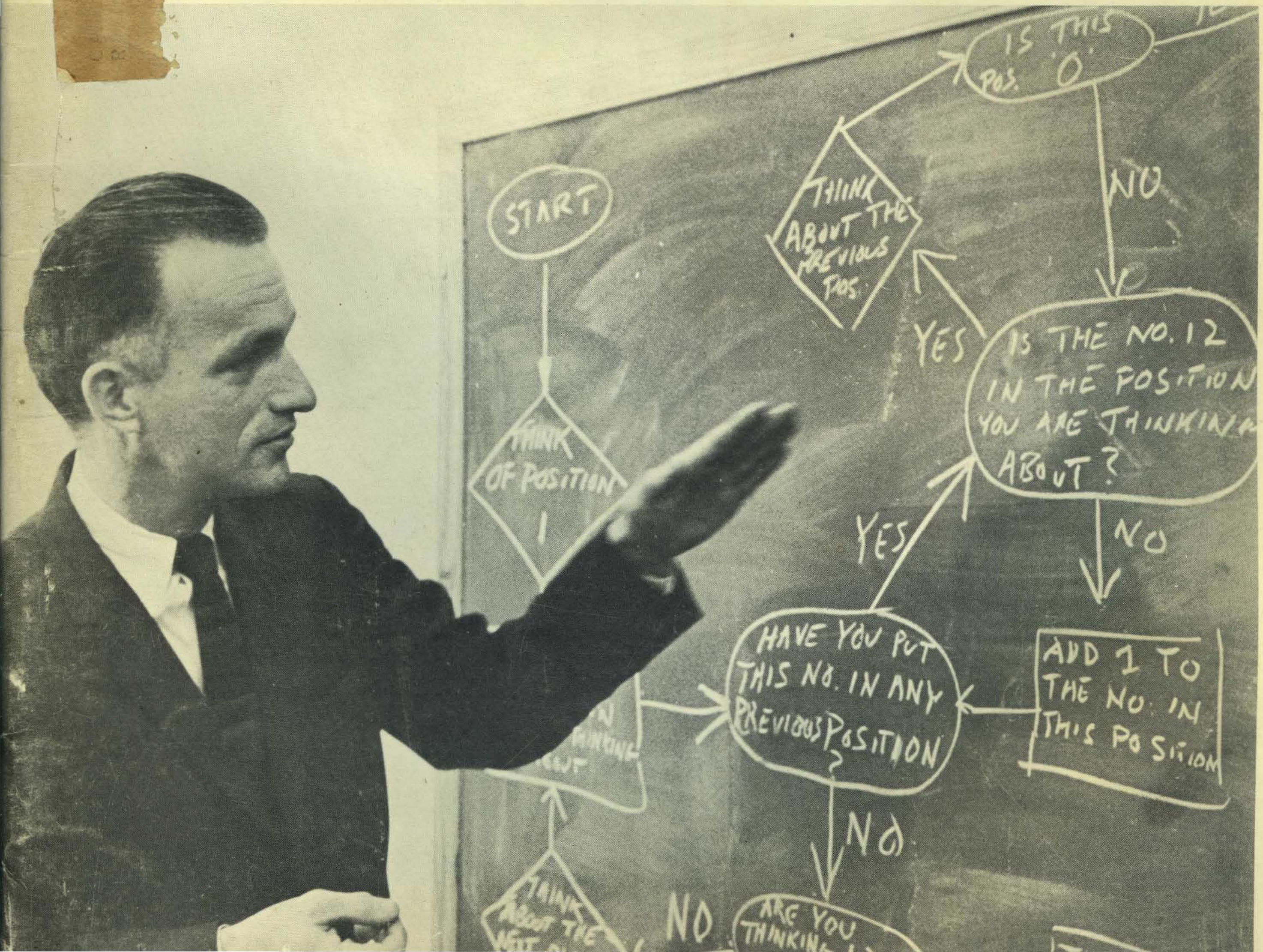
December, 1963

compute
and autom

A [illegible] **mputer Application . . . *Automatic Contest Winning***



DDP- 24 Digital Computer introduced March, 1963

~~17~~ 29 Orders to date* including . . .

Three DDP-24 Computers To EAI For Hydac – 2400

FRAMINGHAM, MASSACHUSETTS — Electronic Associates, Incorporated, Long Branch, New Jersey, has ordered three DDP-24 general purpose digital computers from Computer Control Company, Inc. The three computers were ordered as part of a continuing EAI/3C contract by which 3C supplies the digital portion of EAI's new HYDAC-2400 — the first standard, commercially available analog/digital computer system. The design of the HYDAC-2400 provides for the system to function as a totally integrated unit and also as separate analog and digital computers.

3C Delivers DDP-24 Computer For Gemini Trainer

FRAMINGHAM, MASSACHUSETTS — Computer Control Company, Inc., delivered the first of two DDP-24 Digital Data Processors ordered by McDonnell Aircraft Corporation for use in the Gemini Flight Trainer System.

The DDP-24 will be the basic computer in the system and will provide real-time simulation of the on-board guidance computer through all phases of launch, boost and insertion, orbit, rendezvous and docking, retro and re-entry, and letdown. The computer also ...

NASA Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A DDP-24 Digital Data Processor has been ordered from Computer Control Company, Inc., by NASA for the Goddard Space Flight Center.

The high speed, general purpose computer will be used as a simulator for a world-wide tracking network for manned spacecraft. Data will be utilized in determining vehicle orbits, prediction of landing sites, etc. The DDP-24 is supplied with a comprehensive soft...

Litton Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Litton Industries for their Communication Sciences Laboratory in Waltham, Massachusetts.

Litton will use the high speed DDP-24 for open-shop scientific and engineering computation. Included as part of the standard DDP-24 contract agreement is a comprehensive software package including FORTRAN II and 3C engineering support services.

Air Force To Get 3C DDP-24

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by the Air Force Systems command, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

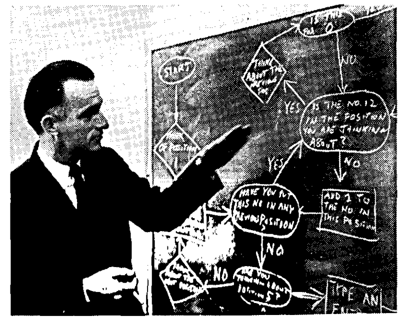
The Air Force will use the high speed DDP-24 for on-line data format conversion and also off-line for general purpose computation. Included with the DDP-24 is a comprehensive software package incl...

3C DDP-24 Slated For Haskins Lab

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Haskins Laboratories, Inc., New York, N. Y. Haskins will use the very high speed, 24-bit word DDP-24 for applications in speech simulation and analysis...

* ~~OCTOBER 30, 1963~~ NOV. 19, 1963

Our front cover shows engineer G. Woodruff explaining the flow chart of the strategy he used to guide a computer to certain victory in a national contest. *See "Computer Wins Contest" on page 47.*



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In This Issue

In Every Issue

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Computers and Computer People, Against Assassination

The tragic events of the end of November must have shaken all men of good will in America. First: the violent death of President John F. Kennedy — shot from ambush by an assassin in Dallas, Texas. Second: the dishonor — the prime suspect, shot by another assassin in Dallas, and dead without a fair trial before the bar of justice.

As Ralph McGill said in his column "Harvest of Hate" printed in the "Boston Globe" on November 23:

> "We would do well to understand that hate.... unchecked in behalf of morality, decency, and human dignity.... can also kill a nation, or so weaken it that it will die."

But these are only two in a long succession of similar murders in the United States. In 1963 alone:

— Four Sunday school children were dynamited to death in a church in Birmingham, Alabama, on Sept. 15;

— Negro leader Medgar Evers was shot to death by a sniper in the driveway next to his home in Jackson, Mississippi, in June;

— The white postman William L. Moore was shot to death in the back as he walked wearing a a sign "End Segregation in America" along a road near Gadsden, Alabama, in April; and

— Benjamin M. Gurley, computer scientist, who put together the PDP-1 computer in four months, was shot to death through a window while at supper with his wife and children in the kitchen of his home in West Concord, Massachusetts, on November 7.

Ben Gurley was liked and admired by almost everybody who knew him, and loved by many. I shall never forget sitting in the living room of his house after dinner on November 4, listening while he held his two-year old daughter on his lap and read aloud a book of young people's riddles to her and to all of us, while we gaily tried to guess them. He leaves seven children, a widow, and unfinished projects. His friends and admirers are forming a "Ben Gurley Association". (If you are interested in more information about this, circle No. 1 on the Readers Service Card, or write "Computers and Automation".)

Assassination is sometimes a prelude to hatred and murder on a much larger scale. In Germany during the years 1919 to 1933 before Hitler came to power, over 400 distinguished democratic Germans were assassinated by neomilitarist individuals and groups. When charged with murder in court, they were regularly freed by judges and juries on the defense that they were fighting treason to Germany. This uncorrected perversion of justice makes it a bit less surprising that after the Nazis came to power in 1933, they killed over 6 million unarmed Jews and over 5 million captives of other nationalities 1939-45.

Assassination and genocide are not inevitable. They are outcomes of hate; they are phenomena of human behavior; and they can be dealt with through common sense, science including sociology and psychology, wisdom, idealism, and determination. It may be argued that if M decides to assassinate P, there is nothing or very little that can be done to prevent it. This is far from true statistically. Some of the prevention can be exercised by P; some more of it can be exercised by society and its organs of government. A belief in M's mind that he will certainly be severely punished acts as a real deterrent in a great many cases. The attitudes of M's circle of friends and associates towards assassination is another critical factor. In most circles of our present society, only rare types of persons would seriously undertake the assassination of someone else. These points and other points make the problem manageable, and make it in large part a problem in information processing.

For example, in Britain there is an organization called Special Branch which works on prevention of assassination. According to the reporter Robert Musel, it "pinpoints every known subversive in the United Kingdom and neutralizes him — by detention if necessary" when royalty or heads of state are visiting. "A classic example of Special Branch ingenuity was shown during a visit of President Tito of Yugoslavia, when he was to lay a wreath at the War Memorial in Whitehall before thousands of people and thousands of windows. .... Special Branch stalled all traffic in Whitehall, so that there were solid masses of doubledecker busses on both sides of the boulevard. Between this improvised bullet-proof shield, Tito laid his wreath." According to current newspaper reports the Federal Bureau of Investigation in this country keeps a file on every known person who might be a "subversive".

The basic function of computers and computer people is to provide information engineering — the converting of great quantities of information from one form into another more desired form. The information on persons in the files of Special Branch or the FBI is doubtless already being operated on with computers and data processors. The programs for processing the data and the applications of the results can certainly be improved.

But there are two big provisos: provided the supervisors of the information processing know the techniques for doing a good job, and provided they really want to do a good job (i. e., are not persons who secretly sympathize with the assassins).

In the case of Ben Gurley, he had reported to the local police a month or so earlier that he had been threatened by a former associate and that he believed his life was in danger. The police provided protection of a sort, of the usual local-police-station quality; but it was not adequate; he had not even been warned to pull his shades down at night. In fact, I have never heard of any police station issuing a leaflet or booklet on "Safety Procedure", to help protect the persons that the police station guards. After the shot, the prime suspect, Allen Blumenthal, was arrested the same evening; and the next day was charged in court in Concord with the murder of Ben Gurley; the case is awaiting trial. But this is lokcing the stable door after the horse is stolen.

There have been fifty bombings of Negroes and Negro property in Birmingham, Alabama, since 1945; not one has been "solved". Two white persons were arrested in connection with the bombing of the Negro church in which four little girls were killed; the two whites were charged only with possessing dynamite, and sentenced to six months at hard labor. Floyd Simpkins, the Alabama storekeeper who was charged with shooting William Moore, on the basis of evidence from the Federal Bureau of Investigation, was let go by the local court. So far as I know, no white man in the South has ever been executed for assassinating a Negro. Under these conditions it is difficult to believe that the persons in charge of the governmental apparatus in many parts of the South really want to stop assassination.

Let us all work, now while there is still time and as diligently as possible, to reduce the bitterness and hatred and venom, irrational or rational, which appears to be spreading through the society of America. Let us deal generously and justly with some of the rational causes of bitterness, especially the suffering of American Negroes from discrimination, segregation, and violence. Let us try to increase the safety of people from assassination: for example, assassination like kidnapping could be a Federal crime, and assassins could be tried and sentenced according to the laws of the United States, so that we would no longer tolerate the warping of justice in local, segregated areas of the country. Let us find good men who are really determined to prevent assassination and incipient genocide in America, and put them in charge of sufficient resources in the field of data processing, and in other fields, so that the rate of assassination like the rate of kidnapping approaches zero. And let us repair and heal our society, for the very worth and value of our society is at stake.

Edmund C. Berkeley

EDITOR

c & a
READERS' & EDITOR'S FORUM

"PEEPHOLE" TO THE OUTSIDE WORLD

I. From David E. Van Buskirk

Supervisor, 41679
Tabulating Department
Indiana Reformatory, Department of Correction
Pendleton, Ind.

We would like to express our sincere appreciation for the help that you extended to us in providing a complimentary subscription to your very informative, superbly edited magazine.

In the year that we have been receiving **Computers and Automation,** the class as a whole has benefited from them in innumerable ways. Essays, briefs, and other assignments have been derived from each month's issue for the students to complete. In point of fact, your publication has allowed us to view the outside data processing world from inside these walls.

Concerning our progress in the last year: We have increased our curriculum to include approximately 50 various Remington Rand and I.B.M. machines and we now have a small library started which includes approximately 125 books on related material. The Central Indiana Chapter of the D.P.M.A. has consented to indorse our diploma to all qualifying students and we have had 30 programmers qualified to date.

Everything that we have accomplished here, everything that we as individuals will accomplish in the future in this field, can be directly attributed to the broad-minded, understanding people like yourself who have shown compassion to us as young men in need of their help. This fact we are fully aware of while taking advantage of this opportunity.

Only those with the best potential are allowed to enter our department. They must be way above average in personality, sincerity, disposition, motivation and in intelligence. They must have an I.Q. of 105 or better and an S.A. of at least 8.0 or more. These men are screened for approximately 2 weeks, tested with the I.B.M. aptitude tests and logic evaluation problems. After screening, the handful that is left begin a strict and rigid course covering all related EDP machines.

We believe that the men who eventually complete this course are the most highly qualified graduates of any school of its kind and should go a long way in this field upon their release.

We are starting a new class September 15 and unless we receive another year's free subscription to **Computers and Automation,** we will very much miss the issues. As student reference aids and as our "peephole" to the outside world, your magazine is tops in the field. I was pleased to see a couple of copies of **C & A** in the office of the supervisor of a tab section which our class visited recently.

Thank you for your time and support in this matter.

Respectfully yours, ...

II. From the Editor

Thank you for your letter, with comments on the value of **Computers and Automation.** We are glad to know that it has been useful to you.

We are renewing your complimentary subscription for another year, and hope that it will continue to be useful to you and your colleagues.

c&a EDITOR'S SCRATCHPAD

COMPUTERS, MAGIC NUMBERS, AND 'SO WHAT ELSE IS NEW?'...

Three is shaping up a magic number -- one might even say the Midas number -- in the computer field. The unit in this case is years. Since 1955 the number of new computers introduced and the number of new orders for computers appear to increase and decrease in three-year cycles (with an ever increasing baseline, to be sure). All of 1955, 1958 and 1961 were years of heightened activity for both new equipment announcements and new orders for computer systems.

The reason for this three-year activity cycle is not deeply hidden. A major factor in that three-year cycle is the minimum payback period on an equipment leasing arrangement, during which a computer manufacturer can recover his production and development costs, interest, and a basic profit. A vendor is not likely to introduce equipment obsoleting a large population of his existing computer installations which will be on lease for less than three years by the time the new equipment is ready for installation. The strong cyclic flavor to this activity in the computer field comes from the fact that the industry is polarized around the activities of a common competitor. Since IBM currently commands over 80% of the computer market, it sets the basic rhythm for the movements of the other players. In 1958, IBM was at the height of its marketing drive on the 709 series. In 1961, the 1401 series was generating orders at the rate of 15 per working day. In 1964, intense ordering activity on the 1440 and 1460 is anticipated, as well as on the first models of a yet-to-be-announced new computer series. Other manufacturers are readying their launching pads for the introduction of an impressive range of competitive computing equipment. Truly '64 should be a banner year for the computer census taker.

An early indication of this impending activity is that during the first 11 months of 1963, 11 new gp computers were announced. In the current month alone, General Electric is planning to announce 4 new business-oriented computers, and "leak" information on 2 new scientific computers. Two of the new GE business computers, the 425 and 435 are designed to be competitive with the IBM 1410, RCA 501 and H-1400. They will lease at from $6,000 to $15,000 per month. Deliveries will start in July, 1964. The other two business computers, the GE-455 and 465, are designed to be competitive with the H-800 and IBM 7070 series. They will lease at from $15,000 to $30,000 per month. Deliveries will start in mid-1965. The new scientific computers, the GE-625 and 635, are claimed to be in the Control Data 3600 class, with operational speeds faster than the 7094. Formal announcement of this 600 series is expected in Spring '64.

Among the rumored offspring of other systems builders in the computer field in 1964 are:

- General Precision will announce an LGP-22 shortly, featuring an 8K disc memory and an $800/month lease price. Also their L-3055 computer, originally developed for the 473L system, will be commercially available in 1964.

- Burroughs is expected to announce a large-scale system based on the B-5000 but featuring begabits of random access storage and thin film internal memory.

- Control Data is expected to bridge the gap between the G-15 and the 3200 with a new introduction.

- Honeywell is expected to bid seriously for the small computer market in '64 by announcing their $4000/month H-200 this month.

- IBM is expected to introduce an assortment of new large storage devices (look for a semi-permanent memory unit with optical read/write techniques), I/O gear, as well as the basic members of a new series of computers specifically designed for extensive data communications processing.

- RCA is expected to offer an improved computer in the 301 price class.

- Univac's IV is due in 1964, designed for data communications routing, processing, and control.

WHAT'S DUE FROM ACM DUES

We noted with much interest and some financial anguish the recent increase in ACM dues from $10 to $18 per year. We feel this is an unwise and unnecessary step on the part of the only professional association that speaks for the scientific and engineering users of computers -- the core computer people who expand the horizons of information processing technology. Do you remember the first few years when ACM dues were $2 a year?

We feel this step from $10 to $18 is very unwise, because (1) by nearly doubling the membership fee, the ACM is inhibiting membership among those elements who are most in need of the information services its publications provide, namely, the student and junior mathematician and programmer; and (2) by nearly doubling the membership fee, the ACM will be cutting the interest/cost curve of membership at a significantly lower point, and consequently will only embellish its caricature of serving ivory-tower mathematicians and numerical theorists.

We feel that in fact the $8 per year membership fee increase is unnecessary because the ACM's $50,417 deficit last year was almost entirely due to losses on one activity: the publication of the Computing Reviews. The ACM paid $27,811 in printing and mailing costs and $29,607 in salaries for the production of the Reviews in the 1963 fiscal year, for a total expense of $57,418. The ACM'ers picked up $8,131 in subscriptions to the Reviews and approximately $5,000 more in advertising, for a net loss of about $44,000...88% of their deficit for the year.

Computing Reviews, as a six-issue-a-year publication, is extremely spotty in its coverage of articles, books, and conference proceedings. It also duplicates the job already being well done by Data Processing Digest and Automation Reports, and by a number of foreign publications. As such, it certainly seems the weakest part for most people of the benefits of a membership in the ACM. In any case, it does not appear to have sufficient merit to justify the $8 per year additional financial burden it is placing on ACM members.

We recommend, therefore, that

(1) the ACM drop the Computing Reviews as a compulsory association publication;
(2) the ACM tighten its belt on its other operations to the extent of about $6,500 per year, a small reduction of about 2%; and
(3) the ACM retain its $10 per year membership fee.

These steps should prove significant in allowing the ACM to continue to increase its role as a clearing house for information, activity, and education in the computer field, and in professional achievements in information processing.

DIEBOLD RESEARCHERS UNDERTAKE STUDY OF EDP DEVELOPMENTS

"Prediction is difficult, especially when dealing with the future"...Danish Proverb

Unchilled by Danish folk wisdom, John Diebold, president of the Diebold Group of management consulting firms, announced last month that he has mustered up a blue ribbon platoon of sponsors for an extended research study of the changes expected from automation and information technology in the next ten years.

As outlined by Diebold, his Research Program is conceived as a "troika" effort among firms which have considerable existing and potential use for computers, firms building computer systems, and the staff of the Diebold Group. The purpose is to study future developments in the information systems field in the areas of automatic data processing, scientific computation, management science techniques which use computers, digital data transmission, information storage and retrieval, and data display techniques for business. The initial two-year phase of the study is already in progress, the first quarterly meeting of the sponsors having been held in the last week of October.

The effort does not appear underfinanced... with a $16,000 participation fee from computer builders, and a $9,000 fee from the users. Diebold has already collected over $250,000 from the twenty-two existing sponsors, and the number of participants is still growing. The roster of user firms sponsoring the project includes DuPont, Standard Oil Co. (California), Xerox, IT&T, Equitable and John Hancock Life Insurance Companies, Richfield Oil, Southern Pacific Railroad, Field Enterprises, Dun & Bradstreet, and United Shoe Machinery Corp. The names of builders on board were not officially revealed,

The research techniques announced for the study include (1) a series of seminars and briefing sessions bringing together the key systems planning staffs in sponsoring companies with members of the Diebold Group, and invited leaders in advanced information technology; (2) field studies by Diebold researchers among computer builders, and computer users in government, universities, research organizations and appropriate military areas; and (3) an evaluation of information in existing Diebold research studies, which had previously been used to guide new product and service development for information systems builders, but which can now be made available to the users through the study. In particular, the study will examine current developments in military and space information systems, and use these activities as a basis for assessing future developments in the commercial field. According to Diebold, characteristics of military command-control and intelligence systems foreshadow those of commercial systems by a fairly constant lead time (three to five years).

Diebold expects to start a European section of the research program in January, 1964. Several European firms have already joined this second project, and joint meetings with U.S. sponsors are planned in 1964 in the U.S., and in 1965 in Europe. A summary report on the results of the first two years of the U.S.-based study will be issued to the public in 1965.

John Diebold started in 1954, working from a room in his home. In the decade since then, he has developed his organization into a multi-million dollar operation, maintaining six offices in the U.S. and eight overseas, and completing over 240 corporate, market, or product planning assignments for major firms around the world.

"DO-IT-YOURSELF" PROGRAMMING SYSTEMS

Bruce R. Hering
Bendix Corp.
Mishawaka, Indiana

When an organization reaches the decision to buy or lease a computer, it is generally assumed, with the exception of a few large computer labs, that the manufacturer will also supply the necessary software to utilize the computer. These smaller groups, by being thus dependent upon an outside source for their programming systems, are overlooking a possibility which may be much more profitable: they should consider writing their own software.

The feasibility of this approach is not dependent upon a large number of programmers; in fact, I am directing these remarks especially to small programming staffs with little or no systems programming experience. I must further clarify a "small staff" as one including about ten programmers. My arguments may be valid for as few as six; with fewer than six, this approach would probably be unfeasible.

Need for "Do-It-Yourself" Programming

In many cases there is a real need for this "do-it-yourself" systems programming. This need arises from inherent deficiencies in most software packages delivered by the manufacturers. I will now categorize these deficiencies and explain how they can be alleviated or eliminated by the "in-house" approach:

1. Inefficient Programs. I do not mean that the manufacturer employs incompetent programmers. The inefficiencies result because the manufacturer cannot possibly write a complete software package for each different hardware configuration in the field. He must write a fairly general programming system with a specific hardware configuration in mind. Since present-day computers are extremely modular, it is only natural that most installations will be unique as far as types of readers, size of memory, number of tape units, etc.; this means the user can either modify the main software package for use on his particular machine or beef up his hardware so he can use the main package.
   It is easy to see how a system written "in-house" can circumvent these problems because it is written for a specific application and a specific hardware configuration.

2. Difficult to Modify. Most installations recognize the inefficiencies just mentioned, and wish to change sections of the system that has been supplied to them. To alter a program with which one is unfamiliar is difficult at best. Then, if modifications are made, the user must assume full responsibility for the system. To be in a position to make intelligent system changes, the user must assign one or more programmers to the task of becoming familiar with the software. But when the system is written in-house, it can be maintained by the programmers who wrote it; this is obviously far more desirable.

Table 1

Computer Group Manpower Allocations for
29 Month Period (January 1961 – May 1963)

	Programmer	Systems Programming: Supervision	Simulator	Monitor	Compiler	Assembler	Systems Subtotal	Engineering Programming Subtotal	Total
Original Computer Group	A			2	5	18	25	4	29
	B			24			24	5	29
	C		9	6	5		20	3	23
	D	14-1/2		4			18-1/2	10-1/2	29
	E			2	15		17	5	22
	F			7	3		10	19	29
	G	8					8	8	16
	H							29	29
	I							29	29
	J*			12			(12)		(12)
	K							17	17
	L							14	14
	M				3			6	9
	N							6	6
	O							1	1
	TOTALS	22-1/2	9	57	31	18	125-1/2	156-1/2	282

*Manufacturer's applications representative. ( ) = not included in totals. Units are in Man-Months.

3. Late Arrival. When a user is depending on a software package that the manufacturer has not yet released, he had best be prepared for a delay. The odds are against on-time delivery of a workable system. This leaves the user almost helpless.
   If the system is written by the user, parts of the system can be used before the final version is ready. I realize that this does not insure that deadlines will be met, but the individual computer group *does* have control of the situation.

4. Poor Documentation. In all honesty, this criticism cannot be restricted to manufacturer's software groups. The problem is much more serious, however, when using programs written elsewhere. To clarify discrepancies and omissions in manuals there must be someone on hand who is familiar with the system. Costly delays can develop if it becomes necessary to communicate with the manufacturer. On the other hand, if the author of the program is available, a loose-leaf notebook containing coffee-stained flow charts and listings can prove quite adequate.

5. Lack of "Programmer Feedback." I sympathize with systems programmers who work in the sterile atmosphere of a manufacturer's software group. They must produce complete systems without having the opportunity of seeing their routines operate as a part of real application at a customer's site. Computer groups which write their own software can literally *build* a system, one routine at a time. In this atmosphere a programmer can observe his handiwork functioning as an integral part of the system. I believe that this type of programming is still enough of an art (rather than a science), so that it requires constant observation by the programmers to evolve a smooth, efficient operation.
   This "programmer feedback" advantage that is gained by a group that writes its own system is the most important of these five points.

A very desirable side effect occurs upon programmers who are involved in systems work. Out of necessity they must learn much more about the hardware and detailed information about the logical structure than would normally be expected of programmers.

Hesitations

There are two important reasons why a small group might hesitate to adopt this "do-it-yourself" attitude. They may feel that (1) the programming staff lacks systems experience and (2) the programming may require too much manpower.

Our Experience

I trace the experience of our installation over the past three years as an example to illustrate that systems experience is not critical and the programming time can be well worth the time. I do not outline a step-by-step procedure for building a programming system. The variety of applications among users make this impractical, if indeed not impossible. I point out decisions which shaped our system and the manpower required by specific system elements.

Our group is responsible for providing service to a moderately sized engineering department. Until November, 1961, we shared an IBM 650 with the Data Processing Department. The engineering computer group at that time consisted of nine programmers (including supervisor), eight of whom were engineers, one was a physicist; the average computer experience was two and one-half years per man. Almost all of this experience was in writing engineering programs for the IBM 650.

In May, 1960, due to increasing work loads in both Data Processing and Engineering, it was decided that more powerful equipment was necessary. It was also decided that the two groups would no longer share a common machine and that the Engineering Department would obtain a G-20 for its computer work. It was realized that the effort of a major part of the group would be necessary to effect a smooth transition from the 650 to the G-20; so plans were made to postpone the programming of all but the most urgent engineering problems. Over the next four or five months, due to repeated delays in software specifications, plus uncertainties with what hardware configuration we would arrive at, the decision was made to begin work on our own system. Actually, there were several different software decisions arrived at in the following order:

1. simulator
2. assembler
3. monitor
4. compiler.

At the outset of this programming effort, there was only one basic philosophy stressed: there would be no rigid specifications. Since the programmers were beginners in writing systems, instead of guessing what the final system should look like in all its splendor, they were to write a routine with a minimum of frills, check it out, and observe its operation for a short time. If they were dissatisfied, they could begin rewriting it or modifying it. Meanwhile, it was operational, even though it may have been very basic. To work in this atmosphere meant that each component must be modular. Subroutines were definitely IN. At first glance this may seem to be an extremely crude approach to developing a system, but the rapid feedback (a programmer observing his routine operating as a part of the system) was invaluable in the process evolving a smooth operation.

I shall now outline each major component and sketch its development.

Simulator

A brief survey of our existing 650 production programs was undertaken; it was determined that a simulator would be able to handle almost all previously written 650 programs. A generalized simulator for the 650 could have been a massive job, mainly due to simulating the wiring panels on the 650 input-output units. By writing our own simulator, huge savings were possible in this area since we had traditionally used only three card formats and one printer format in our 650 programs. Furthermore, there were some op-codes on the 650 which were never used, making it unnecessary to simulate them. It was operational when the machine (G-20) was accepted. Total man-months of effort: nine.

Assembler

We had very little desire to program in octal, so it was decided that an assembler should be written. Since plans were made to take checkout trips to other installations before our machine arrived, it would be necessary to have the ability to assemble G-20 instruction decks on the 650. Since the 650 was a decimal machine, and quite a bit smaller than the octal G-20, several concessions were made to speed up completion of this routine. They were:

1. only most necessary pseudo-ops (four or five) were included
2. strictly one-for-one
3. no decimal-octal conversion for data
4. no relocatable output decks.

Feature (3) was omitted because first programs did not include any engineering work; hence, very little need for conversion. Also, it was a two-pass assembler, using disc storage for pass I. The output was one word (binary) per card to allow for easier changes on checkout trips. This version was in use five months before the G-20 was installed. As soon as this job was completed, work was initiated on an assembler to run on the G-20. This was basically the same routine, except that the pass I output was on cards, which had to be reread into pass II. This version was operational two weeks after the G-20 was installed, but there were several objections. One of them was the large volume of cards and card handling necessary, which also reduced the assembly speed. This was quickly remedied by a 10-word per card binary format which, in two more weeks, gave way to a 22-word card. An octal-decimal converter for data was added, promptly followed by several additional pseudo-ops. These pseudo-ops were added at the demand of fellow programmers who were then using the assembler (this "programmer feedback" in some cases being about 10 microseconds). At present there are 18 pseudo-ops. When the magnetic tape units were installed, they were quickly utilized to store pass I.

The latest feature added was the ability to produce relocatable binary decks. Thus, by utilizing hardware additions and improvements, we progressed from an effective assembler rate of 50 cards per minute to 220 cards per minute. Both assemblers were written by a programmer with 20 months' experience; he spent 18 months writing and modifying them.

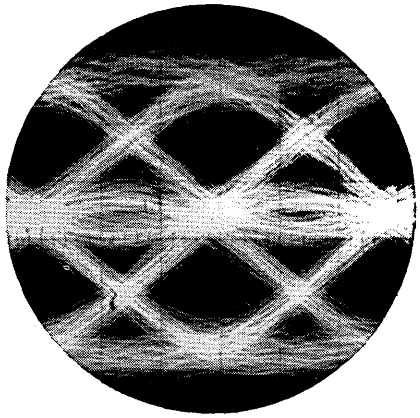
Monitor

The term monitor originally referred to control and input-output routines. Now it is defined as everything that is in memory at all times. The first monitor was in operation about five months before the machine was delivered. It was quite sketchy and provided for interrupt servicing and allowed a few service routines to be accessed from the console and return of control to the console. These routines were:

1. octal type-in and type-out
2. one-word-per-card binary read-and-punch
3. one-word-per-line printout.

About all this monitor accomplished was to give us a better understanding of the input-output tie-ins. With this knowledge, the monitor was rewritten and the new version was in operation when the machine was delivered. Of course, the read and punch routines had to be rewritten every time the basic binary card format was changed. This was bothersome enough to prompt a read image and punch image routine—at least these wouldn't have to be rewritten! There was another lesson quickly learned. After re-assembling the monitor, it was necessary to notify the rest of the programming staff where each service routine (read, punch, etc.) was now located. Thus, we reserved an area of "permanent locations" in the monitor area (I have learned since then they are called "transfer vectors" elsewhere).

Octal-decimal conversion routines, a decimal print routine, a very flexible, yet standard, data input routine and better diagnostics followed. The next major addition was the use of control cards. Any operation previously done from the console could now be accomplished by a specially punched card. This speeded up debugging runs dramatically and also allowed stacking of programs. Shortly after the tape drives were installed, a complete set of subroutines were in the monitor. Soon, all of our production programs were on tape and able to be called off by a control card. Since the initial machine arrived there have been five hardware changes (new printer, reader, tapes, punch, additional memory), each requiring monitor changes. Each routine was ready when the unit was installed, however. Then there was the "icing on the cake" —routines like "print date on each page," "type out problem number and amount of time used," "print page numbers," etc., which were added when time allowed. Several people had their fingers in the monitor pie. One pro-



grammer with two and one-half years' experience has been working full time developing and maintaining it. There have been 57 man months invested in the monitor.

Compiler

Management decreed that we would develop FORTRAN for the G-20 and 13 months hence it would be compatible with 7090 FORTRAN. After a short investigation of possible paths to take, a very important decision was made. There would be no intermediate language involved and the compiler would punch no cards. Avoidance of assembly language would increase the efficiency of the compiler and eliminate the messy task of making corrections in the assembly deck. Of course, part of this gain due to efficiency would be lost because of the necessity to recompile for each run, but it was felt that increasing the compiling speed and minimizing the card handling would make this approach worthwhile. As a result of this decision, people unfamiliar with assembly language could also use FORTRAN. To avoid as many recompilings as possible, it was decided that compiling should not stop on an error, but continue through the source deck.

Again, our "get it operational fast" attitude dictated that the first version would be incomplete. It used our standard monitor I/O routines (no format statement), had no subroutine capabilities, and allowed no subscripting. This version was in operation in seven months.

Fortran

Another decree was made that the entire engineering department should be instructed in the use of FORTRAN and be encouraged to use it. So, a basic course was taught (five days, one and one-half hours per day) and we began operating an open shop. Subsequently, an advanced FORTRAN course was taught, but it was soon discontinued. It seemed that the engineers interested in the intricacies of FORTRAN learned for themselves, and those not interested refused to learn by any method! Six months after the initial version ran, the final version was operable. It met the 7090 specifications and contained some extras also. By using tape storage while compiling, it was possible to compile programs as large as the memory could hold. A "PLOT" statement which would give an automatically scaled plot on the printer was included. Both FORTRAN and machine language subroutines could be called from tape by a FORTRAN program or subroutine.

Much to the surprise of the computer group, this open shop operation proved successful. The fact that a person with *no* knowledge of the computer could write and debug a FORTRAN program was considered to be the main reason for this success.

Diagnostics

While all the components of the system contain debugging aids, they have much in common. For instance, most of the routines would originally, upon detecting an error, print out "Error No. XX." A programmer would then have to refer to his error sheet to interpret this number. It was decided that, although it was much easier on memory storage, it was very unsatisfactory so far as programmer efficiency in checking out a program. All routines now print out explicit error messages. There is a trace for assembly and machine language programs that operates at printer speed and prints each instruction (alphabetic op code), index (if used), contents of index and the accumulator, both in octal and decimal. On either a monitor or a program-detected error, the type of error will be printed, followed by the location where the error occurred. Then the memory will be searched for a symbol table; if one is found (this implies a FORTRAN program), each variable name and its current value will be printed out; otherwise the index registers and the memory will be printed. Since, for each statement compiled, FORTRAN will print out the first location used in that statement, even a person unfamiliar with machine or assembly language can pinpoint an error such as an overflow.

Operation

For the first few months, an operator was available to run production programs, but most of the time was consumed by individual programmers who would sign up and then be given the machine. This was very undesirable and was our main motivation for instrumenting control cards. We saw that in order to achieve efficient operation, we must keep people off the console. Even the operator typing in READ (to initiate a run) was wasteful; we shortened it to "R." When FORTRAN came of age, it became necessary to streamline our system even more. Programmers were forced to estimate the amount of time their program would take. If it took longer, an internal timer automatically booted it off the machine. We did not want to discourage new FORTRAN users, so we initiated an express service for three minute (or less) runs. By doing so, we were able to achieve a "turn-around" time of about one hour. But now the people with long runs were being discriminated against. The best we could do for these users was to give one-day service. We achieved this by instrumenting NIGHTRANE. By taking our backlog near the end of the working day and loading the cards (image wise) onto short tape blocks, then instructing the monitor to read tape instead of cards, we could (making sure there was plenty of paper in the printer) all go home, and the G-20 would process automatically. It has, in several cases, run for eight or nine hours unattended.

Table 1 shows the manpower requirements necessary to build this system and the time spent by each programmer on different phases of the system is detailed. Although these figures show that during this period 44.5 per cent of the programming effort was spent on systems, this does not reflect the large amount of programming time spent outside the group due to "open shop" FORTRAN. For instance, two months ago, a total of 2359 runs were made on the G-20, while only about 600 of these were made by members of the computer group. Including the supervisor, there were nine programmers in the group in January, 1961. During the period under consideration there were never fewer than nine nor more than the present total of 11.

Conclusion

In conclusion, it is not only feasible for a small group to program its own system, but can be quite successful. In this type of environment, a system programmer has three advantages over those working in a software factory:

1. He is programming for a specific application.
2. He can observe his routines being used in the system.
3. He has a high efficiency.

The third item bears explanation. We have found that the following equation is valid when jobs require more than one programmer: $E = K/N$ where:

$E =$ efficiency of i th programmer on large job

$K =$ individual efficiency of i th programmer

$N =$ number of programmers working on same job

It is impossible to make an accurate cost analysis of in-house systems programming as compared to using the manufacturer's software. I feel, however, that there are many organizations who would, like ourselves, find that there is little financial sacrifice necessary, if any, in order to build such a system.

The next time a new machine enters your domain, give serious thought to "do-it-yourself" programming!

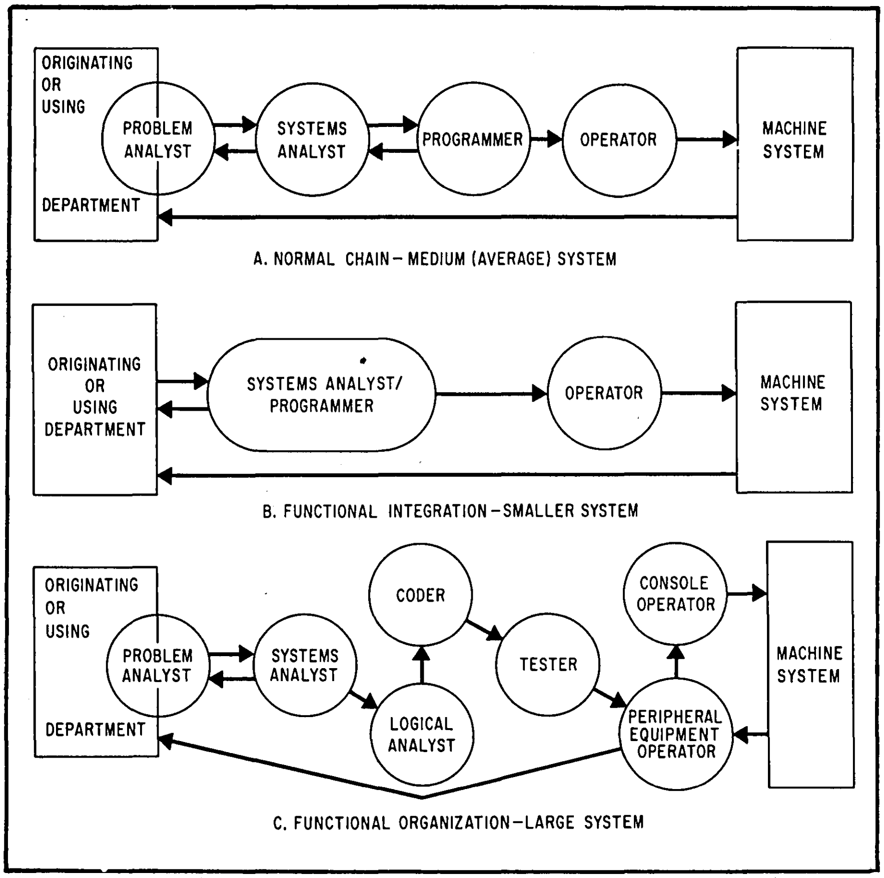


Figure 1 — Typical Functional Flow

SYSTEMS ANALYSIS STANDARDS

This article is the second in a series on the subject of user standards for automatic data processing. Dick H. Brandon is Director of Data Processing Services of The Diebold Group, Inc.; a part of these articles is reprinted with permission from *Management Standards for Data Processing* by Dick H. Brandon, published by D. Van Nostrand Co., Princeton, N. J., 1963.

Systems analysis represents a major link in the chain of translation from the problem to its machine-assisted solution. Because methods standardization is necessary in this task of translation, it follows that there is a major potential for standardization in the systems analysis function. Perhaps more than any other function, however, systems analysis relies on creativity, rather than rote analysis, to develop effective computing systems. This creativity must be channeled and documented effectively if lasting value is to be obtained from the systems analysis effort.

"Man-machine communication" is the phrase that can be used to describe the process required to translate a problem into a form suitable for machine-assisted solution. Systems analysis and programming tasks may be done by one person, as in the case of the engineer who writes his own FORTRAN program, creates input data, and evaluates the output. More commonly, however, these tasks are divided among several people: one formulates the problem; another does the coding; and still another evaluates the output.

The tasks making up the systems analysis function may be defined in the following manner:

- Problem analysis—consists of defining the problem and of determining exactly what is required to arrive at a solution.
- Systems analysis—defines broad outlines for machine-assisted solution. Problem specifications serve as a link between the problem analyst and the programmer.
- Programming—the defined machine solution is translated into machine language.
- Operation—output is created from the inputs provided. (See Figure 1.)

In many instances, the systems analyst will produce an analysis of the problem as well as the systems design. For purposes of illustration, we are dividing problem analysis and systems analysis into two specific tasks each performed by an analyst.

The following functions will normally be performed by the problem analyst:

- Definition of system objectives
- Design of required outputs; what fields should appear on each document and with what frequency should each document be produced
- Design of inputs
- Isolation of exception conditions and definition of processing methods
- Determination of formulas and factors presently used
- Indication of types of controls needed in processing
- Service as liaison between data processing and involved departments
- Approval of job specifications when they are drafted
- Supplier of test data for over-all systems testing

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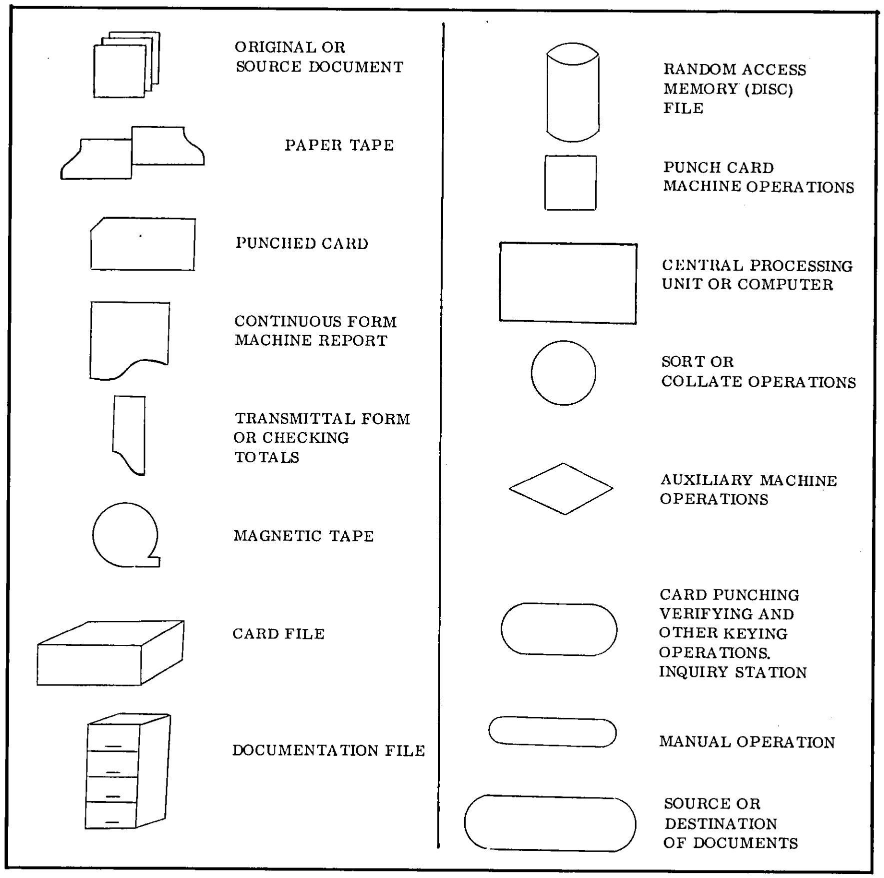

Figure 2 — One Set of Conventions for System Flow Charting

The following functions would normally be performed by the systems analyst:

- Development of the "job specification" manual
- Design of input layouts for machine processing
- Design of output layouts in machine format
- Design of record layouts
- Design of over-all information flow through the system
- Development of specifications for each of the programs making up the run of the system, including: timing analysis; program descriptions; input-output flow chart; statement of program functions; description of program features; formulas and factors to be used; description of program controls.
- Preparation of program test data

The same general functions will be found in most data processing problems. Variations may occur in engineering and scientific problem-solving, but the basic concepts remain the same. In an engineering problem, for instance, the engineer will frequently do problem analysis and systems analysis because problem complexity usually requires a knowledge of the application and its most effective mathematical solution. The engineer may do the programming as well. This is possible since he need not be an expert in using the machine. Software is provided by manufacturers specifically for this contingency. FORTRAN, a statement-level language, is probably being used by more non-data processing personnel than data processing personnel.

Standards

Several aspects of the systems analysis function must be standardized if performance is to be measurable and predictable:

- Definition of terms—a glossary of terms and abbreviations must be developed.
- Layouts—card, report, tape, and disk record design methods must be standardized.
- Procedure and document analyses—review of input and output documents.
- Problem definition—the problem and its requirements are defined.
- Control coding—assignment of meaningful designators to systems, programs, reports, and files.
- Flow-charting—a pictorial system representation.
- Job specification manual—final, documented output of the systems analysis function.

Definition of Terms

Most terms used in data processing have more than one meaning. The term label, for instance, means one thing to an operator and another to the programmer. To the operator, it is the pressure-sensitive identifier attached to the tape reel. To the programmer, it is an identifier for an instruction or a routine or the header indentification on a magnetic tape.

It is important to establish a glossary of terms for use by all members of the data processing staff. This glossary should consist of four parts:

1. Glossary of data processing terms.
2. Glossary of standard abbreviations.
3. Glossary of industry terms—terms peculiar to the industry or company in which the system is to be used.
4. Specification of terms—general rules which apply to the computer; its objectives and its use.

Several glossaries of data processing terms are available. Many government agencies have compiled glossaries of data processing terms, and most computer manufacturers distribute glossaries. The X3. 5 committee of the American Standards Association plans to promulgate a comprehensive glossary in February of 1964. Until a standard glossary is available, each installation must develop a glossary of its own or adopt one of the many available as a standard for all of its staff members.

Standardization of terminology is but one of the many areas within the systems analysis function that lends itself to standardization.

Layout Standards

One of the responsibilities of the systems analyst is to develop layouts of input and output records. This includes layouts for:

- Card input and output records
- Printer output
- Tape input and output records
- Memory layouts when tables are used

Standards for these layouts should include a specification of the level of detail required. In developing layouts, standard forms should be used. It makes little difference whether the forms are provided by the manufacturer or whether they are contrived by someone at the installation, so long as they provide the necessary information and are used by everyone doing analysis work.

Card layout forms should be completed for each card format used in the program. The layout should include:

- Application name
- Program name and number
- Anticipated card volume
- For each data field, data source, data size and type of data (alpha, numeric, or alphanumeric)

Printer layout forms should be completed for each output document required. A standard layout form should be used. The layout should include headings, sample data lines, total lines if needed, and should indicate the type and size of data fields.

The layout of tape records is more complex, since tape records can be variable in length. Also, since tape is an ancillary data storage, data tapes are frequently used in more than one program and possibly in more than one application. Standards should include specification of the layout form to be used and what the record should include, such as:

- System name
- Tape record name
- List of programs in which the data is used
- Field layouts, including field name, field length, data type, and other pertinent data

The systems analyst will specify memory layouts when he has designated use of tables which will be stored in core memory. Ordinarily, the programmer is responsible for providing a memory layout as a part of the program documentation*. Standard forms should be used for memory layouts and the form type should be specified in the manual of standards. Memory layouts should also be prepared for peripheral devices such as disk or drum when they are used.

Numbering Systems

A standardized numbering scheme should be devised for the control systems, programs, forms, tapes and data files. The use of an arbitrary number system is discouraged. It is easier to develop a standard, logical system that will be understandable to all. The number should reflect:

- The application
- The program
- Frequency of operation

Flow-Charting

For desired flow chart uniformity, the analyst must be given standards defining the kinds of flow charts to be prepared, format to be used, method of preparation, and symbology to be employed. Flow-charting symbols are different from those used in preparing block diagrams which illustrate specific machine processing steps. A clear distinction should be made between the two.

In most cases, two levels of flow charts should be prepared: a macro-flow chart to illustrate the total flow of information through the computer system and a micro-flow chart describing each program comprising the system.

Standards should describe in detail each step of preparing the flow charts, including what template is to be used and what flow-charting form is to be used. (See Figure 2.)

Problem Definition

There have been many attempts to define a discipline for systems analysis. Among the most widely used are:

- Abstract notation system*
- Decision tables
- Document analysis
- Job specification manual

Document analysis and the job specification manual are discussed below.

Document Analysis

One of the more complex functions of systems analysis is the review and evaluation of existing documents and existing procedures. Before an appropriate system can be designed, an examination must be made of existing systems and procedures. A standard methodology and standard procedures for this task should be defined so that analysis performance can be measured and scheduled.

It is necessary to analyze each of the documents used to determine whether:

- The document is really necessary
- Information is not already available in another form
- The proposed system may eliminate the transfer of this information
- The document may be simplified, combined, made smaller or distributed less frequently, to reduce costs

The Job Specification Manual

One basic output of systems analysis is a complete description of tasks to be performed, with record layouts and flow charts: the job specification manual. Standards for preparation and use of the job specification manual overcome communications difficulties among users, analysts and programmers.

The job specification manual may include:

- Scope of the system
- General description of the existing system
- Output of the existing systems
- General description of the new systems
- Flow chart of the new system

* Documentation standards will be discussed in Part IV of this series, to be published in February, 1964.

* John Young and Henry Kent—American Institute of Industrial Engineers—"Abstract Formulation of Data Processing Problems," *Journal of Industrial Engineering*, November-December, 1958.

- Output layouts
- Output distribution
- Input layouts
- Input responsibility
- Macro-logic
- Files to be maintained
- List of programs

The programmer will use the manual to block out program logic and to develop the system. Steps involved in systems analysis must produce documentation adequate to allow the programmer to produce the desired system.

To insure that each step in system analysis is accomplished completely and that the documentation prepared is comprehensive, standards must be developed and rules established for each task.

Conclusion

Substantial economies may be realized from the use of standard methods for data processing functions. Standardization of methodology in one functional area is not sufficient, however; systems analysis standards need to be followed by standards for programming and operation. These standards as they are developed should be written down and distributed to all data processing personnel in the form of a Manual of Standards. The Manual of Standards becomes a reference book on established methods for the resolution of disagreements concerning established standards and the guidance of all concerned with the data processing function. Standards nearly always enforce themselves because of their utility, and in time the Manual of Standards will become more important to an installation's operations than the manufacturer's programming and operations manuals.

CALENDAR OF COMING EVENTS

Jan. 7-9, 1964: 10th National Symposium on Reliability & Quality Control, Statler Hilton Hotel, Washington, D. C.; contact B. W. Marguglio, Fairchild Stratos Corp., Hagerstown, Md.

Jan. 30-31, 1964: Annual Computer Applications Symposium, LaSalle Hotel, Chicago, Ill.; contact Milton M Gutterman, IIT Research Inst., 10 W. 35th St., Chicago, Ill. 60616.

Feb. 3-7, 1964: ASTM International Conference on Materials, Sheraton Hotel, Philadelphia, Pa.; contact H. H. Hamilton, American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa.

Feb. 5-7, 1964: 5th Winter Conv. on Military Electronics (MILECON), Ambassador Hotel, Los Angeles, Calif.; contact IEEE L. A. Office, 3600 Wilshire Blvd., Los Angeles, Calif.

Feb. 10-14, 1964: 6th Institute on Information Storage and Retrieval, The American University, 1901 F St., N.W., Washington 6, D. C.; contact Marvin M. Wofsey, Asst. Director, Center for Technology and Administration, The American University, Washington 6 D. C.

Feb. 19-21, 1964: International Solid-State Circuits Conference, Sheraton Hotel & Univ. of Pennsylvania, Philadelphia, Pa.; contact Howard Parks, Martin Co., R & AT Dept., Mail 683, Baltimore 3, Md.

Feb. 26-28, 1964: Scintillation and Semiconductor Counter Symposium, Shoreham Hotel, Washington, D. C.; contact Dr. George A. Morton, RCA Labs., Princeton, N. J.

Mar. 23-26, 1964: IRE International Convention, Coliseum and New York Hilton Hotel, New York, N. Y.; contact E. K. Gannett, IRE Hdqs., 1 E. 79 St., New York 21, N. Y.

April 7, 1964: Control Data 160 and 160-A Users Group (SWAP) Meeting, Hilton Hotel, Albuquerque, N. M.; contact J. L. Tischhauser, Organization 7242, Sandia Corp., P. O. Box 5800, Albuquerque, N. M.

April 8-10, 1964: Control Data Large Scale Computer Users Group (CO-OP) Meeting, Hilton Hotel, Albuquerque, N. M.; contact J. L. Tischhauser, Organization 7242, Sandia Corp., P. O. Box 5800, Albuquerque, N. M.

April 13-15, 1964: 3rd Symposium on Micro-Electronics, Chase-Park Plaza Hotel, St. Louis, Mo.; contact H. H. Margulies, P. O. Box 4104, St. Louis, Mo. 63136.

Apr. 20-24, 1964: Institute on Research Administration, The American University, 1901 F St., N.W., Washington 6, D. C.; contact Marvin M. Wofsey, Asst. Director, Center for Technology and Administration, The American University, Washington 6, D. C.

Apr. 21-23, 1964: 1964 Spring Joint Computer Conference, Sheraton-Park Hotel, Washington, D. C.; contact Zeke Seligsohn, Pub. Rel. Chairman, 1964 SJCC, 326 E. Montgomery Ave., Rockville, Md.

Apr. 22-24, 1964: SWIRECO (SW IRE Conf. and Elec. Show), Dallas Memorial Auditorium, Dallas, Tex.

May 5-6, 1964: 5th National Symposium on Human Factors in Electronics, San Diego, Calif.; contact Wesley Woodson, Convair Astron. Div., San Diego, Calif.

May 11-13, 1964: NAECON (National Aerospace Electronics Conference), Biltmore Hotel, Dayton, Ohio; contact IEEE Dayton Office, 1414 E. 3rd St., Dayton, Ohio.

May 12-14, 1964: Annual General Meeting of POOL (Users of General Precision Computers), Palmer House, Chicago, Ill.; contact Dr. Roebert L. Stearman, C-E-I-R, Inc., 9171 Wilshire Blvd., Beverly Hills, Calif., or Al Erickson, General Precision, Inc., 808 Western Ave., Glendale, Calif.

May 25-27, 1964: 10th National ISA Aero-Space Instrumentation Symposium, Biltmore Hotel, New York, N. Y.; contact J. K. Stotz, Jr., Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.

June 26-28, 1964: Fifth Joint Automatic Control Conference, Stanford University, Stanford, Calif.; contact Gene F. Franklin, Chairman 1964 JACC, Stanford Electronics Laboratories, Stanford, Calif.

Aug. 25-28, 1964: WESCON Show and IEEE Summer General Meeting, Los Angeles, Calif.; contact WESCON, 3600 Wilshire Blvd., Los Angeles, Calif.

Sept. 14-16, 1964: 8th National Convention on Military Electronics (MILECON), Washington-Hilton Hotel, Washington, D. C.

Sept. 23-25, 1964: 1st International Congress on Inst. in Aerospace Simul. Facilities, Paris, France.

Oct. 4-9, 1964: National Symposium on Space Electronics, Dunes Hotel, Las Vegas, Nev.; contact Charles H. Doersam, Jr., Grumman Aircraft, Eng. Corp., Elec. Bldg. #5, Bethpage, N. Y.

CONSIDERATIONS IN COMPUTER DESIGN —Leading up to a Computer Performing over 3,000,000 Instructions a Second (Part 2)

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Chippewa Falls, Wisc.

(Continued from the November issue of **Computers and Automation**, page 61)

The advantages to be had must, of course, outweigh the loss of quick design and quick change. The idea of parallel functional performance appeared early to be a design problem. But comparing it to the more basic trend of design, the problem of inflexible design technique is already here. Machine speed per dollar is still the principal competitive issue in selling computers. Any and all schemes for improving speed will be tried. The fact that they cause dislocations in the designing and manufacturing is merely a sign of the passing of time.

ON TIME

Aside from the weather, time is the subject of more casual discussion than most. In respect to the weather, time may be considered the opposite, in that its passage is highly predictable. In another way, time is very much like the weather. Both have a kind of fundamental rhythm or motion. We are familiar with the inexorable motion of time when we want to slow it; we know its tortuous passage when we want to speed it; we know the gradual acceleration of time as we grow older. In spite of our subjective notion of time, we live by it, watch it, cook by it, and measure by it. It is a distinctive element in almost every modern measurement or analysis, whether physical, chemical, statistical, or whatever.

What is it?

It is difficult to describe time. It is certainly one of the dimensions of the physical universe; but it is that unusual dimension with only one direction: positive. Its measurement has progressed from the hourglass, water clock, pendulum and crystal to the "atomic clock." Man's attempts to give a standard accounting of time have encountered such devious problems as the beginning hour of the day, the duration of a year, and daylight saving time, among hundreds of others.

The principal objectives in accounting accurately for the passage of time are to measure *what is done* in an elapsed period of time and to *synchronize* one activity with another concurrent activity. The range of measurement is considerable. Biological, mechanical, atomic, atmospheric, and astronomical events operate in grossly different scales of time. It is of interest to examine the relationship of the duration of real events of a scientific nature with the corresponding length of time to solve a mathematical model of the event. Scientific computers were conceived for this work; and for the scientist, the computation time is of critical importance. For him, it constrains the depth and complexity of his model . . . along with the strain on his patience.

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- Commonwealth Bureau of Census & Statistics, Canberra, Australia
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discussing the two most discussed subjects in the world, time and the weather.) Could such a model be solved as fast as the weather? I know very little about meteorological problems, but I would expect that the thermodynamic and hydrodynamic computation on a world-wide scale is enormous. It would be a very happy circumstance if the mathematical model could be reduced to a workable size for machine solution, and still be effective.

Computing to date has been almost exclusively slower than real time, with notable exceptions in some military cases. These cases demand shortened sights and perhaps qualify only marginally as scientific. This little drawback hasn't restrained the burgeoning computer industry one little bit. The fact is that only occasionally, in the past, has there been a real demand for such speed. Many problems which appeared amenable to solution merely required a single result, once and for all time. Others were sufficiently beyond hand-solution as to welcome the machine's help. These kinds of problems point out or corroborate a new direction, a decision, a solution; or perhaps they fill a gap in the store of knowledge, to become useful later.

Computers made possible the attack on problems which were never attempted before (no one lost his job to the machine). This unusual circumstance is bound up in time relationships. The machine was built to operate without error for a certain period of time (usually as good as the designer could do). The computation, or some major part of it, had to be possible in less than that errorless period. In order for the first computer to be successful, its speed had to be very high or its health very good! There was some threshold of speed and reliability under which the computer industry conceivably might *not* have been launched. This time relationship was enough to make computing machines practical.

The question of which problems were practical involves another time-speed relationship. Not *all* problems were now practical; only those which could be completed in the life of the machine, the duration of funds, the patience of the user, and so on. This really means that brand-new problems are available *each* time a faster computer is made, not just the first time. It isn't at all difficult to see that the impetus to make machines faster arises from these new problems along with the speedier solution of already-practical problems. We have been discovering a surprising backlog of new problems. The continued—in fact, accelerating—demand for more speed means that more efficiency is needed in the basic machine operations as well as in the use of the machine.

It should be obvious that any treatment of the methods employed in a computing machine must include a substantial discussion of time. It is the single outstanding obstacle met by the designer at every turn. In the following pages, I hope to tread a forward path in the attempt to overcome the time obstacle. Remember that time has a way of fighting back!

We're running out

Modern computer circuits employ high-speed switches for the complex decision networks. These switches require a finite time to change from one state to the other. This time period is an intricate balance of the electrical demands and constraints of the immediate surrounding network. Many careers are devoted to optimum combinations of materials, geometries, packaging, and processing of these switches to give the maximum speed with respect to a set of operating specifications. Many careers are devoted to finding the optimum adjustment of operating specifications to take advantage of the best available switch. Needless to say, the degree of perfection in this optimization is among the highest known in any field. Designers of the newest computers are able to depend on extremely fast and reliable components. It is no longer possible to foresee a factor of five or ten times speed improvement in the components now in use, or like them. A factor of five or so was a working requirement for beginning a new computer not long ago. This factor came exclusively from the basic circuit. Claims made for many new computers tend to skirt this issue and concentrate on other time considerations (for example, lumping all of the man-and-machine times together). This is certainly understandable and entirely valid. BUT, the issue really can't be skirted, if we wish to move the computing machine up to real time or other comparable uses.

Set your watch

I mentioned earlier the synchronism of concurrent operations. This is, in some quarters, the signal for an immediate argument. It *seems* self-evident that two mechanisms working in unison must be synchronized if they are to work together. Actually this is entirely true; the argument is over a more subtle complication of the mechanism timing. If two mechanisms are to operate concurrently on two suitable portions of a computation providing answers to a third mechanism, the third cannot proceed until both answers are there. This is, in itself, a definition of synchronism. The two concurrent mechanisms may be constructed in a way which insures their simultaneous completion; or they may be constructed with no thought of the completion. In either case, it can be demonstrated that some time waste occurs. The very early computers were designed with a "tight" timing system. That is, every step of the computation (in fact, every simple decision or command) was activated by a central clock. The principal reason was that these early machines used many simple steps in a small amount of simple circuits to make up a major operation. As the economy allowed for more complex circuits, the very tight timing has given way.

Waste of time in a tight timing system is apparent in every step, since the logical decision made must be accompanied by a temporary storage. The storage allows for the circuit tolerances and resynchronizes any concurrent events. However, the circuit tolerances (with regard to time) are not allowed to accumulate beyond the single time period. The circuit tolerances have an upper and lower limit. If these tolerances are allowed to accumulate over a long series of steps, the earliest or latest time for the answer would vary considerably. Eventually, this spread of time makes for time waste, especially with devices which have a minimum and maximum *rate* of operation. Notwithstanding the tolerance problem, the unclocked methods offer some advantages.

The synchronism problem is, most assuredly, an engineering problem rather than any other. The methods which I have mentioned are entirely valid. That method which produces the most effective result should be chosen. Matters of electrons, voltage, heat, and time have considerable bearing on that choice. The result must be a clock system of dependable tolerances and yet highly effective. In this case, a choice of synchronism in-the-large seems most effective. Computer history can record a long period of comparison by clock frequency. That day is gone. No longer is the basic clock a reliable measure of the performance. The simple reason is that there either isn't any clock at all or that synchronism has moved to a higher level. It is sufficient to say here that the move was fruitful.

Other internal time considerations are also important. The most common one mentioned is the memory access time. This is defined as the time taken to fetch a word from memory. It is normally measured from the instant the address is formulated until the fetched word is available for computation. This is usually about half the total storage time in destructive memories. With one memory, a three-address instruction would require three storage times plus compute time. With two memories having the ability to overlap the second access with the first restore, the above case could be one and a half storage times (three access times) plus compute time. The smaller the ratio of access time to storage time, the better this overlap system looks. Note, however, that the overlap doesn't work for addresses to the same bank of memory.

An extension of the overlapping memories might simply add enough memory banks to reduce the probability of referencing the same bank. To this can be added schemes for overlapping more than the access periods and schemes for reducing addressing bottlenecks. These are certainly important and represent significant speed improvement. However, memory time is typically an integral sequential element in *every* instruction, and as such cannot be reduced to zero. That is, it can't unless memory acquisition is separated from the instruction. To accomplish this, a set of high-speed registers may be included in the computer to serve as buffer between memory and arithmetic. These registers must refill concurrently with computing and must empty to memory also concurrently with computing.

A concurrent structure such as described above places the memory in a secondary role of refill and empty. Time for this secondary role is a vague complication of memory bank overlaps, conflicts, priorities, and so on. It defies generalizing in the time domain. It, nonetheless, makes for a faster computer and points the way to even more speed. It is most important to note here that this speed increase is entirely aside from circuit or component speeds.

By now, the reader will be aware (and tired of hearing it) that concurrency is the magic way around the time obstacle. The technique need not be limited to concurrent memories. Arithmetic units may be arranged to take advantage of this technique. In fact, it is within reason to consider independent and concurrent processors as an example of the principle.

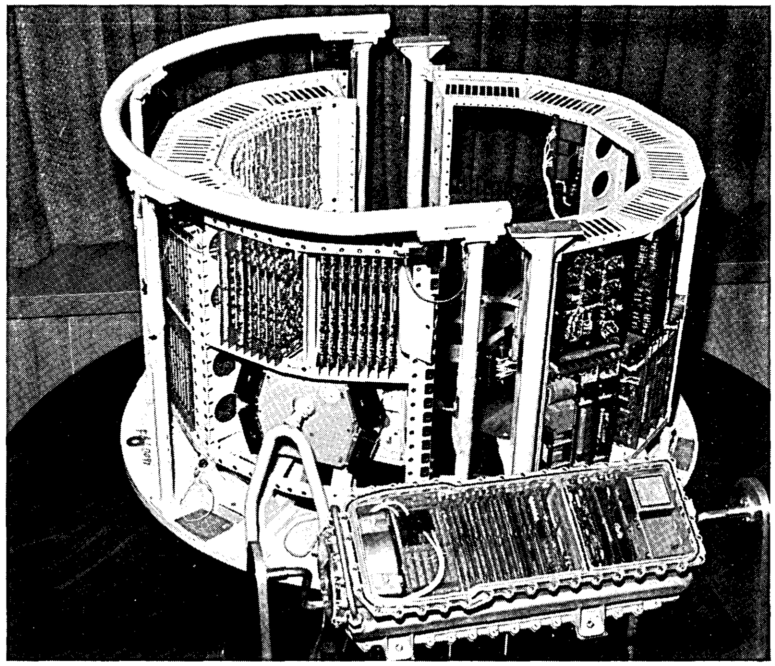
(To be Continued in the Next Issue)

Annual Pictorial Report

DIGITAL COMPUTERS

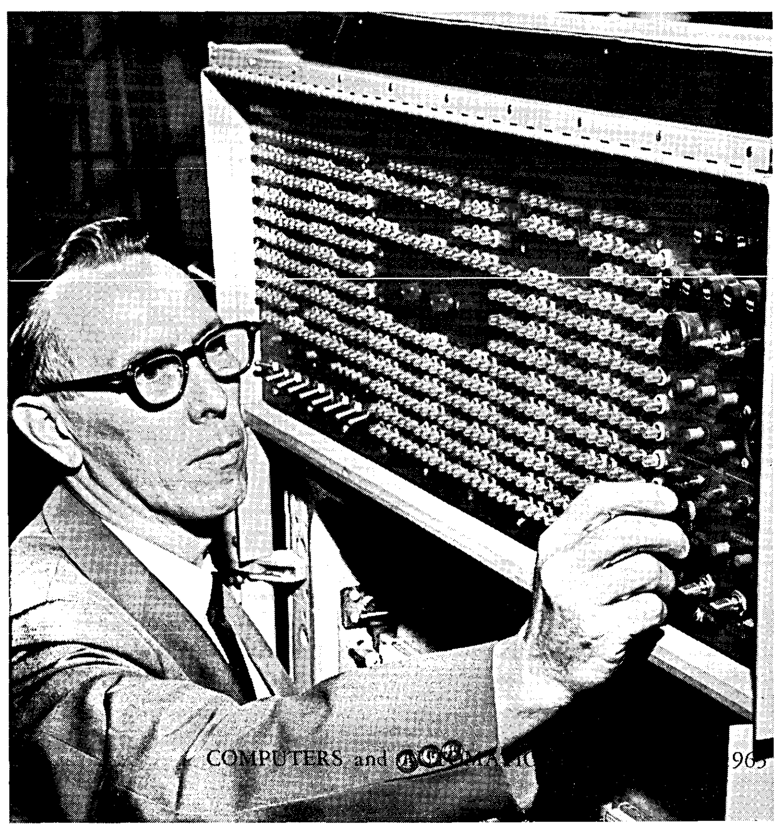
MINUTEMAN D37B MICROELECTRONIC COMPUTER
Autonetics
Anaheim, Calif.

The Minuteman D37B microelectronic computer is shown in front of the Minuteman D17 computer it replaces. The computer is used in the WS-133B Improved Minuteman guidance and flight control system. The D37B is a general-purpose, digital data processor which uses a dual-sided magnetic disk for internal memory storage. Extensive use is made of integrated circuits plus microminiaturized discrete components. In addition to being smaller, lighter and more reliable than the D17 it is replacing, the D37B also has a larger memory capacity -- 6966 words of 24 bits.
(For more information, circle 80 on the Readers Service Card.)



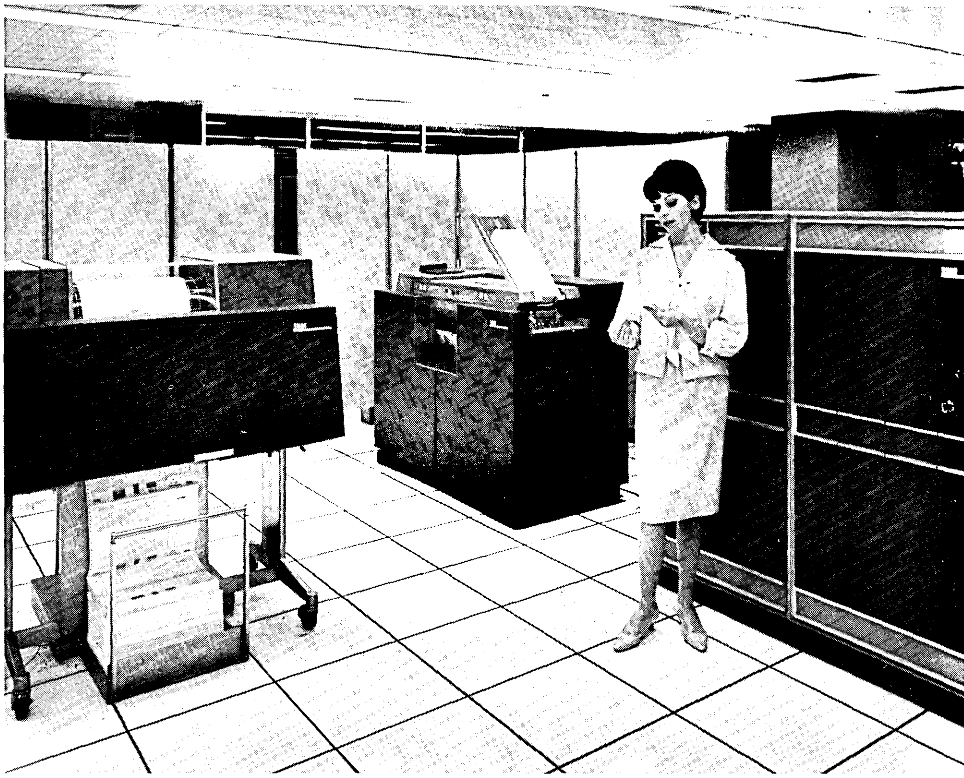
UNIVAC CP-642B
Univac
Division of the Sperry Rand Corporation
Washington 7, D.C.

The UNIVAC CP-642B is a large-scale general-purpose military computer with a magnetic thin-film memory which permits the computer to repeat a set of operations in 667 nanoseconds (billionths of a second). The computer has three memory sections: (1) the main core storage has a cycle time of 4 microseconds and a capacity of 32,672 words of 30-bits each; (2) the thin-film control memory of 64 words; and (3) the UNIFLUXOR® non-destructive readout memory for automatic program recovery. The CP-642B computer has 16 input and output channels and a self-contained real-time clock. The maintenance and control panel is shown in the picture.
(For more information, circle 82 on the Readers Service Card.)



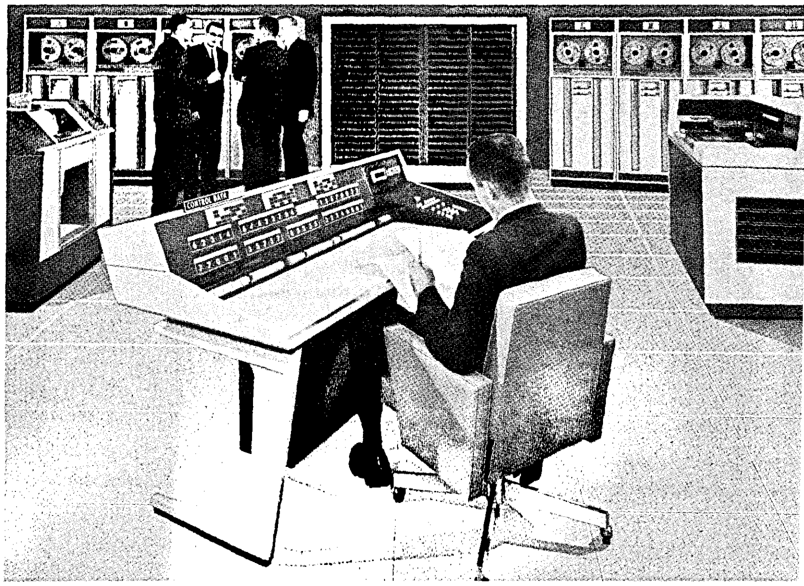
IBM 1401-G
IBM Corporation
Data Processing Division
White Plains, N.Y.

The IBM 1401-G computer, a low-cost version of the 1401, is engineered especially to process information from punched cards. The 1401-G system (left to right in the picture) consists of an IBM 1403 printer, IBM 1402 card-read punch and the 1401-G central processing unit. Cards may be read at up to 450 a minute and punched at up to 250 a minute. The printer operates at 450 lines a minute and is available in a 100 or 132 print position unit. It is available with 1400, 2000 or 4000 characters of core storage. Memory cycle is 11.5 microseconds. Unlike other 1401 computers, the "G" cannot use magnetic tape drives or disk file storage.
(For more information, circle 89 on the Readers Service Card.)



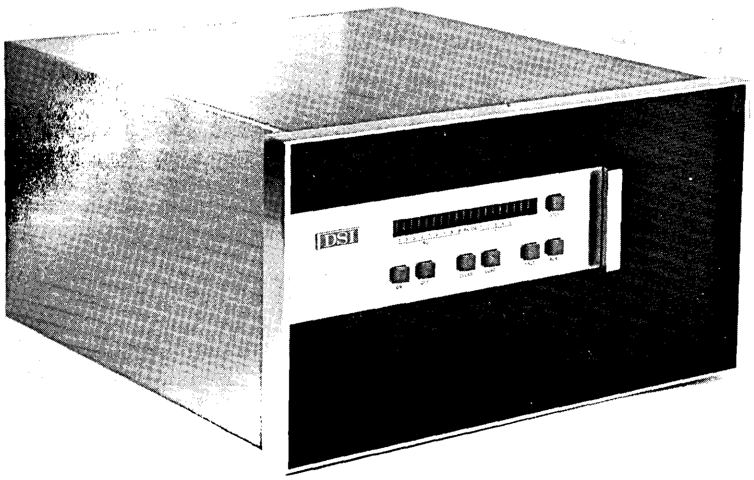
CONTROL DATA 3200
Control Data Corp.
Minneapolis, Minn.

The CONTROL DATA 3200 is a low cost, high-speed computer system designed to handle scientific, real-time, and data processing tasks with equal facility. The computer features a 1.25 microsecond cycle time for basic operation, with an overlapped storage module construction, with asynchronous operation, to increase the effective working cycle time. A high-speed register file of 64 words with a .5 microsecond access time is another feature. Software includes FORTRAN 32, and COMPACT COBOL.
(For more information, circle 81 on the Reader Service Card.)



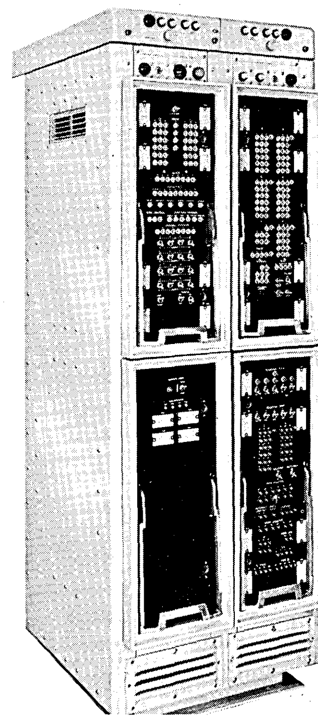
DSI 1000 COMPUTER
Data Systems Incorporated
Grosse Pointe Woods, Mich.

The DSI 1000 computer is a real-time, general-purpose digital computer which may serve as a separate unit or as an integral part of a computer system. It is a binary, single address stored program computer; memory cycle time is 3.2 microseconds; there are 2048 12-bit words with an average random access time of 100 microseconds. It measures only 10 1/2" x 19" x 19 1/4".
(For more information, circle 85 on the Readers Service Card.)



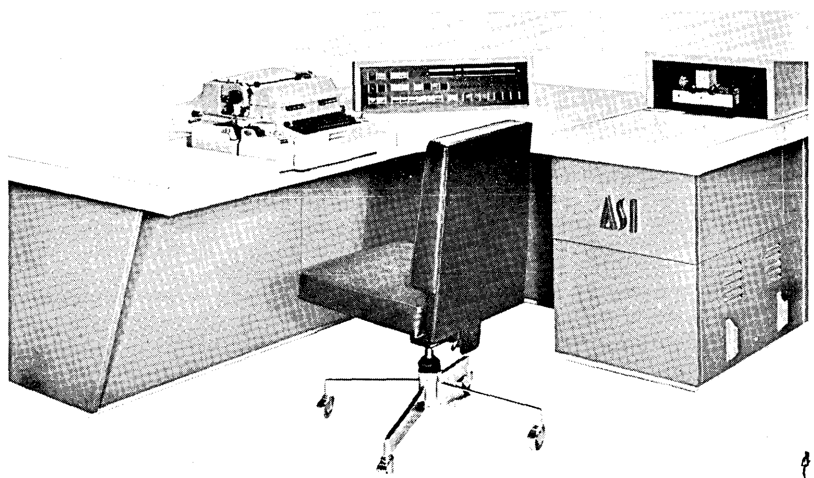
UNIVAC 1218 MILITARY COMPUTER
UNIVAC Div. of Sperry Rand Corporation
New York 10, N.Y.

The UNIVAC 1218 Military Computer is a stored-program, medium-scale, general-purpose digital computer. It has an 18-bit-word ferrite-core memory, a 4-microsecond cycle time, and a memory capacity of 4000 to 16,000 words. The basic 4096-word memory is expanded by simply adding memory modules; electronic or mechanical modifications are not required. The 1218 has eight input and eight output channels. Arithmetic and input/output operations may be performed on single-length 18-bit words or on double-length 36-bit words. The channels may be linked in pair to provide 36-bit parallel input or output. A repertoire of 98 instructions and internal high speeds permit rapid processing of large amounts of complex data. An average multiply instruction takes 38 microseconds; and add instruction is executed in 8 microseconds. The computer includes an extensive programming package.
(For more information, circle 92 on the Readers Service Card.)



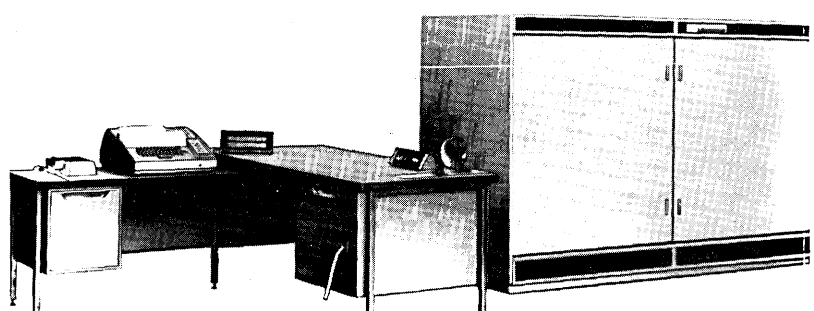
ASI 2100 DIGITAL COMPUTER
Advanced Scientific Instruments
Minneapolis 20, Minn.

The model 2100 digital computer has a 2 microsecond total memory cycle time and a 500 KC input/output word rate. Standard equipment includes a 4096 21-bit word memory, three index registers, indirect addressing, and double-precision hardware; also, character communication channels with assembly register and interface control for providing an input/output rate of up to 10.5 million bits per second. There are 64 external interrupts each with its own interrupt address. Complete peripheral equipment is available.
(For more information, circle 84 on the Readers Service Card.)



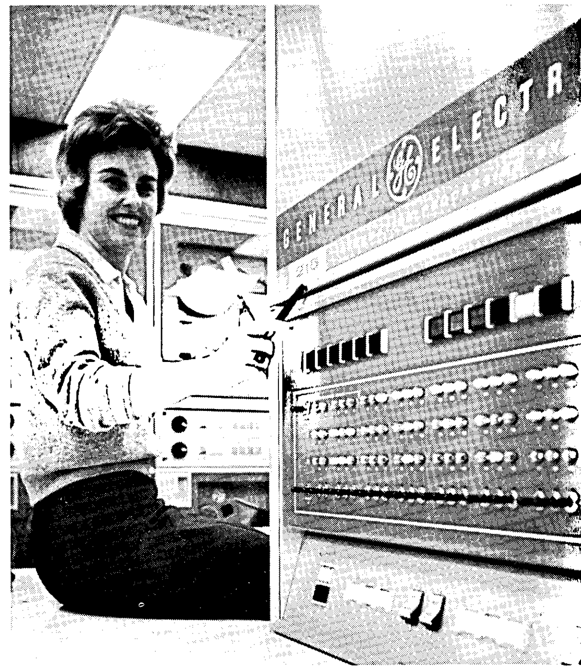
FP6000 COMPUTER
Ferranti Electronics
Toronto 15, Ontario, Canada

The Ferranti FP6000 computer, an automatic time-sharing computer system, is constructed in packaged modular form and centers on a general purpose digital computer. It has a minimum core store of 4096 words (24 binary digits each). This can be expanded in 4096 word modules to a total of 32,768 words. Store cycle time can be 2, 4, or 6 microseconds. Time sharing in the FP6000 is automatically organized by a master program called the EXECUTIVE. Up to four separate programs can run through the computer concurrently with no risk of interference. The FP6000 has been designed to meet the needs of special systems while retaining all the advantages of general purpose computers.
(For more information, circle 86 on the Readers Service Card.)



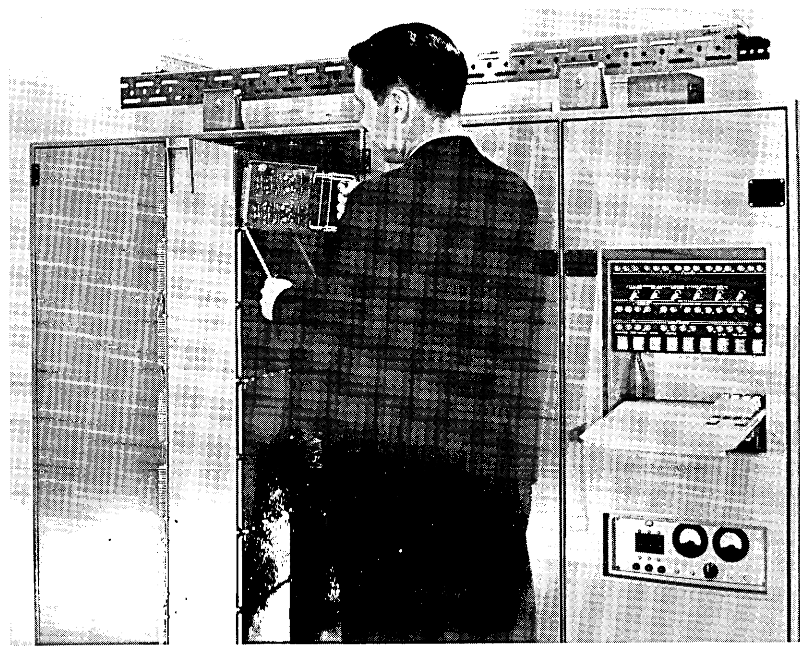
GE-215 GENERAL PURPOSE COMPUTER
General Electric Company
Computer Department
Phoenix, Ariz.

The GE-215 is designed to allow smaller businesses and industries to convert to electronic data-processing at minimum start-up costs. It has complete compatibility with the large GE-225 and with all programming packages presently used with that computer. The medium-class GE-215 has a magnetic core memory of 4000 or 8000 words; short word lengths are 20 bits; long words, 40 bits. Instruction time is 35.6 microseconds. A basic system includes the central processor with console typewriter, a 400-cpm card reader; 100 cpm card punch; two dual tape handlers; MICR document handler; and a 450-line-per-minute printer. (For more information, circle 93 on the Readers Service Card.)



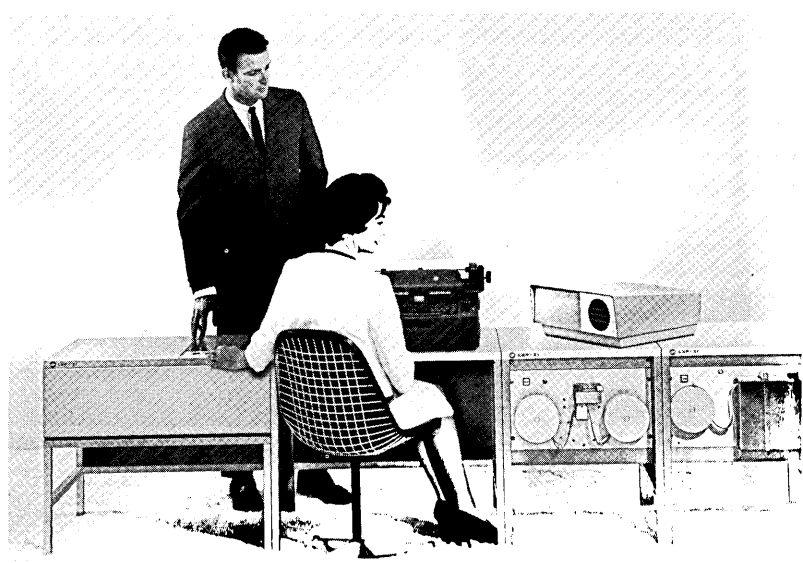
M-190, MILITARIZED COMPUTER
Honeywell Electronic Data Processing
Wellesley Hills, Mass.

The M-190 computer was developed for real-time tactical applications such as: ground support test complexes and telemetry; in-flight control of airborne vehicles from the ground; and calculating the impact point of a projectile. It is fully transportable, and compact. It has a memory cycle of six microseconds. It has an 8192-word, coincident-current core memory. A 10-level automatic priority interrupt permits execution of out-of-sequence instructions at any time during a particular program. The operators console may be folded back into the panel recess when not in use. Direct access from the front of the computer is provided to both "wire" and "card" sides of logic and memory circuitry. The peripheral equipment rack contains paper tape punch and reader, input/output typewriter and printer.
(For more information, circle 87 on the Readers Service Card.)

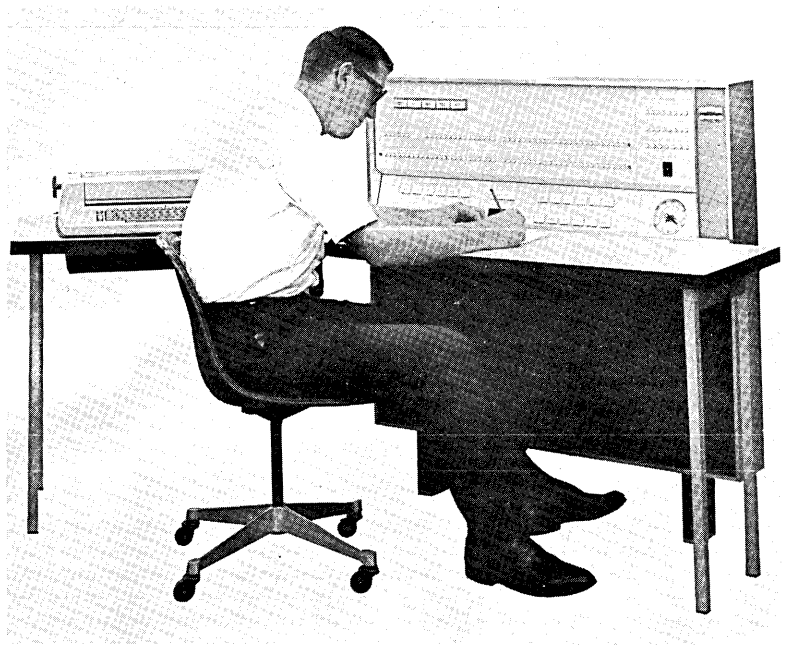


LGP-21
General Precision, Inc.
Information Systems Group
Commercial Computer Division
Burbank, Calif.

The LGP-21 digital computer weighs only 90 pounds, yet has a memory capacity of 4096 words. The compact 23-instruction vocabulary includes all of the basic arithmetic functions permitting full range to the solution of engineering, scientific and accounting problems. A library of over 400 programs is available. The basic LGP-21 is available with an electric typewriter with paper-tape punch and reader. Shown in the photograph, from left, are the computing section, electric typewriter and stand, high-speed paper-tape reader, and high-speed paper-tape punch. A register display scope, used for program check-out, is small device resting on cabinets.
(For more information, circle 83 on the Readers Service Card.)

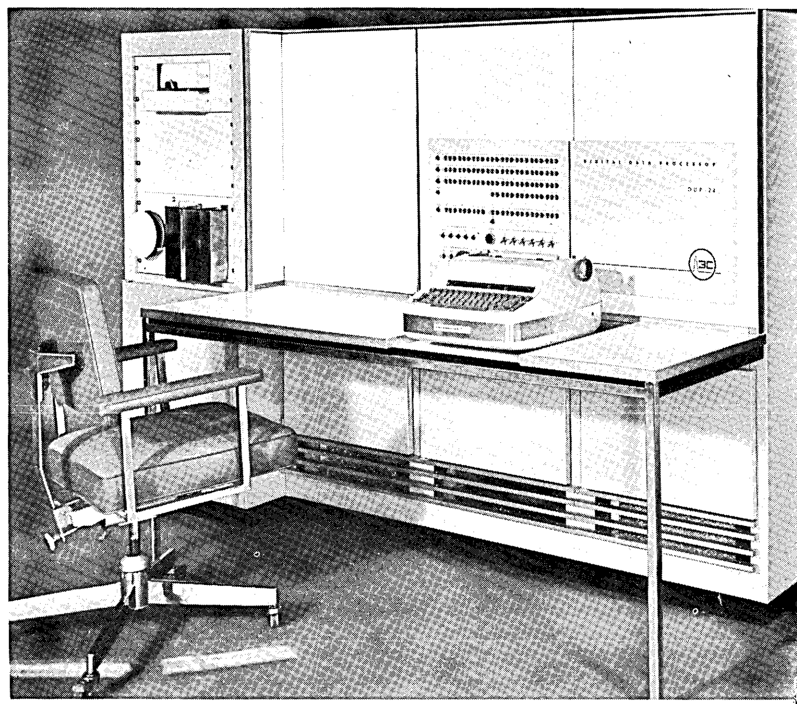


DIGITAL COMPUTERS



SDS 9300 DIGITAL COMPUTER
Scientific Data Systems
Santa Monica, Calif.

This high-speed digital computer, Model SDS 9300, is intended for general-purpose scientific computation and special-purpose systems integration. Typical floating-point programs, using a 48-bit word, can be executed at rates in excess of 100,000 instructions per second. It adds in 1.75 microseconds and multiplies in 7 microseconds, including indexing. The SDS 9300 may have up to 8 automatic data channels, each operating in excess of 2 million 24-bit words per second. Eight magnetic tape units can operate concurrently (at 96kc) without disturbing the arithmetic computations. Basic core memory is expandable to 32,768 words, all addressable -- each word contains 24 binary bits, plus one parity bit.
(For more information, circle 91 on the Readers Service Card.)

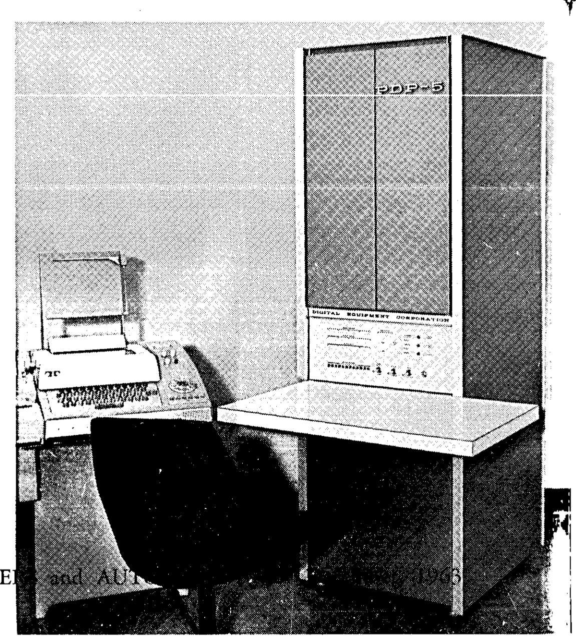


DDP-24
Computer Control Company, Inc.
Framingham, Mass.

The complete standard DDP-24 is contained in a single cabinet, including control unit, arithmetic unit, core memory, input-output system, integrated operator console, maintenance panel, paper-tape punch and reader, and electric typewriter. It is a solid-state, parallel-24-bit word, binary, single-address, stored-program, general-purpose computer, with indexing and indirect addressing. The DDP-24 is capable of up to 100,000 computations per second and communicates with peripheral equipment with a minimum of external decoding. Input and output can occur asynchronously and be interleaved with processing at transfer rates up to 166,000 words per second.
(For more information, circle 90 on the Readers Service Card.)

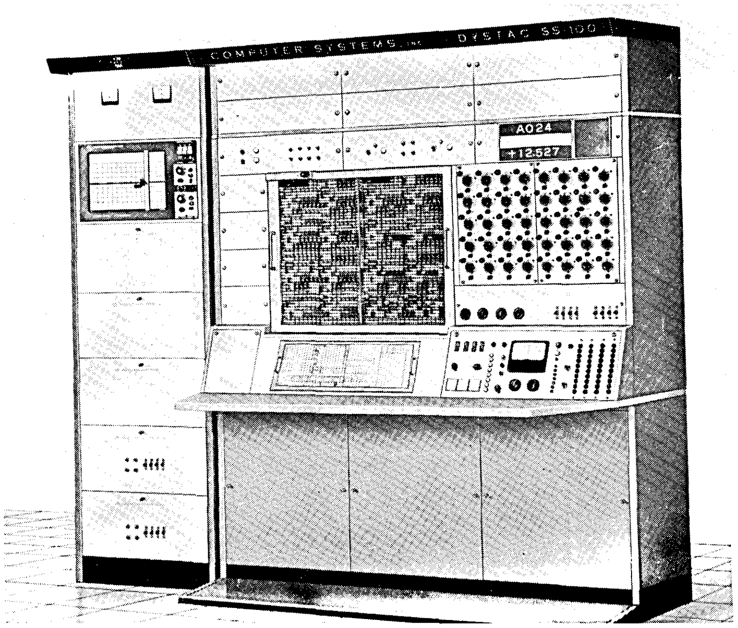
PROGRAMMED DATA PROCESSOR NO. 5
Digital Equipment Corp.
Maynard, Mass.

The PDP-5 digital computer is a single address, fixed word, stored program device, operating on 12-bit, 2's complement binary numbers. It has a 6-microsecond memory cycle time and fully parallel processing providing a computation rate of 55,555 additions per second. The standard PDP-5 is contained in a single bay and console and consists of an internal processor, operator console and memory. The computer is available with 1024 or 4096 words of random access, magnetic core memory. A Teletype, Model 33ASR, combination read-punch and typewriter, standard equipment with the PDP-5, allows paper tape to be read or punched, or information to be typed in or out at a rate of 10 characters per second.
(For more information, circle 94 on the Readers Service Card.)



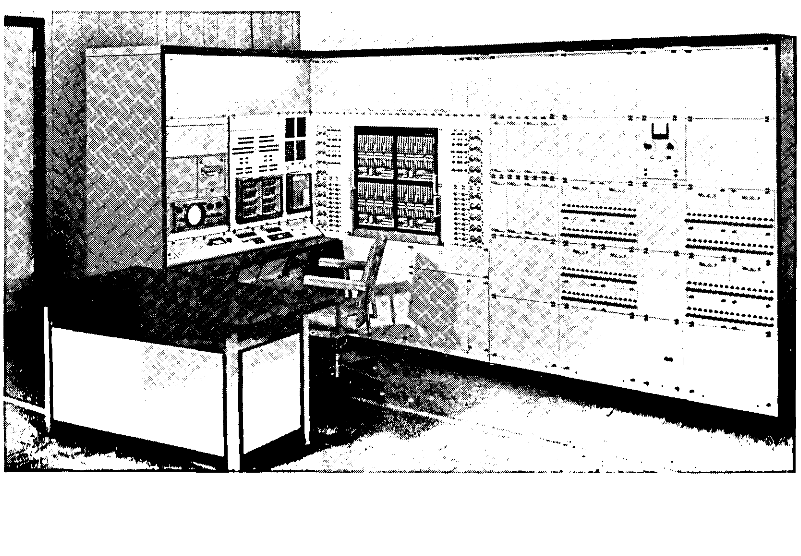
ANALOG COMPUTERS

DYSTAC SS-100 ANALOG COMPUTER
Computer Systems, Inc.
Fort Washington, Pa.



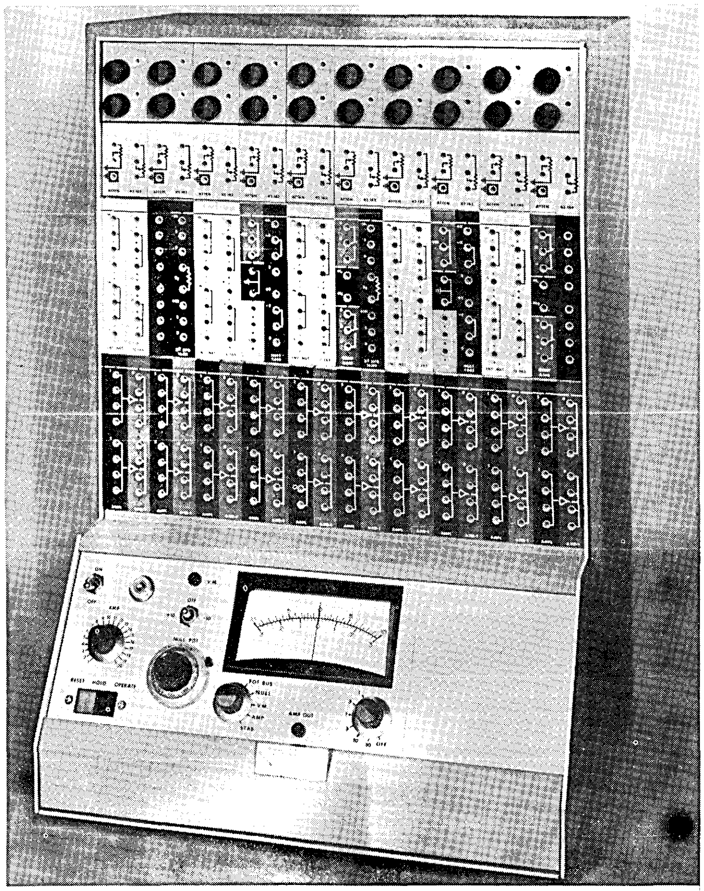
This all solid-state analog computer, the DYSTAC SS-100, has a computing range of +100 to -100 volts -- and uses the full 100 volt dynamic range. The development of a 100 volt solid-state amplifier, with its reduced size and low heat generation, made possible the design of a general purpose computer with these advanced capabilities: (1) precision at computing speeds from real-time to iterative rates in excess of 1000 solutions per second; (2) modular construction, for rapid expansion up to systems able to solve great, complex problems; (3) adaptability to linkage with digital computers in hybrid installations; (4) compatibility with current analog computing equipment; (5) ease in installation with no requirements for air conditioning; and (6) light-weight construction for a high degree of mobility.
(For more information, circle 76 on the Readers Service Card.)

AD-256 ANALOG COMPUTER
Applied Dynamics, Inc.
Ann Arbor, Mich.



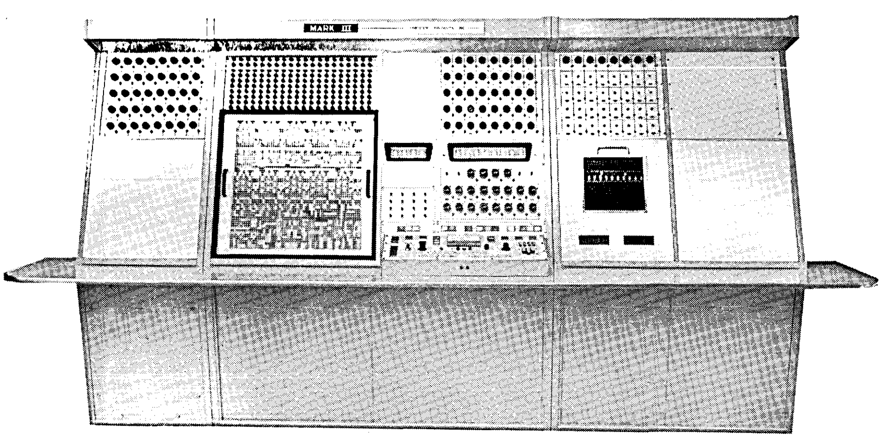
The AD-256 general purpose analog computer has been designed for hybrid applications. All control signals are at a digital logic level. The control logic system provides flexible control programming and automatic high-speed operation. All control inputs and outputs in the entire computer system may be interconnected since all control signals are compatible, being either logic one or logic zero. Complexity is reduced to a minimum. It is possible to integrate high-speed repetitive operation with real-time computation, automatically change time scale, or control separately a number of different problems programmed in a single console.
(For more information, circle 77 on the Readers Service Card.)

DESK-TOP ANALOG COMPUTER, EAI TR-20
Electronic Associates, Inc.
Long Branch, N.J.



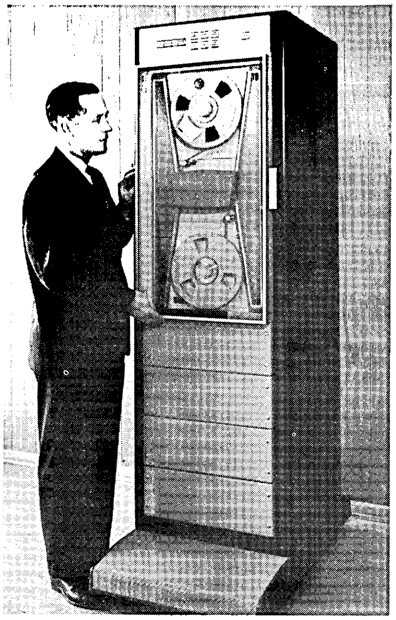
The EAI TR-20 is an all-transistorized analog computer, and the successor to the TR-10. It has improved accuracy, increased versatility and simplified programming. Internally packaged resistors eliminate external resistors and permit programming with bottle plugs and patch cords only. New variable slope/breakpoint function generators and Sine/Cosine generators broaden the range of problem solving. A new set-up procedure reduces the time for setting up non-linear functions. The TR-20 also includes an amplifier computing accuracy of .01%, a new high-speed comparator and electronic switch and a new four-channel oscilloscope display for improved readout of high-speed repetitive solutions.
(For more information, circle 78 on the Readers Service Card.)

MARK III ANALOG COMPUTER
Computer Products Inc.
Belmar, N.J.



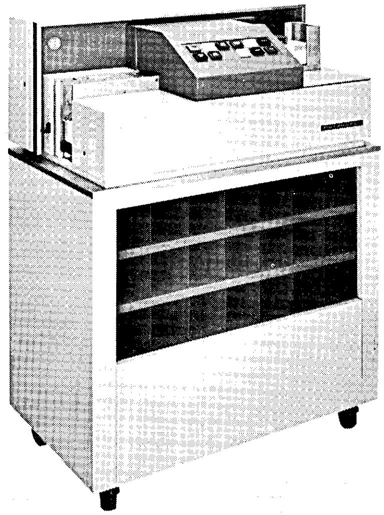
All necessary computing elements for a full computer system are contained within the single console of the Mark III analog computer. This includes 200 operational amplifiers, 180 pots and 60 multiplier products. Printed circuits are used for all plug-in components; digital packaging techniques are used. The patchboard layout affords maximum use of bottle plugs to minimize patchboard clutter. The Mark III has real time, iterative, and hybrid applications.
(For more information, circle 79 on the Readers Service Card.)

INPUT-OUTPUT EQUIPMENT



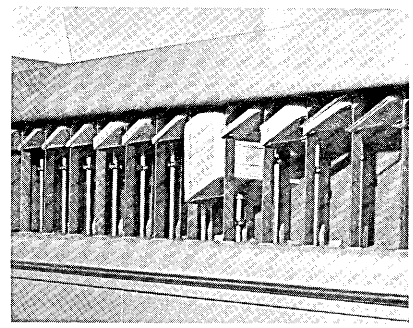
TM-3 -- MULTIPURPOSE TAPE TRANSPORT
Ampex Corporation
Redwood City, Calif.

The TM-3 high-speed tape transport is designed for a wide range of computer and systems applications. It operates at 112.5 ips, 200 and 556 bpi, compatible with IBM 729 MOD IV; uses standard ½-inch magnetic tape; and has a seven-track head assembly.
(For more information, circle 122 on the Readers Service Card.)



BURROUGHS BC122 CARD READER
Burroughs Corporation
Detroit, Mich.

The Burroughs BC122 has serial (column by column) reading; the first column is read within 85 milliseconds of initial demand. It can transmit either binary or alphanumeric information to any computer system. An immediate access clutch maintains a demand or free flow rate of 200 cards per minute. Hopper capacity is 500 cards each.
(For more information, circle 129 on the Readers Service Card.)

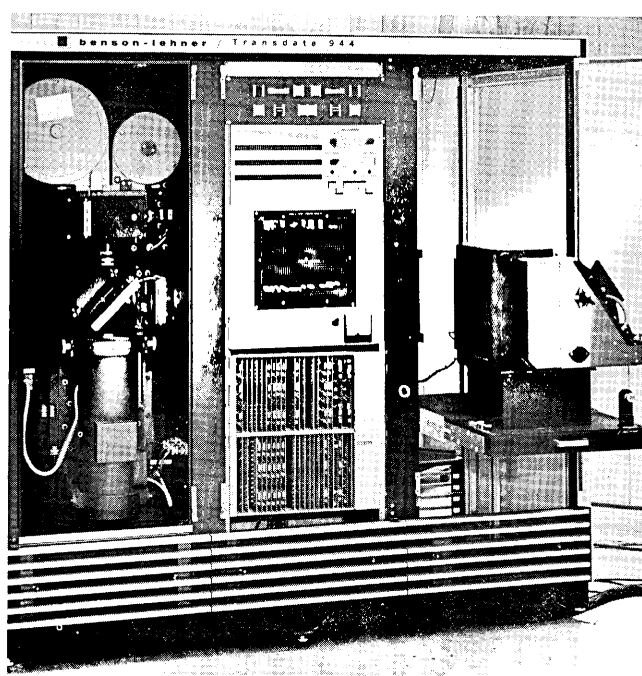


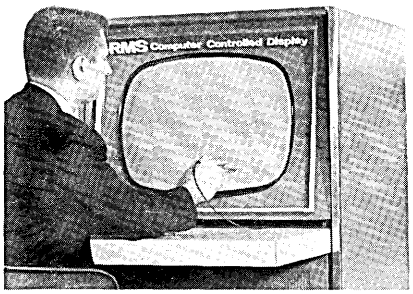
NCR 406 SORTER-COMPARATOR
The National Cash Register Co.
Dayton 9, Ohio

The 406 has 14 pockets in order to accomplish an alphabetic sort in two passes. In the first pass, every other letter beginning with the letter "A" is sorted into one of the first 13 pockets, and all the remaining letters are directed to the reject pocket. The unsorted letters are then transferred from the reject pocket to the hopper and the sort is completed in the second pass. Normally, more than half the cards are sorted on the first pass. The speed is 1000 cards sorted per minute.
(For more information, circle 128 on the Readers Service Card.)

TRANSDATA 944, PRINTER READOUT SYSTEM
Benson-Lehner Corp.
Santa Monica, Calif.

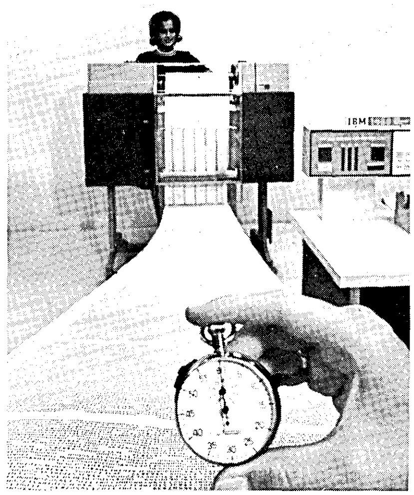
This printer readout system is capable of printing 62,500 characters per second. The Transdata 944 reads digital data directly from computers or magnetic tape, translates it at computer speeds into curves, lines, or characters on a cathode ray tube, and records the picture instantly on microfilm or photographic paper. Computer printout speed is 30,000 lines per minute. The system consists of a basic printer/plotter, including 35 mm microfilm camera. In the photograph, the opened interior of the Transdata 944 shows placement of the 35 mm microfilm camera used to record information from the cathode ray tube.
(For more information, circle 109 on the Readers Service Card.)





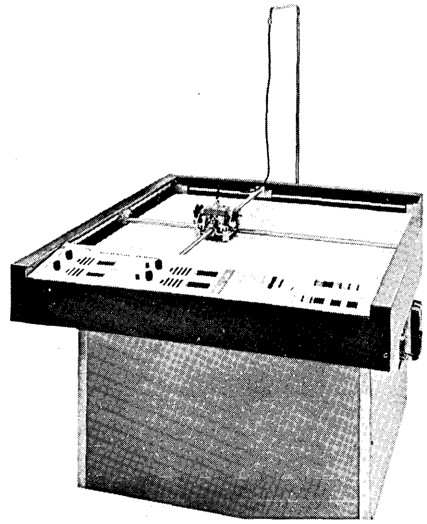
COMPUTER CONTROLLED DISPLAY
RMS Associates, Inc.
Mount Vernon, N.Y.

Solid-state CRT Computer Controlled Displays plot up to 2300 points or formatted characters at a flicker-free rate of 30 frames per second. Almost any requirement can be met including such features as character and vector writing, light pen, digitally controlled size and intensity, mode decoding, buffers, and keyboard to the basic display. Some of the applications for the display systems are simulation, computer monitoring and troubleshooting, and machine-aided design. (For more information, circle 120 on the Readers Service Card.)



IBM 1403, MODELL III PRINTER
IBM Corporation
Data Processing Division
White Plains, N.Y.

The 1403 printer, model III is capable of producing 1100 lines of alphabetic and numeric information in one minute. The photo shows the results of one minute of operation by the printer -- a listing of computer output that stretches 16 feet across a room. The model III uses a method of printing -- a rotating line of type -- similar to its model II counterpart. However, the type slugs (separate from each other) ride in a precision channel for maximum printing quality at higher speeds. The linear type speed of the model III is 206 inches per second. (For more information, circle 112 on the Readers Service Card.)

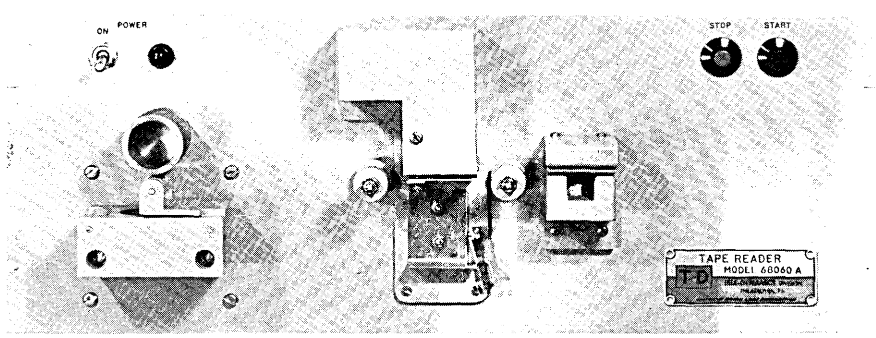


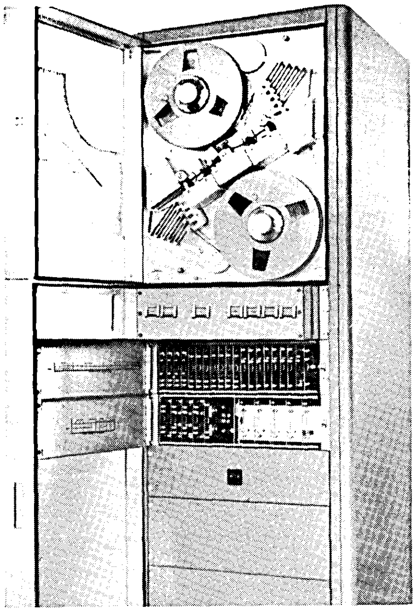
ELECTROPLOTTER II
Benson-Lehner Corp.
Van Nuys, Calif.

This plotter is capable of drawing straight or curved lines automatically in graphs, charts or maps, in any combination of four colors, and annotating them with words or symbols. The four-pen plotting head which permits drawing in four colors also permits four line widths. This electronic "artist" can receive its design and color instructions from magnetic tape, punched cards or tape, or directly from a computer. It will operate under program or operator control. Electroplotter II accommodates graphs as small as 8½ x 11 inches and charts as large as 42 x 58 inches. (For more information, circle 107 on the Readers Service Card.)

HIGH-SPEED TAPE READER
American Bosch Arma Corp.
Tele-Dynamics Division
Philadelphia, Pa.

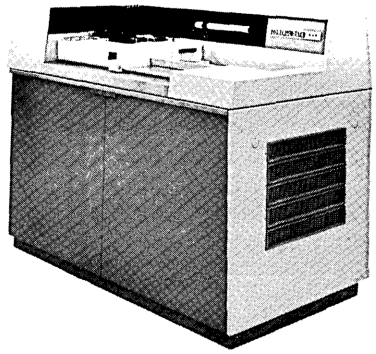
The Tele-Dynamics tape reader provides either parallel or serial outputs. The reader uses a reflected-light photoelectric system to read both electrostatically marked tape or punched paper tape. The device is capable of reading at rates of 300, 600, or 1000 characters per second. (For more information, circle 114 on the Readers Service Card.)





MODEL 5900
DIGITAL MAGNETIC TAPE SYSTEM
Cook Electric Company
Data-Stor Division
Skokie, Ill.

The Model 5900, shown with its cabinet open, has complete front accessibility of the tape transport, control panel, read electronics, and write electronics (top to bottom). The all-solid state system may be controlled locally or remotely. It is to be fully compatible with IBM tape. The bi-directional-drive tape transport handles tape reels up to 10½ inches in diameter. Transport start time is 3.5 ms.
(For more information, circle 117 on the Readers Service Card.)



CONTROL DATA 405 CARD READER
Control Data Corporation
Minneapolis 20, Minn.

The 405 Card Reader reads 1200 cards per minute by columns rather than rows, with each column photoelectrically monitored twice for increased reliability. As punched cards move into the pick position, the cards are separated pneumatically. The read station accepts or rejects cards on the basis of data error and comparison check. After the last column is read the computer has 1.7 milliseconds to determine if it should accept the card or direct it into a secondary tray without slowing the reading rate. The 405 can continue reading or stop depending upon the computer instruction.
(For more information, circle 113 on the Readers Service Card.

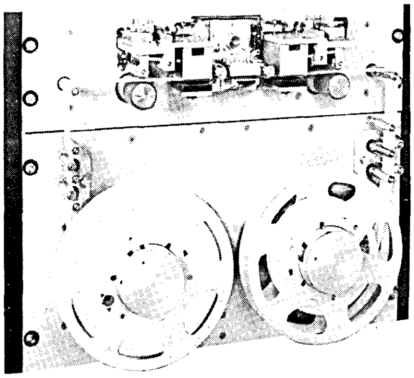
J-4138

NAVCOR TAPEWRITER --
PRINTING TAPE PUNCH
Navigation Computer Corporation
Norristown, Pa.

The Tapewriter Series 1010 prepares paper tape with easily-read bottom-margin printing for instant verification and up to 8-hole punching. Input is from full 49-key alphanumeric or 20 key-numeric keyboard, or from remote inputs such as tape readers. The device is 75% electronic, including magnetic keys, printed-circuit keyboard encoding, and semiconductor circuits. Up to 10 characters per second are simultaneously printed and punched. Typing errors are deleted by pressing delete key which punches all 1's code and prints delete character. Tapewriter Series 1020 incorporates a compact tape reader to permit automatic tape reproduction and comparison.
(For more information, circle 110 on the Readers Service Card.)

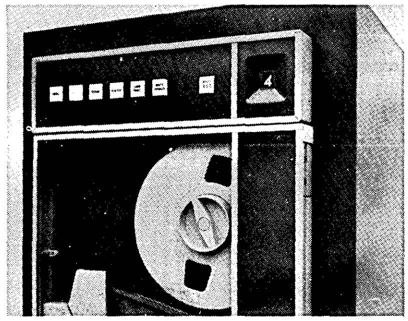
NCR 450 BANK PROOF MACHINE
The National Cash Register Company
Dayton 9, Ohio

The NCR 450 proof machine is designed to enable a bank's proof department to combine several separate operations into a single step. Sorting, listing, imprinting amounts and ABA number in magnetic ink, and endorsement of checks are an automatic by-product of verifying the accuracy of customer deposits. If a customer deposit is incorrect, the machine signals the operator and prevents further processing until accounting entries are in balance. Every processed document is routed into one of 40 bins at the touch of a key. A printer associated with each bin lists the contents of the bin along with machine identification and a transaction tracer number. The automatic batch control is programmed for reconciling the prrof operation with other bank operations without affecting the accumulated control totals of the proof machine.
(For more information, circle 116 on the Readers Service Card.)



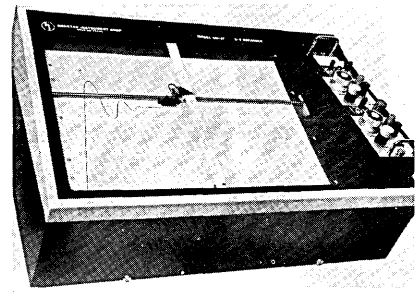
MODEL 110
PUNCHED TAPE READER-SPOOLER
Cook Electric Company
Data-Stor Division
Skokie, Ill.

This bidirectional punched-tape reader and spooler (shown with cover removed) is capable of reading all standard computer formats. It can be used as a strip or reel-to-reel tape reader. The photoelectric reader and the spooler are separate assemblies; they can be used together or separately on computer and off-line data processing systems. The unit can handle all standard paper, paper-mylar, and aluminum-backed mylar tapes. Any tape thickness to 0.008 inch is acceptable without adjustment. The system has a reading error rate of less than one error per 10^9 characters in continuous or character read mode.
(For more information, circle 118 on the Readers Service Card.)



D 2020 MAGNETIC TAPE UNIT
Datamec Corporation
Mountain View, Calif.

The triple-density computer magnetic-tape unit, called D 2020, writes and reads tapes in all three standard compatible formats (800, 556 and 200 bpi). Density is selected with a switch on the tape unit's operator control panel. Tape speed is from 3 to 45 ips. Start time is 5 ms, bidirectional. In multiple tape-unit systems, a single set of triple-density-data electronics serves all tape units, by means of a switcher under computer command.
(For more information, circle 115 on the Readers Service Card.)

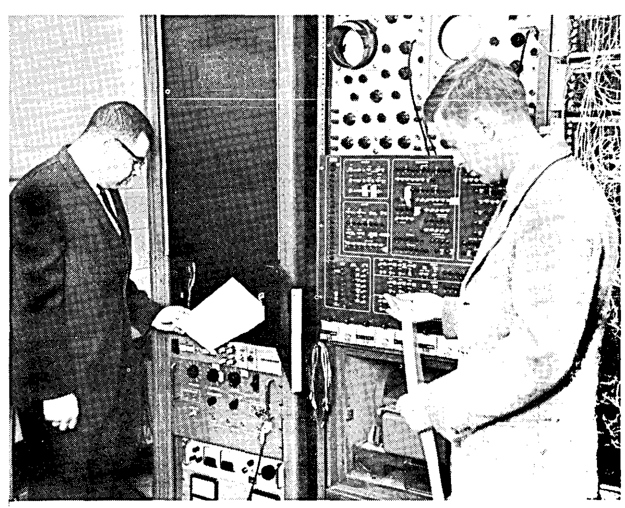


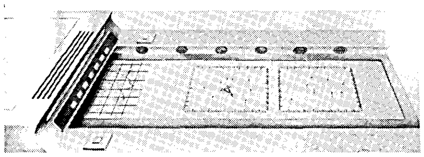
X-Y RECORDER, HR-97
Houston Instrument Corp.
Houston 27, Texas

This simplified 11" x 17" X-Y recorder has 1 mv/in. basic sensitivity, 0.25% of full-scale accuracy, 15 in/sec. pen speed, zener reference voltages, snap-on pen assembly, and vacuum paper hold-down. The HR-97's interchangeable plug-in control modules all have precision ten-turn input attenuators, full-scale zero adjustments and automatic pen-lift controls. A load-operate switch automatically picks up the pen and positions it away from the chart area for easy loading of paper.
(For more information, circle 108 on the Readers Service Card.)

ELECTRONIC MULTI-FONT PRINT READER
Sylvania Electric Products Inc.
New York 17, N.Y.

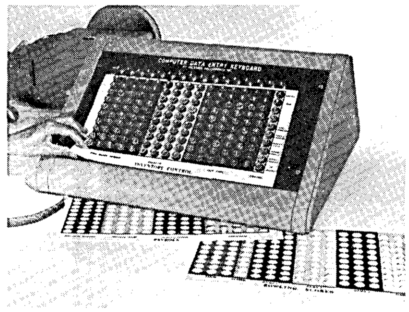
The electronic multi-font print reader converts what it "sees" into data on punched cards or tape at the rate of 700 characters per second. The machine reads letters 1/12 to 1/2 inch high from printed or typewritten documents. The device requires no intermediate film negatives, can separate and read conventionally-spaced typewritten characters, and makes automatic compensation for variations in paper and type registration. Dr. Donald B. Brick (left), Manager of Information Processing Research at Sylvania's Applied Research Laboratory, removes a page of typewritten copy from the reader's scanning unit which starts the reading process. Engineer James C. Stoddard (right) checks the punched tape output which can be fed into either a computer for processing or a flexowriter for display.
(For more information, circle 123 on the Readers Service Card.)





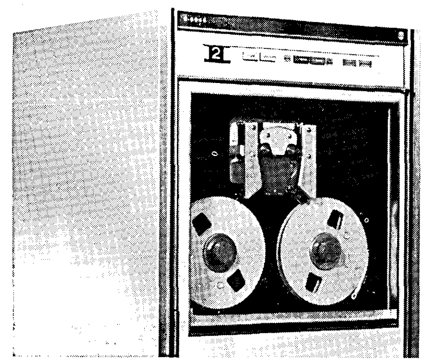
DREXAMATIC HIGH SPEED
ANNOTATING PLOTTER
Drexel Dynamics Corp.
Horsham, Pa.

The Drexamatic High Speed Annotating Plotter, Model 1065-1-ONL, is a high-resolution (100 points per inch) facsimile electrolytic type recorder that produces hard dry copy suitable for pencil marking notations. The device is capable of reading digital information from an IBM 7090 computer and translating it into graphic plots with annotation and line printing. The plotter logic is operated at 100KC at a paper speed of 10 inches per second. It will accept, decode and mark a maximum of 100 10-bit plot words per millisecond. The plotter is completely self-contained within a desk type console.
(For more information, circle 130 on the Readers Service Card.)



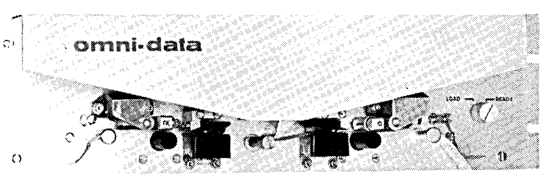
C-DEK,
COMPUTER DATA-ENTRY KEYBOARD
Colorado Instruments, Inc.
Broomfield, Colo.

This device for preparing digital data for computer entry is useful in such operations as Pert programming, job estimating, engineering studies, scientific problems, computer program preparations, and many phases of accounting procedures. As a pushbutton is pressed to enter the numbers, the keys illuminate allowing the operator to verify entries prior to recording them on punched paper tape. After verification, the "record" button is pressed, activating the electronic scanner, which scans the entire field of lighted numbers and records them on paper tape. The C-Dek generates a fixed field of data automatically. Versatility is provided by a simple change of the keyboard's plastic overlay mat, whose columns, clearly marked in differed colors, make data entry almost self-explanatory.
(For more information, circle 119 on the Readers Service Card.)



MAGNETIC TAPE UNITS
Collins Radio Company
Dallas, Texas

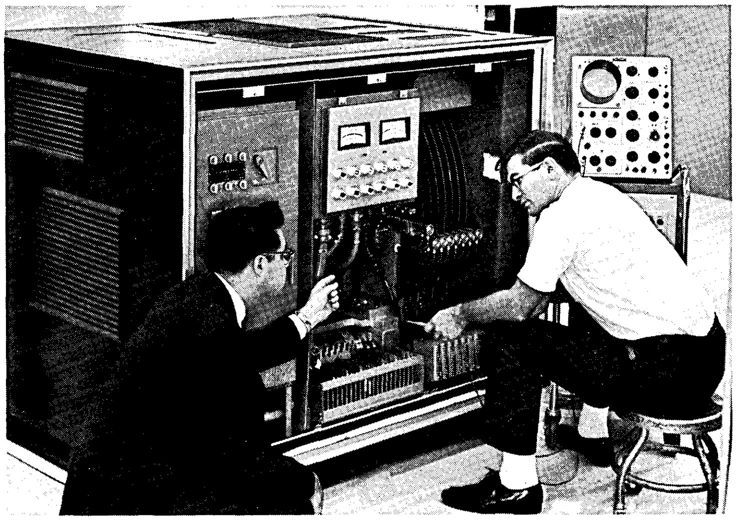
The Collins C-8046 (shown) and C-8047 magnetic tape units are digital sequential storage devices for use in high speed automatic information switching and processing systems. Complete read and write electronics, dual-gap read/write head, and electronic skew compensation are provided. Substantial noise margins are maintained on all command and response lines. The tape format and control/response interface of the C-8046 and C-8047 permit complete interchangeability with IBM 729II and 729IV units respectively and are compatible with other magnetic tape equipment.
(For more information, circle 111 on the Readers Service Card.)

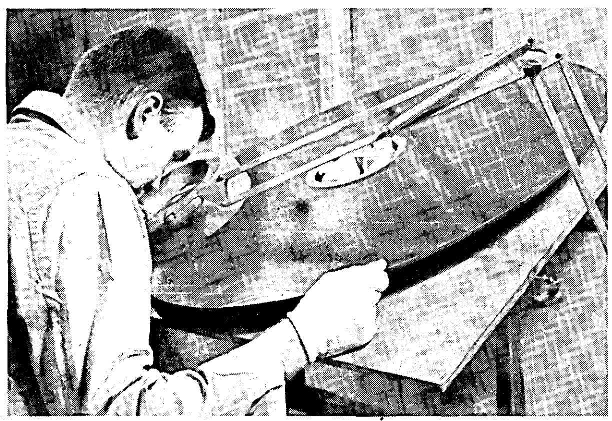


OMNI-DATA® PHOTOELECTRIC TAPE READERS
Omnitronics, Inc.
Philadelphia 23, Pa.

The photoelectric tape readers, Model PTR-90 (unidirectional) and Model PTR-91 (bidirectional) are designed for reading all types and colors of paper and plastic tape at speeds up to 1000 characters per second. The Omnitronics principle of reflected light is used in these models to permit interchangeable reading of opaque or transparent, punched or printed, light or dark-colored tapes without need for amplifier adjustment. There are no variable electrical components in these readers.
(For more information, circle 121 on the Readers Service Card.)

MEMORIES

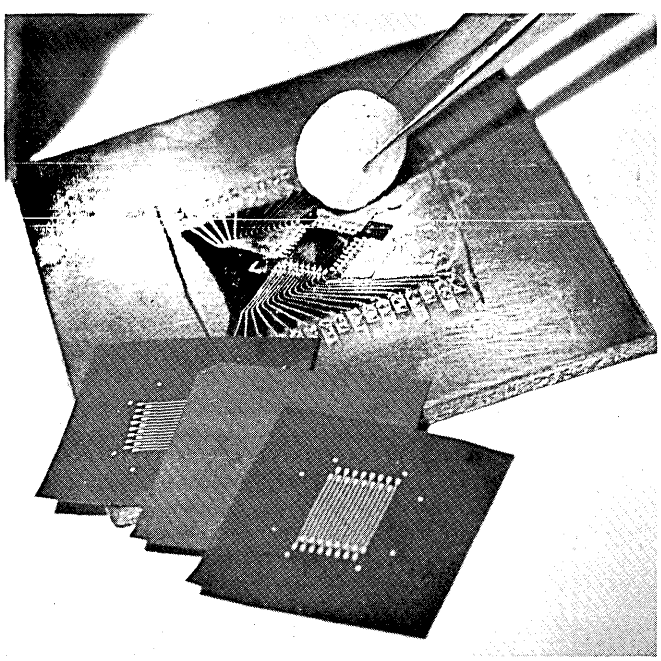




SERIES 4000A DISC FILE
Bryant Computer Products
Walled Lake, Mich.

The six-data-disc Series 4000A Disc File is a random-access mass memory, capable of storing up to 390 million bits using 600 bits-per-inch, block-format recording. Average access time is less than 100 milliseconds. This addition to the series, which includes the 13-data-disc Series 4000B and 25-data-disc Series 4000C, provides prospective users with a selection of storage capacities ranging from 31 million to over 1.6 billion bits. In the photograph at the left, the field engineer (right) is adjusting gain of the read amplifiers (located in rack at lower center of file), during the final phase of installation of the first Bryant Series 4000A Disc File at RCA's EDP Division, West Palm Beach, Fla.

In second photograph, a laboratory technician optically inspects a storage disc for surface anomalies. Series 4000 disc files are expandable in the field, modules being added until the maximum number of discs for each family has been reached.
(For more information, circle 102 on the Readers Service Card.)



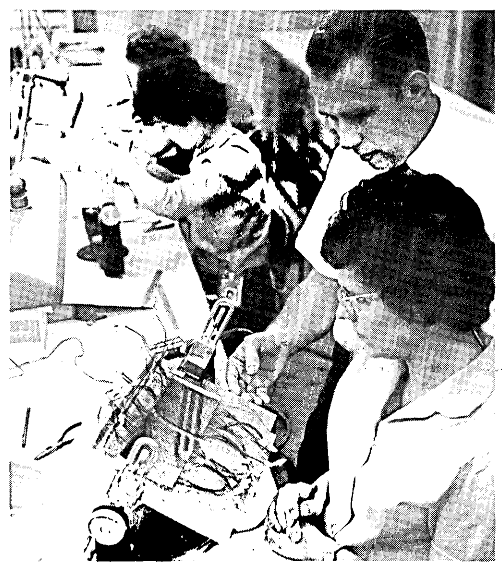
MINIATURE INTEGRATED COMPUTER MEMORY
Radio Corporation of America
New York 20, N.Y.

The diamond-shaped unit in the photograph, is a high-speed computer memory produced by a new process borrowed from the plywood manufacturing industry. Dwarfed by a tweezer-held aspirin, the unit shown is capable of storing up to 256 bits of information permanently or of processing up to 10 million bits per second. Using thin laminated sheets of ferrite, the new memories are built by a series of "doctor-blading", silk-screening, lamination and high-temperature processing techniques. In the foreground are typical ferrite sheets, in their "green" or unfinished form.
(For more information, circle 95 on the Readers Service Card.)

10-MEGACYCLE BIAX MEMORY
Aeronutronic Division
Philco Corporation
Newport Beach, Calif.

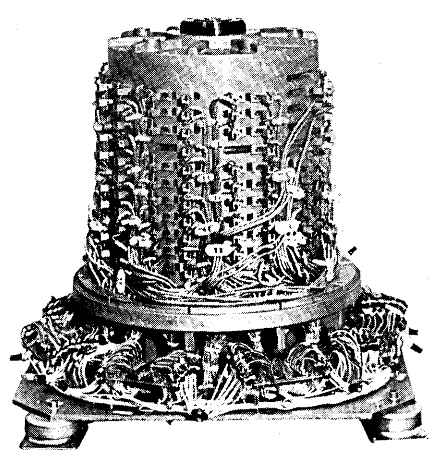
The photograph, at the right, shows the 10-megacycle BIAX memory, which operates in 100 nanoseconds, the time in which light travels 100 feet. The memory stores 50,000 bits of information in 1024 words. It can read out 48 bits of data in one tenth of a millionth of a second. In common with other BIAX memories, it has non-volatile storage, non-destructive read-out, and low power consumption.

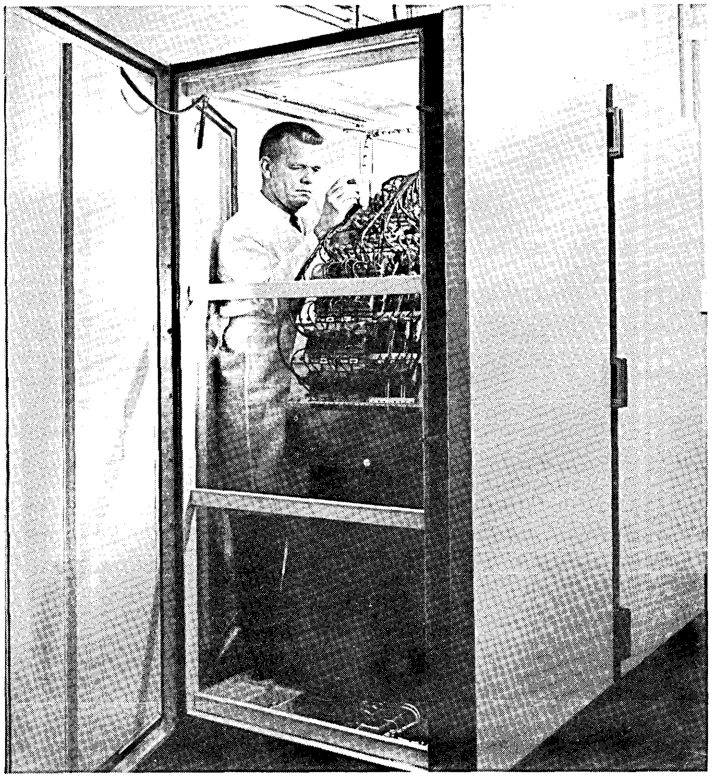
The second photograph (below right) shows BIAX memory arrays, being assembled from thousands of tiny BIAX ferrite magnetic elements which store electronic information. The tiny elements are woven together to form the arrays, which are later assembled into BIAX memories.
(For more information, circle 96 on the Readers Service Card.)



METALLIC-PLATED MEMORY DRUMS
Metwood Manufacturing Co.
Gardena, Calif.

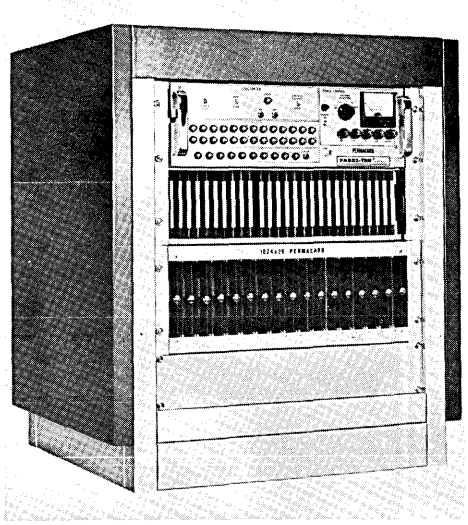
This series of memory drums have their recording surfaces electrolytically plated with a cobalt alloy. These memory drums, designated series 1200, are 13" in diameter, with heights from 11" to 22". Drum speeds range from 900 to 12,000 rpm. They are supplied with up to 540 tracks. Storage capacities range from 50,000 to 3,500,000 bits.
(For more information, circle 105 on the Readers Service Card.)





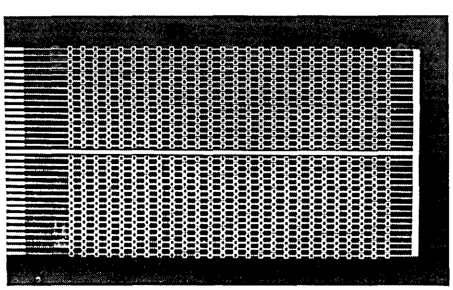
L-1500 MASS-MEMORY MAGNETIC DISC FILE
General Precision, Inc.
Information Systems Group
Librascope Division
Glendale, Calif.

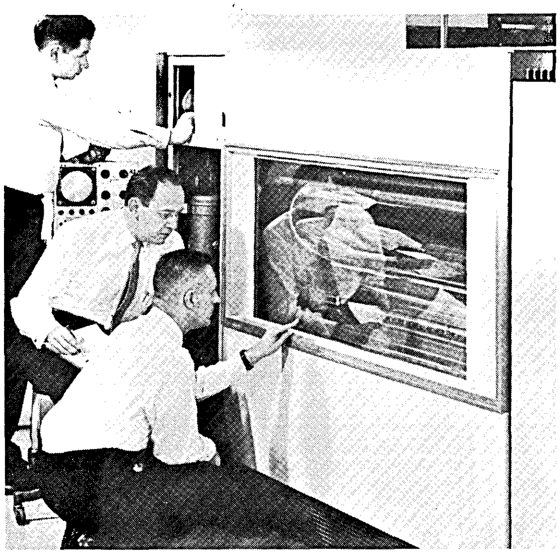
Six discs make up a basic L-1500 fast-access Mass-Memory Magnetic Disc File (shown) capable of storing up to 306 million bits. An engineer adjusts device that electrically records information on and withdraws information from the magnetic discs. Up to 56 disc-file modules can be linked to and controlled by a medium or large computer, providing a storage bank of 17.1 billion bits. On demand from its computer "executive", the mass memory disc file can retrieve information and present it for transfer to the computer (using a search-by-content feature) in a span of time ranging from 35 milliseconds to 70 milliseconds. It can transfer 2,136,000 bits a second.
(For more information, circle 104 on the Readers Service Card.)



SERIES PA PERMACARD MEMORY SYSTEMS
Fabri-Tek, Inc.
Amery, Wisc.

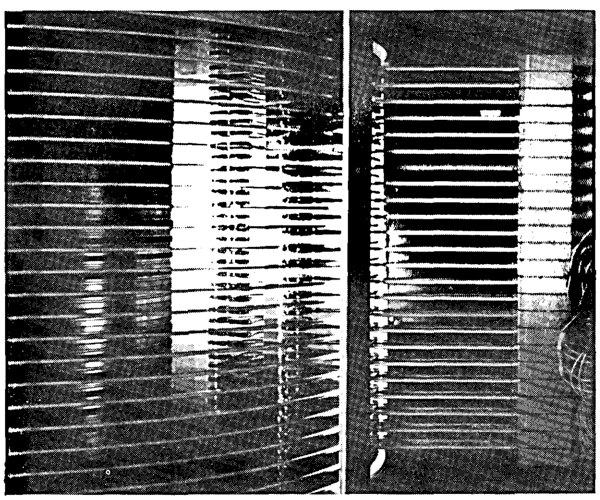
This system uses the principle of current loops on a pluggable printed circuit word line array to store digital data. The memory elements are planes capable of storing 64 words and are mass-produced in a neutral or unwritten state (shown in photograph below) ready for information loading. When installed they provide a permanent storage with fixed constants that are free from chance of alteration due to faulty read-restore operations. They can be inserted or removed in the system chassis in seconds. The present system cycle time is 1 μsec with an access time of 0.5 μsec. Systems having any bit capacity are possible. Modes of access are random, read-only nondestructive readout, and parallel readout. A typical PERMACARD system has 1024 words and has the optional features of: output data registers, output coax or twisted pair drivers, address parity check, data parity check, and self-exerciser.
(For more information, circle 97 on the Readers Service Card.)





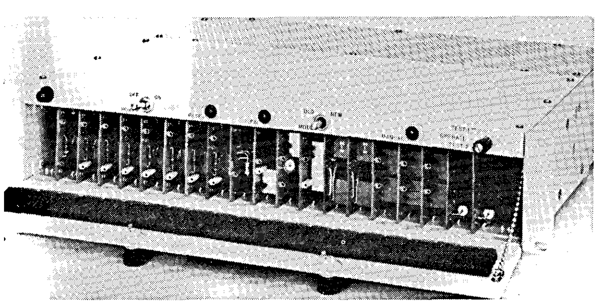
UNIVAC 490 FASTRAND MASS STORAGE SUBSYSTEM
UNIVAC Div. of Sperry Rand Corporation
New York 10, N.Y.

The device, known as the UNIVAC 490 Fastrand Mass Storage Subsystem, was developed for the storage of large masses of business data, which can be retrieved by an electronic computer in 92 thousandths of a second. These units have a storage capacity of 64 million characters of information each. Each unit consists of two drums revolving at 870 rpm. Sixty-four flying heads mounted on flexure springs are used to search the rotating drums for desired facts. Two motors, one integrally mounted to each drum, are used to drive the system, which is completely self-contained with its own power supply. Programming packages for the UNIVAC 490 Real-Time Computer will operate the subsystem.
(For more information, circle 106 on the Readers Service Card.)



IBM 1302 DISK STORAGE UNIT
IBM Corporation
Data Processing Division
White Plains, N.Y.

The electronic filing system, composed of the new IBM 1302 disk storage units, can hold nearly a quarter of a billion characters of information. The 1302 has two access mechanisms in each module — with each mechanism providing access to 250 independent data recording tracks. The access mechanisms can both seek at the same time, or one can seek while the other is reading and writing. Access "arms" fly in and out, over and under recording tracks to retrieve information in less than two-tenths of a second. Up to five 1302 units can be linked to any of nine IBM computers to provide a total storage capacity of more than a billion characters.
(For more information, circle 103 on the Readers Service Card.)



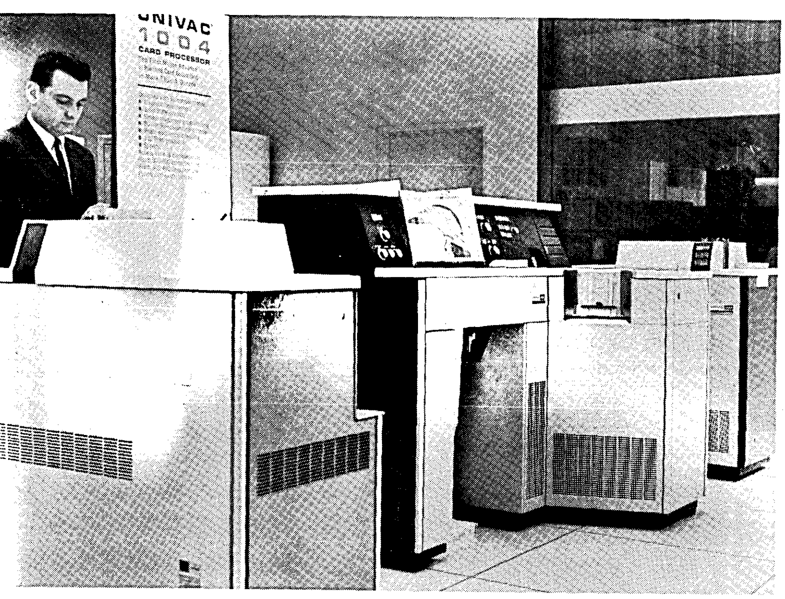
MAGNETICALLY CONTROLLED CORE MEMORY
DI/AN Controls, Inc.
Boston 25, Mass.

Model SA-VB-INT 240/12-400, a magnetically controlled coincident-current core memory, has a read-write cycle time of 2.5 microseconds and an access time of approximately .8 microseconds. The shelf model has 240 words of 12 bits each and two address counters, permitting use as a serial "variable-block" buffer storage. The compact memory (3½" height) gives high reliability. Simplified magnetic address, drive, and sense circuitry cuts the semi-conductor count to a bare minimum. The model is compatible with the broad range of pre-engineered standard options.
(For more information, circle 100 on the Readers Service Card.)

DATA TRANSMITTERS

BI-DIRECTIONAL DATA CONVERTER, SC-332
General Dynamics/Electronics
Rochester 1, N.Y.

The SC-332 is a "translator" that converts one kind of "computer talk" to a different "language" at high speeds. Data is converted from magnetic tape to punched paper tape, from punched paper tape to magnetic tape, and from punched paper tape in one code to punched paper tape in a different code. The device has a speed of 500 characters per second when operating in the magnetic tape mode. When converting data to paper tape, it has a speed of 250 characters per second. Five, six, seven, or eight-level paper tape codes can be accommodated, with or without parity. On the magnetic tape application, the converter operates with either the IBM 729 II/IV binary, or binary-coded-decimal low-density format. Code translation, formating, and error-checking are performed automatically.
(For more information, circle 127 on the Readers Service Card.)



UNIVAC DATA LINE TERMINAL
UNIVAC Division of Sperry Rand Corp.
New York 19, N.Y.

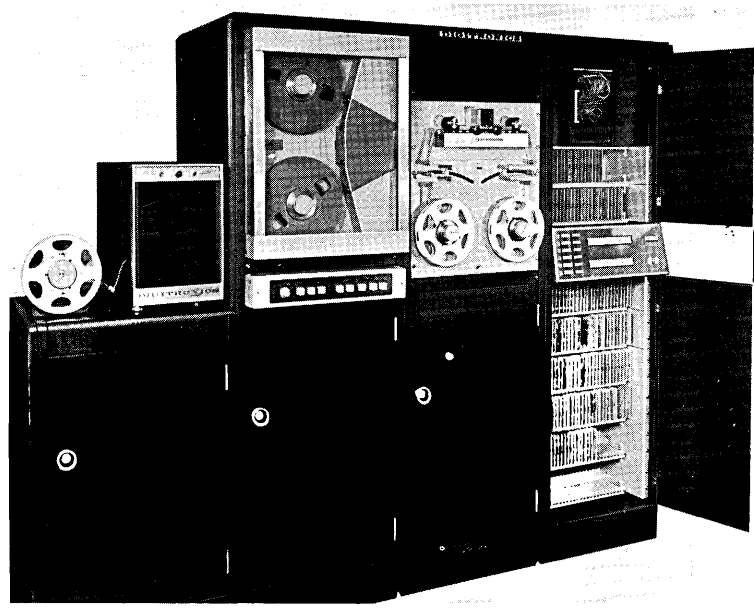
The device, called Univac Data Line Terminal, enables the low-cost Univac 1004 Card Processor to transmit or receive business, scientific and engineering data over ordinary telephone lines at a rate of 3400 words per minute. With the Data Line Terminal, a Univac 1004 can communicate with another 1004, the Univac 490 Real-Time or the Univac 1107 Thin-Film Memory systems. The Data Line Terminal operates with standard Bell Telephone 201A or 210B Data Phone Sets. The Univac 1004-DLT can transmit information consisting of data read from cards, data such as constants stored in memory, data generated by plugboard wiring, or data computed by the processor. It can print and punch the data being transmitted, and can print and punch into cards and process data received from another 1004, 490, or 1107.
(For more information, circle 125 on the Readers Service Card.)

AND CONVERTERS

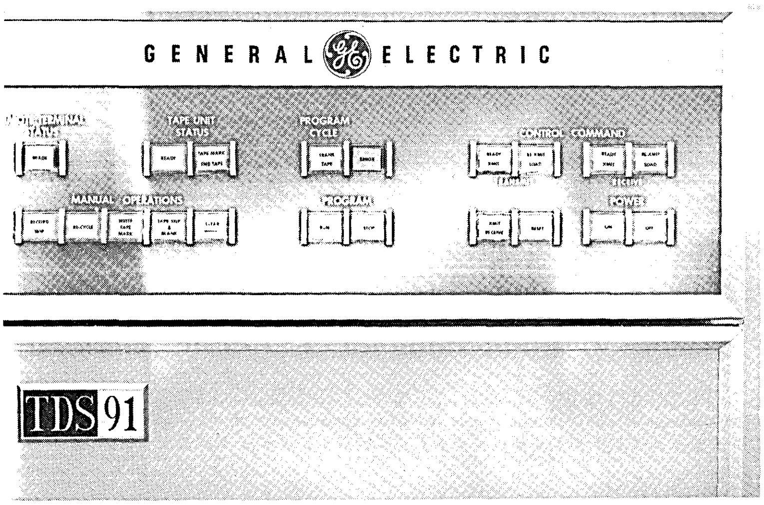
IBM 7740 COMMUNICATION CONTROL SYSTEM
IBM Corporation
Data Processing Division
White Plains, N.Y.

The IBM 7740 communication control system, operating alone or linked to a computer, speeds the flow of messages and data among widely dispersed points. Messages, shown being inspected by the system's operator, are routed automatically from origin to destination; manual handling at the center is eliminated. Permanent electronic copies of all messages are recorded on interchangeable disk packs of IBM 1311 disk storage drives (left). The operator's console (foreground) monitors the system and can communicate with other points in the network.
(For more information, circle 126 on the Readers Service Card.)

PAPER-TAPE-MAGNETIC-TAPE CONVERTER
Digitronics Corporation
Albertson, N.Y.

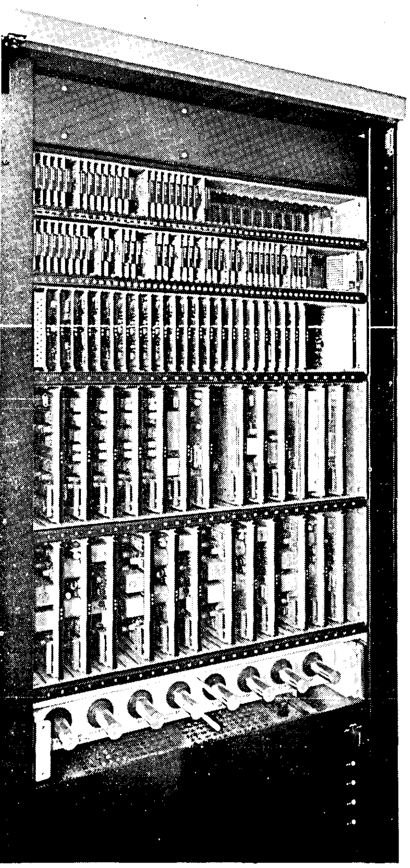


This solid-state magnetic-tape-paper-tape converter, Model D327, takes variable-size input records and codes them for direct processing by the computer. It can be used to integrate high and low speed remote data communications with a centrally-located computer. The Model D327 converts magnetic tape to paper tape at a speed of 50 words per second. Paper tape is converted to magnetic tape at 160 words per second. It accepts 5, 6, 7 or 8-level paper tape as input, and produces output magnetic tapes compatible with IBM 1401 or 7090 computers. It also can accept as input, magnetic tape prepared by these computers, and put out 5, 6, 7 or 8-level punched paper tape.
(For more information, circle 124 on the Readers Service Card.)



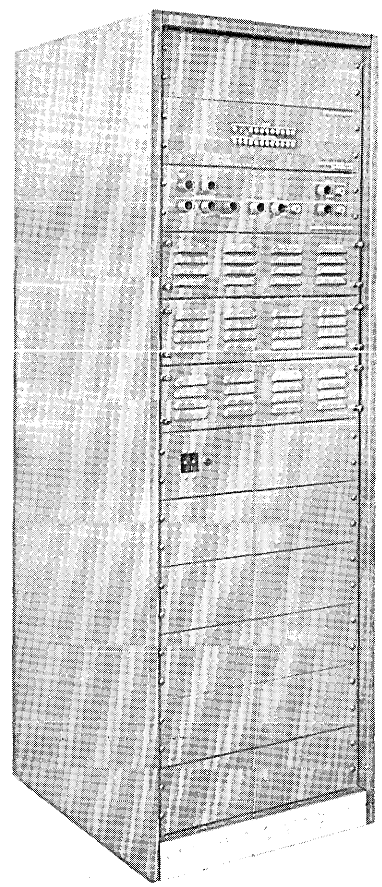
TDS-91 TERMINAL
General Electric Company
Communication Products Department
Lynchburg, Va.

The TDS-91 magnetic tape-to-magnetic tape data transmission terminal, reads data record-by-record into a magnetic core buffer for conversion to transmission line speeds. Tape data is converted into electrical signals which may be transmitted intra-city or cross country at speeds determined by the transmission facilities. Speeds range from 150 to 28,000 characters per second.
(For more information, circle 99 on the Readers Service Card.)



C-8210 DIGITAL DATA COMMUNICATION MODEM
Collins Radio Company
Dallas, Texas

Collins C-8210 digital data communication modem is a solid-state, full duplex transmitter and receiver for data transfer between geographically separated Collins communication processors. The modem operates at a 2400 bits-per-second data rate over nominal three kc bandwidth voice channel facilities such as wireline, cable, or carrier.
(For more information, circle 98 on the Readers Service Card.)



ANALOG-TO-DIGITAL CONVERTER, TYPE 142
Digital Equipment Corp.
Maynard, Mass.

The Type 142 converter, developed for use with the Programmed Data Processor computers, also can be used as an independent unit. It transforms an analog signal to a signed binary number with 10-bit accuracy in a total time of six microseconds. Conversion accuracy is ±0.15 percent ± 1/2 least significant bit.
(For more information, circle 101 on the Readers Service Card.)

"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

TABLE OF CONTENTS

NEW APPLICATIONS

IBM AND TULANE REVEAL JOINT EFFORT IN BIOMEDICAL COMPUTING

Progress in applying electronic data processing methods and systems to a variety of medical research problems was demonstrated to the press by Tulane University and International Business Machines Corporation officials last month.

In a joint study, under way for more than a year, research teams made up of IBM computer scientists and Tulane physicians, radiologists and bio-medical specialists have been exploring new methods of using computers to:

... develop new ways to analyze brain wave and heart electrical patterns;
... explore techniques in extracting new information from x-rays;
... conduct research in organizing medical records collected in the course of observing and treating large numbers of people;
... analyze patient information gathered from various electronic measuring devices.

Physicians and specialists from other medical institutions around the country are also contributing to the study.

This research work is being carried on at the Tulane Bio-Medical Computing System Center, which is under the direction of Dr. James W. Sweeney. The center was established in February, 1962 under terms of a $1,674,854 grant to Tulane from the National Institutes of Health. It was one of the first major bio-medical computer centers established in the United States. Housed in the center are IBM 1410 and 1401 Data Processing Systems and other specially-built medical research equipment. An IBM 7094 computer is expected to be installed in 1965, according to Dr. Sweeney.

The center's relationship with the International Business Machines Corporation began in August 1962 when a joint study of methods and systems for processing large volumes of medical information began. In the cooperative study, a team of Tulane and IBM computer specialists and scientists have explored methods of using electronic data processing equipment to analyze complex physiological data from hospital patients.

IBM scientists stationed at the center have made valuable contributions to medical systems development by designing and evaluating analysis techniques.

Tulane has provided the building in which the center is housed, some of the key personnel, and the necessary administrative functions.

Dr. Herbert E. Longenecker, Tulane president, emphasized the importance of the Tulane-IBM partnership. "By means of this study, private industry and a university medical school are cooperating to achieve a necessary new inter-disciplinary competence in the application of information handling technology to life science problems. Neither partner — IBM or Tulane — could work as effectively alone".

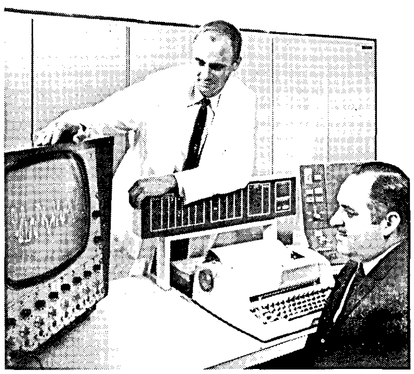
Some examples of the problems which are being explored by the Tulane-IBM teams follow:

ELECTROCARDIOGRAMS

A computer has been used to distinguish the difference between electrocardiograms collected from cardiac patients and normal ECGs. When perfected, this technique could be used to continuously monitor heart patients and to screen normal population groups.

ELECTROENCEPHALOGRAMS

Work in electroencephalogram analysis is divided into several different efforts. (a) The collection and detection of significant information in brain waves; (b) the analysis of waves to determine significant features which may be related to the condition of the patient; (c) the automatic classification of normal and abnormal brain wave patterns using digital computer pattern recognition techniques. In the latter application, the EEG is recorded directly on magnetic tape via special data acquisition instruments. The signal is then divided into 36 different frequencies by a bank of filters. All of these 36 new signals are analyzed simultaneously.



— Dr. Richard Yoder of Tulane University discusses the brain wave signals displayed on a cathode ray tube monitor with W.J. Nettleton, Jr., assistant director of the Tulane Bio-Medical Computing System Center. Mr. Nettleton is seated at the console of an IBM 1410 which is being used to analyze electroencephalogram wave forms.

The next step involves identifying and classifying amplitude "peaks" and "valleys". This is done for each of the 36 readings that are available simultaneously. The filter outputs are coded as either peaks or valleys, and they may be high, medium or low. Included in the high designation are those filters with amplitude within 70 per cent of the highest levels. Those from 30-70 per cent are medium peaks and those under 30 per cent are classed as low. A similar criteria is used to classify the valleys.

With the EEG information now represented by a sequence of such coding, the information is presented as input to an experimental adaptive pattern recognition program on an IBM 7094 Data Processing System in Yorktown, N. Y. Two stages are included in this program — a learning phase which develops a definition of a normal EEG, and a testing phase which indicates how closely an unknown EEG matches the definition of a normal EEG.

In the learning mode, information on peaks and valleys for pairs of frequency channels both within and between time instants is obtained from EEGs previously designated as normal. The definition of normality is refined by adding one normal EEG sample at a time. A computed number gives an approximate indication of information learned. When new samples do not significantly increase this number, enough information has been obtained to determine the variation existing among normal EEGs. While this does not imply that good discrimination between normal and abnormal EEGs will be obtained, it does show that the definition of normality has been stabilized.

In the testing mode, the program produces a number between zero and one that indicates how well an unknown EEG matches the definition of normality established in the learning mode. If the match number is one, there is a perfect correspondence with this definition.

X-RAY IMAGE PROCESSING

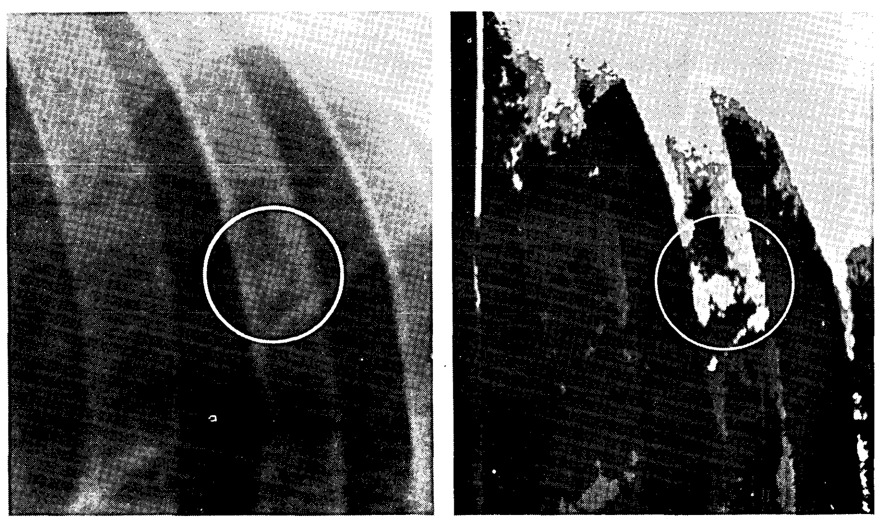
An experimental technique to process x-rays through digital computers and other electronic equipment and retrieve them in more readable form has been demonstrated at the Tulane center.

The first part of the process involves scanning the x-rays and converting them into digital form which computers can store and process. The computer, operating under special programming instructions, analyzes the image and reproduces it on an oscilloscope screen which can be photographed. Members of the Tulane-IBM team believe that this photograph makes it possible to observe information or characteristics not clearly visible on the x-ray film.

An experimental IBM system designed to scan, process and display x-rays on a TV-like screen, has also been used in this project. The original illuminated x-ray and the image projected on the unit's screen can be studied simultaneously. When displayed on the screen, the x-ray can appear as a positive, a negative or an enlarged image.

MEDICAL RECORDS RESEARCH

Techniques are being developed to integrate clinical laboratory, x-ray and physiological data into a computer medical record. These methods will allow conversion of traditional, bulky medical records of patients into a form that can be stored in a computer and retrieved when needed. The goal is to have available for scientific use the clinical medical records



— An experimental x-ray image processing technique has been developed at Tulane by a research team of radiologists and bio-medical engineers, and computer specialists. Picture at left is typical radiograph, or x-ray. The metastatic cancer nodule (circle area) is more clearly visible in right photograph after scanning and conversion of information in original x-ray, and processing by computer. Reproduced image is displayed on oscilloscope screen, which can be photographed.

of patients as well as all information regarding observations, procedures and conclusions to aid physicians in diagnosing and treating patients.

Team members foresee the extension of such a system to the establishment of regional and national medical record centers linked by high-speed communications facilities. This would make a person's medical record available quickly from a central point when it is required.

In addition, computer processable records could be gathered from sources throughout the nation to study major health problems of the population or to detect trends of infectious diseases.

PULSE ANALYSIS

A Tulane-IBM team has been applying computer technology to the study of blood pressure pulse waves. The effort is directed toward correlating the velocity and shape of the pulse wave detected in an individual's finger, for example, with the status of his cardiovascular system.

To collect this information from patients, a small, mobile unit equipped with electronic monitoring devices has been developed. The unit is being used experimentally in the Tulane departments of surgery and psychiatry.

According to team members, this project will lead to more effective techniques for monitoring surgical patients and may also be useful in monitoring astronauts undergoing training in our manned space program.
(For more information, circle 31 on the Readers Service Card.)

COMPUTER WINS CONTEST
(FRONT COVER STORY)

George Woodruff, a space engineer at Cape Canaveral, Fla., has used an electronic computer to turn out 95,040 entries in a national contest sponsored by the Onan division of Studebaker Corporation, Minneapolis, Minn. The Onan contest called for contestants to select and rank in order of importance five out of 12 numerically listed features of Onan generators that customers like best. There was no limit on the number of entries from one person.

The computer used was a TRW (Thompson Ramo Wooldridge) model 230. Of its 8192 memory units, only 82 were required for the exercise.

Woodruff assured himself victory by programming the computer to write every possible five-digit permutation of the numbers one through 12. His entry — measuring 160 feet long and weighing almost three pounds — automatically made him winner of one of 10 1500-watt portable electric plants offered as prizes. Programming time was estimated at approximately two hours. Think time for the computer was 1 minute, 44 seconds.

The retail value of Woodruff's prize is $375. Why did he put so much (relatively) into so little? Mainly because of the intrigue the contest held for him — knowing it could be beaten with a computer and proving it. Also, his company (an operating division of TRW) was in the process of purchasing the computer and he was assigned to check it out. Hence his imaginative feat at no real cost to the employer.

COMPUTER TO SPEED CONTROL SERVICE FOR GREATER NEW YORK BLOOD COUNCIL

A computer will be used to speed and control the task of managing New York City's scattered inventory of whole blood. The Community Blood Council of Greater New York, a non-profit organization formed to improve the supply and distribution of whole blood in New York, will use an IBM 1440 data processing system to process records of some 100,000 pints of whole blood which it expects to handle in 1964. The system can be expanded to handle up to 300,000 units of blood a year as the need develops.

The Council, after receiving a request for a particular type of rare blood, will be able to retrieve from the computer a list of locations where that type of blood is stored, or a list of names, addresses and telephone numbers of possible donors — in approximately two minutes.

On a day-to-day basis, the data processing system will maintain round-the-clock inventory control of whole blood scheduled for refrigerated vaults planned by the Blood Center. It will be capable of maintaining similar control for some 100 hospitals and other agencies in the metropolitan area. Each day, the computer will provide such records as: tabulations of the amount of blood on hand at each location; estimates of new blood units — by type — needed by each location to maintain sufficient inventories; lists of new blood donations — by type — needed to replenish units used during the previous day throughout the city; and tabulations of all blood units which have reached the dangerous age of 21 days and, therefore, must be removed for use in blood plasma. The computer will also provide weekly rosters of donors, who after an eight-week waiting period, are eligible to donate again.

Two IBM 1311 disk storage drives will provide random access memory for the computer system. They will use five interchangeable packs which are capable of holding a total of almost 10 million characters of information.

New information will be fed into the computer as it is received. From the information fed into it, the IBM 1440 will compile, sort, tabulate and otherwise prepare reports as directed by programs of the Blood Council.
(For more information, circle 28 on the Readers Service Card.)

COMPUTER CONTROLS EXCHANGE OF TRANS-ATLANTIC MESSAGES

An electronic computer has controlled the transmission of messages between Europe and the United States, automatically routing them to their destinations over trans-Atlantic communications facilities. The intercontinental exchange originated in Brussels, Belgium, during a meeting of the International Aeronautical Telecommunications Society (SITA).

The purpose of the demonstration was to illustrate the feasibility of world-wide computer-controlled communications over existing facilities. It made use of IBM Corporation's internal Teleprocessing system, a network which links 257 IBM offices in the United States. The IBM office in Brussels joined the network temporarily for the demonstration.

A computing center at IBM's laboratory in Kingston, N.Y., routed messages from Brussels to IBM offices in Los Angeles, New York, Washington, White Plains, N.Y., and other U.S. cities. Responses were channeled through the Kingston center for retransmission to Brussels. The two-way transmissions were completed in minutes.

The demonstration illustrated the system's ability to intercept messages with incorrect addresses, messages sent out of sequence, and messages which are incomplete because of operator error or faulty transmission. The Kingston switching center automatically instructed Brussels to re-transmit erroneous messages which deliberately had been placed in the system.

During the demonstration, the Kingston center continued its normal operations, which include the routing and logging of thousands of messages daily. Since beginning operations in April of this year, the IBM system has routed more than one million messages among company locations throughout the United States.
(For more information, circle 27 on the Readers Service Card.)

COSTS OF ELECTRICAL WORK ESTIMATED BY COMPUTER

A small computer, an LGP-30, is performing a new money-saving role in the construction field — helping a contractor to estimate costs of electrical work on commercial and industrial buildings. The cost-estimating technique was developed by Hoffmann Electric Co., Inc., St. Paul, Minn., in cooperation with the Commercial Computer Division of General Precision's Information Systems Group. A prime result has been reduction in the cost of cost-estimating — traditionally one of the major overhead expenses in the electrical-contracting field.

To prepare a cost estimate, a heavy volume of computations is required. A $25,000 job may require some 2000 items such as several types of wire, conduit, boxes, and devices. The contractor must estimate the cost of these items. In the past the computations have been performed manually, a repetitive and tedious job.

In the Hoffmann system, data on costs, inventory levels and other pertinent factors concerning the items are stored on the computer's memory drum. Fresh information on requirements of a new job is given the computer. It then computes the required cost estimates at electronic speeds and prints out the results.

John P. Friel, Hoffmann Electric's treasurer says as much as 25% of an estimator's time has been saved. Hoffmann's is now able to bid all the jobs it wants — even if three or four come up within a couple of days of each other.

The cost-estimating program can be used effectively by other contractors of the construction industry as well as by plumbing, air-conditioning, cement, and general contractors.
(For more information, circle 26 on the Readers Service Card.)

NEW CONTRACTS

NASA COMPUTER PROGRAM TO CALCULATE TO A PRECISION OF ONE IN A BILLION

A new mathematical approach is being prepared for NASA's earth-bound computers by Sperry Rand Corporation, Great Neck, N.Y., to determine the orbit of a space vehicle with a precision of .999999999 — or a hundred thousand times more accurately than scientists can now gauge the orbits of the natural planets. The new computer program is being compiled for NASA's Goddard Space Flight Center under a $190,000 contract.

To space probes travelling progressively farther into space, a precision of one part in a billion would mean a positional accuracy of about one foot at the moon, 12 feet at Venus, and 17 feet at Mars. Reversing the comparison, as the computer will inevitably do, would mean pinning down the position of the moon, Venus, Mars or other planets with far more accurate a yardstick than the 92,900,000-mile astronomical constant in current use. The location of Venus, by today's standards, is a question of a few thousand miles.

The new program being prepared uses a recent mathematical approach called the Minimum Variance Method, which was devised largely by Dr. R. E. Kalman, from the Research Institute for Advanced Sciences. Using the Minimum Variance technique, an orbit is calculated as the vehicle is in flight by what might be termed the "building block method" First raw data is converted into an orbital estimate. Then the estimate becomes the basis for the next calculation.

In contrast, the conventional Least Squares method takes and stores data over an entire portion of flight before the computer begins to calculate an orbit; then the process begins anew with data for the next leg of the voyage.

Sperry's Minimum Variance approach is called ODP, or Orbital Determination Program. An abbreviated version (accurate only to one part in a million) will be rushed to NASA in time for a shakedown run during the launching of Goddard's unmanned interplanetary probe, IMP.

The longer version, accurate to a billionth, is scheduled for delivery in July, 1964. The unabridged ODP will be under the control of an executive program. It will be written in Fortran.
(For more information, circle 33 on the Readers Service Card.)

SPERRY SELECTED TO PROVIDE EDP EQUIPMENT FOR AIR FORCE INVENTORY ACCOUNTING

Sperry Rand Corporation has been selected, on the basis of the lowest bid submitted, to provide electronic data processing equipment for the Air Force base level inventory accounting system. The Corporation's Univac Division, Washington, D.C., will furnish computers, assist in installation, provide training, system support and maintenance at approximately 152 bases in the United States and overseas. Major components of the equipment will be manufactured in Philadelphia, Pa., and Utica, N.Y.

The first operational computer is scheduled to be installed at the base supply facility, Andrews Air Force Base, in May, 1964. Following acceptance of this computer, based on a 90-day test, the Air Force will install 10 computers per month at other bases until the program is completed. The anticipated cost of purchased equipment is approximately 37 million dollars. Lease of non-purchase equipment and maintenance of all systems when installed will be about $250,000 monthly.
(For more information, circle 38 on the Readers Service Card.)

SDC RECEIVES CONTRACT TO STUDY COMPUTER-BASED FOOD-ORDERING SYSTEM

The first step in the automation of menu planning for large hospitals — a computer-based food-ordering system — will be studied by scientists of System Development Corporation, Santa Monica, Calif., and Veterans Administration professional personnel under a nine-month $62,000 contract. The SDC/VA team will determine if the Veterans Administration can advantageously incorporate linear programming as a tool in its food-ordering system. Food purchases for VA hospitals throughout the country currently amount to $50 million a year.

It is hoped that the study will enable VA dietitians to request sets of food which can satisfy hospital needs for a 28-day period at minimum cost.
(For more information, circle 34 on the Readers Service Card.)

ITT DIVISION RECEIVES $1.5 MILLION CONTRACT FROM NAVY CENTER

A $1,535,569 contract extension to provide computer programming services to the Navy's Fleet Computer Programming Center, Atlantic, at Dam Neck, Va., has been awarded to the Data and Information Systems Division of International Telephone and Telegraph Corp., Paramus, N.J. The contract, awarded by the Naval Supply Center, Norfolk, Va., requires ITT DISD programmers to translate the existing navigational, operational and tactical plans into computer language for use aboard ship. This is an extension of the original contract awarded to DISD last January, which expired on June 30, 1963.
(For more information, circle 40 on the Readers Service Card.)

MULTI-MILLION CONTRACT TO UNIVAC FROM AIR FORCE

A $5.5 million Air Force contract for nine computing systems has been announced by UNIVAC Division of Sperry Rand Corp., New York, N.Y. The contract calls for three UNIVAC 1107 thin-film memory computers and six UNIVAC 1050 systems for use within the Air Force Logistics Command (AFLC). The systems will be connected through AUTODIN, the Air Force world-wide communications network, to perform a wide variety of command support functions.

Each of the Air Force 1107 systems will contain 32,000 words of core memory and be equipped with sixteen Uniservo III-A tape units, a paper tape unit, a flying head 880 immediate access storage unit, and two Uniservo III-C tape units. Three of the six 1050's will contain 12,000 positions of core memory using five peripheral units, which include two Uniservo III-A tape units; one 1000 card-per-minute card reader; a 300 card-per-minute punch; and a 700-922 line-per-minute high speed printer. The balance of the 1050 systems will have the basic configuration but will be equipped with a 16,000 positions memory and two 700-922 line-per-minute high speed printers. The systems will be installed in Sacramento, Calif; Rome, N.Y.; and AFLC Headquarters, Dayton, Ohio.
(For more information, circle 35 on the Readers Service Card.)

NEW INSTALLATIONS

NORFOLK NAVAL SUPPLY CENTER INSTALLS LARGEST IBM 1410

An IBM 1410 data processing system, the largest computer of its type ever built by the IBM Corp., is the heart of a management control system for the Naval Supply Center, Norfolk, Va. The IBM 1410 system is capable of storing 280 million characters of information in its random access memory.

The Naval Supply Center will be able to combine speed and precise inventory and financial control in every aspect of ordering, warehousing and shipping the 726,000 different items handled by the Center. The items range from one-ounce transistors to 10-ton anchors. The system is linked electronically to seven remote inquiry terminals in warehouses and management control points within the Naval Supply Center. The Center itself is linked through a world-wide logistic data communications network to 526 points in the United States and to 26 foreign countries.
(For more information, circle 48 on the Readers Service Card.)

DATA ACQUISITION SYSTEM DELIVERED TO LOCKHEED PROPULSION COMPANY

A high-speed data acquisition and processing system has been delivered to Lockheed Propulsion Company's rocket engine test facility, Redlands, Calif., by Beckman Instruments, Inc., Fullerton, Calif.

The Model 210 Data Acquisition System was designed to process data gathered during static test firing of solid fuel rocket motors. The system samples analog data from the test complex, changes the data to a digital format, and records it on magnetic tape for later processing.
(For more information, circle 49 on the Readers Service Card.)

EAI PROPORTIONING COMPUTER FOR CEMENT RAW MATERIALS

A computer, for use in the proportioning and control of cement making raw materials, will be installed at the Alpha Portland Cement Company, Cementon, N.Y. The analog computer, known as PC-12, has been ordered from Electronic Associates, Inc., Long Branch, N.J., by the M. W. Kellogg Company, which has engineered and is constructing the cement plant.

The PC-12 proportioning computer, while specifically tailored to the special requirements of the cement industry and the plant in question, is basically similar to other EAI PC-12 units used to control various process functions.
(For more information, circle 53 on the Readers Service Card.)

EG&G INSTALLS MAJOR COMPUTER COMPLEX

Edgerton, Germeshausen & Grier, Inc., Boston, Mass., has installed a Control Data 1604B/160A system at its new research laboratory in Las Vegas, Nevada. The system is built around a high-speed master computer, with a 32,000 word memory (48 bits/word), eight magnetic tape transports, and a 160A satellite computer. A 1612 printer also is associated with the system. In addition to its scientific tasks, the new computer will be used to perform extensive Program Evaluation and Review Technique (PERT) studies for the Atomic Energy Commission.
(For more information, circle 55 on the Readers Service Card.)

BANK INSTALLS IBM 7010 — REPLACES IBM 1410

Girard Trust Corn Exchange Bank, Philadelphia, Pa., has recently installed an IBM 7010 computer system, replacing the IBM 1410 system which has been in operation since early 1962. The

new system, while equal in size to the 1410, has four times the speed and 50% more memory capacity. It is fully compatible with the bank's former IBM 1410-1401 system.
(For more information, circle 57 on the Readers Service Card.)

ORGANIZATION NEWS

EAI ACQUIRES WEST COAST COMPUTER FIRM

Electronic Associates, Inc., Long Branch, N.J., has acquired control of Pacific Data Systems, Inc., Santa Ana, Calif., a firm specializing in low-cost digital computers. Pacific Data Systems formerly was a wholly-owned subsidiary of the Mesa Scientific Corporation of Inglewood, Calif. The acquisition was made for an undisclosed amount of cash.

PDS will be operated as an EAI subsidiary with headquarters and manufacturing facilities in Santa Ana. PDS products will find use in advanced hybrid computer systems as an input/output device. They also will extend EAI capabilities in process control. The PDS computer line does not replace either the analog or the hybrid computer at EAI in their established field of scientific computation. The new line includes the PDS 1020 engineering computer and the PDS 1068 general purpose control computer.
(For more information, circle 61 on the Readers Service Card.)

NEW FIRM FORMED

Announcement has been made of the formation of Howard Aiken Industries, Inc., which will take over the businesses presently operated by the P. R. Hoffman Co., Carlisle, Pa. and Mechanical Products, Inc., Jackson, Mich. Both of these companies will be operated as separate divisions of Howard Aiken Industries which will maintain its executive offices in Carlisle, Pa.

The P. R. Hoffman Co., founded in 1938 to manufacture machinery for the production and processing of quartz crystals, is now one of the prime suppliers of both synthetic and natural crystal blanks used in the electronic and aerospace industries.

Mechanical Products, Inc., founded in mid-1940, manufactures aircraft circuit breakers, overload protectors for small motors and controls for smog free mufflers.

Dr. Howard H. Aiken, president and board chairman of the Hoffman organization, will retain the same positions in the newly-formed company. Other officers of the new parent company will include C. Albert Nelson, vice president; Leon W. McGinness, vice president; R. H. Early, secretary-treasurer; Edward R. McPherson, Jr., assistant secretary; and Freida McKillip, assistant treasurer. As presently composed, the company is engaged in the electronic component, aerospace, electrical equipment, home appliance and aeronautical fields.
(For more information, circle 66 on the Readers Service Card.)

HUGHES DYNAMICS ACQUIRES TELLERTRON CORPORATION

Hughes Dynamics, Inc., Los Angeles, Calif., has acquired Tellertron Corp., Boston, Mass., manufacturer and operator of automated systems for financial institutions. Under terms of the agreement, Hughes Dynamics acquires all assets of Tellertron, including its product designs and engineering drawings, plus the services of S. Gerald Stone, president of Tellertron. Mr. Stone will henceforth headquarter in Los Angeles.
(For more information, circle 60 on the Readers Service Card.)

AMPEX EXPANDING INTERNATIONAL OPERATIONS

Ampex Corporation, Redwood City, Calif., has announced plans to begin manufacturing operations within the European Common Market, and to double its manufacturing capacity in the United Kingdom.

Ampex will occupy a plant at Nivelles (near Brussels), Belgium, early in 1965, to manufacture instrumentation and computer tape recording equipment for Common Market customers.

At Reading, England, construction has already begun on a new plant to expand present facilities. The new plant is expected to be completed in the latter part of 1964. It will be used for manufacture of magnetic recording and ferrite memory devices.
(For more information, circle 63 on the Readers Service Card.)

NEW ACQUISITION FOR AUERBACH CORPORATION

Auerbach Corporation, Philadelphia, Pa., has announced the acquisition of Scientific Information Services, Inc., a Philadelphia company that provides literature research and documentation services, particularly in the areas of medical, pharmaceutical, and related scientific information. All of the services formerly provided by SIS will be continued as part of the Auerbach Information-Management Sciences Division.
(For more information, circle 65 on the Readers Service Card.)

COMPUTING CENTERS

COMPUTER TAPE LIBRARY

The Internal Revenue Service, Washington, D.C. has recently announced a library of computer tapes containing income data compiled from tax returns. The computer tapes hold the raw material used in compiling Internal Revenue Statistics of Income reports on individuals, corporate and non-corporate businesses, and gift, estate and fiduciary tax returns. Tapes used for the "tax model" (a sampling of tax returns that are a representative cross-section of all returns filed) are also in the library.

The computer tape library will provide a source of historical data for business researchers, analysts, legislators and government officials. It will enable information and comparisons to be drawn from tax returns that have never been published before. The tapes contain edited, unsummarized data for each return used in the sampling from which Internal Revenue has prepared its statistical reports.

Access to library contents by private researchers may be made under the provisions of Public Law 87-870. Use of the library is on an actual cost basis. Users may pay to have their projects run on Internal Revenue equipment, and within certain limitations, copies of the computer tapes may be purchased from Internal Revenue.
(For more information, circle 68 on the Readers Service Card.)

CSC SERVICE BUREAU TO OFFER NATIONWIDE ON-LINE COMMUNICATIONS

Direct on-line communication with a large scale computer will soon be available to business and scientific users throughout the United States at the Service Bureau Division of Computer Sciences Corp., El Segundo, Calif. Computer Sciences Corporation, a data processing service organization, has offices in Houston, Los Angeles, San Francisco, New York and London.

Customers with machine time on CSC's large scale 1107 computer will be able to transmit up to 342 characters per second through use of standard Data phone sets and a new Univac Data Line Terminal to be installed on the 1107. The system is expected to be operational within six months.

The system is especially suited to users with Univac 1004 card processors, although it will accept all 80- or 90-column card data. CSC customers, using the new communications system, will experience a turn around time of minutes as opposed to hours. Problem solutions will be printed on-line at customer sites throughout the country. At present, 24-hour turn around service is available to eastern users.

Machine independent languages such as COBOL, FORTRAN, etc. will continue to be used with the new system.
(For more information, circle 69 on the Readers Service Card.)

COMPUTER CENTER FOR SHORT LINE CARRIERS

A new data processing center will open in the heart of the trucking industry in Montebello, Calif., January 1964. The new facility, known as Transport Data Processing, will offer modern automated accounting to the trucking industry. The company was established to bring the age of computer accounting to small, medium and even large carriers who heretofore were unable to avail themselves of this service because of the high rental cost of computers and the technical skill necessary for programming and carrying out these systems.

Transport Data Processing, using an IBM 6400, will act as the general accounting office for carriers who have offices or terminals in the Southern California area. The new company offers complete research facilities in conjunction with nearby IBM offices to answer any accounting or statistical questions in relation to trucking operations.
(For more information, circle 70 on the Readers Service Card.)

CONTROL DATA OPENING NEW YORK COMPUTING CENTER

Control Data Corporation, Minneapolis, Minn., is opening its newest computing center in New York City. This brings to a total of five, the Control Data Centers serving the metropolitan areas of New York; Los Angeles and San Francisco, Calif.; Washington,D.C.; and Minneapolis. The New York Computation Center will be located in Great Neck, Long Island.

Computing equipment will include the Control Data 1604-A computer system and the high-speed Control Data 606 magnetic tape handlers as well as a complete line of other peripheral devices to handle a variety of data processing formats.

In addition to leasing computer time, the Center will provide computation services including mathematical and systems analysis, programming services, and equipment operations.
(For more information, circle 67 on the Readers Service Card.)

EDUCATION NEWS

AUTOMATED TEACHING SYSTEM FOR ACCIDENT PREVENTION

A new automated system for teaching accident prevention has been developed by Ken Cook/Lectron, Milwaukee, Wis. The system, called LECTRON Audio-Vision, is custom created for individual plant or plant departments. The device offers a four-step method of safety control.

The Audio-Vision System works in the following manner:

(1) A complete evaluation of safety violations is made in a particular plant department. From this data a ratio of violations to exposures is made to pinpoint possible danger areas.

(2) Actual on-the-job scenes are photographed in full color and training programs are prepared based on the client's exclusive safety needs.

— LECTRON Audio-Vision — a new automated teaching system for accident prevention.

(3) Audio-Vision programs on safe and unsafe practices are presented to supervisory personnel on the LECTRON Console. Personnel participate in the presentation; they respond to questions and the console tells them, automatically, whether they are right or wrong. Supervisors are trained to remember and recognize unsafe work practices.

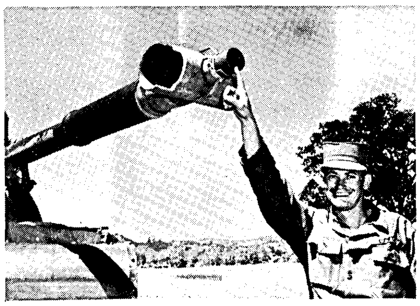
(4) The LECTRON Console may be used as a training tool for new employees. Its programs are subject to constant review and updating by Ken Cook personnel.
(For more information, circle 71 on the Readers Service Card.)

HIT-KILL INDICATOR

The military training problem of firing weapons at live targets and gaining immediate indication of a "hit" on a live target at effective hit-kill ranges — all without the use of live ammunition — may soon be solved with a new electronic system developed by Aircraft Armaments, Inc., Cockeysville, Md. The new training device, known as the "Hit-Kill Indicator", is designed for tanks and other modern weapons. It can be installed without modification of the weapons, insuring rapid return to a combat ready condition when required. The new device is undergoing performance tests by US Army Combat Developments Command Experimentation Center (USA CDCEC) personnel.

Newsletter

The Hit-Kill Indicator fires ammunition, a paper round — a data card bearing fuse and range marks — which is inserted in the weapon's control unit by the gunner. When Hit-Kill Indicators are mounted on tanks, all targets (tanks) on the battlefield are on standby until one tank fires. Firing consists of an infrared flash directed at all targets on the field — with only the one being aimed at and fired having the matching identification code or pulse. This is flashed back to the firing tank and picked up by its photo-electric telescope, closing the circuit.



— The "killing" end of the Hit-Kill Indicator is a photo-electric telescope in the tank's barrel which exchanges infrared signal pulses with the target to make the "kill". The photo-electric device, which completes a "fire mission" in less than a half second, can be used for weapons capable of 4000 meter ranges, while other versions are man-portable for simulated combat with the M-14 Rifle.

Instantly a firing simulator detonates, producing smoke and noise, while the target tank also detonates smoke. Before the tank's circuits are remotely turned off, a light signals the crew their tank is hit and disabled. The whole cycle — aiming, locking on, firing and the kill — takes less than a half-second; and is recycled by a simple key switch.

In addition to the basic hit indicator elements, the device includes accessory devices which generate, process, record and transmit data required for hit assessment.
(For more information, circle 72 on the Readers Service Card.)

"MAGNETIC MEMORY" — A 16mm COLOR FILM

A professionally-produced, 16mm color film on magnetic recording tape is being offered by the 3M Company, St. Paul, Minn.

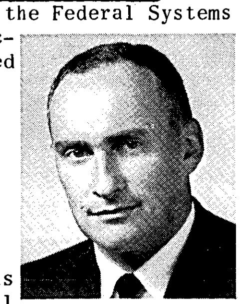
The 25-minute sound film, entitled "Magnetic Memory", opens with a non-technical description of the theory of sound and recording. The film progresses through the many uses of tape, from capturing a baby's first words to preserving the technical data of a manned space shot. The manufacturing process is outlined, along with a description of the controls needed to produce a quality tape.

The 3M Company is making the film available on a free-loan basis for showings to clubs and other organizations.
(For more information, circle 73 on the Readers Service Card.)

PEOPLE OF NOTE

SPONSLER JOINS IBM FEDERAL SYSTEMS DIVISION

Dr. George C. Sponsler has joined IBM as the Federal Systems Division director of advanced planning. He will analyze the Federal Government's long-range advanced systems requirements and develop operating plans for the Federal Systems Division.



Dr. Sponsler formerly held the dual responsibility of the chief scientist for research and development, and director, technical analysis and operations research staff in the Navy's Bureau of Ships.

COMMITTEE CHAIRMAN APPOINTED BY IEEE

Gerhard L. Hollander, President and Technical Director of Hollander Associates, Fullerton, Calif., has been appointed Chairman of the Computing Devices Committee of the Institute of Electrical and Electronics Engineers for the year 1964. The retiring chairman is C. A. R. Kagan of Western Electric.

The Computing Devices Committee consists of 40 experts in the computer field whose function it is to guide the Institute's technical activities in the computer field. This function includes the review of papers for Institute conventions and publications, the annual assessment of computer progress, the sponsoring of special technical sessions and conferences, and the conducting of workshops.

EXECUTIVE NOTES FROM IBM

T. V. Learson, IBM vice president and group executive, has been assigned group responsibility for the Data Processing Division, IBM's major marketing group.

A. K. Watson, IBM vice president and group executive, and since 1954 president of IBM World Trade Corporation, will now head the IBM corporate staff. He will continue his association with the IBM World Trade Corporation as chairman of the board of that subsidiary.

Dr. John Gibson has been elected IBM vice president and group executive with responsibility for the Data Systems, General Products, and Components divisions.

G. E. Jones has been elected vice president and group executive and president of the IBM World Trade Corporation.

Dr. E. R. Piore, IBM vice president, has become a group executive with responsibility for the Advanced Systems Development and Federal Systems divisions and IBM Research — which now becomes the Research Division.

M. B. Smith, IBM vice president and group executive, has been given responsibility for the Supplies and Electric Typewriter Divisions and will be the corporate reporting point for the Service Bureau Corporation.

Richard H. Bullen, formerly treasurer, has been elected a vice president and deputy director of the corporate staff of IBM Corp.

Kenneth N. Davis, Jr., formerly controller, has been elected treasurer.

Hilary A. Faw, Jr., has been elected IBM controller. He was formerly controller of the company's Data Systems Division.

APPOINTMENTS ANNOUNCED AT GENERAL PRECISION

The appointment of R. W. Lee as president of the Information Systems Group, General Precision Inc., Glendale, Calif., has been announced by General Precision president D. W. Smith. Mr. Lee, formerly executive vice president and general manager of the group, replaces W. E. Bratton, who resigned effective November 1. No successor has been named to Mr. Lee's former position at this time.

Announcement has also been made of the appointment of Francis J. Alterman as president of the Commercial Computer Division of the Information Systems Group of General Precision, Inc. This division produces a line of low-cost business and scientific computers and a wide range of computing and missile-ordnance components.

UNIVAC NAMES NEW CONTROLLER

John F. Walrath has been appointed controller of the UNIVAC Division of Sperry Rand Corporation. Mr. Walrath was formerly with General Electric where he served for 26 years in various financial and business planning positions.

ANGIER NAMED DIRECTOR OF EDP INDUSTRY COUNCIL

Myron A. Angier has been named director of the EDP Industry Council by Honeywell Electronic Data Processing, Wellesley Hills, Mass. The post is a new one. Mr. Angier was formerly New England District and area sales manager for the Univac division of the Sperry Rand Corporation.

In his new position he will direct the activities of the Council, which was formed earlier this year to provide specialized support for Honeywell marketing activities in eleven industries ranging from financial management to public utilities.

MEETING NEWS

FJCC EX POST FACTO PROFILE

What? 1963 Fall Joint Computer Conference

Where? Las Vegas Convention Center, Las Vegas, Nev.

When? November 12-14, 1963

Who attended? Approximately 2600 computer executives, engineers, and programmers registered at the show.

Who exhibited? 73 exhibitors occupied 163 booths and displayed approximately $8 million in equipment. Eleven operating digital computers were displayed including the new CDC 3200, a Honeywell 400, IBM 7044, LGP-21, and SDS-920.

Proceedings? The 600+ page collection of technical paper is available from Spartan Books, 301 N. Charles St., Baltimore, Md.

Highlights...

● The Air Force's Major General Terhune called in his keynote address for a re-evaluation of the approach to systems design. He said that in the past, computer programming on some command and control programs has run over $30 per instruction, yet the user was not able to communicate in a flexible way with the computer. Terhune emphasized the need for "implicit programming" of computers so that the military commander can have the power to directly interrogate the information stores of the computer in versatile ways.

● A group of 12 Las Vegas high school students were taught to program a computer during the conference, and within two hours they had operating programs on a G-15 computer. Later they put on an impressive set of computer demonstrations for their classmates.

● A special symposium on "Computers and Changing Employment Patterns" featured speakers from the U.S. Department of Labor, the AFL-CIO, Fund for the Republic, Computer Manufacturers and Users, and AFIPS. After three hours of noble efforts, the participants failed to agree on either the qualitative or quantitative aspects of the problem. Fletcher Jones of Computer Sciences Corp. termed the effect of computers on employment "of no consequence during the next five to ten years", while Ted Silvey of the AFL-CIO recommended immediate Federal action to step up the retraining of workers with obsolete skills, and to administer the rate of introduction of automation. U.S. Dept. of Labor's Gantz saw the situation as one "worthy of further study".

● An LGP-21 computer matched its calculating ability against a "21" dealer at the Tropicana Casino, and won $350 in 50 minutes with bets ranging from $2 to $42.

BUSINESS NEWS

SALES AND PROFITS INCREASED DURING FIRST QUARTER AT CONTROL DATA

The first quarter of Control Data Corporation's seventh fiscal year, the three months ended September 30, 1963, shows sales, rentals, and service income was $19,618,815, up 62% compared with the same period of the previous year. Net profits after provision for federal and state income taxes for the three months period ended September 30, 1963, were $1,129,058.

Per share earnings on the common stock, on the basis of the number of shares outstanding at September 30, 1963 and 1962 were $0.27 and $0.06 in the two periods respectively.

LITTON PROFITS UP 43%

In its annual report, Litton Industries has stated that fiscal 1963 after-tax profits rose to $23,296,107, a 43% increase from the $16,315,952 earned in the previous year. Federal and foreign income taxes amounted to $20,500,296, compared with $14,533,547 in fiscal 1962.

Earnings for 1963, after payment of preferred dividends, were equal to $2.29 a share on the 10,145,217 common shares outstanding on July 31. In the previous year earnings per share amounted to $1.64 after adjustment for a two-for-one stock split in August 1962 and a 2½% stock dividend in December 1962.

Sales and service revenues increased 40%, to $553,146,239, from $393,807,709 in fiscal 1962.

At year end, the company had 43,417 shareholders of record, compared with 32,755 at the close of the previous year.

IBM NET EARNINGS UP 17.9%

For the nine months ended September 30, 1963, net earnings of IBM Corp. were $206,970,232 after estimated U.S. Federal income taxes, an increase of 17.9% over the $175,522,831 reported for the same period last year. Net earnings for the nine months ended September 30, 1963, before U.S. Federal income taxes, amounted to $420,370,232 compared with $358,722,831 in the corresponding 1962 period.

Gross income for the nine months ended September 30, 1963, from sales, service and rentals in the United States amounted to $1,509,215,727 compared with $1,399,360,957 in the corresponding 1962 period, an increase of 7.9%. Gross income from IBM regular products showed an increase of 12.9%. Military products gross income showed a 30.7% decrease compared with the nine months of 1962, reflecting a reduction in supply or production type contracts and a greater emphasis toward research and development contracts.

Included in IBM's net income are net earnings of the IBM World Trade Corporation totaling $24,475,985 for the nine months of this year compared with $18,430,205 for the same period last year.

Undistributed net earnings of IBM World Trade Corporation's foreign subsidiaries, excluded from net earnings reported, amounted to $48,384,686 for the nine months ended September 30, 1963, compared with $42,310,238 for the nine months of 1962.

CSC REPORTS RECORD MID-YEAR SALES AND EARNINGS

CSC President Fletcher Jones has announced that sales and net earnings for Computer Sciences Corporation during the six months ended September 30, 1963, have established a record mid-year high for the company.

Service revenues during the six month period were $1,968,657, an increase of 49% over $1,318,115 for the corresponding period in 1962. Net earnings also increased from $144,923 to $201,254, and per share earnings rose from 23 cents to 31 cents based on 640,000 shares outstanding.

NCR'S NINE-MONTH SALES TOTAL $415,002,618

Sales of the National Cash Register Company for the first nine months of 1963 totaled $415,002,618; for the comparable period of 1962 NCR's sales were $393,577,734. Net income was $12,348,076, compared with $13,515,311 for the first three quarters of last year. The 1963 nine-month earnings amount to $1.49 a share on the 8,298,957 shares outstanding on September 30, compared with $1.63 on 8,298,707 shares as of September 30, 1962.

Earnings reported by NCR subsidiaries and branches outside the United States were $10,786,813 after foreign taxes, compared with $10,820,159 for the first nine months of 1962. In accordance with company policy only those foreign earnings remitted to the United States, plus the earnings of NCR's Canadian subsidiary, were included in net income. After U.S. taxes these foreign remitted earnings were $7,038,729 for the nine months, compared with $6,836,363 last year.

Robert S. Oelman, chairman and president of NCR, said the reduction in the company's net income for the first nine months of the year was due primarily to the increasing volume of NCR's machine rental business — largely made up of electronic computer systems. Rental of such systems requires that the company initially bear the substantial manufacturing marketing, installation and depreciation costs involved, even though its rental income is received only over a period of years. Mr. Oelman anticipates that the long-range results of the expanding rental business will be favorable.

COMPUTER SYSTEMS, INC. REPORTS 6-MONTHS EARNINGS

Computer Systems, Inc., Fort Washington, Pa., reported earnings for the first six months ending June 30th of $26,434 on sales of $358,388. For the corresponding period of 1962, the company showed a loss of $334,600 on sales of $424,283. CSI is accelerating production of hybrid computing systems for engineering and scientific applications. The DYSTAC SS-100 analog computer announced in March is scheduled for production in mid-1964.

"NEW PATENTS"

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

November 7, 1963

The following is a compilation of patents pertaining to computer 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 Commissioner of Patents, Washington 25, D. C., at a cost of 25 cents each.

September 10, 1963 (Continued)

3,103,578 / Wallace E. Dietrich, Jr., Baltimore, Md. / U.S.A. as represented by the Sec. of the Navy / Digitized Analog Computer.
3,103,580 / Donald F. Foreman, Vestal, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Selective Data Shift Register.

September 17, 1963

3,104,317 / Harry W. Cochrane, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of New York / Binary Matrix Multiplier Utilizing Coincident Inputs and Sequential Readout.
3,104,318 / John L. Hill, North St. Paul, and Bernd H. Richelmann, St. Paul, Minn. / Ramsey Engineering Co., St. Paul, Minn., a corp. of Minn. / Integrating Circuit.
3,104,319 / John W. Ericson, Verona, Pa. / Westinghouse Air Brake Co., Wilmerding, Pa., a corp. of Pa. / Analog Computers.
3,104,325 / John A. Kauffmann, Hyde Park, and Robert M. Tomasulo, Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Binary Trigger.
3,104,326 / Aurie S. Myers, Jr., Poughkeepsie, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Self-Propagating Core Logic Circuits.
3,104,327 / William D. Rowe, Pittsburgh, Pa. / Westinghouse Electric Corp., East Pittsburgh, Pa., a corp. of Pa. / Memory Circuit Using Nor Elements.
3,104,346 / John Edward Marshall, Baginton, near Coventry, England / Whitworth Gloster Aircraft Ltd., Baginton, near Coventry, England / Pattern Controlled Programming Mechanism.
3,104,378 / Lyle Glen Thompson, Primos, Pa. / Burroughs Corp., Detroit, Mich., a corp. of Michigan / Static Memory System.
3,104,380 / Luther H. Haibt, Croton-on-Hudson, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Memory System.

September 24, 1963

3,105,143 / William A. Hosier, Stoneham, Mass., and Harry S. Hoffman, Jr., Saugerties, N. Y. / Research Corp., New York, N. Y., a corp. of N. Y. / Selective Comparison Apparatus for a Digital Computer.
3,105,144 / Leonard Roy Harper, San Jose, Calif. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Magnetic Core Adder.
3,105,157 / Robert H. Norman, Glen Oaks, N. Y. / Sperry Rand Corp., Great Neck, N. Y., a corp. of Delaware / Shifting Register Having Improved Information Transferring Means.
3,105,225 / Robert L. Williams and Bill L. Waddell, San Diego, and Joseph W. Crownover, La Jolla, Calif. / Daystrom, Inc., Murray Hill, N. J., a corp. of Texas / Method and Apparatus for Utilizing Ferroelectric Material for Data Storage.
3,105,226 / Andrew W. Bobeck, Chatham, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of N. Y. / Magnetic Memory Arrays.
3,105,231 / Bernard M. Gordon, Newton and Robert P. Talambiras, Boston, Mass. / Epsco Inc., Boston, Mass., a corp. of Mass. / Data Signal Processing Apparatus.

October 1, 1963

3,105,874 / Charles R. Fisher, Jr., Rochester, N. Y. / General Dynamics Corp., Rochester, N. Y., a corp. of Delaware / Solid-State Time Position Multiplexing and Demultiplexing System.
3,105,875 / Freddy David, Henrietta, N. Y. / General Dynamics Corp., Rochester, N. Y., a corp. of Delaware / Solid-State Binary Code Multiplexing and Demultiplexing Device.
3,105,897 / Herman Jacob Heijn, Eindhoven, Netherlands / North American Philips Co., Inc., New York, N. Y., a corp. of Delaware / Binary Parallel Adder Utilizing Sequential and Simultaneous Carry Generation.
3,105,956 / Evon C. Greanias, Vestal, and Arthur Hamburgen, Endicott, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Character Recognition System.
3,105,957 / Jam Li, Levittown, Pa. / R.C.A., a corp. of Delaware / Negative Resistance Diode Memory.
3,105,958 / Edwin J. Slovodzinski, Hopewell Junction, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of N. Y. / Memory Systems.
3,105,959 / Jacob Fredrik Klinkhamer, Eindhoven, Netherlands / North American Philips Co., Inc., New York, N. Y., a corp. of Delaware / Memory Matrices Including Magnetic Cores.
3,105,960 / Jean Francois Marchand, Eindhoven, Netherlands / North American Philips Co., Inc., New York, N. Y., a corp. of Delaware / Dynamic Magnetic Storage Circuit.
3,105,961 / Bloomfield James Warman, Charlton, London, England / Associated Electrical Industries (Woolrich), Ltd., London, England, a British company / Magnetic Storage Core Arrangements.
3,105,962 / Andrew H. Bobeck, Chatham, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of N. Y. / Magnetic Memory Circuits.

October 8, 1963

3,106,637 / Glenn A. Oliver, Ardmore, Pa. / Burroughs Corp., Detroit, Mich., a corp. of Michigan / Arithmetic and Logic System.
3,106,644 / Leo P. Retzinger, Jr., Los Angeles, Calif. / Litton Systems, Inc., Beverly Hills, Calif., a corp. of Maryland / Logic Circuits Employing Minority Carrier Storage Diodes for Adding Booster Charge to Prevent Input Loading.
3,106,648 / Howard O. McMahon, Lexington, and Albert E. Slade, Cochituate, Mass. / Arthur D. Little, Inc., Cambridge, Mass. / Superconductive Data Processing Devices.
3,106,649 / William R. Johnston, Los Angeles, Calif. / Ampex Corp., Culver City, Calif., a corp. of Calif. / Sensing Circuit Employing Two Tunnel Diodes to Provide Proper Current Distribution Upon One Being Switched.

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 American-made general purpose computers installed or on order as of the preceding month. 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.

Most of the figures are verified by the respective manufacturers. In cases where this is not so, estimates are made based upon information in the reference files of COMPUTERS AND AUTOMATION. The figures are then reviewed by a group of computer industry cognoscenti.

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

AS OF NOVEMBER 20, 1963

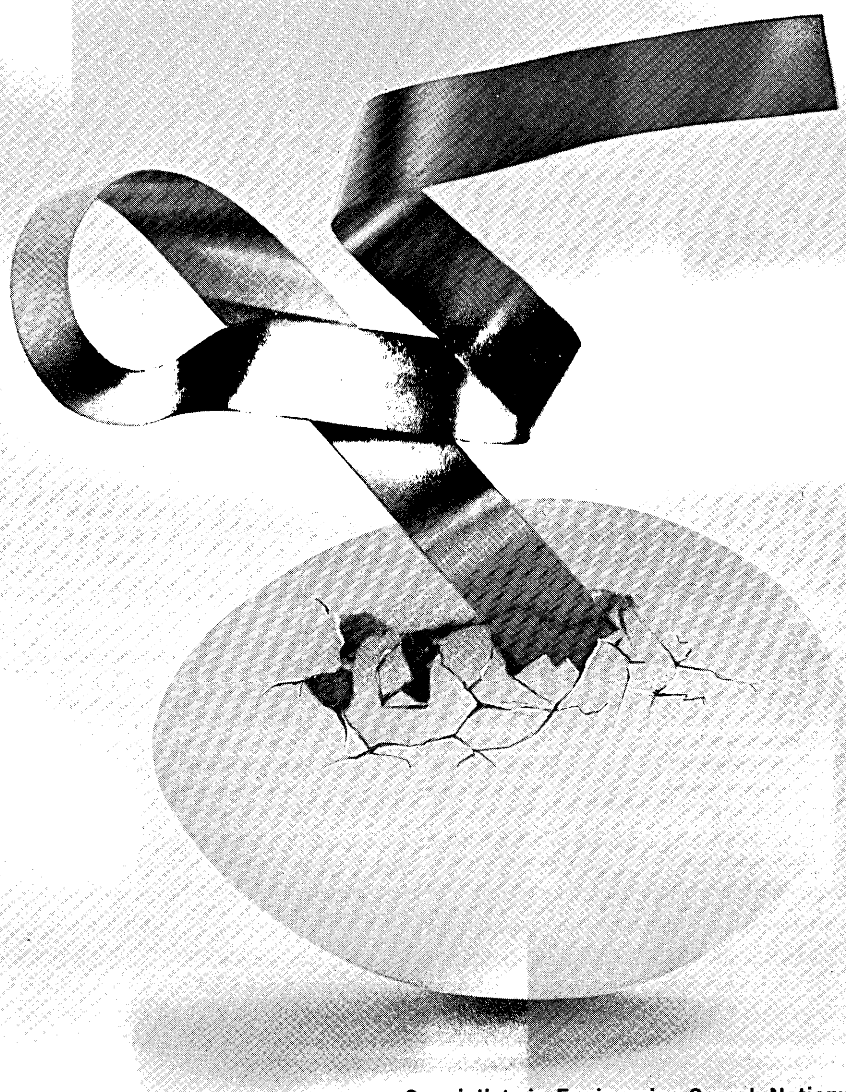
NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	19	10
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	11	2
	ASI 2100	Y	$3000	12/63	0	3
Autonetics	RECOMP II	Y	$2495	11/58	102	X
	RECOMP III	Y	$1495	6/61	28	X
Burroughs	205	N	$4600	1/54	55	X
	220	N	$14,000	10/58	42	X
	E101-103	N	$875	1/56	140	X
	B250	Y	$4200	11/61	59	28
	B260	Y	$3750	11/62	50	38
	B270	Y	$7000	7/62	35	24
	B280	Y	$6500	7/62	36	20
	B5000	Y	$16,200	3/63	11	22
Clary	DE-60/DE-60M	Y	$525	2/60	125	1
Computer Control Co.	DDP-19	Y	$2800	6/61	3	X
	DDP-24	Y	$2750	5/63	2	16
	SPEC	Y	$800	5/60	10	0
Control Data Corporation	G-15	N	$1000	7/55	280	X
	G-20	Y	$15,500	4/61	26	1
	160/160A	Y	$1750/$3000	5/60 & 7/61	330	30
	924/924A	Y	$11,000	8/61	20	18
	1604/1604A	Y	$35,000	1/60	52	8
	3600	Y	$52,000	6/63	6	12
	3200	Y	$9,000	5/64	0	14
	6600	Y	$150,000	2/64	0	1
Digital Equipment Corp.	PDP-1	Y	Sold only about $120,000	11/60	45	7
	PDP-4	Y	Sold only about $60,000	8/62	19	10
	PDP-5	Y	Sold only about $25,000	9/63	4	12
	PDP-6	Y	Sold only about $300,000	7/64	0	1
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	32	X
General Electric	210	Y	$16,000	7/59	79	4
	215	Y	$5500	11/63	2	22
	225	Y	$7000	1/61		38
	235	Y	$10,900	12/63	0	16
General Precision	LGP-21	Y	$725	12/62	64	30
	LGP-30	semi	$1300	9/56	472	6
	L-3000	Y	$45,000	1/60	1	0
	RPC-4000	Y	$1875	1/61	103	3
Honeywell Electronic Data Processing	H-290	Y	$3000	8/61	8	X
	H-610	Y	$3500	9/63	1	6
	H-400	Y	$5000	12/61	66	40
	H-800	Y	$22,000	12/60	55	8
	H-1400	Y	$14,000	3/64	0	10
	H-1800	Y	$30,000 up	1/64	0	8
	DATAmatic 1000	N		12/57	5	X

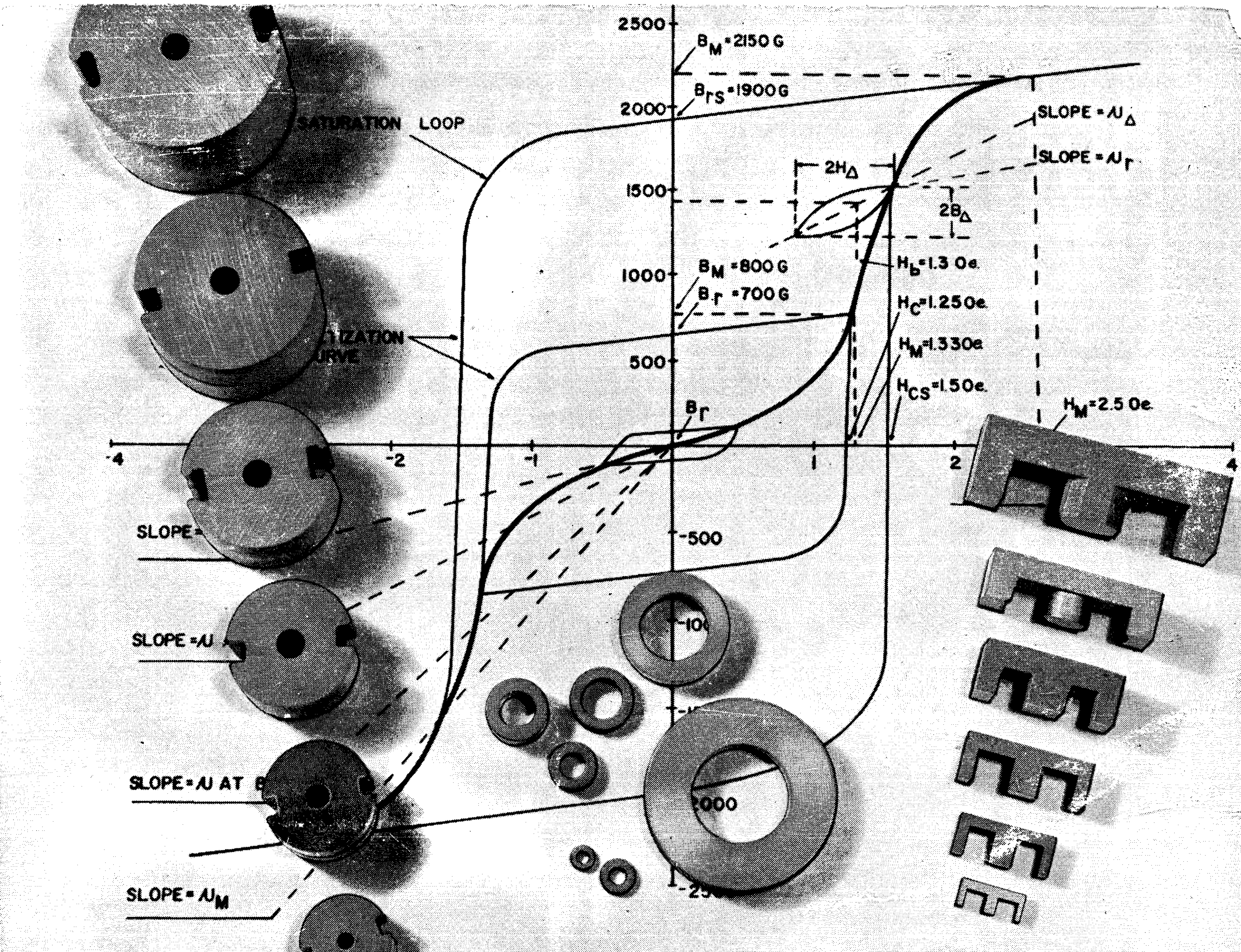
NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
H-W Electronics, Inc.	HW-15K	Y	$490	6/63	1	3
IBM	305	N	$3600	12/57	630	X
	650-card	N	$4000	11/54	500	X
	650-RAMAC	N	$9000	11/54	120	X
	1401	Y	$3500	9/60	6100	1900
	1410	Y	$12,000	11/61	238	260
	1440	Y	$1800	4/63	220	2800
	1460	Y	$9800	10/63	60	320
	1620	Y	$2000	9/60	1380	130
	701	N	$5000	4/53	2	X
	7010	Y	$19,175	10/63	4	30
	702	N	$6900	2/55	2	X
	7030	Y	$160,000	5/61	7	1
	704	N	$32,000	12/55	63	X
	7040	Y	$14,000	6/63	16	72
	7044	Y	$26,000	6/63	8	11
	705	N	$30,000	11/55	115	X
	7070, 2, 4	Y	$24,000	3/60	450	130
	7080	Y	$55,000	8/61	60	25
	709	N	$40,000	8/58	17	X
	7090	Y	$64,000	11/59	265	25
	7094	Y	$70,000	9/62	74	55
	7094 II	Y	$76,000	4/64	0	55
Information Systems, Inc.	ISI-609	Y	$4000	2/58	19	1
ITT	7300 ADX	Y	$25,000	7/62	6	3
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	177	2
	Monrobot XI	Y	$700	12/60	280	209
National Cash Register Co.	- 304	Y	$14,000	1/60	29	0
	- 310	Y	$2000	5/61	46	36
	- 315	Y	$8500	5/62	110	135
	- 390	Y	$1850	1/64	422	275
Packard Bell	PB 250	Y	$1200	12/60	151	11
	PB 440	Y	$3500	11/63	0	12
Philco	1000	Y	$7010	6/63	7	13
	2000-212	Y	$52,000	1/63	5	6
	-210, 211	Y	$40,000	10/58	18	8
Radio Corp. of America	Bizmac	N		-/56	4	X
	RCA 301	Y	$6000	2/61	335	205
	RCA 3301	Y	$15,000	7/64	0	5
	RCA 501	Y	$15,000	6/59	68	11
	RCA 601	Y	$35,000	11/62	2	2
Scientific Data Systems Inc.	SDS-910	Y	$2000	8/62	32	15
	SDS-920	Y	$2700	9/62	24	10
	SDS-930	Y	$4000	4/64	0	2
	SDS-9300	Y	$7000	1/64	0	1
Thompson Ramo Wooldridge, Inc.	TRW-230	Y	$2680	8/63	8	7
	RW-300	Y	$6000	3/59	37	2
	TRW-330	Y	$5000	12/60	12	17
	TRW-340	Y	$6000	12/63	0	4
	TRW-530	Y	$6000	8/61	20	5
UNIVAC	I & II	N	$25,000	3/51 & 11/57	44	X
	Solid-State II	Y	$8500	9/62	30	8
	III	Y	$20,000	8/62	31	98
	File Computers	N	$15,000	8/56	53	X
	Solid-state 80, 90, & Step	Y	$8000	8/58	390	15
	490	Y	$26,000	12/61	20	20
	1004	Y	$1500	2/63	460	1820
	1050	Y	$7200	9/63	5	17
	1100 Series (except 1107)	N	$35,000	12/50	21	X
	1107	Y	$45,000	10/62	11	10
	LARC	Y	$135,000	5/60	2	X
X -- no longer in production				TOTALS	15,609	9271

NOTE: The UNIVAC 60 and 120 plugboard programmed calculators have been deleted from the Computer Census.

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.





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