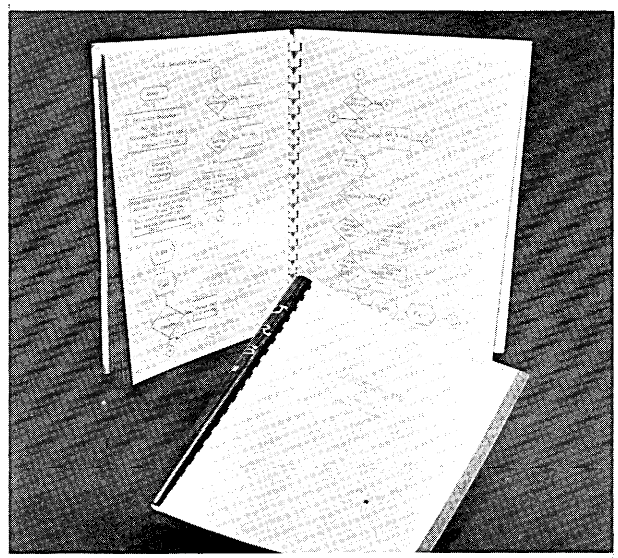


Figure 4 - A finished flow-diagram photographed directly from a Project Workbook illustrates the way in which descriptions of complex procedures can be produced gradually. This avoids trying to write out elaborate, complex procedures all at once and under the pressure of close deadlines.

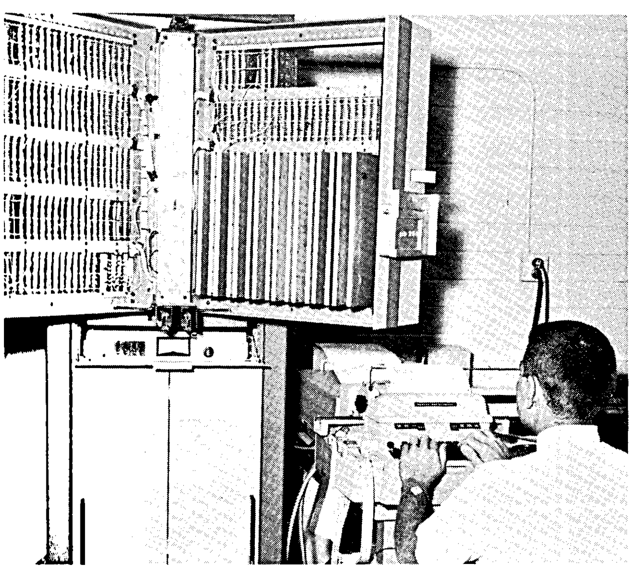


Figure 5 - The computer is the tool used to complete a software project. But the Project Workbooks are the link between the raw data and the meaningful, current answers the customer desires.

TOWARDS GREATER GENERALITY OF SOFTWARE: EXECUTIVES SYSTEMS IN THE SIXTIES

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As the software for general-purpose digital computers approaches the end of its second decade, it is clear that the dominant trend is towards greater generality. This article will briefly report on the development of executive systems, and show this trend for that major class of software.

What Software Is

The term *software* has sometimes been used in a broad sense to denote anything that isn't hardware. I use it here in the narrower context common in discussions of programming, to mean programs used by programmers. In this sense software includes utility and service routines, procedural language translators and interpreters, executive control programs, common-use library subroutines, debugging packages, and other programs used in the development, debugging, maintenance, and control of programs. A unit of such software could be as modest as a test-one-bit macro or as majestic as a time-sharing complex that accepts a dozen languages.

For the purposes of this article *executive systems* and their supporting programs will be considered to include all kinds of programs mentioned in the preceding paragraph with the exception of language translators and interpreters.

Manual Operation

IN THE BEGINNING (genesis here refers to the first stored-program general-purpose digital computation, by M. V. Wilkes and his associates at Manchester on EDSAC in 1946), all loading, control, operation, and debugging were manually performed. All addresses were absolute; all locations for programs and data were pre-specified and fixed. Those early machines that permitted overlap of computing and input/output required that it be programmed in detail for each instance.

The EDSAC group started the trend towards generalization by providing generally-available programmed relative addressing. They later added "B-box" (index register) hardware for relative addressing. At this point a programmer could issue an address of the form E equals S plus I, where E is Effective Address, S is Starting Address, and I is Address Increment.

Other generalizations were developed rapidly. Many of them followed the same pattern as had relative addressing; they were first developed and demonstrated in programmed form — for complete generality, this required interpretive execution of the augmented function — and then they were offered as special hardware in the case of functions that were used frequently enough to justify the extra cost. Floating-point arithmetic and elaborate input-output functions were among the earlier "hardware macros."

The Closed Subroutine

By the time the first large-scale commercial computers appeared in the early 'fifties, a number of programming techniques permitting an orderly expansion and generalization of applications had come into wide use. Perhaps the most basic of these, the closed subroutine — another legacy from the Manchester group — was in use everywhere, and various hardware conveniences had been supplied for executing subroutine jumps and returns.

The distinguishing feature of this technique is that, unlike the open subroutine or in-line macro, its connectivity with the calling program is entirely explicit and is specified completely in a Calling Sequence.

The applicability of this idea encouraged many users to specify subroutine conventions and characteristics carefully, and this permitted subroutines written by one user to be used by another merely by careful adherence to the conventions.

Widespread sharing of standard subroutines helped to justify great interest in User Groups starting in the middle 'fifties. Knowledge that a subroutine could have wide utility encouraged programmers to plan them with great care and to provide more flexibility and generality than would be required for a typical single application.

Among the earlier packages to be so generalized were input/output subroutines of great flexibility. Some of those distributed through SHARE by early IBM 704 users, for example, permitted many kinds of number formats, elaborate conversion choices for number bases and amount of checking provided, free-form input formats, and limited logical capability.

During the same era other kinds of system software also grew rapidly in generality. It still, however, was necessary to link and load programs by manual operations that were time-consuming and less predictable than desired.

In the late 'fifties, the first Batch Monitors were developed at Bell Laboratories, General Motors Research, and North American Aviation.

Batch Monitors

Generalization of loading and control capabilities began to be realized late in the 704 era with the first of the monitor systems. These systems sequenced jobs automatically (in rigid sequence as determined manually); they also provided some guidance information for operators, and loaded utility and service routines from magnetic tape as requested, at load time, by control lines associated with each program.

Memory allocation for program and data space was still rigidly fixed at load time, although the relocatable loaders associated with the monitors had permitted programs to be generalized as to actual location and compiled relative to register zero.

In this period generalized I/O buffering was first planned and eventually gained wide use. It has been said that Mock's Buffering was such a great idea that its principles have been published as new at least once a year since it was first described[1] in 1959.

One paper[2] chronicled in some detail the stepwise progress of one user of a new-type machine from the most primitive software tools to a rather powerful batch monitor[3] particularly planned for efficient loading and execution of multiple cases of highly-generalized application programs.

A transition point from Batch Monitors to more general kinds of systems was reached with the first systems that provided symbolic file access for both programs and data.[4]

Dynamic Reschedulers

The Batch Monitors were either executed in "single-phase mode"[3] (i.e., with input, execute, and output phases of each job in a batch completed in sequence before the next job was started) or in "multi-phase mode"[1] (i.e., with input for all jobs in a batch processed first, then all executes, and, finally, all outputs). Yet all suffered from the same lack of one generality: jobs were executed in a rigid sequence that was determined prior to load time. This caused turnaround time (the time delay between request for and delivery of computer service) to be much longer, on the average, than the optimum value[5] for the important case of a workload mix consisting of jobs having a variety of run times and requested at irregular times.

Dynamic Reschedulers[6,7] attacked this problem directly. They provided generality in the sequence in which a job could be started, independent of its arrival time, through stacking of input data, control information, and all system and library programs on random-access mass-storage hardware. They provided software capability for flexible control of and access to all waiting jobs. Some such systems processed I/O and internal work on the same type of processor[6] while others[7] used special-purpose I/O processing computers. The result in all cases was greatly increased flexibility of operation, including the ability to apply priority adjustment to waiting jobs. This, in typical workload environments, substantially improved turnaround time for (a) all jobs, on the average, and (b) short jobs, almost with certainty.

Multiprogramming and Multiprocessing Systems

The advent of plans and systems to include true multiprogramming capability (as defined in references 6, 8, 9)* represented another significant step towards greater generality. To be operationally and economically attractive, such systems must have almost arbitrary interruptibility. This includes:

- The ability of a processor to be interrupted while I/O operations in progress continue independently to completion without loss of control;
- The capability for more than one program to be executing a common string of coding or operating upon a common data table concurrently (or, for multiprocessor systems, even simultaneously); and
- Memory protection having scope and flexibility far beyond what was considered adequate for the most elaborate of earlier program environments.

The alternative to this high order of interruptibility was defined elegantly in 1961[15] for the environment of hardware and software typical at that time. This involved the treating of entire program tasks as entities and enforced essentially a general solution of the scheduling problem. But it now seems doubtful whether such an approach could have achieved general acceptability, either operationally or economically.

A key element in achieving the degree of interruptibility outlined above is truly general dynamic storage allocation capability.[10] With this facility the physical location of program and data elements in memory is not only not to be specified at load time (i.e., "preplanned storage allocations"), but is determined by the Executive at segment load time and may, in fact, be changed during execution (hence, "dynamic . . .").

Such capability permits many jobs to be in active status in main (directly-addressable) memory at a given time. It also permits available memory space to be coalesced by the moving of jobs under executive control. Hence, average utilization of memory space can be high.

Multiprocessing capability (in some of the references, less conventionally but more descriptively referred to as "multi-processors" capability) consists of generalizing the number of central processors that can be associated with all (or almost all of) the same memory. It seems clear that, when the major problems associated with multiprogramming have been solved, the additional ones associated with multiprocessing are relatively minor in difficulty.[6,9,14]

In connection with the technically challenging multiprogramming-multiprocessing developments, we see at once a very large step in generality and spectacular improvements in system flexibility and efficiency.[9, page 103] The cost-value relationship for these technical advances thus becomes more perceptible and more satisfying.

*From Ref. 9: "Multiprogramming is the time-sharing of processor(s) by a number of not-necessarily-related programs that are simultaneously present in main memory; the number of programs may be larger than the number of processors."

It should be noted here that all of the software technique developments discussed in this Section have been contributed to in large measure by many military research-and-development projects. Although they had proprietary immediate objectives, yet they shed light on many problems and have contributed to their general solution. In several cases the actual development and demonstration of working software was performed upon complexes of "conventional" hardware in which many of the requisite hardware advances (e.g., high-powered memory-protection facilities) were absent and therefore had to be simulated in the software.[16]

"Public Utility" Computation

The most challenging generality of all is perhaps that an arbitrary number of remote users of a large system should be able to obtain computation service in ". . . much the same way that the average householder buys power and water from utility companies . . .".[11] This was first described in published form in 1958.*

The conceptual workability of this concept based upon time-sharing of a large computing system (see references numbered 2 and 8 quoted in reference 9 of the present paper), and the value of such a facility to a large population of users having a variety of interests, has been demonstrated in large-scale experiments. These involved the application and adaptation of circa-1960 computing hardware to development and use of large and comprehensive software systems.

The experiments were successful. They justified the further development of hardware-software complexes specifically planned to provide the flexibility and economy of operation that are required in order to make such systems truly general in their applicability. At least two commercial systems have been planned and announced,[14,17] each in conjunction with planning activities of advanced customers. The initial installations are expected to reach operational status during 1966.

The executive systems planned and now under development for these computer systems will presumably provide greater generality than any earlier executive systems. Since all of the requisite hardware and software features will be available and used, the systems should be highly effective. Other commercially-available systems, either announced or being prepared for announcement will, it is expected, be competitive in scope, generality, and performance to the two systems mentioned above.

Several new aspects of generality are already evident in those portions of these system plans that have been presented to public view. I shall mention only two items as samples of the fresh approaches now being planned in order to reach beyond the generality that could have been achieved through "conventional" implementation techniques.

In the IBM 360/67 system, it has been announced that the source-language debugging capability for at least one major compiler language, PL/1, will be enhanced by providing a Conversational Package that is largely interpretive in nature, i.e., that will translate source language into object code line-by-line at execute time.

In the MULTICS System now being developed for the GE 645 ". . . most of the programming of the system will be done in the PL/1 language."[13] The developers of this system recognize that they will pay an initial penalty in loss of efficiency because ". . . the initial version of the translator generates inefficient object code . . .", but they are willing to do so in order to achieve greater flexibility, extensibility, maintainability, and generality than would have been possible had they written the entire system in assembly source language.

*Although Reference 11 evidently followed several years' earlier thought, and was based upon somewhat earlier unpublished documents, the author orally acknowledged prior public remarks on a similar general objective by R. W. Bemer.

Conclusion

From this review of the history of executive systems it is clear that there has been steadily increasing generality in their characteristics. This trend, I believe, more than any other factor, characterizes the development of Executive Systems in the Sixties.

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c&a CAPITAL REPORT

A Special Report from C&A's Washington Correspondent

Representatives from major computer manufacturing firms were called to Washington December 21 and told that increased competition in the computer industry will be the "principal purpose" of future procurements at the National Aeronautics and Space Administration.

According to one of the industry men who attended, this meeting was a direct result of complaints over an $80 million contract awarded to IBM's Federal Systems Division back in October, 1965, on a sole-source basis, that is, on a non-competitive basis. This claim is backed up by NASA Administrator James E. Webb's insistence at the meeting that the selection procedure was the only choice open to NASA. Webb told the meeting that presidents of several computer firms were invited to NASA before October and were told about the situation at the Manned Spacecraft Center in Houston. After seeing how deeply IBM was involved with operations there, Webb said, the presidents agreed with the sole-source decision.

The all-day session in December began with an introduction by William Rieke, NASA Deputy Associate Administrator for Industry Affairs, who reported the preliminary recommendations from a committee formed at the request of Webb to review NASA's computer procurement and come up with a plan that will increase competition. According to Rieke, there are three main reccommendations:

(1) Annual briefings will be held to inform computer firms of NASA's long-range plans, problems, needs for improved system technology and projected procurements. The first will be held next May.

(2) Computer firms will be given an opportunity to conduct individual briefings for NASA personnel to inform them of their own plans, problems and developments.

(3) On large or unusual computer procurements with restrictive requirements, NASA will hold pre-specification briefings for interested companies before issuing Requests for Proposals.

The industry spokesman said there was a resounding crash of silence when NASA officials asked for comments about all of this. It seems that there is a good deal of skepticism about this future "competition" among manufacturers, especially about any that might develop at Langley Research Center, in Hampton, Va., an IBM stronghold for years. Langley is now working on a large procurement that will involve an integrated computing facility for handling applications in analytical and engineering studies, data reduction, and real-time simulation. The spokesman said it will most likely go to IBM.

He was more hopeful about another procurement in the works — probably much larger — at Marshall Space Flight Center, in Huntsville, Ala. February 21 is the deadline for proposals on hardware and software that will make up the "third generation" computing system to replace existing computers at Marshall and at Slidell, La. NASA has dozens of computers at these sites, not all from IBM, and the competition should be keen for this contract.

The impression in Washington about future NASA procurements seems to be a cautious hopefulness for companies other than IBM.

A system to evaluate conventional tactical weapons by simulation will be installed over the next year at the Air Force Air Proving Ground Center, Eglin Air Force Base, Fla. Raytheon Company was recently awarded an $11 million contract for the system as prime contractor. Subcontractors include the IBM Federal Systems Division, Hayes International Corp., and Vitro Corp.

The Weapons Effectiveness Testing Instrumentation System, as it is called, will simultaneously monitor multiple engagements during a simulated battle in a combat zone 100 miles in diameter and up to 70,000 feet in altitude.

Changes in position and activities of attacking and defending aircraft, vehicles, missiles, artillery, rockets, and other weapons in the area will be recorded instantly on a display board. Air Force monitors will be able to follow the battle conditions as they occur.

In addition to the display, the system will consist of computers, sensors, and communications equipment.

A White House task force has begun a study of ways to improve the storage and retrieval of Federal Government statistics. A report to the Budget Bureau Director is expected from the group early this year.

More than 20 separate Government agencies currently collect and publish statistics. To use this information more effectively, the White House said a number of major changes will have to be made, including the establishment of standards and some form of easy access to available, but unpublished data.

James Titus

JAMES TITUS

BASIC RESEARCH IN SOFTWARE

Dr. Ivan Flores
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There is a dearth of basic research in software.

By basic research I mean research directed not towards a specific system but towards understanding the general principles of design, structure and use.

Of course many systems programmers flourish, and they are doing much useful work, but it is useful in a pragmatic sense. Their work is directed towards present needs and immediate uses. The problems they attack are to make software for new equipment. Or, they are trying to design better software for existing equipment. Even workers connected with the universities are directing their attention to pragmatic problems: making compilers or supervisors which the manufacturer has not supplied, or improving running or compiling time on existing systems.

Is No Research Being Done?

It would be wrong for me to imply that there is no basic research in software going on. The most active field, as we all know, is in the area of formal and natural language. Frontiers are being pushed forward, but this is a long, hard struggle. More important, though, research in these areas is not research in the basic principles of programming systems organization.

It is true that research is going on in the precincts of the manufacturers. They realize that some theory must be developed if improvements are to be made in their software packages. However, what research they are doing is closely guarded, for its considerable economic value is realized, and it is feared that it could be profitable to other manufacturers or software dealers. As far as I know, practically no research of a similar nature is going on at universities.

The computer user will benefit from this type of activity only in the sense of slightly improved software; the basic principles may not be common knowledge for a long time.

What Is Needed?

Research should be done to further understand each of the five major software areas:

— translation
— supervision
— loading
— editing
— input-output executives

Each of these packages can become quite complicated.

For each package we should first know what tasks are specifically performed. At a second level, we should know what options are available: this includes options which are required in some designs and those which are luxuries in all.

After the needs of the users are stated precisely, a full examination of how they are met by all currently available software gives at least a start towards a compendium of methodology.

We should know the advantages and disadvantages of each methodology for each task for each software package. Of course advantages are contingent upon use and extensiveness of needs. All of these factors interrelate and depend upon hardware as well as software. A few of the contingencies are:

— speed of the computer
— size of the memory
— extensiveness of tasks
— installation policies

Theory

The ultimate goal of research of course is to obtain a unified theory. A theory of software design needs to be preceded by a theory of programming design and operation. The nature of a programming theory is a question which is open to argument. It seems to me that programming theory should incorporate the topological concepts of graph theory, but that we should not expect too much exactness at the outset.

Why Aren't We Doing Basic Software Research and Building Theory?

Probably there are a number of reasons why there is insufficient basic research in software. There may be too few computer scientists. The field is perhaps dominated by workers whose interests lie in the pure sciences, who are more interested in the particular problems they are trying to solve rather than the general tools for solving the whole class of problems. This might explain why the universities are not pursuing much basic research in computer software. At the universities people who have contact with the computer are usually more interested in solving problems in physics, mathematics, chemistry, etc., and are less interested in problems of computer programming *per se*.

(Please turn to page 54)

AUTOMATIC WAREHOUSING AND INVENTORY CONTROL

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This article discusses the current status of automatic warehousing and automatic inventory control. This field is one of the newer areas to which automatic control concepts and computer concepts have been applied; so, some general background information has been included.

Virtually all producers of manufactured products must maintain a supply of raw materials and finished goods called inventory. These goods are conventionally stored in a space called a warehouse. The purpose of inventory is to provide better delivery, customer service and a balanced production efficiency.

Figures

In a typical manufacturing company, appproximately one-third to one-half of the firm's total assets are invested in inventories. Moreover, approximately 13 cents of every sales dollar is spent in the physical movement and storage of the product. There are over 200,000 large warehouses in the United States today, employing over 2 million people at an annual operating cost of more than $20 billion.[13] It is, therefore, not surprising that the automation of inventory policies and material handling are receiving top management attention.[8]

Automated Warehousing

There is no generally accepted definition of automated warehousing. For many it means a computer-controlled operation with no people, while more often in the last five years it has meant increasing use of mechanization in the handling and storage of product. For purposes of this report we have examined automation from the view of automatic control concepts applied to the problems. By definition, then, we have looked for demonstrations of dynamic feedback and feed-forward. An automatic warehouse tries to integrate the necessary information flow required for operating business decisions in a closed loop with the physical handling and storage of the product. Such a restrictive definition, therefore, deliberately excludes most cases which are purely open loop mechanizations of manual operations.

The warehousing and inventory function is part of a total system for managing the quantity and flow of materials. It has been pointed out that while the traditional goals of process control have been the attainment of specified product *quality* standards, in this field we are dealing with the control of *quantity* standards.[5] Thus, one finds such terms as "Automatic Material Control"[13] and "Dynamic Quantity Control"[5] used to convey the concept.

Basic Warehouse Loop

A simplified block diagram of the total system is shown in Figure 1. Viewed in this way, the ideal automatic warehouse involves as much a system of data processing procedures and communications as it does materials handling and control hardware.

Management Inventory Strategy

Of particular significance is the *Management Inventory Strategy*. Inventory strategy has received a considerable amount of attention by researchers in the field of Operations Research. A scanning of the journals of the OR groups shows a number of rather sophisticated studies in production, inventory, and distribution control concepts. However, it is probably correct to say that not much of this work is clearly recognizable in practice.

The problem is made difficult by the fact that inventory management rests ultimately on a high degree of prophecy. That is, some management decision process must first predict demand for the product, the mix of models to be supplied, and the outlook for the future costs of material and labor.

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Furthermore, judgments must be reached on the economic value of alternative delivery schedules versus customer satisfaction; and the cost of delivery falldowns must be weighed in terms of their impact on future business and customer relations. It is evident that a great deal of management intuition is an inherent part of the full inventory and warehousing control loop. Consequently, there exists a considerable literature reporting on techniques of economic and business trends analysis, as well as many sales forecasting methods. No attempt however is made to cover these developments here.[2,4,9]

Functions

The *Accounting and Data Handling* function must collect, organize and communicate essential information for decision making. In many cases the data handling system itself makes the routine decisions. The primary accounting functions are:

1. Customer order entry
2. Inventory records
3. Re-order point control
4. Production scheduling
5. Invoicing and billing
6. All data logging and processing
7. Special and periodic reports

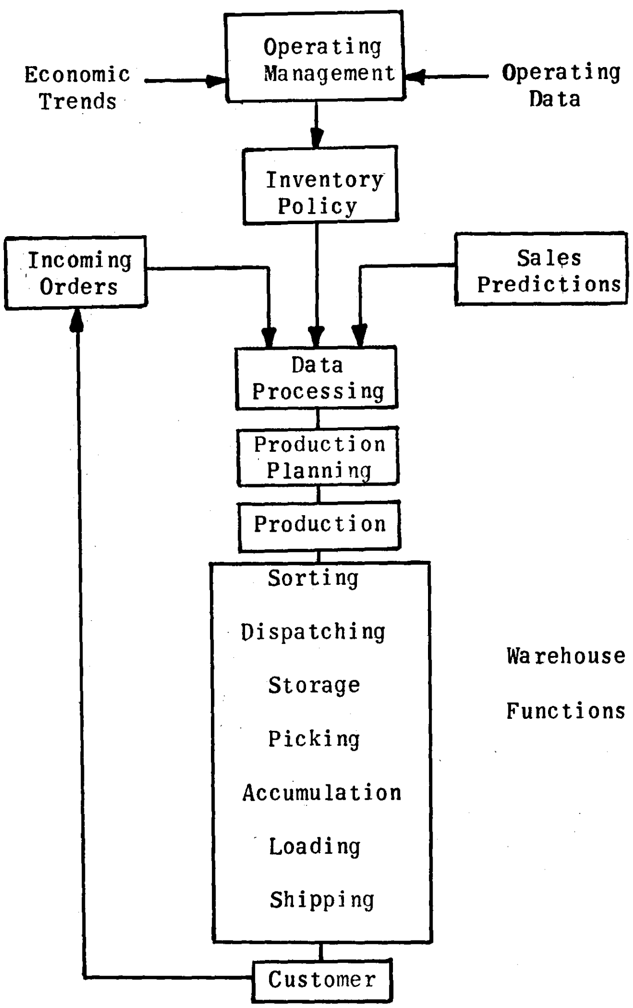

Figure 1 — Three major elements comprise this system. 1. A management inventory policy. 2. Accounting and data handling procedures. 3. Physical materials handling operations.

The *Materials Handling Operation* is important both in the production stage and the warehouse stage. Since we are dwelling on the warehouse and inventory aspects, we will not consider physical handling in the production area.

When the product enters the warehouse, it proceeds through a number of physical handling steps listed in Figure 1. Usually the product enters as a random sequence of items. These will differ in size, type, weight, and product class.

Sorting involves the selection of like products from the array flowing by.

Dispatching involves the transportation of the sorted items to a storage point in the warehouse where they are left until needed.

Storage is the handling and depositing of product to an assigned space within the product storage area.

Picking is the physical collection from storage of the items comprising the order to be satisfied.

Accumulation is the collection at one point of all items picked for an order.

Loading is the final packing and transporting of accumulated orders to the shipping dock.

Shipping is the ultimate step of removing the product from the warehouse via some transportation vehicle. It also involves the generation of records indicating a product is on its way to the customer.

We can now redefine the ideal automated system as one that has tied together in a closed loop all the functions of Figure 1. The distinguishing feature between automation and mechanization is the ability of the automated system to make decisions and possess some memory that permits it to evaluate changing conditions over a period of time. Its computing and control centers are on-line, receiving feedback signals from sensors throughout the plant. If this view is taken very rigorously, there is probably only one installation in the country that presently meets these criteria.[20] However, there exist quite a few installations that have taken large steps to implement portions of this concept.[27]

The First Step in Automation

One of the first steps generally taken is to automate the data handling and accounting functions. The tremendous acceptance of the digital computer and its assorted peripheral equipment has made available quite a broad assortment of machines for sales order and inventory data manipulation. Most companies with sales in the millions have adopted punched card or tape with automatic collating and reading techniques in the handling of incoming orders. These procedures usually carry over to the production control and warehousing operations. Even when such mechanizing of data exists, it does not always follow that a digital computer is involved or justified.

Inventory Control

As more and more data becomes accessible by these means, more sophisticated approaches to production planning become feasible, and some rather complex systems of inventory management have evolved.[2,6] Basically, they all cope with the same questions:

1. What is the predicted future usage of stock?
2. At what rate is present stock being exhausted?
3. When should new quantities be reordered?

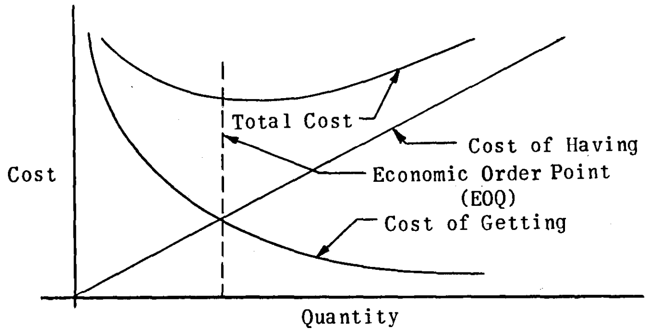

Figure 2

4. How much shall be re-ordered?
5. What is optimum inventory level?

The questions boil down to when and how much?

Underlying the answer is a prophecy about the future. However, given a prediction, a system can then be automated to compute optimum *economic order quantities* — called EOQ. At present, a vast number of concerns arrive at such points through graphical and tabular aids. Once automatic tabulating and collating systems are adopted, however, production control can be highly automated.

The concern for EOQ is a recognition that inventory and warehousing policy involves two sets of costs. First there is the "cost of getting" and then the "cost of having." The trend of such costs with quantity are shown in Figure 2.

Thus, we have a minimization problem that the system must continuously solve. It can be seen from the nature of the variables entering into such a computation how the successful automation of a warehousing operation should integrate with the total business operation.[6,9] The potential for savings in cost and investment seems impressive. For example, it has been estimated that over the past 10 years, the "cost of having" has increased from 18% of inventory value to 25%. Much work remains to be done in this field, particularly from the viewpoint of a dynamic system of variables.

Materials Handling

Regardless of the system used to determine the selection and rate of flow of products to inventory, there is a materials handling problem which starts at the door to the warehouse. The operations of sorting, storing, picking, etc., involve a considerable amount of product handling requiring much human intervention. Tremendous strides have been taken in the past 10 years to mechanize most of these operations. Thus, we see increasing use of automatic palletizing and conveyor transport systems. Lifting and carrying is being done with stacker cranes, fork lift trucks — radio operated or push button operated from consoles. Electronic intercom and television monitoring is increasing. The warehouse laborers' job is being gradually upgraded from the strong back and muscle stage to the console operation stage.

Warehouse Classification

Warehouses can be simply categorized into three types, according to equipment patterns employed.[27]

1. *Rack/conveyor* — For carton and case goods. Highly conveyorized with gravity racks and chutes.
2. *Pallet/rack/stacker retriever* — Palletized loads in layers. Automatic replenishment and picking. Controls by push button, punched card or tape.
3. *Overhead crane/suction retrievers* — Palletized loads in layers. No racks required. High storage density. Controls by push button, punched cards or tape.

The automation of these systems may employ logic controls, computer controls, or a combination of both. Logic control systems tend to be an "open loop" type of control wherein the designer has rigidly locked in a sequence of operations. These systems tend to be rigid and do not readily respond to changing conditions. By introducing a computer with memory capacity, a system is created which can calculate the best way to do things and respond to a variety of alarm conditions and other non-routine contingencies.[28]

The industry of warehousing and materials handling has been slow to exploit the concepts of total automatic control.[30] This is due to a variety of reasons:

1. Mechanizing of materials handling is costly, and the design requirements are severe to meet the variety of shapes and sizes to be handled.
2. Automated systems must have flexibility to meet changing conditions.
3. Systems must be able to handle a vast number of storage and shipment combinations.
4. Proper interfacing between control equipment, electronic data processing systems, and mechanical handling equipment has not been appreciated until recently.

Recent developments in process computer designs and collaboration of materials handling equipment designers with control equipment designers has led to significant progress. The lower cost, general purpose, process computer has made more feasible the concept of automated warehousing.

Fully Automated Warehouse

A fully automated warehouse would fill orders and replenish its stock automatically in accordance with a management inventory policy, taking care of all the details of data processing and materials handling. The means for implementing this concept exists today. The motivation for doing so is increasing. However, there is a wide spread between full automation and no mechanization at all. The justification for full automation will, of course, be almost entirely economic. A great deal of variability in approach is possible since significant improvements can be made just by automating specific problem areas. For example, removing one bottleneck can be equivalent to an expansion in warehouse capacity.

Selected Examples of Warehouses

Existing warehouse installations in the United States provide a wide spectrum of automation applications. There are thousands of systems for automatically breaking down incoming loads and dispatching them to storage; also thousands which consolidate and deliver the orders. There are only a few that approach full automation of materials handling. Some of the more advanced installations are described below.

Kitchens of Sara Lee, Deerfield, Illinois

This installation[20,31] represents the most advanced approach to completely automatic production, warehousing and inventory control. It is the first application in the food industry of a digital computer-directed control system for processing and quality control and, at the same time, the first application anywhere of a computer to direct and control completely mechanized functions of a warehouse.

Because this system is the only installation known which virtually integrates all functions of Figure 1, it will be described in more detail than the rest. This system is under on-line computer control with closed-loop feedback from inventory strategy, to scheduling and baking of cakes, to the handling and control of process materials, to the final storage and shipment of products to order.

This unique bakery-warehouse-office covers an area of 500,000 square feet, has a production potential of over 1 million cakes daily, and freezer-storage space for 7,800,000 cakes. The warehouse freezer space is maintained at minus 10°F and is completely mechanized for sorting, picking, accumulation and shipping of product.

Two computers are tied together via magnetic tape. The central data processing computer determines the order and shipping schedules each day and generates a schedule tape for the process computer which then directs the process and warehouse operations in accordance with business requirements. In turn, the process computer then provides the business office with a continuous warehouse inventory record, what types of products moved in and out, what freezer space is available and how much of each product has been baked.

Other functions performed by the process computer are:

1. Signals and controls the amount of liquid and dry ingredients to be added to batch operations.
2. Monitors storage amounts of all liquid and dry ingredients.
3. Controls batch blending in accordance with stored recipes.
4. Computes and monitors time cycles, oven temperatures and conveyor speeds.
5. Counts baked products.

Product leaving the computer-directed baking process is then automatically loaded on pallets by special suction-lift palletizing cranes and ejected onto a main conveyor line. As the pallet enters the warehouse, a photo-reader reads and checks the contents, providing a check against the computer memory. The computer thereafter keeps track of every movement and location of that pallet until shipment. The computer then decides where to store. At the proper storage aisle the input registers of logical controlled stacker cranes are set to receive the correct pallet. The stacking crane returns to a home position where it finds the load and delivers it to the proper storage bin.

As product is ordered out, the computer redirects stacker cranes to pick up product on a "first-in," "first-out" policy. Conveyors then deliver units to accumulation and thence to the shipping docks.

Colgate-Palmolive Co., Jersey City, N. J.

In five years this company[25] has installed three highly automated warehouses. Its latest is in Jersey City and the most sophisticated:

- Handles 18,000 cases per shift.
- Product mix, 350 items.
- 75% of cases automatically dispensed from storage lanes by punched cards.
- 10% of cases are manually picked.
- Automatic storage lanes replenished by pallet truck.
- Accumulated orders automatically delivered to shipping docks.
- General purpose computer is on-line through sensor network of photocells, gate switches, and other detectors.
- Customer-order data supplied by punched cards.

Naval Supply Center, Oakland, Calif.[21]

This is the latest step in the Navy's automatic materials handling program. The Naval Supply Center extends automation to the handling of receipts, sorting, replenishment and accumulation.

- Handles 12,000 items per shift.
- Product mix, over 750,000 items.
- Picking is done manually.
- All items loaded in standardized tote boxes.
- Moving belt conveyor system.
- Tote boxes identified by number cards which are read by sensing devices along the conveyor.
- All traffic and order analysis, controlled by on-line computer and data processing center.
- Television scanning of conveyors for troubles.

Genesco Inc., Nashville, Tenn.

This is an example of selective automation with manual operations. It is basically a computer-directed warehouse, for 3.2 million pairs of men's shoes.

- Receives and stores 50,000 pairs a day.
- Picks and ships 40,000 pairs in 8 hours.
- Uses special-purpose sorting computer.
- General-purpose computer plans shipments, maintains inventory records, schedules stock replacement and assigns storage bins.
- Sorting is done automatically by computer.
- Picking is done manually.
- Photoscanners read contents of passing boxes.

Consolidated Cigar Corp., Port Newark, N. J.

This warehouse provides automatic receiving, sorting, and shipping of cartons of cigars.[24]

- Handles 480 cartons per hour or 5 million cigars daily.
- Automatic stacking towers store and pick cartons, via operator console remote from storage.
- Product touched by human hands only as received and at final shipment.
- No computer.

International Business Machines, Poughkeepsie, N. Y.

The central materials distribution center of IBM, at Poughkeepsie, N. Y., is primarily an advanced example of data processing systems to handle the accounting functions for running a $12 million dollar inventory of 40,000 active parts.

- Handles 900-1000 receipts per day.
- Issues 7000 items daily.
- Goods dispatched to storage areas by tow-line trucks under automatic control.

These examples are not intended to be exhaustive, but represent a selection of those installations which have pioneered in the implementation of modern warehouse automation. They illustrate the application of many of the principles discussed earlier.

Conclusion

If we consider the automated warehousing system as one which automatically scans incoming orders, adjusts production and inventory levels, directs mechanized warehouse functions of sorting, storage, picking, accumulation and shipping, then there are at most a half a dozen installations currently in the United States that approach this ideal.

However, with the advent of the low-cost process computer, and with the newer designs of control-compatible materials handling equipment, there will be increasing attention to the application of closed-loop control concepts to inventory control, production control and materials handling.

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KURTZ — NEW DEMANDS

(Continued from page 13)

Standardization Needed

Although the problem of standardizing languages has been shown to be extremely difficult, yet more work in that direction still needs to be done. As much as possible, software must be interchangeable between different computer systems, especially those of different manufacturers. It is too vast an economic waste to have to reprogram entire huge software systems every time a new line of hardware is brought out. This is not to suggest that a single, super-software system completely compatible with all hardware should be considered, or is even possible. But compilers, file maintenance systems, and business systems should be written, as far as possible, independently of particular machine configurations. We now have several reasonable machine-independent de facto standard languages: languages for expressing numerical algorithms (FORTRAN, ALGOL); a language for expressing programs that involve mainly file manipulation and input-output (COBOL); and even a new language especially designed for amateurs of all ages (BASIC).

What is needed is a new language for expressing software systems: compilers, assemblers, file maintenance programs, and supervisors. This language might well be a list processing language with string handling and some arithmetic capabilities. It might even be a combination of existing languages. But it should be one that can take over most of the coding now done in symbolic machine language and at the same time be hardware-independent. Of course, a certain portion of every software system will have to be handled in the fundamental machine language of whatever computer is involved, but this should be kept to a bare minimum.

Such a common language would permit installations to exchange systems programs even though their computers had incompatible machine codes. If a large number of installations adopted an efficient input-output supervisor, for instance, that would improve greatly their software situation without requiring extensive systems re-programming efforts. A standardized language for software systems is one possible approach to the shortage of systems programmers, just as FORTRAN helped solve the shortage of application programmers. Finally, the development and use of huge computer-utility complexes may be impossible without some standardization (including a standard language) for software systems.

FLORES — BASIC RESEARCH

(Continued from page 48)

On the other side of the picture, the manufacturers appear to be engrossed in the practical problems of mass-producing software for mass-produced computers. Deadlines and the shortage of warm bodies are the main roadblocks to their effort.

Who?

If the manufacturers are too busy with practical problems, and the universities are too busy with problems of science, who is to do basic research in computer software?

The responsibility under these conditions falls on all of us, and we can each act, according to our role in the field, to further basic software research.

If you are a user, you can make it your responsibility to know just what is the system you use: you can probe deeply and demand to know how it acts and why the particular alternatives were adopted.

If you are a system programmer and design software for a manufacturer, you can ask how the design objectives were chosen, examine closely the procedural details, question why alternatives were not preferred, and strive for complete documentation.

Above all, you can follow the policy that, as for any other science, secrecy is anathema, and that the interchange of knowledge can help you more than secrecy can delay your competitor.

If you are a government research worker, you can foster basic software research by guiding grants to stimulate universities and independent agencies in an area which will bring wide dividends in the use of computers.

Finally, if you are a mathematician, you can consider that the software of computer science, the programming and logical design of computers, are fit subjects for mathematical investigation. They call for the development of adequate and powerful theory.

READERS' AND EDITOR'S FORUM

(Continued from page 18)

Computer people are men.

Therefore, computer people should be responsible citizens.

The social problems which beset the world seem to be technical problems — not in the sense that we lack technology to solve them, but rather that we lack techniques for translating our good intentions into effective actions. Society is transformed by making ideas concrete. It is important for social preservation to keep good ideas and even lofty ideals in public currency, for if they are lost there will be nothing worthwhile to translate into reality. Computer people although especially gifted in implementing the abstract are no better than others at changing an "ought" into an "is." Yet even we should attend to the vexing problem of translating social goals into social realities.

We are a long way from over-emphasizing the social responsibilities of computer people, many of whom have privileged knowledge of special problems.

KEEP PLUGGING!

III. From Richard A. Erlanger
Utica, N. Y.

The computer is man's first encounter outside himself with something that is exactly like some inside part of himself, and, accordingly, the social responsibilities of its adherents are unique as well. Fear has always stymied progress, and fear is the computer's greatest enemy. Perhaps the greatest responsibility of computer personnel is to help alleviate this distrust.

Increased emphasis should be placed on educating the public, and management as well, to the true powers of the digital computer, its capabilities and its failings. The fear that springs from ignorance must be eradicated by capable and interested computer personnel who will assume this unique social responsibility.

MONTHLY COMPUTER CENSUS

The number of electronic computers installed or in production at any one time has been increasing at a bewildering pace in the past several years. New vendors have come into the computer market, and familiar machines have gone out of production. Some new machines have been received with open arms by users — others have been given the cold shoulder.

To aid our readers in keeping up with this mushrooming activity, the editors of COMPUTERS AND AUTOMATION present this monthly report on the number of general purpose electronic computers of American-based companies which are installed or on order as of the preceding month. These figures included installations and orders outside the United States. We update this computer census monthly, so that it will serve as a "box-score" of progress for readers interested in following the growth of the American computer industry, and of the computing power it builds.

In general, manufacturers in the computer field do not officially release installation and on order figures. The figures in this census are developed though a continuing market survey conducted by associates of our magazine. This market research program develops a documented data file which now covers over 85% of the computer installations in the United States. A similar program is conducted for overseas installations.

Any additions, or corrections, from informed readers will be welcomed.

AS OF JANUARY 10, 1966

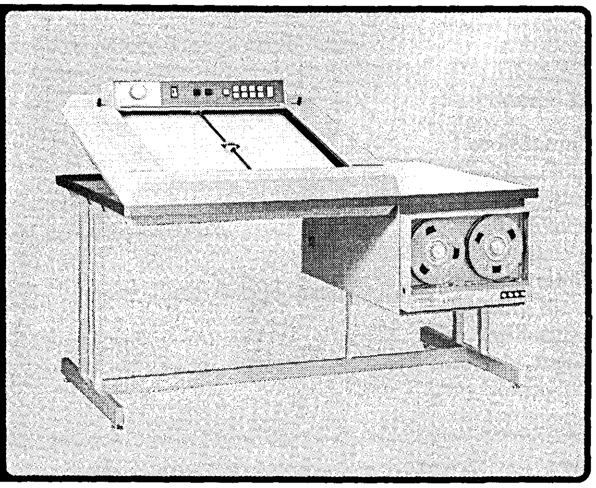
NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	24	1
	ASI 2100	Y	$3000	12/63	6	1
	ADVANCE 6020	Y	$2200	4/65	5	4
	ADVANCE 6040	Y	$2800	7/65	3	6
	ADVANCE 6050	Y	$5000	10/65	0	3
	ADVANCE 6070	Y	$10,500	10/65	1	6
	ADVANCE 6080	Y	$7000	1/66	0	0
Autonetics	RECOMP II	Y	$2495	11/58	48	X
	RECOMP III	Y	$1495	6/61	10	X
Bunker-Ramo Corp.	BR-130	Y	$2000	10/61	158	5
	BR-133	Y	$2400	5/64	13	4
	BR-230	Y	$2680	8/63	15	X
	BR-300	Y	$3000	3/59	38	X
	BR-330	Y	$4000	12/60	34	X
	BR-340	Y	$7000	12/63	20	X
Burroughs	205	N	$4600	1/54	52	X
	220	N	$14,000	10/58	43	X
	E101-103	N	$875	1/56	150	X
	B100	Y	$2800	8/64	110	28
	B250	Y	$4200	11/61	95	4
	B260	Y	$3750	11/62	215	16
	B270	Y	$7000	7/62	150	13
	B280	Y	$6500	7/62	110	17
	B300	Y	$8400	7/65	60	100
	B5000/B5500	Y	$20,000	3/63	48	10
	B8500	Y	$200,000	2/67	0	1
Clary	DE-60/DE-60M	Y	$525	7/60	347	4
Computer Control Co.	DDP-24	Y	$2500	5/63	70	8
	DDP-116	Y	$900	4/65	36	45
	DDP-124	Y	$2050	2/66	0	9
	DDP-224	Y	$3300	3/65	16	15
Control Data Corporation	G-15	N	$1000	7/55	311	X
	G-20	Y	$15,500	4/61	23	X
	LGP-21	Y	$725	12/62	100	X
	LGP-30	semi	$1300	9/56	300	X
	RPC-4000	Y	$1875	1/61	50	X
	160*/160A/160G	Y	$1750/$3400/$12,000	5/60;7/61;3/64	450	1
	924/924A	Y	$11,000	8/61	30	X
	1604/1604A	Y	$45,000	1/60	58	X
	1700	Y	$2200	5/66	0	27
	3100	Y	$7350	12/64	58	35
	3200	Y	$12,000	5/64	90	18
	3300	Y	$15,000	9/65	2	35
	3400	Y	$25,000	11/64	16	18
	3500	Y	$30,000	6/66	0	4
	3600	Y	$58,000	6/63	49	10
	3800	Y	$60,000	1/66	0	16
	6400	Y	$40,000	1/66	0	11
	6600	Y	$110,000	8/64	6	9
	6800	Y	$140,000	4/67	0	4
Digital Equipment Corp.	PDP-1	Y	$3400	11/60	60	X
	PDP-4	Y	$1700	8/62	55	2
	PDP-5	Y	$900	9/63	112	1
	PDP-6	Y	$10,000	10/64	10	6
	PDP-7	Y	$1300	11/64	36	44
	PDP-8	Y	$525	4/65	92	302
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	21	X
Electronic Associates, Inc.	8400	Y	$7000	6/65	2	6
Friden	6010	Y	$600	6/63	319	179
General Electric	115	Y	$1375	12/65	5	410
	205	Y	$2900	6/64	42	8
	210	Y	$16,000	7/59	52	X
	215	Y	$6000	9/63	54	2
	225	Y	$8000	4/61	138	2
	235	Y	$10,900	4/64	61	8
	415	Y	$7300	5/64	90	60
	425	Y	$9600	6/64	50	50
	435	Y	$14,000	10/64	20	25
	625	Y	$41,000	12/64	11	25
	635/645	Y	$45,000	12/64	4	28
Honeywell Electronic Data Processing	H-120	Y	$2600	1/66	2	270
	H-200	Y	$5700	3/64	710	130
	H-400	Y	$8500	12/61	122	5
	H-800	Y	$22,000	12/60	86	3
	H-1200	Y	$6500	2/66	0	42
	H-1400	Y	$14,000	1/64	12	1

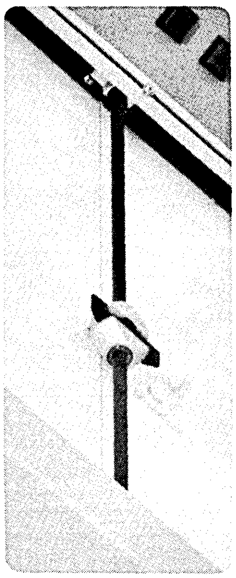
NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Honeywell (cont'd)	H-1800	Y	$30,000	1/64	16	6
	H-2200	Y	$11,000	1/66	0	44
	H-4200	Y	$16,800	2/66	0	8
	H-8200	Y	$35,000	3/67	0	1
	DATAmatic 1000	N	$40,000	12/57	4	X
IBM	305	N	$3600	12/57	168	X
	360/20	Y	$1800	12/65	15	4000
	360/30	Y	$7200	5/65	600	3200
	360/40	Y	$14,500	4/65	450	900
	360/44	Y	$12,000	9/66	0	400
	360/50	Y	$28,000	8/65	20	360
	360/60	Y	$48,000	1/66	0	9
	360/62	Y	$55,000	1/66	0	5
	360/65	Y	$46,000	11/65	2	110
	360/67	Y	$49,000	9/66	0	22
	360/75	Y	$78,000	2/66	0	70
	360/90 Series	Y	$140,000	6/67	0	6
	650	N	$4800	11/54	250	X
	1130	Y	$850	11/65	25	1900
	1401	Y	$4500	9/60	6650	180
	1401-G	Y	$2000	5/64	1220	60
	1410	Y	$14,200	11/61	735	25
	1440	Y	$3300	4/63	2600	250
	1460	Y	$9000	10/63	2200	200
	1620 I, II	Y	$2500	9/60	1700	20
	1800	Y	$3700	1/66	0	140
	701	N	$5000	4/53	1	X
	7010	Y	$22,600	10/63	180	30
	702	N	$6900	2/55	8	X
	7030	Y	$160,000	5/61	7	X
	704	N	$32,000	12/55	39	X
	7040	Y	$18,000	6/63	115	8
	7044	Y	$35,200	6/63	115	20
	705	N	$30,000	11/55	61	X
	7070, 2, 4	Y	$27,000	3/60	340	7
	7080	Y	$55,000	8/61	75	X
	709	N	$40,000	8/58	11	X
	7090	Y	$63,500	11/59	44	1
	7094	Y	$72,500	9/62	125	6
	7094 II	Y	$78,500	4/64	105	20
ITT	7300 ADX	Y	$18,000	9/61	9	6
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	150	X
	Monrobot XI	Y	$700	12/60	580	100
National Cash Register Co.	NCR - 304	Y	$14,000	1/60	26	X
	NCR - 310	Y	$2000	5/61	42	X
	NCR - 315	Y	$8500	5/62	385	60
	NCR - 315-RMC	Y	$12,000	9/65	12	25
	NCR - 390	Y	$1850	5/61	1060	40
	NCR - 500	Y	$1500	10/65	100	750
Philco	1000	Y	$7010	6/63	20	0
	2000-210, 211	Y	$40,000	10/58	18	1
	2000-212	Y	$52,000	1/63	10	1
Radio Corporation of America	Bizmac	N	$100,000	-/56	3	X
	RCA 301	Y	$6000	2/61	622	5
	RCA 3301	Y	$11,500	7/64	49	18
	RCA 501	Y	$14,000	6/59	99	2
	RCA 601	Y	$35,000	11/62	4	X
	Spectra 70/15	Y	$2600	11/65	10	80
	Spectra 70/25	Y	$5000	11/65	4	40
	Spectra 70/35	Y	$7000	4/66	0	35
	Spectra 70/45	Y	$9000	11/65	3	120
	Spectra 70/55	Y	$14,000	5/66	0	12
Raytheon	250	Y	$1200	12/60	172	2
	440	Y	$3500	3/64	14	3
	520	Y	$3200	10/65	3	5
Scientific Control Systems	650	Y	$1600	12/65	0	2
	660	Y	$2000	10/65	2	1
	670	Y	$2600	12/65	0	2
Scientific Data Systems Inc.	SDS-92	Y	$900	4/65	30	42
	SDS-910	Y	$2000	8/62	155	13
	SDS-920	Y	$2700	9/62	100	12
	SDS-925	Y	$2500	12/64	16	35
	SDS-930	Y	$4000	6/64	78	32
	SDS-9300	Y	$7000	11/64	18	7
Systems Engineering Labs	SEL-810	Y	$750	9/65	4	13
	SEL-840	Y	$4000	11/65	2	3
UNIVAC	I & II	N	$25,000	3/51 & 11/57	28	X
	III	Y	$20,000	8/62	86	1
	File Computers	N	$15,000	8/56	19	X
	Solid-State 80 I, II, 90 I, II & Step	Y	$8000	8/58	285	X
	418	Y	$11,000	6/63	56	30
	490 Series	Y	$26,000	12/61	83	60
	1004	Y	$1900	2/63	3250	180
	1005	Y	$2400	2/66	0	120
	1050	Y	$8000	9/63	270	90
	1100 Series (except 1107)	N	$35,000	12/50	12	X
	1107	Y	$45,000	10/62	29	2
	1108	Y	$50,000	9/65	4	18
	LARC	Y	$135,000	5/60	2	X
				TOTALS	31,391	16,073

X = no longer in production.

* To avoid double counting, note that the Control Data 160 serves as the central processor of the NCR 310. Also, many of the orders for the IBM 7044, 7074, and 7094 I and II's are not for new machines but for conversion from existing 7040, 7070 and 7090 computers respectively.

DIRECT DIGITIZING WITH CALMA'S NEW MODEL 302 DIGITIZER

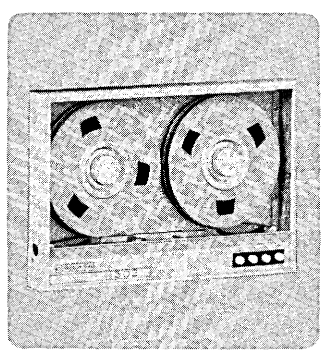




DIRECT TRACING—To digitize analog data directly, the operator simply traces the analog curve with a moveable stylus. Tracing with the Model 302's low-mass, low-friction stylus is a smoothly continuous motion, . . . no handwheels, . . . no cranks, . . . no laborious point-by-point entries. And because this is a manual digitizing system, the input data can be in any format, on any kind of paper.

DIRECT DIGITAL ENCODING—CALMA's unique direct digital encoder completes the digitizing operation without variable potentiometers, A-to-D voltage converters, or any analog components. This all-digital system eliminates the constant compensation and adjustment required to keep conventional digitizers within reasonable performance tolerances.

DIRECT MAGNETIC TAPE OUTPUT—The Model 302 Digitizer outputs directly on 556 bpi, 7-channel, computer compatible magnetic tape. No punch cards or card-to-tape conversion through a small inter-process computer is required.



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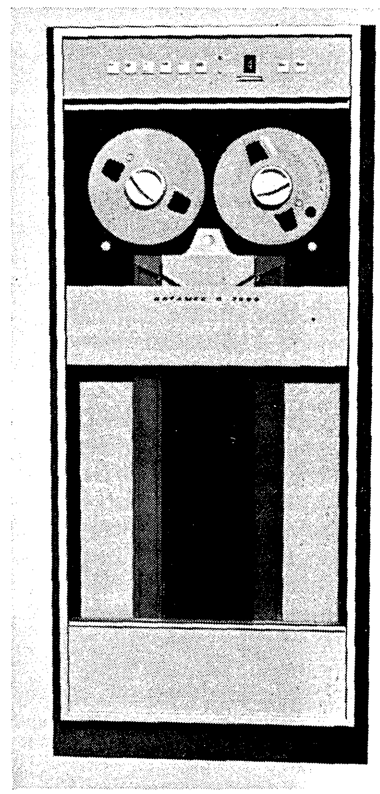

Datamec D 3029 Tape Unit (interchangeable with IBM 729-II and 729-V)
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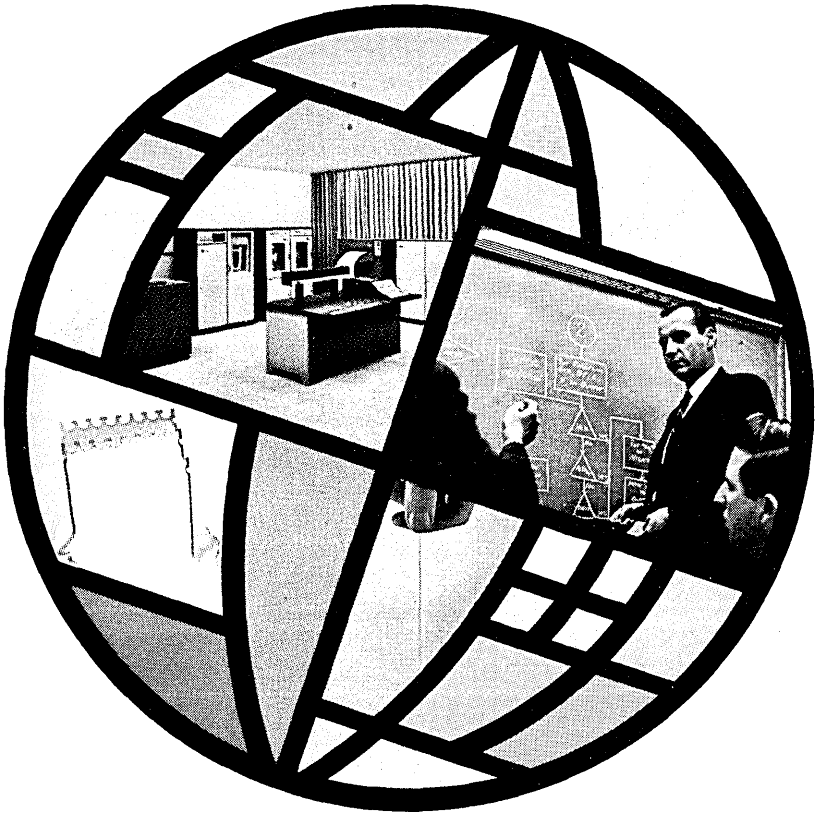


NEW PATENTS

RAYMOND R. SKOLNICK
Reg. Patent Agent
Ford Inst. Co., Div. of Sperry Rand Corp., Long Island City 1, New York

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.

August 31, 1965 (Continued)

3,204,112 / Raymond C. P. Hinton, West Englewood, and Ernest H. P. Bigo, Nutley, N. J., and Peter Pleshko, Bronx, N. Y. / International Telephone and Telegraph Corp. / Logic Circuits Employing Negative Resistance Elements.

3,204,127 / James C. Meier, Cedar Rapids, Iowa / Collins Radio Co., Cedar Rapids, Iowa / Digit Memory Circuit.

3,204,128 / Marvin E. Petersen, Clearwater, Fla. / Honeywell Inc. / High Speed Turnoff Gate Driven By A Gating Means.

3,204,223 / Hewitt D. Crane, Palo Alto, Calif. / Burroughs Corp., Detroit, Mich. / Magnetic Core Storage And Transfer Apparatus.

3,204,227 / Victor T. Shahan, Wappingers Falls, and Wilbert L. Shevel, Jr., Peekskill, N. Y. / IBM Corp. / Magnetic Memory.

September 7, 1965

3,205,433 / Gerhard Dirks, Morfelder Landstrasse 44, Frankfurt am Main, Germany / Matrix Device.

3,205,484 / Frederick A. Schwertz, Pittsford, N. Y. / Xerox Corporation / Electrostatic Memory System.

September 14, 1965

3,206,726 / Christiaan Johannes Van Dalen, Leidschendam, Netherlands / De Staat der Nederlanden / Reading Device For An Information Bearer.

3,206,730 / Ryo Igarashi, Tokyo, Japan / Nippon Electric Co., Ltd. / Tunnel Diode Memory Device.

3,206,731 / Andre Michel Eugene Richard, Paris, and Andre Pierre Jeudon and Herveline Jeudon, Gentilly, France / Societe d'Electronique et d'Atomatisme, Courbevoie, France / Magnetic Core Information Handling Systems.

3,206,733 / George R. Briggs, Princeton, N. J. / Radio Corporation of America / Memory Systems Having Flux Logic Memory Elements.

3,206,734 / George R. Briggs, Princeton, N. J. / Radio Corporation of America / Memory Systems Having Flux Logic Memory Elements.

CALENDAR OF COMING EVENTS

Feb. 9-11, 1966: 13th Annual International Solid-State Circuits Conference, Sheraton Hotel and Univ. of Pa., Philadelphia, Pa.; contact Lewis Winner, 152 W. 42 St., New York, N.Y. 10036

Mar. 21-24, 1966: IEEE International Convention, Coliseum & New York Hilton Hotel, New York, N. Y.; contact J. M. Kinn, IEEE, 345 E. 47 St., New York, N. Y. 10017

Mar. 24-26, 1966: 4th Annual Symposium on Biomathematics and Computer Science in the Life Sciences, Shamrock Hilton Hotel, Houston, Tex.; contact Office of the Dean, Div. of Continuing Education, Univ. of Texas Graduate School of Biomedical Sciences at Houston, 102 Jesse Jones Library Bldg., Tex. Medical Center, Houston, Tex. 77025

Mar. 29-31, 1966: ACM Symposium on Symbolic and Algebraic Manipulation, Sheraton-Park Hotel, Washington, D. C.; contact Miss Jean E. Sammet, IBM Corp., 545 Technology Sq. Cambridge, Mass. 02139

Apr. 12-14, 1966: International Quantum Electronics Conference (Sequel to 1963 Meeting in Paris), Towne House, Phoenix, Ariz.; contact Lewis Winner, 152 W. 42 St., New York, N. Y. 10036

Apr. 20-23, 1966: International Conference on Automated Data Processing in Hospitals, Hotel Marienlyst, Elsinore, Denmark; contact Conference Secretariat, Databehandlingskontoret, Juliane Mariesvej 6, Copenhagen Ø, Denmark

Apr. 26-28, 1966: Spring Joint Computer Conference, War Memorial Auditorium, Boston, Mass.; contact AFIPS Hdqs., 211 E. 43 St., Rm. 504, New York, N.Y. 10017

May 3-5, 1966: Bionics Symposium, Dayton, Ohio; contact Bionics Symposium 1966, P.O. Box 489, 300 College Park Ave., Dayton, Ohio 45409

May 3-5, 1966: British Joint Computer Conference, Congress Theatre, Eastbourne, Sussex, England; contact Public Relations Officer, Institution of Electrical Engineers, Savoy Place, London, W.C.2, England

May 10-12, 1966: 16th Annual National Telemetering Conference, Prudential Center, Boston, Mass.; contact Lewis Winner, 152 W. 42 St., New York, N. Y. 10036

May 16-20, 1966: Australian Computer Conference, Canberra, A.C.T., Australia; contact S. Burton, Honorary Secretary, P.O. Box 364, Manuka, A.C.T., Australia

May 18-20, 1966: 29th National Meeting of the Operations Research Society of America, Los Angeles, Calif.; contact Dr. John E. Walsh, System Development Corporation, 2500 Colorado Ave., Santa Monica, Calif. 90406

May 30-June 1, 1966: National Conference of the Computing and Data Processing Society of Canada, Banff Springs Hotel, Banff, Alberta, Canada; contact Mr. K. R. Marble, Mgr., Systems and Computer Services Dept., Western Region, Imperial Oil Ltd., Calgary

June 15-17, 1966: Federal Government Accountants Association 15th National Symposium, Radisson Hotel, Minneapolis, Minn.; contact Federal Government Accountants Association, 1560 Rand Tower, Minneapolis, Minn. 55402.

June 15-17, 1966: 1966 IEEE Communication Conference, Sheraton Hotel, Philadelphia, Pa.; contact Lewis Winner, 152 W. 42nd St., New York, N.Y. 10036

June 20-23, 1966: 74th Annual Meeting of American Society for Engineering Education, Washington State University, Pullman, Wash.; contact Lewis Winner, 152 W. 42 St., New York, N. Y. 10036

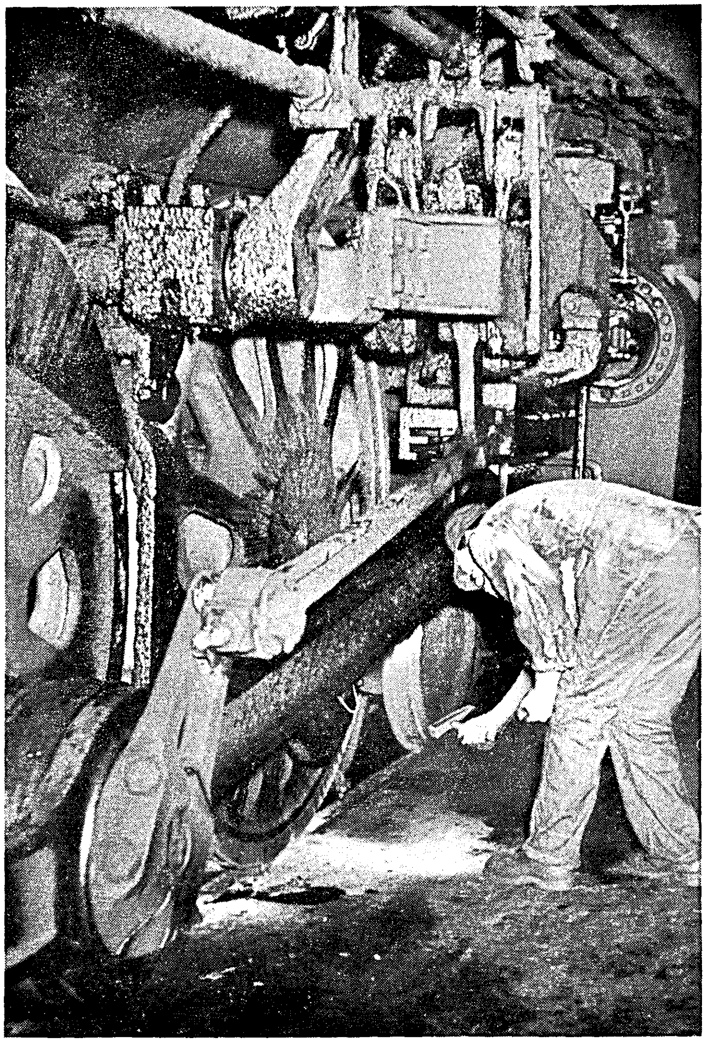
June 21-24, 1966: Data Processing Management Association June International Conference, Hilton Hotel, Chicago, Ill.; contact R. Calvin Elliott, Exec. Dir., DPMA, 524 Busse Highway, Park Ridge, Ill. 60068

July 4-8, 1966: International Symposium on Mathematical and Computational Methods in Social Sciences, International Computation Centre, Rome, Italy; contact Bernard Jaulin, Centre de Calcul de la Maison des Sciences, de l'Homme, 14 rue Monsieur le Prince, Paris 5e, France. Last date for receipt of papers, Mar. 1, 1966; information from Bernard Jaulin, Secretary General, address above.

July 8-12, 1966: Seminar on Graph Theory, International Computation Centre, Rome, Italy; contact International Computation Centre, P. O. Box 10053, Rome, Italy. Last date for receipt of papers, Mar. 1, 1966; information from Dr. P. C. Gilmore, Thomas J. Watson Research Center, Box 218, Yorktown Heights, N. Y.

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 / readers service number.



What does Old 99 have to do with Brady Tab Labels? It illustrates a point.

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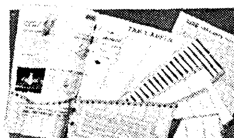
Our approach made so much sense to hundreds of suppliers of data processing supplies (chances are, your supplier among them!) that they now carry a local stock of Brady Tab Labels. And they can give you local service on your special made-to-order requirements, too.



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