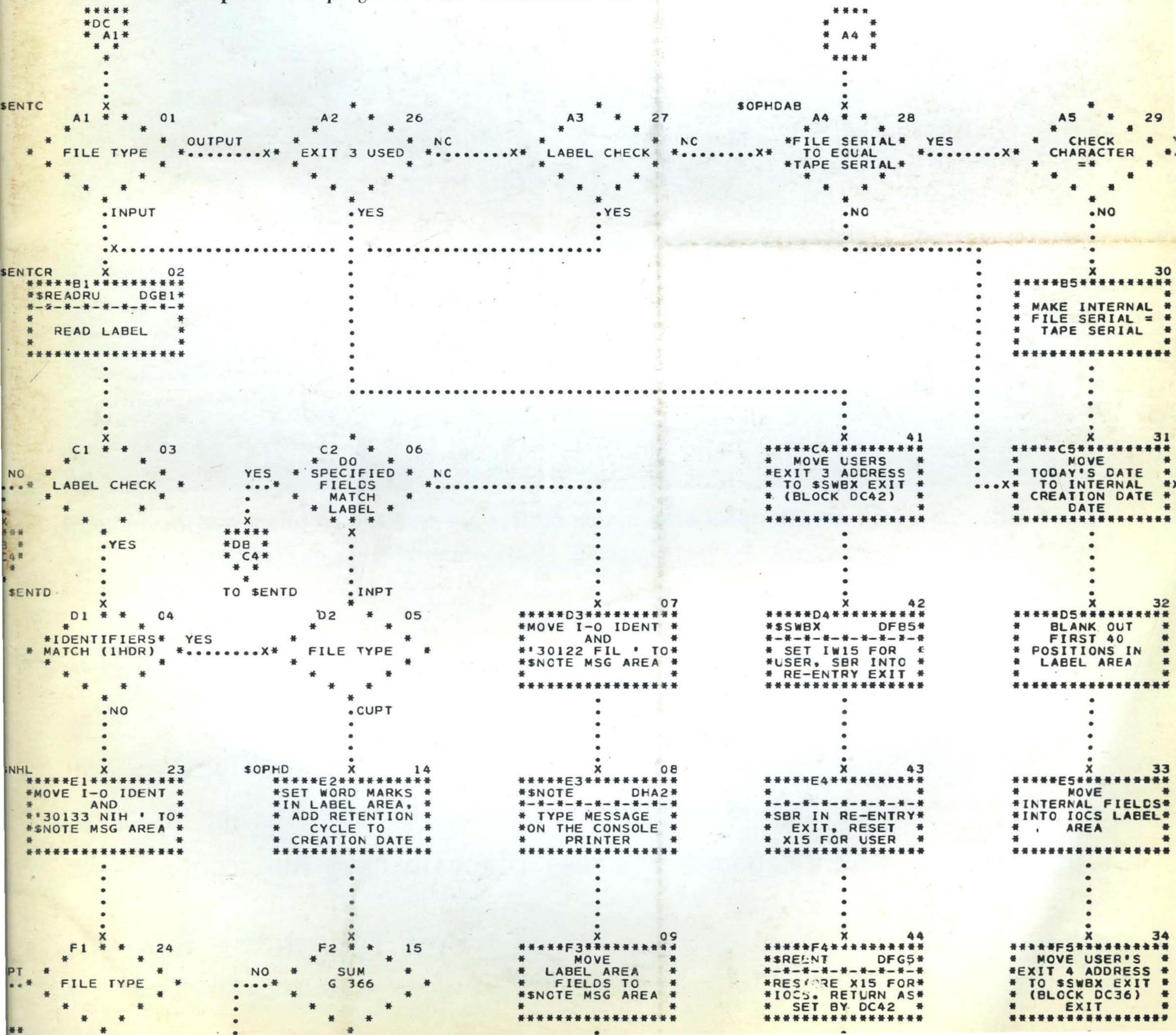
October, 1963

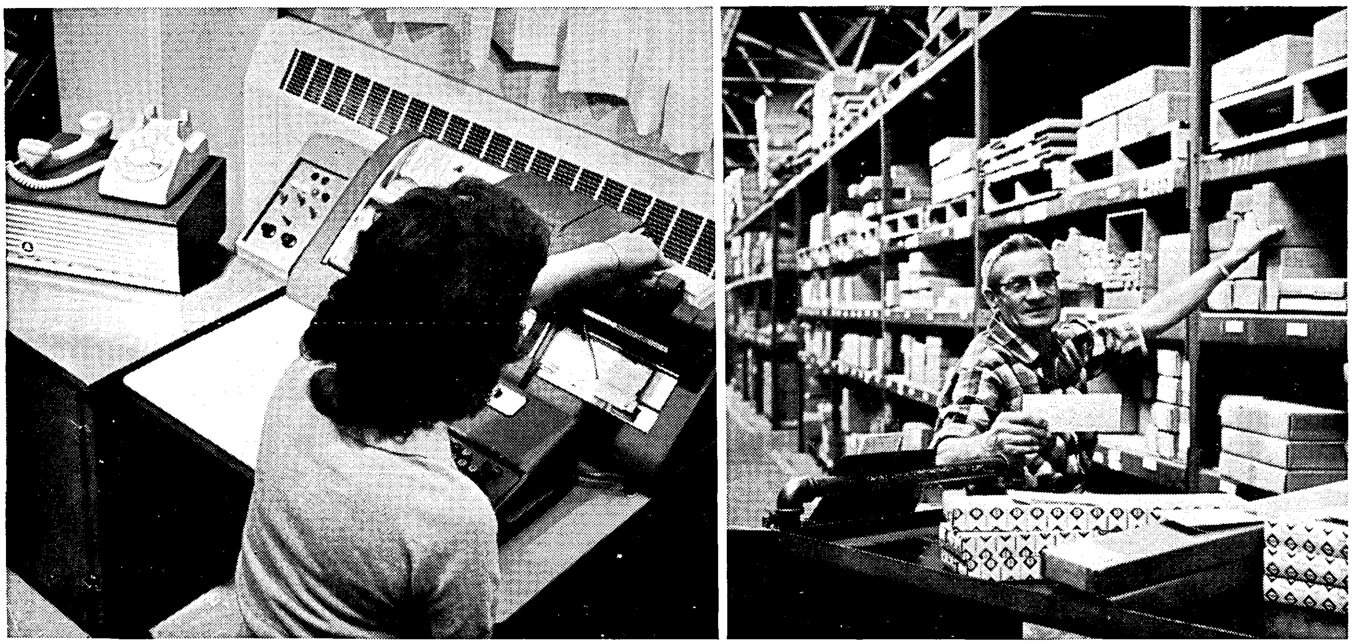
dup

computers and automation

Flow Chart Via Computer: *Helping the User Understand his Problem*



Orders filled in 36 hours, instead of 14 days. Paperwork time and expense reduced by two-thirds. That's how Bell System DATA-PHONE service has helped Whirlpool Corporation speed parts order processing—from receipt to ship-out. Used with data equipment, DATA-PHONE service enables Whirlpool to receive card-punched data sent over regular telephone lines to its La Porte, Indiana, service center from 120 supply points across the country.



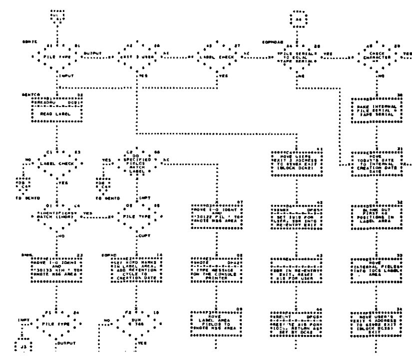
At left, above, orders from Whirlpool distribution outlets are received by phone via DATA-PHONE service, then punched on cards for fast checking, clearing and processing for shipment.

Are you transmitting <u>your</u> business data as quickly and profitably as you might be? Talk with one of our Communications Consultants and find out. Just ask your Bell Telephone Business Office to have him contact you.

Bell Telephone System

Circle No. 4 on Readers Service Card

The front cover shows a flow chart produced by an IBM computer programmed to control a high-speed printer.



computers and automation

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computers and data processors: the design, applications, and implications of information processing systems.

In This Issue

In Every Issue

COMPUTERS AND AUTOMATION IS PUBLISHED MONTHLY AT 815 WASHINGTON ST., NEWTONVILLE 60, MASS., BY BERKELEY ENTERPRISES, INC. PRINTED IN U.S.A. SUBSCRIPTION RATES: UNITED STATES, $15.00 FOR 1 YEAR, $29.00 FOR 2 YEARS, INCLUDING THE JUNE DIRECTORY ISSUE; CANADA, ADD 50c A YEAR FOR POSTAGE; FOREIGN, ADD $1.50 A YEAR FOR POSTAGE. ADDRESS ALL EDITORIAL AND SUBSCRIPTION MAIL TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE, MASS., 02160. SECOND CLASS POSTAGE PAID AT BOSTON, MASS.

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THE PRINTING OF ADVERTISING AS PUBLICITY RELEASES

I. From Joseph M. Ludka

Vice President Sales
Systems Sales Co.
Binghamton, N. Y.

A letter written by Mr. Savage, our Advertising Manager, to your company on August 13th, which was returned with appropriate comments by yourself, has reached my desk, and I felt that some comment was mandated by your attitude.

In his letter, Mr. Savage asked whether you had planned to use a news release previously sent you, and then thanked you in advance for your "cooperation." The letter came back with a "NO" in the margin to the left of the question about use, and with a "NONE" next to the thanks for cooperation line.

An attitude of this type is certainly hard to understand. It leads us to believe that you are not interested in garnering any part of our forthcoming advertising budget, which will be the biggest in our history. Some samples of what we have been doing with competitive magazines are enclosed for your vilification [sic].

I am pleased to be able to report that your desires will be honored. We definitely WILL NOT give **Computers and Automation** any consideration in our budget deliberations in the future.

At least it is interesting to find a Publisher who is no longer interested in money; one who feels he has all the advertising he requires. Congratulations!

II. From the Editor to Joseph M. Ludka

I am delighted to have your letter. I hope I will have the privilege of talking with you the next time I am in New York. We are always delighted to have people argue with us.

The letter which I replied to seemed to me one of the most impolite and presumptuous letters which I had read in a long time. It asked us why we had not printed certain releases, and it clearly implied that we were derelict in not having done so.

The field we try to cover is computers and data processors, and their design, construction, applications, and implications including automation. In addition, we try to cover components intimately related to this field, such as magnetic drums and logic circuits. Racks for holding magnetic tape definitely would be in this category, and I was wrong in not realizing that some of your products were not "office furniture" but "computer-related equipment."

Because we have a $15 paid subscription rate for our magazine, we are independent of advertising, and we can establish and maintain an editorial standard for our magazine that we are proud of.

Any advertising that you may consider for **Computers and Automation** it seems to me should be decided strictly on the merits, on whether or not in your opinion **Computers and Automation** will give you certain coverage that you really want to have. It should not have anything to do with whether you like me or my attitude, or whether or not we play the release-printing game as suppliants to attract advertising.

I certainly reacted too hastily to that letter. I am sorry. I am very glad that you have sent me additional information. Will you please keep us on your mailing list of releases related to the computer and data processing field?

By the way, in your letter did you mean "vilification" or "edification"?

III. From Joseph M. Ludka

[Mr. Ludka's responses were written here and there on our letter, and then our letter was sent back to us. In order to express his responses adequately, we show them photographically below.]

BERKELEY ENTERPRISES, INC.

Publishers: "Computers and Automation", &c — Consultants — Manufacturers

RETURN TO

EDMUND C. BERKELEY
President

815 WASHINGTON STREET
NEWTONVILLE 60, MASS. 02160
DEcatur 2-5453

AUG 29 1963

August 23, 1963

Mr. Joseph M. Ludka
Systems Sales Co.
13 Broad St.
Binghamton, N. Y.

Dear Mr. Ludka:

DON'T BOTHER

I am delighted to have your letter. I hope I will have the privilege of talking with you the next time I am in New York. We are always delighted to have people argue with us.

The letter which I replied to seemed to me one of the most impolite and presumptuous letters which I had read in a long time. It asked us why we had not printed certain releases, and it clearly implied that we were derelict in not having done so. IF NOT WHY? well?

The field we try to cover is computers and data processors, and their design, construction, applications, and implications including automation. In addition, we try to cover components intimately related to this field, such as magnetic drums and logic circuits. Racks for holding magnetic tape definitely would be in this category, and I was wrong in not realizing that some of your products were not "office furniture" but "computer-related equipment". – Excellent Account Knowledge!!

Because we have a $15 paid subscription rate for our magazine, we are independent of advertising, and we can establish and maintain an editorial standard for our magazine that we are proud of. Our choice

Any advertising that you may consider for "Computers and Automation" it seems to me should be decided strictly on the merits, on whether or not in your opinion "Computers and Automation" will give you certain coverage that you really want to have. It should not have anything to do with whether you like me or my attitude, or whether or not we play the release-printing game as suppliants to attract advertising.

your choice — too late.

I certainly reacted too hastily to that letter. I am sorry. I am very glad that you have sent me additional information. Will you please keep us on your mailing list of releases related to the computer and data processing field?

No!!! Not in our Adv. Budget –

By the way, in your letter did you mean "vilification" or "edification"?

With warmest greetings to you, and hoping to see you,

Yours sincerely,

Edmund C. Berkeley

Edmund C. Berkeley, Editor
Computers and Automation

J. M. Ludka

ECB:bb

IV. From the Editor

As many of our subscribers know, but perhaps not all, there are basically two kinds of magazines in the United States today:

—"paid" magazines, which are basically paid for by subscribers buying subscriptions, and which are distributed only to them; and

—"free" or "controlled circulation" magazines, which are paid for by advertisers buying advertising, and

c&a
EDITORIAL

Computers and War Safety Control — II

"Among airmen flying blind in a cloud, all the things that men used to disagree about, to hate about, to fight about, to kill each other about, begin to melt away. If you are flying one airplane in this cloud, and I am flying another, it no longer makes any difference what church you or I go to .... what your nationality is or mine .... we shall both be dead if collision is allowed to occur. .... On the verge of final extermination through accident, it is no longer possible to make any important distinction between my own selfish concern for my own safety and my equal concern for your safety .... . Whatever I do to assure your safety, I simultaneously do to assure my own." (— Howard Kurtz)

This is the concept that led to Air Traffic Control and that is now being expanded (by a group of concerned persons led by Howard Kurtz) into "War Safety Control".

"War Safety Control" is essentially a proposed, multi-national, technological control system (making use of computers, other devices, and people), to secure safety from war on behalf of all nations jointly, and regardless of the governments that they have. It is a multi-nation system to find out and give alarm about dangers of military collision. Our January, 1962 issue presented the first report in "Computers and Automation" on this subject, a report in some 14 sections over a dozen pages.

There has now been published "War Safety Control Report", 103 pages long, by War Control Planners, Inc., Box 35, Chappaqua, N.Y., at $3. This publication puts together another large instalment of information, discussion, and argument (some of it reasonable, and some of it not), on this interesting and particularly important subject. The group of some 20 authors includes Elmo Roper, Louis B. Sohn, and other persons who have studied or reflected on arms control and disarmament. But War Safety Control does not assume nor require disarmament as a first step.

Harold Rapaport, a Vice President of International Electric Co., contributes in it an important 45-page paper on the nature of large-scale information-handling systems, such as BMEWS and TIROS, and the technology for them. At the end of his paper he says, "Based upon an analysis of these systems and described areas of the supporting technology, it is felt that supported by a reasonable degree of development effort, a War Safety Control System is quite feasible and supportable from the technical point of view."

This point is in fact confirmed by a remark in the letter of Arthur Barber, Deputy Assistant Secretary of Defense, U.S.A., which appears in facsimile at the end of the publication: "Military technology does not represent the principal block to disarmament negotiations. The fundamental problems are political."

However, 1963 has brought new and surprising political developments. The nuclear-test-ban treaty has now been signed by 80 nations; and at present writing the votes for ratification in the U.S. Senate are counted at 81. The political obstacles in the way of something like War Safety Control may be reducing. In fact, the Soviet Union has recently alluded to the possibility of making a treaty to guard against surprise attack, thus picking up an idea put forward by the United States in previous years.

These new political conditions may permit progress towards the application of computers and large-scale information-handling systems to warn of preparations or possibilities for war. War Safety Control is not to be considered fanciful and not worth attention. On the contrary, we are living in an era where in many different ways the "im" is coming off "impossible". As the sound ideas in War Safety Control are sifted out from the chaff, we are likely to see in years to come, an immense expansion of information-handling systems to strengthen the security of all nations from war.

Edmund C. Berkeley
EDITOR

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which are distributed free to the group of persons they want to influence.

In the computer field, the magazine with the largest circulation at present is a controlled-circulation magazine.

Computers and Automation has been from the beginning a paid magazine, and as stated in our October, 1952 issue:

"Our purpose is to help provide information in the field of computing machinery. . . . We hope particularly to gather and publish information which is factual, useful, and understandable. . . . "

Because we are a magazine that is NOT FREE, we can carry out that purpose and try to serve the interests of our readers FIRST—the persons who pay us to receive our magazine. We can refuse to publish advertising puffs in the form of publicity releases UNLESS they are "factual, useful, and understandable." If we should find out adverse reports about some big company which advertises, reports which computer people should know, we can publish them—without going out of business. We do not have to look for our bread and butter to advertising managers who talk about their "advertising budget which is the biggest in our history" and inquire with astonishment why we have not printed their releases.

Of course, we publish many publicity releases. But we take out many puff words, and we hope what is left is "factual, useful, and understandable."

We found out a year and a half ago that we were off the advertising schedule for several years of a big, new manufacturer of computers who had given us much advertising in the preceding couple of years. But did that affect the way in which we printed publicity releases about what they were accomplishing? Not one particle. One of their publicity releases is in this issue, because it is interesting.

Besides the area of free magazines, there are many more areas of American life—such as television programs—where, if the consumers and the public paid directly for what they received, instead of the advertisers, the fare would be enormously better than what it is.

There is a deep-seated danger in receiving one's information without paying an appropriate price for the cost of it. That is one of the places where tyranny begins.

c & a EDITOR'S SCRATCHPAD

NORRIS OFFERS FORMULA FOR COMPUTER BUILDER SURVIVAL

William Norris, president of Control Data, delivered some straight-from-the-shoulder estimates in his keynote talk to the recent ACM National Meeting. He quoted predictions that there would be at least $20 to $30 billion worth of standard computer systems at work in the U.S. by 1970...and that by the same year the foreign market would approach that of the U.S.

Norris also offered some carefully sketched clues as to who he thought would be around to share this lucrative market in the 70's. Outlining his recipe for survival in the computer market during the current decade, Norris said the ingredients "not necessarily in order" were (1) singleness of purpose, (2) dedication and depth of understanding of top management, (3) technical strength, (4) market strength on a world-wide basis, and (5) manufacturing competence. Applying this recipe to the 12 or so U.S. firms currently competing in the computer market, Norris personally estimated that there would be about 6 survivors at the end of the decade.

CDC's president did mention a sometimes neglected basic discipline to which he said his company religiously adheres: "Thou shalt operate at a profit."

A SUPER-6600?

...Speaking of CDC, engineers at the firm's computer development laboratory at Chippewa Falls, Wisc., are not willing to let their laurels wilt following the announcement of specifications for the CDC 6600 computer (see elsewhere in this issue). They are already at work on the design of a super-6600. The design principles behind this new giant computer, according to CDC engineers, will be: the use of miniature circuits with inter-module wire lengths under one inch; the use of transistors with improved switching times, e.g., optical transistors; and the use of 18/12 mil magnetic cores in the central memory. CDC does not expect that thin films will be of practical use in large computer memories for some time. The company also ruled out integrated circuitry for the time being.

An announcement is expected concurrent with the distribution of this issue of Computers and Automation on the new Control Data 3200 computer, a medium-to-large-scale system fitting between the 924A and the 1604A in the product line. Also expected shortly from CDC is a new computer designed to upgrade the information-processing capability of the family of G-15 and 160A users, and also to serve as a satellite for the 3600 computers.

Other information-processing products expected from CDC in the next six months include units to expand their line of data collection and data communication gear...both considered essential to the widespread use of the company's larger computers.

VENDORS COUPLE TO COUPLE GEAR

The increasing interest in, and economic importance of, hybrid computation systems are factors getting considerable attention in the computing industry (see the article on page 10). One of the byproducts of this expansion of the market for such computing capability, is the contractual coupling of makers of analog and of digital computers. For example, Electronic Associates Inc. has announced an arrangement with Computer Control to use their DDP-24 in an EAI Hybrid System.

Also, Packard Bell Computer, showing bright sights of vitality with twelve orders registered on the new PB440 and a very black income statement for the first nine months of 1963, has just signed an agreement with Computer Products Inc. to undertake a joint marketing and systems engineering effort on large hybrid systems. The PB440 and Computer Products Mark III analog unit are likely to be the machines in the proposed hybrid systems. Packard Bell will supply the A-D linkages for the new systems. Proposals for such hybrid systems are already in the works, PB officials report.

BRYANT DISC FILE DELIVERIES NEAR $5 MILLION MARK

Bryant Computer Products, the division of Ex-Cell-O Corp. producing computer drum and disc files, appears to have finally outwitted their engineering difficulties in making a reliable, large capacity disc file. Their Series 4000 Disc File, with an expandable capacity from 31 to 1625 megabits, was first announced in late Fall, 1960. The first installation, at Sylvania, was made in December 1960. However a number of engineering problems plagued the first and subsequent units. Vibration in the hydraulic positioning unit was pronounced. The head positioning time was above the announced average of 65 milliseconds. Costly coating problems developed in creating a satisfactory magnetic disc.

Between December, 1960, and June, 1962, Bryant withdrew numerous disc files from the field for factory adjustments. By June, 1962, however, Bryant's engineers had overcome the major problems with the Series 4000 units. An average access time of 133 milliseconds for a selected track was set up as the new capability of the series.

Since that time Bryant has shipped over 75 disc files to system builders needing large random access memories. With nearly $5 million worth of files shipped, Bryant is easily the largest independent manufacturer of disc files in the world. The combined disc file installations of Data Products, Burroughs, and Anelex are under twenty...all three having introduced disc files within the past year. RCA, Collins Radio, and Honeywell are Bryant's three largest disc file customers.

Bryant has a number of new units expected to be introduced to the disc file market in the coming months. One is a 6-disc unit with disc module, electronics and power supply all within the same cabinet. Another is a redesigned unit which eliminates the massive rocker arm assembly which currently carries the read/write into position over a selected track. The new unit will use a lightweight positioning arm to move the heads across the face of the disc. It is expected early in 1964.

FORTRAN ADVANCES TOWARD STANDARDS GOAL

FORTRAN has moved a giant step forward toward becoming a standard language for scientific and engineering programming. At a recent meeting, the American Standards Assoc.'s X3.4 committee (the group working on the standardization of programming languages) adopted an important FORTRAN resolution. The resolution, drafted by Bill Heising, chairman of X3.4.2, the subcommittee working on FORTRAN, specifically declares X3.4's intention to give full support to FORTRAN standard proposals...subject to conditions which include satisfaction by X3.4 that there is reasonable agreement among those who would be affected by the standardization of FORTRAN that its adoption would serve a useful purpose. The latter condition leaves latitude for considerable hedging by non-enthusiasts of the IBM-originated computer prose.

Correspondingly, ALGOL standards work under X3.4 has cooled off considerably. A recent survey of U.S. computer manufacturers by the ALGOL subcommittee produced only two positive indications that ALGOL compilers were being implemented. With only a couple of subsets of ALGOL in operation, standardization proposals for ALGOL in this country would almost certainly be judged as premature.

EAI IN ANALOG EDUCATION SET-UP

One of the fundamental principles of successful business ventures is often stated as: "Find a need and fill it." A variation on this principle, and one used more consistently in the computer field, is "Create a need and fill it." To generate a need for computer assistance within a potential user's organization, the process is a kind of awakening, cajoling, and persuading usually termed "education." The process has not been neglected in the digital computer field, since the main frame manufacturers have taken steps to insure that their machines are at the disposal of college and technical school students. These students later will be carrying their familiarity of, and desire for, automatic computation to industries across the country. Other steps include setting up training courses for customers (and prospective customers) in EDP methods, and issuing manuals, films, and other instruction devices by the carload.

The analog computer field has not, until recently, placed a similar stress on education of the potential user in the capabilities and uses of analog computation. Electronic Associates, Inc., however, have recognized that newly developed computational techniques in engineering design have overtaken the training of the engineer in nearly every discipline. So they have set up a series of courses on methods and applications of analog and hybrid computation. Among the courses being offered is Modern Methods in Analog Computation, a two-week program designed to give the participant a working knowledge of the analog computer, its efficient programming, scaling, and application to problems in engineering and science. Titles of other EAI courses include Introduction to Hybrid Computation, Bio-Medical Applications of Analog Computation, and Chemical and Petroleum Applications of Analog Computation. These courses are given periodically at EAI's Computation Centers at Princeton and Los Angeles. EAI also has a five-day course entitled Introduction to Analog Computation "on tour." During past weeks it has been given at such colleges and universities as Illinois, Santa Clara, Syracuse, Missouri, and Southern California.

BUMP OF CURIOSITY

Ever wonder how a computer gets its name? In the past, memory, size, cost, and word length have often played a role in determining the name for a computer. However, the new CDC 6600 may be one of the few computers named for aesthetic reasons. It seems that Control Data called in a prominent industrial designer to give the skins of CDC's largest computers a professional look. The designer was appalled with the irregular look of such numbers as 924 and 1604 on the computer's console and main frame; he suggested that future computers be named with some nice "roundish," attractive number. Hence the 3600 and the 6600. What next?...the 8800, the 9900?

Conducted by Leichtlicht Schreibfeder

HYBRID COMPUTATION: WHAT AND WHY?

Alan E. Rogers
Director Systems Analysis
Research and Computation Division
Electronic Associates, Inc.
Long Branch, N. J.

The potential use of hybrid computers in the solution of scientific and engineering problems not conveniently investigated in other ways has been accepted over the last few years. There are many possible machine organizations and we shall discuss here the influence on this organization of the typical expected application, its mathematical programming, and the machine cost. The discussion is presented from the viewpoint of system design through simulation. Thus, although there are probably many worthwhile applications of a good computer to other needs, the major consideration here is a capability in simulation.

A Few Possibilities

For many years now analog and digital computers have provided the applied scientist with their individual capabilities which he has applied skillfully to solve his problems. For example, the speed with which aerospace systems are engineered today is in part valid testament both to their contribution and to his finesse in their application. This is not to imply that all problems are readily resolved by the use of any available computer. One frequently finds that a problem has features leading to computing demands, some of which are not matched by the capabilities of the analog computer, others are not matched by the structure of the digital computer, and still others are not satisfied presently by either. It appears that a combination of the two computers in a manner in which they complement each other would provide a computer more adequate and effectively applicable than either alone. The desirable integration of analog and digital computer techniques, and a consideration of potential applications in aerospace systems design, is the main subject to be discussed here.

The suggested combination of analog and digital computers is not new. As long ago as 1955 the problem of investigating guidance and control of intercontinental ballistic missile trajectories led to the specification of a linkage system for signal conversion between a Sperry Rand 1103A digital computer and an EAI analog computer. It was the intention in this system to solve the trajectory equations on the digital computer and simulate on-board control systems on the higher speed analog computer. Such an arrangement takes advantage of the resolution available from a digital computer to compute in a discretely sampled form the trajectory of the vehicle which is controlled by mechanisms simulated continuously on the analog computer. (See Figure 1) Difficulties and delays in the completion of the linkage defeated the intended application of this first combined system. But more recently many combined analog-digital facilities have been placed in operation for similar uses which demand the resolution of the digital computer and the parallel speed of the analog computer.

A second reason that has been proposed for a combined operation makes use of the readily available data storage of the digital computer. Where large quantities of point data have to be stored for use in a simulation or computer solution of a problem, there is little doubt that economically and practically storage in binary number form within one of the possible digital data storage devices is desirable. Such is the case in the storage of aerodynamic and engine functions for the study of aircraft flight with many degrees of freedom. Although analog function generators have proven valuable and economical in storing such data, when the resolution of the digital computer is necessary for computing precision its storage capacity can also be used to advantage for function generation (table look-up). However, it might be difficult to justify the use of a general purpose digital computer solely for function generation in situations where its resolution is not otherwise required.

The question of data storage is entirely different when the data to be stored is generated within the computer during the computation. A few points can be stored on analog storage devices (capacitors charged to hold voltage levels proportional to the data points), but when a sampling operation within the computer's operation produces many values to be stored and re-used, it appears desirable to turn to the more efficient and economical digital storage devices even though a data conversion operation is called for.

This parallel, separately-operating but synchronized combination of digital and analog computers is not the only possible organization of computing concepts to achieve the improved capability necessary in the solution of many aerospace problems. To achieve increased resolution a hybrid system at the component level is possible. Proposed by persons at the National Bureau of Standards and also at

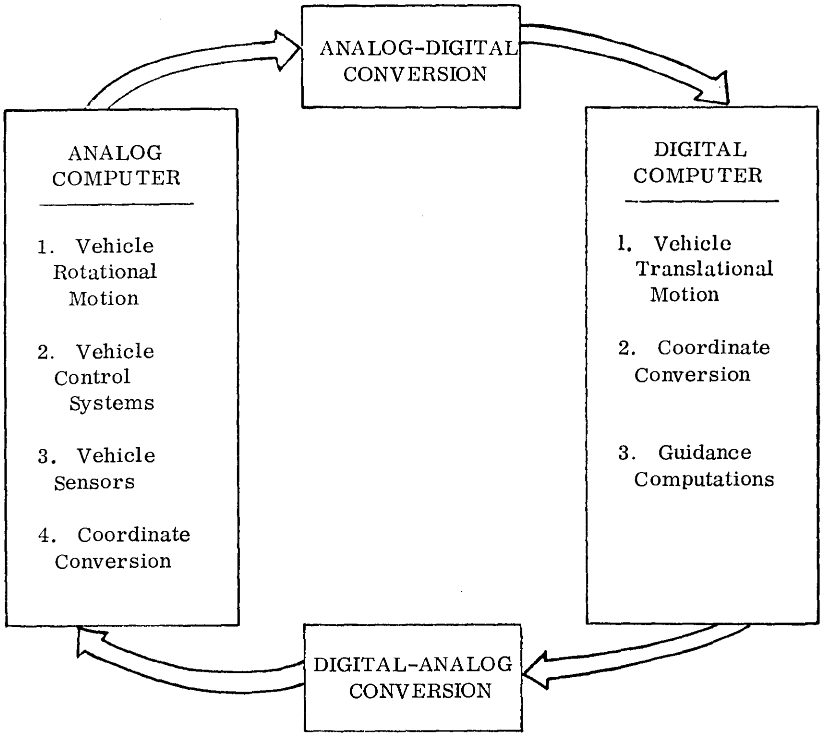


Figure 1.
COMBINED ANALOG-DIGITAL COMPUTATION

Link, the components would have a digital processing section and an analog section treating each variable as the sum of two parts, $x = x_D + x_A$. The more significant digital part x_D might have 5 bits of slowly changing digital data, while the analog section would contain 3 decimal places of voltage data. A 5 bit digital section could be made relatively fast at low cost, and would have no difficulty in this association keeping up with the speeds of the analog section for high speed computation. Of course, there is interaction between the analog and digital sections requiring the generation of carry pulses. As the analog section exceeds a threshold value corresponding to 1 binary unit, a carry pulse must be generated to add one unit to the digital section and clear the analog section. With all design problems solved, components to perform the standard analog computer operations would have a considerably improved resolution. (See Figures 2 and 3)

In contrast to this addition of digital components to a machine organization along analog lines, persons at the MIT Electronic Systems Lab. have proposed the addition of pulsed analog components to be used as a very fast multiplexed analog arithmetic unit in a digital computer. Additional analog integrators would also be included to perform high-speed integration. The concept of this system essentially is to produce a set of analog arithmetic units each programmable to perform specific multiple operations which can then be used in a sequentially sampled manner to satisfy many equation requirements. The data as they are updated are placed in digital memory.

Neither of these latter suggestions have had wide acceptance but they demonstrate the ingenuity of some of the persons working to increase the high speed computing capabilities available to solve demanding aerospace problems.

Another suggested solution is the Digital Differential Analyzer, which although not a hybrid computer does have a parallel, multiple-component, analog computer structure made from digital binary circuits which process numbers. The modern DDA is a powerful tool in solving certain limited kinds of problems. Being a digital computer by circuit design, it has the possibility of relatively unlimited resolution. Having parallel component operation, one would expect a high speed solution capability and this is true, at least in small problems. The interaction between speed of solution and resolution sometimes slows the operation of the DDA disappointingly. However, in the solution of differential equations it is faster than a general purpose digital computer and is more accurate than the analog computer. By itself it does not possess all of the qualities typically required in most dynamic design problems.

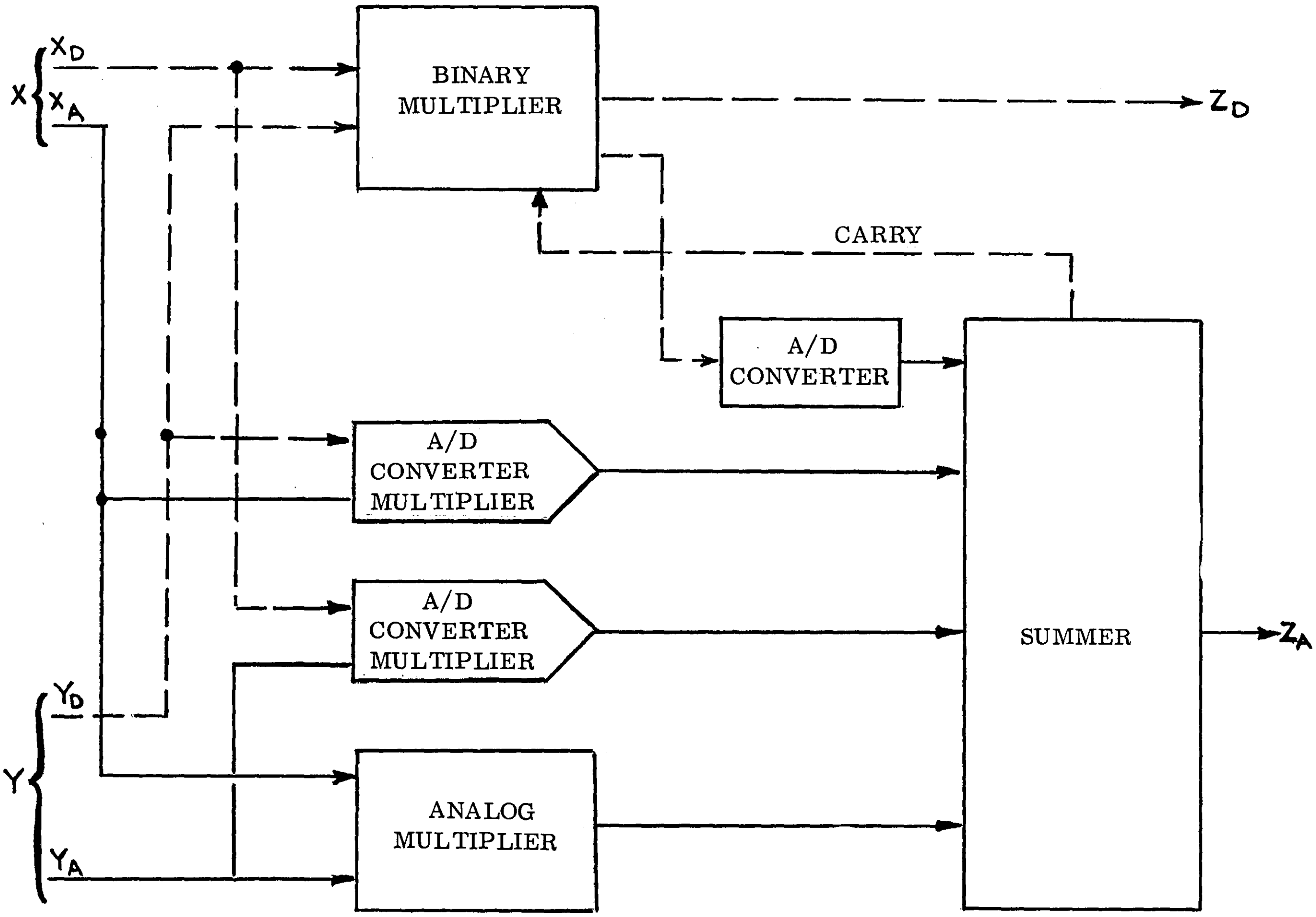
A completely separate and different philosophy in the development of a hybrid computer is represented by EAI's HYDAC system. It accepts the desirable features of the modern analog computer and adds to them computing capability organized along the lines of an analog computer but fashioned with digital devices. In one integrated computer the resolution, storage, logic, and program control of the digital computer is added in many individual components which are interconnectable in parallel. The combination of high speed analog components under direct program control from digital logic, with the resolution and storage capacity of digital devices provides an unusually flexible arrangement.

To consider the advantages of one form of hybrid computer system over another requires attention to its potential applications, the resulting mathematical forms to be computed, the possible questions related to component operation, and the necessary computer operation and controls. Once one has established the capability of a number of different computers to solve effectively problems of interest in a field of application, the question of performance efficiency (capability per dollar) in some acceptably defined terms is the deciding factor.

Where Are Hybrid Computers Desirable?

The different qualities of analog computers and digital computers or components (the one using voltage values to represent variables in a solution, the other using binary numbers) offer separate advantages in the solution of problems. The possibility of employing a hybrid computer presents itself whenever a problem has features some of which are best satisfied by the qualities of one computational form and others are best satisfied by the qualities of the other.

Some of the advantageous qualities of different computers are tabulated below:



$$XY = (X_D + X_A)(Y_D + Y_A)$$

Figure 2. Hybrid Multiplier

General Purpose
Analog Computer

1. High speed simulation due to parallel structure
2. Simple, true integration
3. Continuous variation of values
4. Rapid unprogrammed changes of parameters and structure
5. Output of data does not slow computation
6. Simple communication with system hardware

General Purpose
Digital Computer

1. Unrestricted math operations and logic
2. High resolution which can be increased at will
3. Large, easily reproducible data storage
4. Floating point operations eliminate scaling
5. Solution can easily change program
6. Programming assisted by available software

Digital Differential
Analyzer

1. Rapid integration of differential equations
2. High resolution
3. Parallel operation assists readout of data

From experience with engineering problems in the design of aerospace systems and reviewing this table one can suggest that problems having one or more of the following mathematical features should lead to a consideration of hybrid computation.

1. Simultaneous differential equations with widely different parameters which produce both low and high frequencies in the solution.

2. Differential equations to be solved at high speed, their solutions for different initial conditions or parameters being used in a prediction, iteration or optimization process.

3. Combinations of continuous and discrete variables as in the description of a sample data system or a computer control system.

4. Perturbation analysis about slowly changing, precisely established solutions.

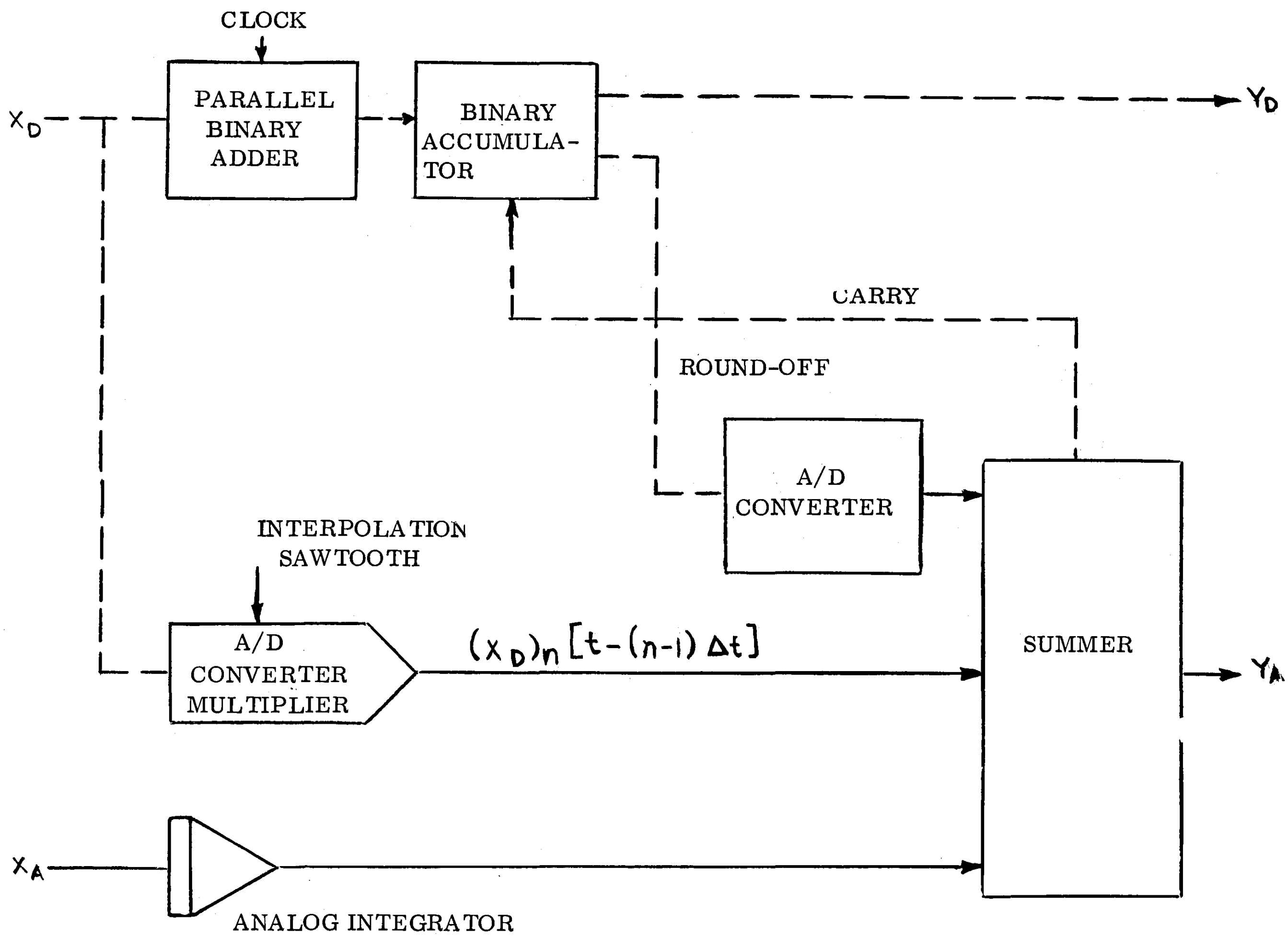
5. Statistical analysis requiring repeated solution of differential equations, including Monte Carlo methods for deterministic problems. This is essentially a data storage and simple evaluation task around the solution of differential equations.

6. Filtering and processing continuous and sampled data for evaluation purposes.

7. Partial differential equations to be solved by serial integration procedures.

8. Ordinary differential equations accompanied by transport delays.

A few examples of practical applications of hybrid computation in aerospace system design help to clarify the situations in which these mathematical features occur. Consider the problem of designing the guidance and attitude control system for a space vehicle attempting to dock with a target vehicle. This docking maneuver might be manually controlled by the pilot in which case the design of the control mechanisms must take due consideration of the problems of a man-machine system. A close-range maneuver control system design suggests immediately the use of an analog computer to simulate the intended system. The choice of the analog computer is particularly emphasized by the desirability of checking the design with a man "in the loop" in real time. Also the selection of control system parameter values, and the possible re-arrangement of any use of sensors for feedback purposes is particularly easy when they are mechanized on such a computer. The later inclusion of real hardware is more readily accomplished using the analog computer. However, there are features of such a control system which are discrete or sampled and, therefore, suggest the use of digital circuitry. The reaction jets which adjust the attitude of the vehicle are "on-off" rather than continuously adjustable. The manual 3-axis control stick used by the pilot energises in a number of pre-selectable ways some, but rarely all of, say, 16 jets. Between the control stick and the jets there is a logic unit whose operation is modified by other manual inputs. These two



$$\boxed{\int_0^t X\,dt = \int_0^t X_A\,dt + \sum_{i=1}^{n-1} X_{D_i}\Delta t + X_{D_i}\left[t-(n-1)\Delta t\right]}$$

Figure 3. Hybrid Integrator

features of the system could be mechanized with difficulty on a conventional analog computer. They are readily established with the logic capability of digital equipment. (See Figure 4)

The same maneuver control system could be completely automatic with a beacon-homing device replacing the pilot's decisions, but in either case, the system is most likely to have many parts which are discrete in their operation and thus call for digital equipment in their representation.

Consider the problem of designing a terrain avoidance guidance system for low flying high-performance aircraft. A radar dish in the nose of the aircraft scans through pitch angles of +5 degrees to −25 degrees to obtain slant range data. This data is sampled and stored to determine flight control commands which allow the aircraft to fly at high speed below an altitude of 500 feet. The range of the radar is 15 miles. Simulation techniques would play an invaluable role in the efficient design of such a system. An analog computer could simulate the flight path and attitude of the aircraft. It could also simulate the on-board control mechanisms and the generation of aerodynamic forces. However, the representation of the radar beam and its reflection from typically rough terrain with reasonable fidelity is not readily achieved with analog function generators. It is well to store the features of many miles of terrain in a digital memory and compute the values of slant range for use in the on-board guidance computer digitally. For real-time simulation and high values of radar PRF (400 pulses/sec), a high speed digital computer would be required. However, this particular problem is very well suited to simulation using parallel interconnectable items of digital hardware. It will be discussed later. (See Figure 5)

A third example of the desirable use of a hybrid computer is in the analysis of rocket parameters and staging times for maximum efficiency in orbit injection. A multi-stage rocket's flight into orbit with the necessary considerations of aerodynamic forces, on-board control system, and staging with its consequent sudden changes in mass, inertia and thrust, is a complicated problem in simulation. To achieve any efficiency in considering many possible system parameters and flight path designs, a high speed simulation of a typical six minute flight to injection is essential. Thus, the speed of parallel computation of an analog computer is desirable. The automatic control and evaluation of the many different sets of parameters with their effect on the selected criterion of efficiency is most appropriately achieved using a digital computer. Such an arrangement would save considerably on the time presently required by an analog computer and even more so on that of an IBM 7090. This kind of problem, a search for an optimum set of parameters for a dynamic physical system, is one having many varied application. Its implications in computation—the solution of differential equations plus the need for up-dating stored values and making of logical decisions according to a criterion—suggest strongly the use of a hybrid computer.

There are many other examples of problem types which place a mixture of demands on computers. They should be most readily solved by the use of a hybrid computer. In choosing such a computer there is good reason to consider both the technical features essential in the computer, and the economic comparison between the different possible organizations.

The Organization of a Hybrid Computer

From a consideration of problem types—particularly those whose solutions are best obtained by a simulation procedure—one can establish the features and organization desirable in a hybrid computer. Taking advantage of existing circuit techniques and hardware a number of equipment combinations is possible. A choice between them rests on their appropriateness to the group of applications envisaged and secondly on their "performance per dollar" according to some measure—usually quite difficult to obtain agreement upon.

Before discussing the different possible arrangements it is well to define the nature of the system that is required. To be of value beyond analog, digital or DDA computers the hybrid computer must combine effectively the qualities of these different computers. Thus, we would expect it to have the following components:

1. An analog section with a parallel array of high speed integrators, summers, multipliers and function generators.
2. A digital section with logic and arithmetic ability, and volatile data storage.
3. An analog-digital data communication system to translate analog voltages to binary numbers and vice versa.
4. A program control capability to maintain the timing of events in the computer.
5. Input-output display and equipment monitoring for program checkout.

A typical use of such a system would find the analog section performing high-speed integration of non-linear differential equations with the digital section providing precise low speed computation of slowly changing variables. These variables might require the numerical integration of differential equations or might be the result of an algebraic function generation. Any other function generation or algebraic transformation might fit on the analog equipment or be performed digitally. Samples of computed

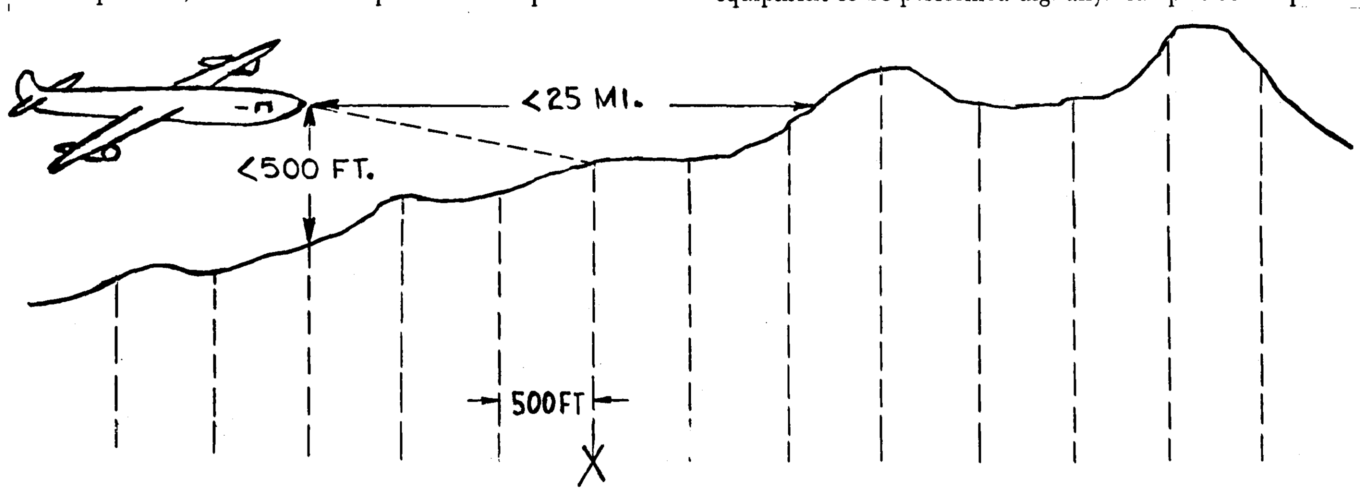


Figure 4. Terrain Avoidance Guidance

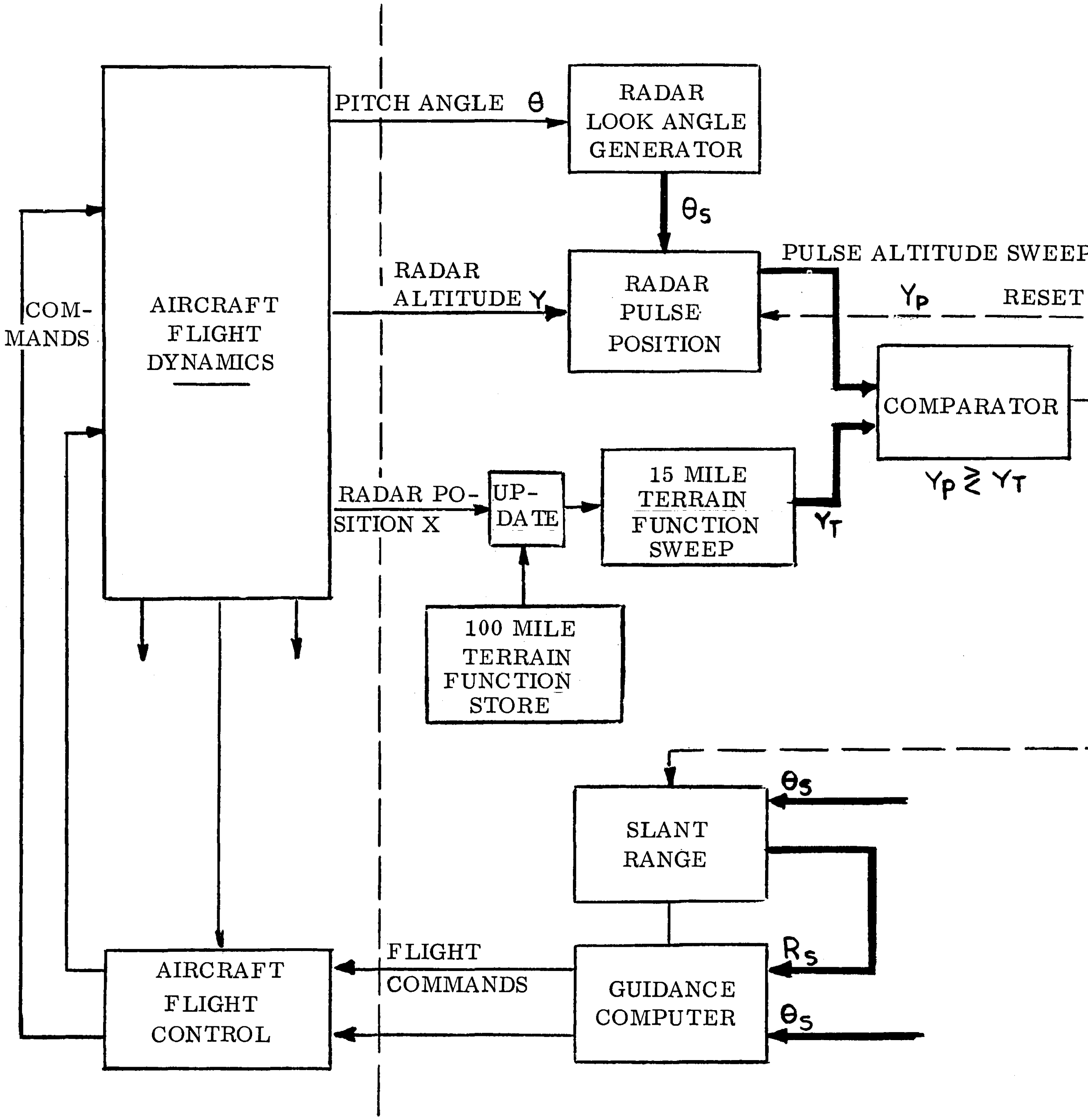


Figure 5. Block Diagram

data would be stored digitally and logical data evaluation would also be performed digitally. The program timing and control would be a responsibility of the digital equipment. However consistent with their normal separate operation, typical usage would require all operations on the digital computer to be completed cyclically, whilst the analog computer might have two modes of operation, one a high speed iterative mode, the other a continuous computation mode.

As has been reported by more than one user, the kind of operation envisaged for such a system, does not demand an expensive digital computer. As might be expected in the combined use of analog and digital computers, the 3-4 decimal place accuracy of the analog computer (~ 12 bits) is well matched by a 16-32 bit range in word length on the digital computer. This requirement appears to follow through no matter the type of digital section considered, be it gpdc, DDA, special purpose or multi component digital computer. The digital section does need to be fast, for the parallel, high-speed nature of the general purpose analog section is otherwise frequently wasted. Other features of the digital section are the subject of considerable discussion.

The choice of linkage equipment is rather easily made. The accuracy of the analog section determines the word length required in the converters. Typically it is 12-13 bits plus sign.

A number of A-D channels are required. Signals can be simultaneously scanned, stored in analog track-and-store units, and converted sequentially by one converter to binary number form for storage in the digital section. Otherwise they can be sequentially scanned, without the need for analog storage, and converted to binary number form. The D-A channels are either separate, each channel accept-ing binary numbers representing consecutive values of a variable and converting them to analog voltages which are updated at the operating rate of the converter, or they also can use a multiplexer. If a multiplexer is used then again the analog signals are stored between the updating times on track-and-store devices. The conversion rates depend on the settling time of the converter. The D-A converter operates in a parallel manner and can be designed to reach a steady value in no more than 10 microseconds. The A-D converter operates serially, the diode gates settling one after another, and can be designed to reach a steady state in approximately 60 microseconds. Thus analog signals can be translated into binary numbers at a rate of 15,000 samples per second.

The control operations desirable in a hybrid computer must cover the needs of typical applications. Certainly there is need for being able to control the mode of operation of the analog section rapidly and consistently. The operation of individual integrators or their operation in groups must be controlled from computed signals. The intention to exploit the high-speed capability of the analog section implies that all switching operations desirably be electronic. Relay switching is acceptable but presumably will slow the simulation of some systems. The sampling of computed values in the analog section must be controllable. Read-out and read-in of data should be automatically controllable. This suggests automatic coefficient setting equipment under the control of paper-tape, digital memory, or computer values, and a complete monitoring system similar to these already available on modern analog computers.

In the digital section, the ability to control the program and the operation of the simulation is built into typical equipment structure.

To meet these features from existing hardware one can suggest a number of combinations. The obvious are:

1. GPAC—linkage—DDA system. It would allow a completely parallel programming of a set of differential equations, the variables requiring extremely accurate computation being programmed on the DDA integrators, other computations on the analog computer. The high speed behavior would typically be produced on the analog computer. The combination provides very limited data storage, no capabilities in logic, and is not suited to essentially algebraic computations requiring precision. In short, from the point of view of applications, the combination provides an analog computer, part of which is exceptionally precise but somewhat slower.

It probably has a few applications in which it excels, but as a general purpose facility is not too promising. The DDA is also an expensive machine.

2. GPAC—linkage—GPDC system. As demonstrated by the number of systems in operation or in process of being set up this combination, on the surface, offers an extremely wide range of capability. It complements the analog computer with the resolution and storage ability of the conventional digital computer. The total system capability and its effective exploitation in design simulation depends on the choice of the digital computer. A wide choice exists, but for hybrid computation the selection is narrowed considerably by an appropriate desire to balance the system capability.

The total performance of such a combination is limited by the linkage, should it be of conventional design, and by the low speed of computation available typically from the sequential digital computer despite its amazingly fast execution of individual operations.

The system will comprise a number of A-D, D-A converters and multiplexers. A timing control provides signals to define sampling time and transfer time of each channel, and control lines from the digital computer determine typically the mode of the entire analog computer. Some sophisticated systems include a bank of central lines switched between two levels by the digital computer and available to cause program switching, individual integrator mode switching, and voltage sampling. It is possible for the digital computer to control directly any digitally-set attenuator system in the analog computer, a desirable feature for the input of data.

A major functional limitation of the system is that if program control of the analog section is required to be dependent on logical processing of variables generated on the analog computer (iteration procedures, multispeed operation for representation of distributed systems), or if variables generated on the analog computer have to be sampled frequently, stored, and then re-introduced, any program on the digital computer will suffer many interruptions, slowing it considerably. To achieve success under these conditions calls for a faster, more sophisticated and much more expensive digital computer.

A similar limitation of the system rests in the need to use the digital computer no matter the type of service required. Even when the simulation demands, say, some simple programmed control actions and the storage of 100 points of data, the digital computer is called upon when it could otherwise be used for separate programs. The system is insufficiently flexible.

It can also be quite expensive.

If we are not satisfied with making use of combinations of existing hardware we must investigate the obvious alternative of designing a system as an integrated hybrid computer. In such a design it might be possible to overcome the limitations of the combined system. It might be less expensive.

The Hybrid System

For the solution of problems where the major requirement placed on the computer is that of simulating a dynamic physical system there is a very strong case for building a hybrid computer with the parallel organization of an analog computer. In other words instead of using a combined system in which the analog computer operates in its traditional manner, the digital computer operates in its traditional manner, and a communication channel is built between them, design a parallel simulator throughout with both analog components to perform the functions they are best suited for and digital components to perform their functions. This does not mean an analog computer is parallel with a number of digital computers. Such a system would be somewhat expensive and not necessarily efficient. It does not mean that every component within the system must be able to communicate at the same time with every other component. This would imply hybrid operation at the component level and would also be expensive. Between these two extremes there is an arrangement of analog components and digital components, effective for solving problems by simulation, yet acceptable in price. One such is the HYDAC system made by Electronic Associates, Inc.

If one begins with an analog computer, then what must one add to this computer at the digital component level to provide a useful hybrid computer for simulation purposes. Firstly recognize that a digital computer has two levels of mathematical capability, not separated in the conventional general purpose machine but very desirably separated in a machine to operate as proposed. There is the capability to perform readily the calculations of Boolean algebra, to deal in the elementary decision logic of TRUE-FALSE, YES-NO, ONE-ZERO. The structure of such a decision making system might be fixed or changing with time. It might be a one stage process (combinational logic) or a multi-stage process (sequential logic), but in any event the equipment implications in a flexible parallel machine are the need for logic building blocks—AND gates, OR gates, Flip-Flops, simple up-down counters. The necessary analog-digital conversion equipment is a comparator with a binary output; the necessary digital-analog conversion equipment is a switch controlling an analog voltage.

In contrast to this simple low-level mathematics the digital computer also has capability to process binary numbers which can represent in a discrete but theoretically infinitely resolvable manner the values of changing variables. This capability allows very effective algebraic computation, for the operations of addition, multiplication and division can be performed reliably, repeatably and accurately. It also permits by the techniques of numerical analysis the manipulation of other mathematical forms, integration, function generation, etc. It is this whole number capability that dictates the major structure of the conventional digital computer. It overshadows the simple Boolean algebra capability which, of course, does not require the memory and arithmetic unit size built into the computer to handle whole numbers. In any hybrid system the necessary communication of the variables available from this capability to the analog section requires the 14 bit conversion units of typical linkage systems. In any flexibly interconnectable, parallel arrangement of digital building blocks, whole number capability is made available in the form of registers, accumulators, and memory units.

In the HYDAC system although these two kinds of units are included for convenience and sound engineering in the same console, their different operational function and consequent application requires them to be distinguished in the mind of the user. The one type of unit allows the construction of logic programs to represent component parts of a physical system, the efficient mechanization of logical algebra in the solution of problems, but just as importantly it provides a capability to design into a simulation automatic control of the experimentation to be performed. The second type of unit provides the data storage and increased computer resolution required to complement the analog components in their high speed simulation.

An integral part of the HYDAC system is the analog-digital communication channels. These are not committed to any particular computing components. They can be connected through the system patch panels to any and all of the components. There are two levels of communication:

1. Many parallel channels of A-D comparators and D-A switches for logic requirements.

2. Many parallel channels of A-D and D-A converters for whole number conversion.

The whole number conversion equipment is also able to convert analog signals to binary numbers for sequential computations in a general purpose digital computer should it be desired to add such a unit to the HYDAC system as a sequential computing component. There is also the possibility of supplementing the arithmetic and accumulation capability of the components of the standard HYDAC system with a few DDA integrators, again considered in the form of components of the system desirable for certain kinds of computations. If DDA integrators are added any necessary conversion would be performed by the whole number converters of the communication system.

The HYDAC system can be separated into two parts: the 231-R analog computer and the DOS 350, digital operation system containing all conversion equipment and digital equipment. The DOS 350 is programmed by establishing interconnections of the digital components through a patch panel. It provides by its parallel operation a higher speed for logic operations than the general purpose digital computer. By its separation of Boolean functions from the whole word computation it spreads the load on the data conversion channels, leading to a higher speed capability or a lower over-all cost. It provides an unusual programming flexibility and approaches very closely the ideas of microprogramming in general purpose digital computation though, of course, the operations to be established are different. It is possible with a HYDAC system to execute any form of program possible with any other existing hybrid computer system.

An Example of the Organization of a Guidance System Design Problem on a Hybrid Computer

Returning to consider the problem of designing a terrain avoidance guidance system for low flying aircraft (See Figure 4) we see that in any simulation of the system the aircraft dynamics and on-board control system could be well mechanized on an analog computer. The digital guidance computer, the radar, and the terrain altitude function are better considered on digital equipment, either because the signals to be represented are binary numbers or sampled values, or because the data that must be stored are large in quantity. Thus in a hybrid computer simulation a separation along the lines shown in the figure appears to be appropriate.

Terrain Avoidance Guidance System Simulation

Analog Section	*Digital Section*
Aircraft	1. Radar Simulation
Flight Dynamics	2. Terrain Storage
and on-board	3. Guidance Computer
Control System	

For simplicity, consider the design of the system for maneuvers in the vertical flight plane only. Let the radar dish be at a point (x, y) in this plane, x being the horizontal distance and y the vertical distance from an appropriate origin. A radar beam sweeps through "look" angles of $+5°$ to $-30°$ and returns are obtained from the terrain for ranges up to 25 miles at time intervals determined by the pulse repetition frequency (500 pulses/sec.). The returns establish the slant range and thus the terrain altitude at a given point ahead of the aircraft. The guidance computer accepts the slant range information and the radar 100K angle to which it relates, and computes aircraft pitch angle and engine thrust commands.

A block diagram of the organization of the simulation appears in the Figure 5.

The programming of the analog section is straight-forward. In the digital section we have

1. Radar Look Angle Generator. A register which adds to the received value of aircraft pitch angle a value equal to n· (Radar scanning rate)/Radar PRF.

2. Radar Pulse Position. An accumulator which integrates the altitude of a transmitted pulse from a value equal to the radar altitude down to a value matching that of the terrain. This integration simply steps forward at each clock pulse a value equal to $\Delta X \tan \theta_s$.

3. Terrain Function Store and Sweep. Nine function storage channels contain 390 9-bit values of terrain altitude corresponding to values of horizontal position separated by $\Delta X = 500$ feet over 25 miles. As the aircraft flies forward the stored values are updated from a store containing 100 miles of terrain data. The 9-bit output of the recycling stores is compared at each clock pulse to the altitude of the transmitted pulse.

4. Slant Range. At each pulse transmission a digital integrator accumulates slant range ($= \Delta X/\cos\theta_s$) until a reset pulse transfers the accumulated value to a buffer register and resets the integrator. The value in the buffer register is used by the guidance computer to compute flight control commands.

5. Guidance Computer. The real hardware or an equivalent system mechanized by the digital section of the computer.

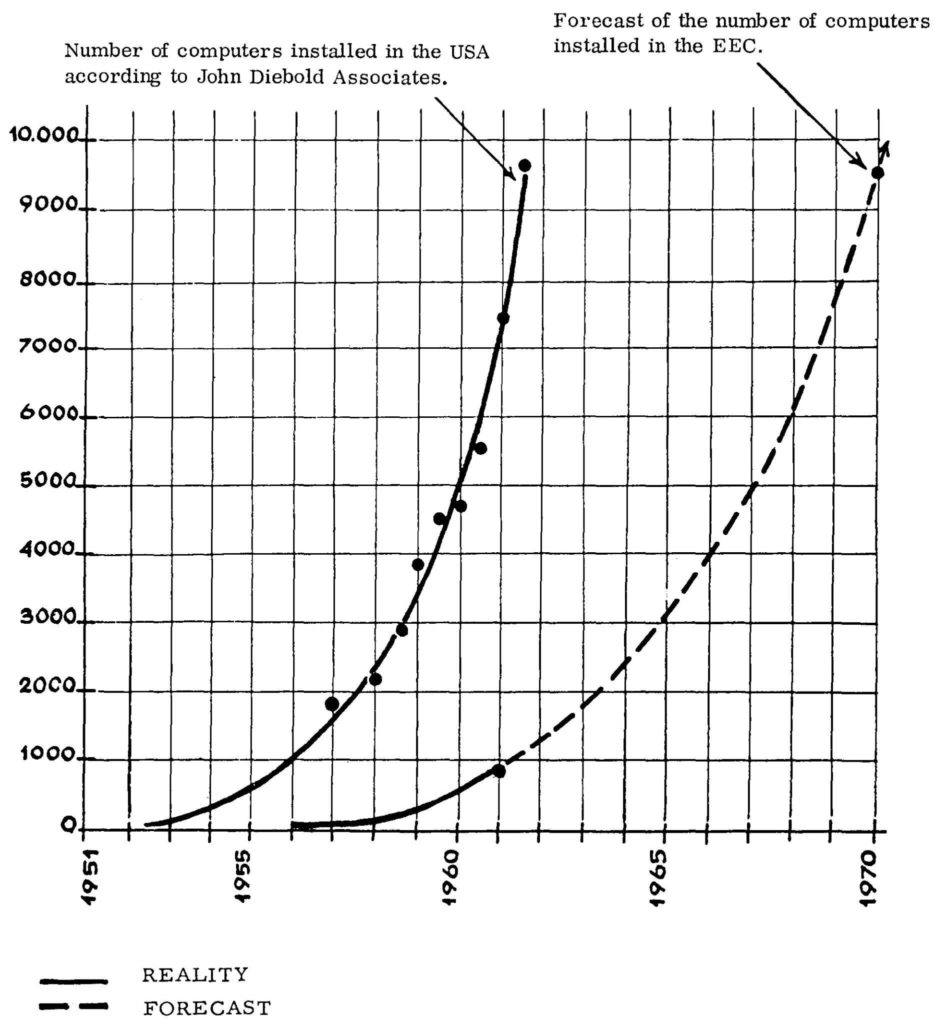


Diagram G

THE DEVELOPMENT OF THE COMPUTER MARKET IN EUROPE (Part 2)

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(Continued from the September issue of **Computers and Automation,** page 15)

D. Service centers

Service centers belong of course to the oldest groups of computer users, and it is clear that this group belongs to the most advanced ones. Yet a distinction can be made between service centers connected with computer manufacturers and independent ones. The latter group may be divided into purely private centers, governmental centers, and those based on some cooperative use of the machine. In addition there is a group of computer users who offer their redundant computer time for rent; these are not, however, considered to be service centers.

The number of service centers in the European Economic Community known to us is 53 with a total of 105 machines. 37 of these with 82 machines are centers of computer manufacturers. Only 16 with 23 machines are independent. The following computer manufacturers run or are establishing service centers in the EEC: IBM (11), REMINGTON-RAND (6), NATIONAL CASH (5), BULL (3, of which 1 is in cooperation with OLIVETTI), SIEMENS (2), ZUSE (2), BURROUGHS, ELECTROLOGICA, FACIT, ICT, ROYAL McBEE, SEPSEA, STANDARD ELEKTRIK and TELEFUNKEN (each has one).

As the "common market" idea further develops it may be expected that the number of service centers will increase. Many of the centers of punched card equipment manufacturers do not yet have computers. Many manufacturers operate service centers only in their own countries. Establishing a center in another country, however, will be one of the best ways to get a reasonable share in the com-

(Based on a report "Development of the European Computer Market," prepared by the Centre at the request of the European Economic Community, and reproduced with permission)

puter market in that country. The introduction of a new type of machine will also often initiate the start or expansion of a service center.

The number of private centers is still small. The development in the USA, however, leads to the expectation that important changes will come. The idea of making use of the services of these centers is growing and several new centers have been initiated during the last few years.

It is interesting to note that in the USA exchange of opinion is going on about who should operate a service center. Two groups are mentioned as qualifying, these being banks and the government. Banks, because they have always had a position of trust and will therefore be more easily accepted as guardians of secrecy. Government, because it can also, like a public utility, offer enough guarantees. Moreover, both groups are, generally speaking, capable of furnishing the capital required. In Europe the situation has not yet reached this stage. A few governmental centers exist but these are serving governmental organizations only.

It may be expected that the number of independent centers will gradually increase. The greatest difficulties regarding this development will be to raise the necessary funds and the relatively long time it takes before a center will yield a profit.

E. Industrial firms

On account of the incompleteness of the data available it is not possible to give an analysis per branch. The total known number of industrial firms within the EEC using a computer or having one on order, is 213 with 314 machines together.

A general impression derived from the data leads us to say that heavy industry together with similar companies such as mines, blastfurnaces, steel plants, machine-, tube-, aircraft- and car-factories, often use computers. Also known are a number of chemical, electrotechnical, mechanical precision and optical firms with computers. Concerning other branches, it may be stated that other computers are being used, mostly by the bigger and very big companies. Yet it is the industrial section especially which shows an enormous interest in automation, one of the reasons for this being the gradually increasing knowledge of production control and process control.

The ever-growing interest in the possibilities of controlling production with the aid of computers justifies the expectation of a considerable increase in the use of these machines by this group during the next 10 years. Proper development of the techniques concerned will make it attractive for many big and also medium-sized industrial firms to change over to automation. There are several important branches, such as textile-, food-, paper- and glass-industry, shipyards and workshops where a start has been made but where the number of computer users is still small.

A development of quite another nature is process control, the direct control of production machines by computers. This possible application has received more and more interest lately and it is to be expected that in the coming years it will reach a much higher degree of development. Two years ago there were probably no process control machines in use in Europe; nowadays the possibility of process control is common talk. It is of interest to remark that in the middle of 1962 the American firm of Ramo Woolridge is reported to have sold 183 process control computers, of which 146 are in the USA, 18 in France, 7 in Great Britain and the remainder in various European countries (i.a. some in Germany). It is reasonable to expect that in this field also the number of machines ordered will rapidly increase.

It should be remembered that especially in this important group (about 30% of all the machines), where many data are missing, the value of statistics is limited. Of the total of 314 known machines 53 (16%) can be classified as smaller scientific ones and only 25 as large ones. The others, with the exception of a few process control machines, belong to the middle class. The types most frequently used are: IBM 1401 (58), IBM 650 (42), BULL GAMMA TAMBOUR (33), UNIVAC SOLID STATE (23), IBM 305 (18), ZUSE (16), IBM 7070 (15), SIEMENS 2002 (15) and SEPSEA CAB 500 (12). None of the others has more than eight. There is a total of 36 different types.

F. Trade

For this group too the data available are far from comprehensive. This makes it impossible again to specify by type of trade, the more so because in this section automation has so far been almost exclusively applied by big organizations. Among these there are several who act simultaneously as wholesalers and as retailers. The only two groups that are sufficiently uniform to be mentioned separately are department stores and mail order firms. Generally speaking automation has not penetrated far into the trading section. But, considering the results achieved so far and the keen interest shown today, it may be expected that especially in this group automation is really on its way.

The number of trading firms known to use or to have ordered computers is 50 with a total of 80 machines. Among these there are 5 mail order firms with altogether 17 computers and 6 department stores with altogether 7 computers. 18 different types of machines are known. Of the 80 machines 7 are large and 4 small scientific ones.

It is obvious that applications in this section mainly deal with inventory problems. As many trading houses are faced with an obvious stock-accounting problem, and the results in this field are remarkable, it is most likely that automation in this area will increase speedily. The possibility of using tele-communication, especially for many multiple shop companies will be important. Particularly in this trade section and for this type of application there is a large market for smaller data processing machines such as cash registers, typewriters, accounting and billing machines that can be directed by papertape or edge punched cards and that can produce the same types of data carriers or punched cards. There is also great scope for the application of optically legible documents such as cash register rolls and for machines which are capable of reading these data carriers. This last type of application is still in its infancy; the use of papertape reading equipment however has come very much into vogue and constitutes serious competition for punch cards and other input languages.

Computers used include IBM 1401 (22), REMINGTON SOLID STATE (17), and other computers (no one type more than 6).

G. Banks and (postal) clearing-services

In this section automation within the EEC started only recently. Though there are some firms who have used computers for several years, a majority of the 62 known companies who have computers installed or on order, are still at the beginning of automation. During the last two years, however, quite a number of banks have started to automate. The fact that of the 107 computers, used or on order by the 62 firms in this class, 44 are IBM 1401, demonstrates clearly that one cannot yet speak of big advances in automation in this section. Among these 107 machines there are 18 different types, none of which (except the IBM 1401) exceeds 10 machines. 16 out of the 107 are big computers. Of the 62 firms, 4 are clearing services ("giro") who use or will use 12 computers altogether (including 2 large ones).

Many of the banks that started earlier have already switched over to bigger and more modern installations or are now doing so. The number of big computers, however, clearly shows that many of the larger banks have not yet ordered such installations. There are several reasons leading one to expect an important development in the coming years in this group:

—The fast development of telecommunication possibilities which will stimulate the centralized processing of data of branch offices.

—The application of magnetically or optically legible writing for checks, the realization of which may be expected shortly. This is already in practice in the USA, Great Britain, Japan and some other countries. European banks keep in close contact in this respect and agree that it will be desirable to start with this application.

—The fact that during the last few years more and more banks have ordered computers, some of them middle class types.

—The development in the USA, where at the end of 1961, 326 banks had already ordered computers. A recent survey of the Federal Reserve Board shows that in the middle of 1962, 40% of the American banks (383) use computers or will do so within 3 years; 178 of them have machines installed. Of the 322 who use or have machines on order, 95 report two or more machines.

—In addition to these computer data it is reported that the application of magnetically readable checks is developing rapidly. Of the 974 banks with deposits over $25,000,000, 950 are using checks preprinted with magnetic ink codes, 695 of those with more than 60% of their checks, 418 have even surpassed 80%. 762 banks (more than 75 per cent) expect to have all their checks preprinted in this way by the middle of 1963. 448 banks have ordered electronic equipment for the processing of checks. About 200 already use electronic check sorters. 80 of these even have more than one in use or on order. These figures clearly show the vast development of electronic data processing by USA banks. Though in continental Europe checks are used in a much smaller degree than in the USA, we can still infer from this what may be expected.

—The (postal) clearing-services are already far advanced in studying automation problems, and here considerable progress may be expected in the near future.

H. Public utilities

In this section, too, automation has only begun to be applied during the last few years. But a considerable increase in activities may be expected in the next few years.

The number of undertakings known to use or to have ordered computers is 17 with a total of 46 machines. The relationship between these two figures is completely changed if we include the big nationalized and centralized French electricity company "Electricité de France," which alone has 28 machines installed or on order, among which are two big ones, seven small scientific ones and seven process control-computers. After elimination of this giant company there remain 16 organizations with 16 machines. Ten of these are UNIVAC SOLID STATES. The 17 undertakings consist of 13 electricity companies, two gasworks, one telephone company and the "Autostrada del Sol" (Italy). In Belgium no users are known.

The fact that most of the big electricity works use extensive punched card installations leads up to the expectation that it will not be long before they start ordering computers, especially because these organizations have great data processing problems. These include the assessment and processing of consumption figures and the collection of amounts due, which problems lend themselves particularly well to automation. The same naturally goes for other public utilities too, such as gas-, water- and telephone companies. In a good many cases these companies are under the local authority of counties and municipalities and will therefore be involved in the automation in that section. (See group J)

I. Governmental organizations

Automation has not made much headway anywhere in this section so far. In view of the present development, however, and especially the situation in the USA, it may be assumed that considerable progress will be made in the coming years. Among the 44 governmental bodies known to use or to have ordered computers are 20 ministries, 7 statistical offices, 5 organizations for atomic energy research, 3 military organizations, 5 undertakings concerning postal, telephone, telegraph and television services and 2 meteorological institutes. This alone shows the enormous field still lying fallow. These 44 users together have 73 machines of 28 different types, among which are 11 big and 20 small scientific ones. The most common type is the BULL GAMMA TAMBOUR (15); the number of each of the other types does not exceed 7.

A comparison with the USA shows an enormous contrast. In the middle of 1962 the federal government there was using 971 machines of which about 180 were large and about 100 were smaller scientific ones. The rapid increase during the last 3 years is remarkable. In this period the number of machines used has been more than doubled:

at the end of 1959	414
at the end of 1960	531
at the end of 1961	755
in the middle of 1962	971

The most important user is, of course, the Department of Defense which uses 661 machines (of which 305 are for the Air Force, 180 for the Army and 163 for the Navy). For atomic energy research, too, many machines are used (90) and for flight research another 65 machines. The most common types are IBM 1401 (192), IBM 305 (116), IBM 650 (90), IBM 7090 (41) and IBM 7070 (40). This manufacturer has supplied more than 57% of the governmental machines.

It should be remembered that in the USA there are a number of reasons for using computers which are of no or little importance in the EEC. Most of these reasons are already shown in the figures mentioned above, according to which more than 83% of the American governmental computers are used for defence, atomic energy and space-flight research. The remainder of 155 machines (upwards of 16%) could be compared with the European data. Therefore it is necessary to deduct from the 44 machines those in use by military organizations, defence departments and atomic energy research institutes, i.e., together 17 machines (as compared with 816 in the USA). The other 27 machines can then be compared with the 155 American ones. This clearly shows that within the EEC there are good prospects for computers in this section even if we bear in mind that the quantities of information to be processed in the USA are much larger than those in Europe (federal taxes may be mentioned in this connection). On the other hand there are in the EEC 6 Treasuries, of which 5 should certainly be considered large enough to use at least one computer, even if the Ministries of the German federal states are left out of consideration.

J. Local governmental institutions

An important group of potential users of computers are the local governmental institutions, such as provinces, counties, and municipalities. This group as a whole is only just starting automation. Some cities where computers are known to be used or on order today are: Milan (2 UNIVAC SOLID STATE), Cologne (1 UNIVAC SOLID STATE) and Amiens (1 BULL GAMMA 30).

Besides, some German cities are using smaller scientific machines for their cadastral work (surveying work showing ownership and boundaries of land) ("Stadtvermessungsämter" in Essen, Cologne, Hamburg and Leverkusen with a ZUSE 11 and at Duisburg with a ZUSE 23). For the same kind of work another 22 regional organizations in Germany are using 26 machines (8 "Landesvermessungsämter," 7 "Flurbereinigungsämter" and 7 "Landeskulturämter"). This is a specifically German development which is probably due to the fact that a German manufacturer of this type of small scientific machines has drawn attention to this kind of application. In fact, 20 machines of the total of 26 appear to be ZUSE 11 type.

Because a growing interest in automation is noticeable in this section and, besides, some progress has been registered in some other European countries the last two years, it may be expected that automation will penetrate into this group in the coming years. In this connection some illustrative figures for other countries are of interest: In England a total of 11 counties and 12 municipalities have computers installed or on order. In Austria 4 "Landesregierungen" (states) and in Switzerland 2 "Cantons" (states). In the USA a total of 131 states, counties, municipalities and towns were using computers early in 1961, while about the same number was on order.

If the assumption is made that a city of more than 500,000 inhabitants would in effect be big enough to operate a computer center (with a medium-sized or large computer) on a profitable scale and that cities having 100,000 to 500,000 inhabitants would have enough work to operate a small to medium-sized machine, it appears that in this group a considerable development may be expected. Within the EEC there are some 110 cities with a population of over 100,000 inhabitants, of which 24 have more than 500,000. Further there are the local governmental institutions like the German States (10), the Italian regions (19), the French departments (90) and the Belgian (10) and Dutch (11) provinces, of which a number would certainly be large enough to use computers.

This gives a clear insight into the possibilities—although these are not yet all. For example, a number of smaller municipalities could operate a computer on a cooperative basis. The application possibilities are numerous in this respect. Apart from pay-roll work and the problems of stock accounting, other opportunities are for example taxes, budgets, recording of school attendance, public services, traffic, elections, cadastral work, statistics, social services, etc.,—together a rather impressive list of possible applications. The small number of users in this area today suggests, however, that a considerable increase in the number of these users should not be expected during the coming three to five years.

K. Other sections

The groups analysed in paragraphs A to I all deal to a certain extent with automation. Besides these, there are a number of areas where hardly anything or very little, and that only on a one time basis, has been done, but where it may be expected that the next ten years will show at least the beginning of the use of computers:

- —Organizations with a large membership, like trade unions, automobile clubs, church groups, blue cross, and the like. In this category a considerable number of clerical activities need to be carried out for which a computer—at least in a number of cases—could be used. In Europe today there are only in Italy and Great Britain such organizations which have ordered computers, namely "Federartigiani" (Federation of Craftsman) and "Federconsorzi" (Federation of Agricultural associations) with respectively one and two IBM 1401 computers on order in Italy, and the British Draughtsman and Allied Technicians Association, a labor organization which has ordered a NATIONAL 803. The second Italian user possibly belongs more to the next group.
- —Organizations in the agricultural sphere. In this group the developments are almost nil also. Except for the "Federconsorzi" mentioned above only the Dutch Laboratory for Soil and Vegetation Research is known to be having a computer installed. This organization uses a computer to compile fertilization and planting advices for farmers and advices concerning the composition of winter-stocks for cattle-breeders. It should not be expected that the developments in the automation field in this agricultural area will be very important.
- —Hospitals and sick-funds form a group where the interest in the possibilities of automation has recently been increasing strongly. Here, too, hardly anything has yet been realized. In Great Britain only three Hospital Boards are using computers. The recording problems in this group are mostly large and of a complex nature. There are other problems like medical statistics, for example, for which computers could be a help too.
- —Also in the catering section (hotels, restaurants and the like) there are some important recording aspects for which, in conjunction with the tendency towards concentration, computers could be used in a number of cases.
- —In the service rendering section different sorts of agencies such as insurance brokers, publicity agencies, labor bureaus, collection agencies, inquiry-offices and patent bureaus may also be mentioned. This kind of organization has in most cases large files (information retrieval problem) and an enormous amount of clerical work.
- —A potential group of computer users are the consulting agencies. These are—in a sense—comparable to the service bureaus mentioned.
- —Finally the productivity centers should be mentioned as potential operators of computers to serve certain branches.

OUTLOOK FOR THE DEVELOPMENTS OF THE COMPUTER MARKET UNTIL 1970

The prognosis given here, can by its very nature not be more than a reasonable expectation. It is based on three points:

- —the present state of development;
- —the possibilities of the different branches as discussed in chapter 4;
- —the development in the USA, which may, as in so many technical fields, be considered the forerunner to Europe.

It may be emphatically pointed out that technical developments, if any, which have not yet been observed (or of which the importance has not yet been recognized), may change the situation considerably. The same applies to possible drastic changes in the political field and perhaps to drastic changes in economic conditions.

A curve representing the number of electronic information processing machines installed in the countries of the EEC, would be rather steep, especially for the last couple of years. Speaking of a saturation of the computer market should, therefore, be considered out of the question; it is just the opposite: the extent to which the different branches have so far been using electronic information processing machines should rather form a basis for expecting a spectacular increase in the number and kind of applications and therefore in the number of computers to be sold. The penetration per branch, that is the number of computers installed in each branch, up to the present moment, justifies the assumption that even if no new computer models were developed, if no new applications for these electronic information processing machines were found, if the prices of such installations were to remain the same, in other words if the conditions under which automation will be applied, would remain—more or less—the same, the number of computers to be installed will still be large.

But to assume that the conditions mentioned will not change is not a realistic point of view with which to approach the expectations for the development in the computer market up to the end of 1970. Several aspects form a reason to expect that such a potential increase of the market will come about that the growth-curve till the end of 1970 will not show any levelling out, aspects which indicate a similar development in the countries of the EEC as in the United States, only with a time-lag of some years.

In the first place there is the tendency to cooperation between business-organizations which is considered to be important, a cooperation resulting from the consolidation of the EEC structure, and which has been or will be realized in different forms. Economic concentration (merger) is one of these. This implies that the organization resulting from this merger will be of a size which enables it to acquire a larger or very large electronic information processing unit on an economically and technically justifiable basis. Merger, however, is not the only form. Voluntary cooperation may likewise be a reason for installing larger computers. A widening of the potential computer market should result from all this; a situation which has already been realized in a number of cases but progress towards which will undoubtedly be made in the near future.

International cooperation is also playing a part with regard to the exchange of ideas and experiences. Similar firms will reciprocally be able to learn much and so gain from each other's ideas and experiences on the subject of the automation of information processing. This means a saving in time and money and results in reducing the problems which may occur in applying automation to (a part of) the information-flow, because various factors that slow down automation are eliminated.

In the USA it is big-business (besides the government) that has pushed the application of electronic information processing machines. Moreover, recent cooperation in the form of an exchange of ideas and experiences—through the manufacturers as well as between the different branches—has worked in the same direction. The expectations with regard to the concentration of business organizations and other forms of cooperation within the EEC justify the assumption of an analogous result, in other words a rather steep increase in the number of computers to be installed.

This tendency to concentration will obviously appear in large, medium-sized as well as in small organizations within the EEC. This implies that at the moment when the structure of this association has been fully consolidated, a European economic structure has been brought into existence that will show more or less the same differentiation in relation to sales, number of personnel, etc., as now exist on a national scale, but on a considerably higher level. This leads to the conclusion that a saturation of the computer market is still in a remote future.

The kind of application for which up to now electronic information processing machines have been used should be taken into consideration. Just as in the USA this concerned the simplest applications in the first instance. In Europe as well as in the USA first of all only payroll, stock accounting and the like were automated. The amount of preparation work for such an application, although by no means negligible, is the lowest compared with most other applications. The costs of these more elementary applications are consequently not so high as those of the more involved applications, while in many cases the immediate results which could be obtained by these applications were determinative in the decision on automation. Very much misunderstanding was found to exist on this point. Consequently, this reason for automation was not always fully justified.

In this respect the situation has now changed. The use of a computer today will nearly always be economically justified. Besides, there is an increasing need for automation of the more complicated elements of the business process. Production control is a good example of such an application.

The availability of well-trained and experienced system analysts and programmers will likewise stimulate the application of electronic information processing systems. In the USA development in this direction has been underway for some years. For Europe the same may be expected.

Closely related to these facts are the types of computers available and the prices of these installations. The present stage of development leads to the expectation that—for the more complicated types of application—new computers will appear on the market, which will be better adapted to this kind of processing. Moreover, the development of smaller units to be used by medium-sized and smaller organizations and in autonomous parts of larger organizations will progress, as may be expected.

Furthermore, the price trend will be a determining factor in the same direction. Simplification and improvement in construction, together with a better insight into the requirements of an electronic information processing unit, lead to the expectation that the price per unit (computer) will show a downward rather than an upward trend in the coming years. The construction of other technical installations, like telecommunication units, will contribute also to a widening and in some cases to a speeding up of the development.

Finally attention should be paid to the role of government. Although the number of computers used by governments in EEC is still very small compared to the share the American government has in the total market of computer users, the next few years will, no doubt, bring a change in this situation. Local government in Europe in particular (municipalities, provinces, etc.) will begin to use electronic installation on an increasing scale. This tendency, too, suggests a comparison between the European and American developments in the sense than an increase in the application of computers by government will result in the above mentioned steep slope of the curve of the number of computers to be installed until 1970.

Summarizing this all leads to the estimate shown in diagram G. In this graphic representation the available data on the ratio between the number of computers installed and on order in 1962 and 1963 are taken into account, while this ratio of about one to one is expected to be about two to one in 1970.

Weighing all factors has led to the estimate that the number of computers installed in the present EEC countries at the end of 1961, will be tenfold by the end of 1970. The curve of growth is even then considerably less steep than that for the USA in the years 1956 to 1961, so that the present lag of five years will increase to eight and a half years by 1970.

It is expected that the required amount of preparatory work will in the near future be more important than the size of the computer system. In other words, the number of computers to be installed, significant though it may be, will not be the only standard by which to measure the importance of the expected growth regarding the computer market. If the number of specialized computer personnel per application increases, and if the personnel costs also show a tendency to increase in comparison with those of the installation itself, the total number of computers to be installed up to the end of 1970 will give an indication of the total investment in this field by industry.

A more or less rough approach results in the following:

A total of 9500 computers and 20 specialists per unit means 190,000 specialists directly engaged in the applications of automation. Adding to this figure the 70,000 specialists who have to be active at the end of 1970 to prepare for the computers on order, leads to a total of 260,000 persons. It may be assumed that about 70% of this total will necessarily have been employed by the organizations involved from the beginning of the preparatory activities (which means the programmers and systems analysts from the start and a number of operators and maintenance technicians from the instalment of the equipment to test the programs). If the total period to prepare the application for an electronic system that functions well is estimated at about two years, this results in a total of 350,000 man years being required. Based on annual labor costs of Dfl. 25,000 per specialist this asks for an investment of about Dfl. 9,000,000,000 ($250,000,000), a rather high investment which will require great efforts on the part of trade and industry in the countries of the EEC.

If these costs are assumed to be 75% of the costs of installing automation for processing the information flow—an installation consisting of an electronic information processing machine plus the connected in- and output equipment—the total European investment in this field would amount to Dfl. 21,000,000,000 ($5,800,000,000) i.e. Dfl. 12,000,000,000 ($3,300,000,000) equipment and Dfl. 9,000,000,000 ($2,500,000,000) preparation.

If this investment is compared to that of, for example, the Royal Dutch Airlines, we see that this enterprise alone from 1957 to 1961 invested a total of Dfl. 600,000,000 ($170,000,000) in its air-fleet. The chemical industry in the Netherlands was found to have invested Dfl. 800,000,000 ($22,000,000) in machinery and equipment during 1959 to 1960; the public utilities in the Netherlands in the same period more than Dfl. 500,000,000 ($14,000,000). The estimated Dfl. 21,000,000,000 therefore, should not be an insurmountably high figure.

ANALYSIS OF THE NUMBER OF SPECIALIZED COMPUTER PERSONNEL

The use of electronic computers for information processing has created a number of new specialized functions. A full agreement on the function-classification of these specialists does not yet exist. Since in practice functions are frequently mixed up, a comparison between these functions is difficult when based on the function-classifications used in industry only. Systems analysts for example from different firms can only be compared as one group if a detailed knowledge exists of the nature of their duties and if existing differences between these duties are eliminated.

Several factors may be of influence on the number of these computer specialists and the classification in an industry, as for example:

—the specific organizational structure;

—the character of the business;

—the size of the firm;

—the size of the installation to be used.

Regardless of these differences it is possible to set up a certain classification of the new functions which have come into existence through the application-developments of computers. This classification is based on the different tasks which are distinguishable when a conversion to office-automation and the good functioning of an automated system has to be accomplished.

The following classification in categories may be used in this respect:

—specialists primarily engaged in the preparation for and the realization of automation;

—supervision of the E. D. P. department;

—systems analysis;

—programming and coding;

—input preparation;

—operation of electronic and peripheral equipment;

—maintenance;

—specialists only partially engaged in the realization;

—soft-ware research;

—information-structure research;

—cooperation of the line personnel.

The following summarized description of tasks may be useful:

Supervision of the E. D. P. department

A high level supervisor responsible for the organization and daily supervision of the department (center) where the electronic and peripheral equipment is installed and where the other specialists are directly engaged in preparation for realization of automation. This supervisor also in many cases directs some of the specialists who are only partly engaged in serving the realization.

Systems analysis

The analysis and set up of diagrams of (a part of) the information-flow for which the electronic installation is or will be installed. This analysis is done by the systems analyst, who lays down the result of his analysis in the form of charts and diagrams (flow-charts and block-diagrams).

Programming and coding

The programmer transfers the chart and diagram data on the origin, flow, and points of use of information, into a program which can be understood by the electronic machine. One of the aspects of programming is the transformation of these charts into machine language. Parts of these latter activities are—in some cases—delegated to a special coding specialist or assistant to the programmer.

Input preparation

This includes the personnel responsible for the preparation of information carriers destined for computer input, like punched cards and punched tape and the verifying personnel.

Operation of electronic and peripheral equipment, for which the operators are responsible. It means starting the computer and other input and output equipment like the punched card and printer installation, etc., including interfering in the process each time a signal given by the installation indicates the necessity; feeding information carriers with input data into the machine, setting the output equipment, etc. The specialists responsible for the magnetic tape installation and library, if these are used, also belong to this group.

Maintenance

This is performed by several kinds of technicians; and it includes preventive maintenance as well as the elimination of break-downs of any kind.

Soft-ware research

Means the design and realization of improvements as, for example, devising simplifications in the programming language used, building a compiler or interpreter, etc. The specialists who perform these tasks are in most cases experienced programmers, sometimes called "creative programmers." They are not directly involved in the operation of the electronic information processing system; but their task serves this operation indirectly because the results of their work may benefit the system in a later stage.

Information-structure research

The realization of improvements in the way in which the information-flow is structured to fit into the set up of an application. Experienced systems analysts are given the task to find new methods with regard to the collection, flow and use of data, resulting in a higher efficiency of the system.

Cooperation of the line personnel

By this cooperation no new specialized functions are created. This category concerns, however, line personnel who, because of the introduction of automation in the administrative sphere, contribute more or less to the realization of the conversion.

Their part is difficult to evaluate but requires in many cases a change in the way of thinking and working methods of this personnel and as such belongs to the impact-area of computer applications.

For determination of the number of specialized computer personnel, it is necessary first of all to obtain a picture of the average number of specialists employed per computer installation. Then it has to be determined to what extent this average multiplied by the number of computers installed might give an exact picture of the present situation.

Several uncertainties, however, should be considered in this connection, for which the following reasons can be given:

—The types of applications which are prepared and put into use with the help of electronic information processing machines will influence (together with other factors not considered important for this report) the size of the computer installed and, consequently, the number of specialists employed. A payroll application, for example, will, in general, not be comparable as such to a production-control application. The latter application probably requires much more time of the systems analysts, programmers and line-employees involved. Moreover, if the payroll requires a smaller machine than production-control—which should by no means be thought impossible—the organization which owns the smaller unit will also have a smaller need of operating and maintenance technicians than the other.

—More or less linked up with the foregoing, the size and character of the enterprise will determine the type of computer application and the size of the equipment. Automation of only payroll accounting in a small enterprise will mostly be less efficient, whereas a combination of payroll accounting and stock control may increase its value. Such a combination, however, makes high demands upon the number and kind of specialists preparing for automation.

—The distinctions between systems analysis and programming, and between operation and maintenance of equipment are in practice not clear. Through the absence of a well-defined classification of functions, some employees are called programmers, whereas in other situations a not inconsiderable part of their activities may be considered the task of the systems analyst. To a certain extent the same applies to operators and maintenance personnel. In some enterprises a part of the direct or simple maintenance is entrusted to the operator, whereas in other cases this is out of the question. If, therefore, the number of maintenance employees is smaller than might be expected on account of the size of the installation, a more detailed analysis of tasks has to provide a better insight into assignments of tasks in the enterprise concerned.

—Finally, with regard to the average number of specialists busy with the computer, it has to be determined to what extent the cooperation of line employees in preparing and performing the job has led to different numbers of specialists engaged. In other words, whether and to what extent the knowledge of the line employees concerned has decreased the need of specialized systems analysts.

As a matter of course, coordination and centralization of data from users of electronic information processing machines could eliminate these uncertainties to a certain degree. However, data gathered in this way make it possible to fix the total number of specialists active at this moment only if:

—the number of electronic installations in use is exactly known, and

—at the same time as accurate an idea as possible of the time schedule in use in a computer application has been obtained. In other words, it is very important to know whether one or more shifts is worked. A night shift mostly consists of fewer workers than a day shift. Consequently the shift distribution is an indispensable piece of information in fixing the exact number of active specialists.

Therefore, the available figures for the number of computers installed may indeed be used as a starting point but, as may be concluded, in a limited sense only.

An investigation into the number of specialists busy with electronic information processing systems in use in institutions of the American government in 1960 reveals a total of some 4000 specialists for 237 computers. This means an average number of 16 specialists per system. The large(r) systems, however, need nearly 50 specialists each.

A more detailed analysis shows the following picture:

8% computer administrators
48% programmers (of all types)
16% computer systems operators
9% peripheral equipment operators
3% electronic technicians, and
16% systems analysts.

Figures concerning the situation in Great Britain show the following tendencies:

—in governmental and research organizations an average number of 10 programmers and systems analysts are fully engaged per installation;

—in technical organizations (air-craft construction, etc.) the average number is 10 also;

—commercial institutions have an average number of 8 programmers and systems analysts employed.

When the number of specialists employed by computer manufacturers (in Great Britain this number varies from 50 up to 100 per firm) is added, a total number of some 4000 programmers and systems analysts is reached in that country. Considering the number of computers installed, derived from the same source, this means an average number of 8 programmers and systems analysts per computer. On the basis of the number of active computer operators (from 1600 up to 2000) and maintenance technicians (about 1000) one may say the total number averages about 14 specialists per electronic information processing machine in Great Britain. When, however, this number of specialists is related to the total number of about 350 computers installed in Great Britain as mentioned in this report, the average rises to 20 specialists per computer.

Swedish sources suggest an average of about 15 specialists per computer; as compared with data from Austria for instance, as far as known, this figure appears to be low.

If a conclusion is based on these data, it can be stated that in general a total number of about 15-20 specialists per computer should not be considered to be improbable. If at the same time this total number—with a reasonable approach of the actual situation—can be divided into the following main groups:

6-8, i.e. 40% programmers
3-4, i.e. 20% systems analysts
4-5, i.e. 25% operators
2-3, i.e. 15% maintenance personnel,

the number of active specialists in the six countries of the EEC may be fixed at a total of from 15,000 to 20,000 (not including the executive functionaries of the computer center, line employees and so-called creative programmers and systems analysts). If the employees not included average ten per cent of the above estimate, the following figures may be given:

6,000- 8,000 programmers
3,000- 4,000 systems analysts
4,000- 5,000 operators
2,000- 3,000 maintenance personnel
1,500- 2,000 other specialists

Total of 16,500-22,000 specialists

EXPECTED NEED OF SPECIALISTS UNTIL 1970

As a matter of course, the expected need of specialized computer personnel is closely connected with the expectation for the increase in the number of computers that will be installed before the end of 1970. A straight relation, however, cannot be expected under all circumstances. Some of the most important causes of this deviation from the straight-line relation are:

—A proportional relationship between the number of electronic information processing machines that will be installed and the number of specialists suggests the same kind of use of the machine now and in 1970. This supposition need not be true.

—As a consequence of a growing urge to increase the really productive computer time more attention may possibly be paid to the analysis of the structure of information. This goes for old as well as new applications.

—The setting up of a 2- or 3-shift service or the continuous use of certain computers will lead to a more than proportional need of specialists.

—A change in the type of application may be expected, by which applications more complicated than at present, will be realized in the coming years. This implies a greater emphasis on systems analysis.

—The purchase of so-called satellite computers, supposing that this will be economically justified for several enterprises in the future, will also lead to a more than proportional increase in the number of specialists.

Whereas the above-mentioned factors point to a tendency for a more than proportional increase in personnel requirements, several other factors show a trend in the reverse direction:

—Development of ready-made programs for similar enterprises and similar applications.

—New technical developments coming into the market such as optical reading, a universal programming language, the possibility of having computer programs made by other computers, etc., which make it possible to employ fewer specialists or fewer highly specialized employees anyway.

—Increasing centralization of information processing by what is known as data collecting by means of data transmission equipment, which enables large decentralized enterprises to buy one large electronic system instead of several smaller computers.

—Decentralization of information processing when service centers are used, or one or more computers are jointly used by several enterprises.

—Establishment of consulting bureaus rendering service in the field of systems analysis and programming by experts trained in working out computer applications. This could decrease the need of some enterprises to have their own specialists.

—Increase in the second-hand computer business, as far as these are used for simple applications. The question arises, however, whether the technical condition of these machines will not lead to a more than proportional increase in the number of maintenance personnel.

Considering these factors it may be supposed that the average number of specialists per electronic information processing unit will increase from around 15 (present situation) to about 20 employees. It is assumed that this number will be built up as follows:

7, i.e. 35% programmers
6, i.e. 30% systems analysts
5, i.e. 25% operators
2, i.e. 10% maintenance personnel

On a total of 9,500 computers installed up to 1970 this means:

66,500 programmers
57,000 systems analysts
47,500 operators
19,000 maintenance personnel

190,000 total

If we add to this number the personnel charged with the management of the computer center and those doing creative programming work, the total number of specialists needed by the end of 1970 will be about 210,000.

A larger number will, however, be required, because a considerable number of electronic information processing machines will be on order but not yet installed then. This number, estimated at approximately 3,500 necessitates the training of about 70,000 specialists to make the installation of these computers in the years after 1970 successful. The training for operation and, to a certain extent, programming of less complicated applications takes a shorter preparation time than the training for systems analysis, maintenance and programming of more complex applications.

This would mean that the training for the simpler functions need not start before 1970 and thus the need at the end of 1970 would be less than 70,000 employees. However, if the delivery time, as supposed in the prognosis, is shortened, this means that for instance systems analysts, maintenance technicians and most of the programmers who have to work with the computers on order at the end of 1970, should receive their first training before that time.

Moreover, it may be expected that a large number of these 3,500 computers will already be delivered in 1971. So the need of 70,000 specialists at the end of 1970 seems a reasonable expectation.

Finally one has to reckon with the normal turnover of computer specialists in the period until 1970. Factors that may play an important part in this respect are:

—Till now the number of women occupied in this field has been very small. This may be expected to change, so the turnover as is usual with female personnel, will increase.

—When an ever-increasing number of specifically trained employees is available, some of them, who in consequence of a shortage of specialists are occupied with systems analysis for example, will return to line activities, which are only indirectly related to computer applications.

—Competent people have to be found for the training of specialists. It may be expected that most of them will be drawn from the group of experienced specialists.

—The novelty inherent in the professions of systems analysts, programmer, etc., will disappear gradually, so that a certain number of these employees will turn away from computer applications.

All these factors lead to the conclusion that some 15-20 per cent turnover for the entire period may be considered correct. This means that till the end of 1970 about 325,000 computer specialists will have to be trained in the countries of the EEC. Starting from the present number of about 20,000 specialists some 300,000 employees should be trained between 1962 and the beginning of 1971. In addition a multiple of the number of line personnel will have to be instructed and trained in the same period. A number of 10 to 15 times that of the specialists may be thought of in this connection.

CONCLUSIONS

Drawing conclusions from the foregoing data and considerations is not primarily the task of the composers of this report but of the reader. Nevertheless it may be useful to give a short summary of the main points that have emerged from this report:

—The present development of the computer market has shown a large increase in the last ten years, when the number of electronic information processing machines installed is considered. The curve representing the growth in the countries of the EEC is, however, less steep than that for the USA in the early years of automation.

—To a certain extent this may be explained by the fact that the USA government has had from the beginning an important influence on the number of applications of electronic equipment. In other words, comparison of the early periods in the two curves has but little sense, as the curve in the countries of the EEC represents almost exclusively the so-called commercial applications, whereas, where the beginning phase is concerned, the American curve does not do so.

—The analysis of different factors such as increasing European cooperation in the form of economic concentration, interchange of experiences, etc., leads to the expectation that the slope of the curve in the countries of the EEC will gradually grow nearer to the American trend of development but that, by the end of 1970 the existing time-lag of 5 years will have been increased to about 8½ years.

—In almost all branches of business, where automation in one or other form is applied, an increase in the number of applications may be expected.

—Comparing the current stage of development with the opinions of some years ago, it seems reasonable to expect that every branch of business will be driven to automate (part of) its information flow in the near future.

—Moreover a change in the nature of the applications to more complicated ones like production control and integrated information processing of other kinds may be expected.

—Likewise more middle-sized and small enterprises will be considered suited to electronic information processing equipment. A sufficient number of usable computer types may come into the market.

—The number of computer specialists who should be trained until the end of 1970 is estimated at 300,000. This is 15 times the present number.

—Moreover a very large number of line employees will have to be oriented on possibilities and properties of electronic information processing equipment.

—Still greater stress will be laid on the costs of preparation in the coming years than is done up to now. It may be expected that in the countries of the EEC about Dfl. 9,000,000,000 ($2,500,000,000) will have to be invested in preparing for automation.

—The investment in equipment is estimated at about Dfl. 12,000,000,000 ($3,300,000,000) for the same period, so that the total investment in automation may be estimated at Dfl. 21,000,000,000 ($5,800,000,000). Not included are the costs of training, rebuilding, etc., nor the investment in applications of the smaller automation equipment.

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.

A SURVEY OF NEW WEST-EUROPEAN DIGITAL COMPUTERS (Part 2)

Joseph L. F. De Kerf
Research Laboratories
Gevaert Photo-Producten N.V.
Mortsel, Belgium

(Continued from the September issue of **Computers and Automation,** page 25)

Nachrichtentechnische Zeitschrift.
Verlag Friedrich Vieweg & Sohn, Braunschweig.
Monthly. DM 3.70 per number.
Neue Technik.
Verlag Neue Technik AG, Zürich/Schweiz.
Monthly. DM 4.50 per number.
Numerische Mathematik.
Springer-Verlag, Berlin.
Irregularly. DM 96.00 per year.
Regelungstechnik.
Verlag R. Oldenbourg, München.
Monthly. DM 16.20 per trimester.
Regelungstechnische Praxis.
Verlag R. Oldenbourg, München.
Quarterly. DM 2.40 per number.
Unternehmensforschung.
Physika Verlag, Würzburg.
Volumes of four parts. DM 40.00 per volume.
Wissenschaftliche Zeitschrift der HfE Ilmenau.
Der Rektor der HfE Ilmenau, Selbstverlag.
Irregularly.
Zeitschrift für angewandte Mathematik und Mechanik, ZAMM.
Akademieverlag, Berlin.
Monthly. DM 20.00 per trimester.

ITALY

Ing. C. OLIVETTI & C. (Divisione Elettronica, Via Pirelli 32, Milano), well-known manufacturers of office machines (typewriters, adding machines, printing calculators, etc.), is the only Italian company producing digital computers. The prototype (ELEA 9002) of a general purpose high-speed digital computer (ELEA 9003), particularly designed for business applications, was installed in 1958 at their own offices. Eleven ELEA 9003's have been delivered since that time (August, 1962). The first type of another general purpose computer (ELEA 6001), particularly designed for technical and scientific research, has been installed at the Electronic Research Laboratory of Borgolombardo (March, 1961). Ten ELEA 6001's have been delivered since that time (September, 1962). About 60 ELEA 9003 and ELEA 6001 computers were on order in late 1962. Teletypewriters, punched tape readers, tape punches, and line printers of both computers are manufactured by OLIVETTI themselves. Moreover OLIVETTI is marketing a vast series of peripheral equipment for computers: electric typewriters with tape punch, business machines with tape punch, punched tape to punched card converters, punched tape to magnetic tape converters, etc. An electronic accounting machine with magnetic core store, the MERCATOR 5000, was shown by OLIVETTI at the INTERDATA Exhibition of the IFIP Congress 62.

ELEA 9003

Control: stored program. Operation mode: serial (input and output operations overlapping during actual computing). Number base: alphanumeric (six bits). Word length: variable. Point working: fixed. Instructions: 1 address type (8 characters). Number of operations: 99. Number of index registers: 40.

Store: magnetic cores. Capacity: up to 8 blocks of 20,000 characters (maximum capacity: 160,000 characters). Access time: 10 microsec (for two characters). Auxiliary store: up to 3 magnetic drums. Capacity: 120,000 characters per drum. Speed: 3,000 rpm. Average access time: 10 ms. External store: up to 20 Ampex magnetic tape units. Tape width: ½ inch. Tape length: 3,600 feet. Capacity: about 13 million characters per reel. Read/write speed: 22,500 or 45,000 char. per sec.

Input/output: teletypewriter (Olivetti: 10 char. per sec.), punched tape readers (Olivetti: 800 char. per sec.), tape punches (Olivetti: 60 char. per sec.), punched card readers (Bull: 500 cards per min.), card punches (Bull: 150 cards per min.), and line printers (Olivetti: 960 numeric or 600 alphanumeric lines per min.). Maximum number of on-line units: 10 (magnetic tape units not included).

Operation speeds: 200 microsec for addition and 1,400 microsec for multiplication. Ten digit terms and factors.

Power consumption: 4.5 kVA. Pulse rate frequency: 100 kc/s. Components: completely transistorized (no tubes). Price: not available (only marketed in Italy for the moment).

ELEA 6001

Control: stored program. Operation mode: serial. Number base: binary decimal (4 bits). Alphanumeric representation: 2 digits per character. Word length: variable. Point working: fixed and floating. Floating point representation: in any size required. Instruction type: 1-3 address. Instruction length: variable (average: 5 characters). Number of operations: 124. Number of index registers: 10. Arithmetic operations are performed directly in the core store.

Store: magnetic cores. Capacity: up to 10 blocks of 10,000 decimal digits (maximum capacity: 100,000 decimal digits). Access time: 5 microsec. Auxiliary store: 1 Olivetti magnetic tape unit. Capacity: 7 million characters. Read/write speed: 15,000 char. per sec. External store: up to 8 Ampex magnetic tape units. Tape width: ½ inch. Tape length: 3,600 feet. Capacity: 7 or 13 million characters per reel. Read/write speed: 15,000 or 22,500 char. per sec.

Input/output: teletypewriter (Olivetti: 10 char. per sec.), punched tape reader (Olivetti: 800 char. per sec.), tape punch (Olivetti: 60 char. per sec.), punched card reader (Bull: 500 cards per min.), card punch (Bull: 150 cards per min.), and line printers (Olivetti: 960 numeric or 600 alphanumeric lines per min.).

Fixed point operation speeds: 364 microsec for addition and 3,804 microsec for multiplication. Floating point operation speeds: 2,198 microsec for addition and 3,426 microsec for multiplication. Ten digit terms and factors.

Power consumption: 2.5 kVA. Pulse rate frequency: 250 kc/s. Components: completely solid state (no tubes). Price: not available (only marketed in Italy for the moment).

A parallel asynchronous computer, called CEP (Calcolatrice Elettronica Pisa), was completed in 1960 at the Institute of Physics of the University of Pisa (Centro Studi Calcolatrici Elettroniche, Piazza Torricelli 2, Pisa). It is used at the Computing Centre for scientific calculations, research applications and training of programmers. Though only transistorized in parts, CEP is the most advanced and most powerful university-made computer of the West-European Continent.

CEP

Control: stored program (plus fixed ferrite rod store for microprograms). Operation mode: parallel. Number base: binary. Word length: 36 bits. Point working: fixed and floating. Floating point representation: 28 bit mantissa + 8 bit exponent. Instruction type: 1 address (with double address modification). Instruction length: 1 word. Number of operations: 128 (plus 220 pseudo-orders). Number of index registers: 64.

Store: magnetic cores. Capacity: 8,192 words. Cycle time: 5.5 microsec. Auxiliary store: magnetic drum. Capacity: 16,384 words. Speed: 3,000 rpm. Average access time: 10 ms. External store: up to 8 Ampex magnetic tape units. Tape width: 1/2 inch. Tape length: 3,600 feet. Capacity: 1,500,000 words per reel. Read/write speed: 20,000 char. per sec.

Input/output: electric typewriter, up to 7 punched tape readers (Ferranti: 300 char. per sec.), up to 6 tape punches (Teletype: 60 or 120 char. per sec.), and 1 line printer (Bull: 150 lines of 120 char. per min.).

Fixed point operation speeds: 15 microsec for addition and subtraction, 140 microsec for multiplication, 190 microsec for division. Floating point operation speeds: 100 microsec for addition and subtraction, 140 microsec for multiplication, 200 microsec for division. Access time included.

Power consumption: 25 kVA. Pulse rate: 10 cycles from 2.5 to 10 microsec (asynchronous from input/output operations). Technical data: 3,500 tubes, 12,000 diodes and 2,000 transistors. Not marketed.

NETHERLANDS

In 1956 the Research Laboratories of the N.V. PHILIPS' GLOEILAMPENFABRIEKEN at Eindhoven started the development of an experimental computer, called PASCAL (Philips Automatic Sequence Calculator). It was built to get experience in the applications of computer components and is now used for their scientific and industrial calculations. Complete descriptions of PASCAL may be found in the Philips Technical Review (Vol. 23, No. 1, p. 1) and the IRE Transactions on Electronic Computers (Vol. EC-10, No. 2, p. 175). A copy of PASCAL, called STEVIN, has been built by the company for their business and administration applications. Moreover the Computing Centre of Philips uses two IBM 650's, two IBM 1401's, one IBM 1410, two Bull Gamma B's, one Bull 300 and an analog computer (PACE). The North American Philips Co. at New York has been linked with The Teleregister Corp. in the design and construction of INSTAMATIC, an airline data processing system. INSTAMATIC was officially put into service on June, 1961 by United Air-lines, Denver (cf. Comp. & Aut., Vol. 10, No. 7, p. 3B).

PASCAL

Control: stored program. Operation mode: parallel. Number base: binary. Word length: 42 bits (sign bit included, + 2 parity bits in the store). Point working: fixed and floating. Floating point representation: 33 bit mantissa + 7 bit exponent (both with sign bit). Instructions: 1 address type (1 halfword: 21 bits). Number of operations: 57. Number of index registers: 8.

Store: magnetic cores. Capacity: 2,048 words. Cycle time: 6 microsec. Auxiliary store: magnetic drum. Capacity: 16,384 words. Speed: 6,000 rpm. Transfer time: 10 ms per channel (128 words). External store: up to 16 Ampex FR 300 magnetic tape units. Capacity: about 1.5 million words per reel. Read/write speed: about 8,000 words per sec.

Input/output: 1 electric typewriter (IBM: 10 char. per sec.), 1 punched tape reader (Philips: 1,200 char. per sec.), 1 tape punch (Teletype: 60 char. per sec.), 2 punched card readers (Bull: 150 & 700 cards per min.), 1 card punch (Bull: 75 cards per min.), 1 line printer (Bull: 150 lines per min.),

Fixed point operation speeds: 10 microsec for addition and subtraction, 70 microsec for multiplication and division. Floating point operation speeds: 10 to 60 microsec for addition and subtraction, 55 microsec for multiplication and division.

Power consumption: 10 kVA. Pulse rate frequency: 660 kc/s. Components: 1,200 tubes, 15,000 diodes and 7,000 transistors. Not marketed.

STEVIN

The same characteristics as those of PASCAL, except for input/output: 1 electric typewriter (IBM: 10 char. per sec.), 1 punched tape reader (Philips: 1,200 char. per sec.), 1 tape punch (Teletype: 60 char. per sec.), 2 punched card readers (Bull: 120 & 700 cards per min.), 1 card punch (Bull: 120 cards per min.), 1 offline printer working from magnetic tape (Anelex: 900 lines per min.). Not marketed.

Several improvements have been added to the X1 computer, manufactured and marketed by the N.V. ELECTROLOGICA (Stadhouder-splantsoen 214, The Hague). The magnetic tape units are manufactured by the Data Recording Instrument Co. Ltd. A more up to date description of this computer is given below. Seventeen X1 systems have been installed and seven are on order (August, 1962).

ELECTROLOGICA X1

Control: stored program. Operation mode: parallel. Number base: binary. Word length: 28 bits (sign bit and parity bit included). Point working: fixed and floating (optional). Instructions: 1 address type (1 word). Number of operations: 48. Number of registers: 12 (1 index register).

Store: magnetic cores. Capacity: units of up to 8 or up to 32 blocks of 512 words (minimum capacity: 512 words). A passive store, used for input routines, fixed subroutines and so on, is added in blocks of 64 words (minimum capacity: 704 words). Total maximum capacity of active and passive store: 32,768 words. Access time: 16 microsec. Auxiliary store: magnetic drum. Capacity: 524,288 words (512 channels of 1,024 words). Speed: 1,800 rpm. Average access time: about 16 ms. External store: up to 16 DRI magnetic tape units. Tape width: 1/2 inch. Tape length: 3,600 feet. Capacity: about 2 million words per reel. Read/write speed: about 7,500 words per sec. (56,250 decimal digits or 30,000 characters). Block length: variable (up to 2,048 words).

Input/output (maximum equipment): 1 or more electric typewriters (IBM: 10 char. per sec.), 1 or more punched tape readers (Ferranti: 150 char. per sec.), 1 or more high-speed punched tape readers (Electrologica: 1,000 char. per sec.), 1 or more tape punches (Creed: 25 char. per sec.), 1 or more fast tape punches (Creed: 300 char. per sec.), 1 or 2 punched card sorters (Bull: 700 cards per min.), 1 or more reproducers (Bull: 120 cards per min. in and out), and up to 3 line printers (ICT: 600 lines of 120 char. per min.).

Fixed point operation speeds: from 32 to 84 microsec for addition and subtraction, 500 microsec for multiplication and division. Access time included.

Power consumption: 2-3 kVA. Pulse rate frequency: 250 kc/s. Components: 5,000 to 7,500 germanium diodes, 3,000 to 5,000 transistors, printed circuits on plug-in boards and magnetic cores. Price (basic machine, active store of 2,048 words, passive store of 1,024 words, punched card sorter and reproducer, including coupling apparatus): about $160,000. May be leased.

Since 1961, reviews of "Literature on Automation" are published monthly by the Netherlands ADP Research Centre (Stadhouderskaai 6, Amsterdam). The surveys are prepared by the documentation service of the centre, in co-operation with those of the Governmental Centre for Office Machines and of the Netherlands Postal and Telecommunication Services. Abstracts are given in the language of publication: Those abstracts are also available on index cards of the international standardized dimensions for libraries. Universal Decimal Classification numbers are provided on the cards, so that they can be filed easily.

SWEDEN

FACIT Electronics AB (Fack, Solna 1), manufacturer of the FACIT EDB computer, is developing and manufacturing special purpose computers for military use. The firm is also manufacturing peripheral equipment as the FACIT ECM 64 carousel type magnetic tape unit, the high-speed punched tape reader PE 1000 and the high-speed tape punch PE 1500. Licensee and sole agent for USA, Canada and Mexico are: Autonetics Industrial Products, Long Beach 5, California.

A newcomer in the field is the well-known Svenska Aeroplan AB (SAAB, Electronics Division, Linköping). A computer called SARA, based on BESK (cf. Comp. & Aut., Vol. 9, No. 4, p. 25), is in operation at SAAB since 1957. In 1960 SAAB's Electronics Division completed and marketed a transistorized process control computer called SAAB D2 (cf. Comp. & Aut., Vol. 9, No. 12, pp. 17 & 26). In 1961 SAAB introduced a general-purpose data processing system called SAAB D21, in many respects based on the previous design. The first has been installed recently and 7 others have been sold (August, 1962).

SAAB D2

Control: stored program (with interrupt feature). Operation mode: parallel. Number base: binary. Word length: 20 bits. Point working: fixed. Instructions: 1 address type (1 word). Number of operations: 32. Index registers: each data store cell.

Store: magnetic cores. Capacity: up to 4,096 words program store and up to 2,048 words data store (may be expanded to a maximum capacity of 32,768 words). Cycle time: 6 microsec. External store: 1 or 2 Saraband systems, with up to 8 magnetic tape units each. Capacity: about 1 million words per reel. Read/write speed: 18,000 decimal digits per sec. Block length: 64 words.

Input/output: up to 64 channels for digital or analog inputs and outputs (built-in analog-to-digital and digital-to-analog converters, accuracy 0.1%). An electric typewriter and punched tape equipment may be connected.

Operation speeds: 7 microsec for addition and subtraction, 23 microsec for multiplication, and 29 microsec for division. Access time included.

Power consumption: 250 VA. Technical data: 2,500 kc/s prf, 3,500 diodes and 6,000 transistors. Price: not available (as susperseded by the D21).

SAAB D21

Control: stored program (with interrupt feature). Operation mode: parallel. Number base: binary. Word length: 24 bits. Point working: fixed and floating (optional). Floating point representation: 40 bit mantissa + 8 bit exponent (2 words). Instructions: 1 address type (1 word). Number of operations: 45 (expandable to 64). Index registers: each data store cell.

Store: magnetic cores. Capacity: up to 8 units of 4,096 words (maximum capacity: 32,768 words). Cycle time: 4.8 microsec. External store: up to 256 Potter 906 II magnetic tape units. Tape width: 1 inch. Tape length: 3,600 feet. Capacity: about 4 million words per reel. Read/write speed 200,000 bits per sec. Block length: variable (up to 1,023 words). Automatic correction of one-bit errors and automatic detection of two-bit errors. Facit ECM 64 carousel type magnetic tape units may be connected.

Input/output: Flexowriter (10 char. per sec.), punched tape reader (Facit ETR 500: 500 char. per sec.), and tape punch (Facit PE 1500: 150 char. per sec.). A punched card reader (Facit ECR 80: 800 cards per min.), a card punch (Facit ECP 80: 120 cards per min.), line printers (Anelex: 500 or 1,000 lines of 120 char. per min.), and any number of channels of analog-to-digital and digital-to-analog converters with an accuracy of 0.1% may be connected. Converters are connected in groups of up to 32.

Fixed point operation speeds: 9.6 microsec for addition and subtraction, 36 microsec for multiplication, and 44 microsec for division. Double precision fixed point operation speeds: 16 microsec for addition and subtraction, 295 microsec for multiplication, and 450 microsec for division. Programmed floating point operation speeds (40 + 8): 250 microsec for addition and subtraction, 420 microsec for multiplication, and 450 microsec for division. Optional built-in floating point operation speeds (40 + 8): about 25 microsec for addition and 80 microsec for multiplication. Access time included.

Power consumption (central processor): 250 VA. Pulse rate frequency: 2.500 kc/s. Number of transistors (basic unit): about 10,000. Price: $200,000 and up. Not leased.

UNITED KINGDOM

The British Computer Society (Finsbury Court, Finsbury Pavement, London EC2) held its Second Conference at Harrogate (Yorks), from July 4-7, 1960. A conference on Data Transmission, Document Reading, and Character Recognition was held in cooperation with the Northampton College of Advanced Technology at London, from March 27-29, 1961. Another two-day conference on Automatic Programming Languages was organized jointly with the same Northampton College at London, on April 17-18, 1962. The Third Conference was held at Cardiff, from September 4-7, 1962. Further activities of the association are: the publication of two quarterlies (The Computer Journal & The Computer Bulletin), the organization of seminars, lectures, and exhibitions, etc. Membership exceeded 2,600 as of August, 1962. The annual subscription is three guineas and there is an entrance fee of one guinea. The British Computer Society represents the United Kingdom in the IFIP (International Federation for Information Processing).

The Elliott Computing Division of ELLIOTT BROTHERS (LONDON) Limited has continued development of the NATIONAL-ELLIOTT 803 computer, marketed by the National Cash Register Co. The latest version embodies a number of improvements in speed and reliability. Ninety-four 803 computers had been installed up to the end of September, 1962, of which fourteen are in the USA. Eighteen of them are used in on-line process control applications. 23 machines, including 3 for installation in the USA, were on order at that time.

A new series of very fast machines has been announced: ELLIOTT 502 and ELLIOTT 503. The first 502 computer, an on-line real-time data processor, has been supplied to the Radar Division of the company for incorporation in a training simulator ordered by the Ministry of Aviation. Another 502 computer, which will be used by the Ministry of Aviation as central unit of an experimental air-traffic control system, is in production. The 503 general purpose computer is designed mainly for scientific and industrial calculations. As announced it provides priority processing under the control of an organizing routine, limited to two programs, one a base-load program and the other a priority program. All programs written for the 803 will run on this new computer. This means that it may be used as the center of a system of 803's. Several 503 computers are on order.

ELLIOTT BROTHERS are also manufacturing the NCR 315, a business data processing system designed by the National Cash Register Co. in the USA. A description of its magnetic card random access memory (CRAM) may be found in this journal (cf. Comp. & Aut., Vol. 10, No. 5, p. 11B). More than ten are on order. At the Olympia Electronic Computer Exhibition (London, October, 1961), ELLIOTT BROTHERS introduced VERDAN (Versatile Differential Analyser), a general purpose computer combined with a serial digital differential analyser. VERDAN was designed by the Autonetics Division of North American Aviation Inc. to assume the role of the central computer in many types of weapon and control systems, both civil and military. ELLIOTT BROTHERS have a licensed agreement with Autonetics to manufacture and market VERDAN in the United Kingdom.

NATIONAL-ELLIOTT 803

Control: stored program. Operation mode: serial. Number base: binary. Alphanumeric representation: 5 bits per character (6 bits internal). Word length: 39 bits (plus parity bit). Point working: fixed and floating (optional). Floating point representation: 30 bit mantissa + 9 bit exponent. Instructions: 1 address type (½ word). Number of operations: 64 (including double precision). Index registers: each store cell.

Store: magnetic cores. Capacity: 4,096 or 8,192 words. Access time: 6 microsec (parallel readout). External store: up to 4 Elliott magnetic film units. Film width: 35 mm. Film length: 1,000 feet. Capacity: 262,144 words per film. Read/write speed: 833 words per sec. Block length: 64 words.

Input/output: teleprinter (Creed: 10 char. per sec.), 1 or 2 punched tape readers (Elliott: 500 char. per sec.), 1 or 2 tape punches (Teletype: 100 char. per sec.), 1 or 2 punched card readers (Elliott: 265 cards per min.), 1 card punch (IBM: 100 cards per min.), analog-to-digital and digital-to-analog converters.

Fixed point operation speeds: 576 microsec for addition and subtraction, 864 microsec to 12.384 ms for multiplication, and 12.096 ms for division. Floating point operation speeds: 864 microsec for addition and subtraction, 4.896 ms for multiplication, and 9.792 ms for division. Access time included.

Power consumption: about 3.6 kVA. Pulse rate frequency: 166.5 kc/s. Components: about 1,500 transistors and up. Price: about $81,000 and up (UK). Not leased.

ELLIOTT 502

Control: stored program (time-sharing: up to 8 programs may be run together). Operation mode: parallel. Number base: binary. Word length: 20 bits. Point working: fixed. Instructions: 1 address type (1 word). Number of operations: 64 basic functions. Number of index registers: 3.

(To be Continued in the Next Issue)

THE CONTROL DATA 6600 COMPUTER — A BIG MOVE TOWARD COMPUTING CONCURRENCY

Patrick J. McGovern, Jr.
Associate Publisher, Computers and Automation

After fourteen months of hedging, "Seymour's Machine" was finally officially announced by Control Data Corporation in August. This title is affectionately given to the Control Data 6600 computer in honor of Seymour Cray, CDC V-P and shirt-sleeve engineer, who 14 months ago, marshalled a band of 10 engineers and 4 programmers, and led them into the bucolic serenity of Chippewa Falls, Wisc., to work toward a single goal: the design and development of a computing machine that Cray was determined to make the fastest in the world.

To achieve its goal, Cray's group used an impressive array of ingredients:

-- One half million silicon transistors combined into 8000 printed circuit logic modules of 200 different types.

-- Over 8 million, 19-mil-inner-diameter ferrite cores combined into a central memory of 131,072 words, 60 bits each; and 10 peripheral memories of 4096 words, 12-bits each.

-- A reduction in length of all intra-module wiring in the computer to 3½" maximum (to reduce waiting time for the signal to pass between logic circuits) and the use of twisted pairs and coaxial cables for all longer wires (to resist electrical resonance problems).

-- An infusion of $7 million of AEC money in the form of a contract from the Lawrence Radiation Laboratory, Livermore, Calif. for the installation of the first 6600 in February, 1964.

The results are equally impressive:

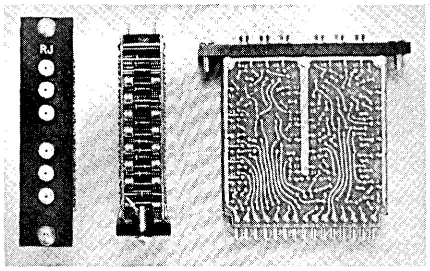
-- An operating speed of over 3 million instructions per second at full utilization.

-- Ten built-in satellite computers or independent Peripheral and Control Processors in the 6600.

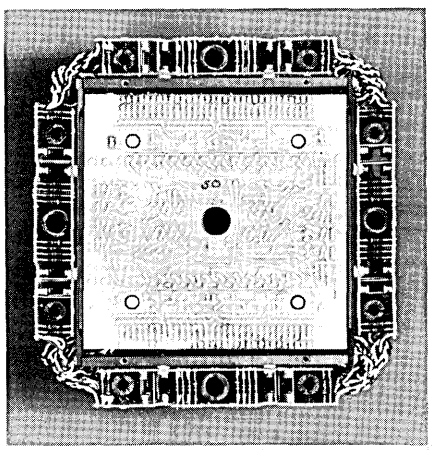
-- Ten functional units in the central processor, as follows:

- 2 adders
- 2 multipliers
- 2 incrementers
- 1 divider
- 1 shift
- 1 Boolean
- 1 branch

-- The ten functional units operate on 8 increment registers of 18-bit length, 8 operand registers of 60-bit length, and 8 memory address registers of 18-bit length. Up to 32 instructions can be held at once for program loops.



-- 6600 logic hardware is constructed from nearly 8000 printed circuit modules shown above. Transistors, resistors, and other components are mounted on and between two printed circuit boards in a high-density cordwood packaging or stacking technique. A 30-pin connector provides in-out electrical access for the circuits, and up to six test points allow circuit performance to be monitored on an oscilloscope.



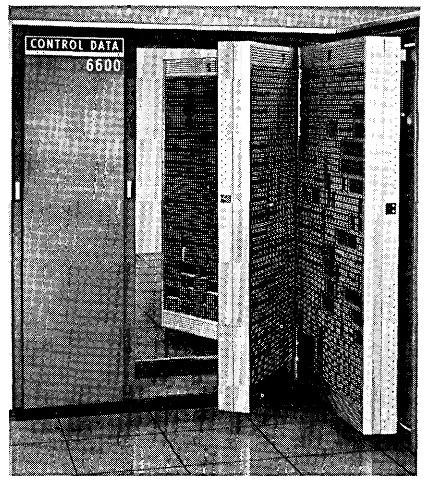
-- The core memories of the peripheral and control processors are constructed from a basic 12-bit, 4096-word magnetic core storage module shown above. Five such modules, driven in parallel, form one 60-bit bank of storage for 4096 central memory words. The module has a read-write cycle time of 1 usec and uses coincident current switching techniques on the drive and inhibit lines which thread the magnetic cores. The module draws only 26 watts of power. Cordwood packaging of 400 transistors and many other components provides an extremely high-density package.

-- Several levels of operating concurrency, consisting of:

- Concurrency in program execution in the 10 Peripheral and Control Processors;
- Concurrency in the 10 basic Central Processor functions;
- Concurrency in the 32 independent banks of the central memory.

-- Eleven programs can run simultaneously on the 6600....and the programs are not time-shared.

-- A freon-cooled main frame to control the environment of the tightly packed cordwood modules.



-- The 6600 main frame and some I/O synchronizer hardware is mounted on 16 page-frame chassis which are hung four to a wing. A refrigeration unit in the end of each wing (unit accessible through door at left of photo) maintains each chassis at a uniform temperature.

In summary, within the 6600 are 11 independent computers. Ten of these are constructed with the peripheral and operating system in mind. These ten have separate memory and can execute programs independently of each other or the central processor. The eleventh computer, the central processor, is a very high-speed arithmetic device. The common element between these computers is the large central memory.

In the course of solution of a problem, one or more peripheral and control processors are used for high-speed information transfer in and out of the system and to provide operator control. If the problem requires significant arithmetic speed, the central processor may be called on by a peripheral and control processor. A number of problems can operate concurrently with sharing of time in the central processor. To facilitate this, the central processor may operate in central memory only within address bounds set by the peripheral and control processor.

CENTRAL PROCESSOR

In the operation of the 6600, a program contained in central memory is begun in the central processor by an exchange jump instruction from a peripheral and control processor. In order to minimize memory references by the central processor, 24 registers (see Fig. A) are provided for arithmetic operands and results.

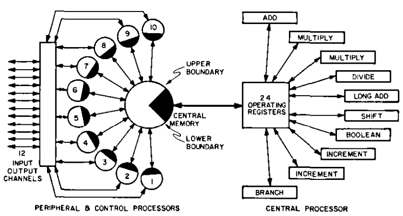


Fig. A -- Block Diagram of 6600

These 24 are divided into 8 address registers (18-bits each), 8 increment registers (18-bits each), and 8 operand registers (60-bits each).

Thirty-two transistor registers are provided to hold instructions, in order to limit the number of memory readings for repetitive instructions, especially in inner loops. In another effort to minimize memory reference time, multiple banks of central memory are also provided. References to different banks of memory can be handled without waiting.

The ten units for operational function are provided to pare down the waiting time for unrelated instructions to be executed. The units are provided with a reservation control which allows a degree of concurrency in instruction execution while maintaining the original sequence of the program.

Programs for the central processor of the 6600 are written in a conventional manner, each specifying a sequence of arithmetic and control operations to be executed. Each instruction in a program is brought up in its turn from one of 32 instruction registers. Each new instruction is tested to determine which of the 10 functional units is needed for execution; if it is busy; and, if reservation conflict is possible. If the unit is free, and no conflict is possible, the entire instruction is given to the specific functional unit for operation.

The original sequence of the program is established at the time each instruction is issued. Those operations which depend on previous steps prevent the issuing of instructions, if the steps are incomplete. The reservation control keeps a running account of the address, increment, and operand registers, and of the arithmetic units in order to preserve the original sequence.

PERIPHERAL AND CONTROL PROCESSORS

The 10 peripheral and control processors are identical and operate independently and simultaneously as stored-program computers. A combination of processors can be involved in one problem whose solution may require a variety of I/O tasks plus the use of central memory and the central processor. Fig. B shows data flow between I/O devices, the processors, and central memory.

All processors communicate with external equipment and each other on 12 independent I/O channels. Each channel has a single register which holds the data word being transferred in or out. All channels are 12-bit (plus control), and each may be connected to one or more external devices. Each channel operates at a maximum rate of one word per major cycle.

The processors generally do not solve complex arithmetic and logical problems but call on the central processor for solutions. The processors organize problem data (operands, addresses, constants, length of program, relative starting address, exit mode), and store the data in central memory. Then, an exchange jump instruction starts (or interrupts) the central processor and provides it with the starting address of a problem on file in central memory. At the next breakpoint, the central processor exchanges the contents of its A, B, and X registers, program address, relative starting address, length of program, and

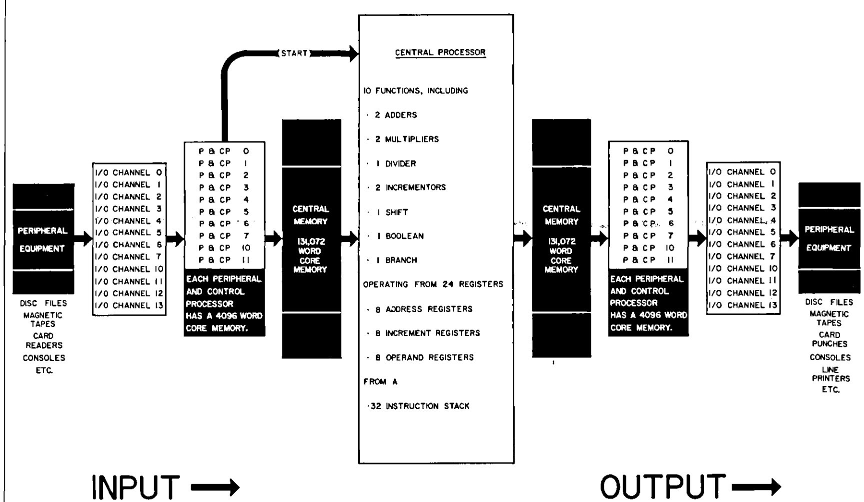


Fig. B -- Flow Diagram of 6600

Each processor has a 12-bit, 4096 word memory (not a part of central memory) and an 18-bit adder. The repertoire of instructions allows each processor access to central memory and the central processor, and features flexible I/O and logical operations, plus 18-bit add and subtract capability. Indirect addressing is also provided.

Execution time of processor instructions is based on memory cycle time, which is one major cycle (one microsecond).

exit mode, with the same information for the new program.

THE MARKET FOR THE 6600

James Thornton, Chief Engineer of the Cray's group, describes the economic raison d'être of the 6600 as "machine speed per dollar is still the principal competitive issue in selling computers". Although this statement would surely meet with a chorus of objections from commercial computer marketers, it no doubt is a principal criterion in the minds of purchasers of computers for use by scientists and engineers. Of course, the key to effective utilization of the dispersed computing power of the 6600 is an able software system, and a band of very knowledgeable programmers.

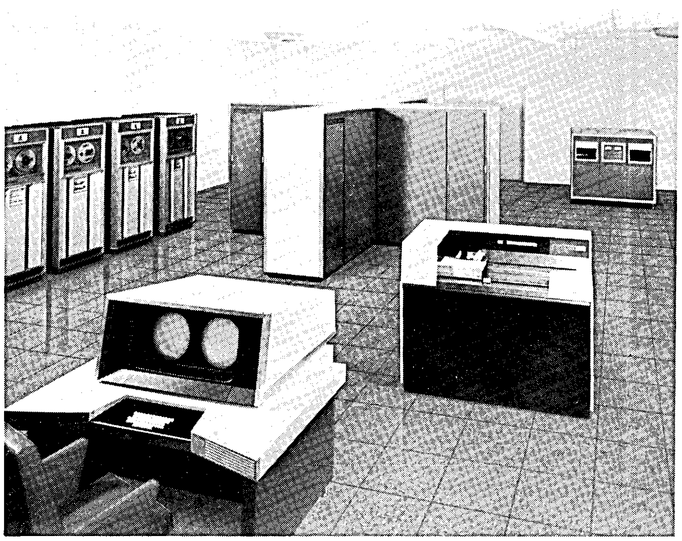
Cray himself has developed a FORTRAN compiler for the 6600, which will be the base language of the machine. William Norris, President of Control Data, acknowledges the lack of current understanding of how to use effectively a high degree of computing concurrency by remarking, "The 6600 represents a new, expanded environment for solving large-magnitude problems, and only with the experience that comes with usage will scientists really begin to tap the tremendous potential of the 6600."

The design of the 6600 in my opinion indicates particular computing effectiveness in implicit calculations using iterative methods, e.g., boundary value problems, regression analysis, optimization calculations, integral equation solutions, etc. For explicit calculations, such as Monte Carlo calculations, data extrapolation, coordinate rotations, etc., the 6600 offers a more typical set of computing tools.

Management at Control Data are firm in their declaration that the 6600 is not a one-of-a-kind computer, and that they intend to add it to the basic product line of the company. Work has already started on the construction of the 2nd and 3rd 6600's at the Chippewa Falls Laboratory. Management at the Laboratory expect to produce up to ten 6600's before turning production over to the Minneapolis plant.

The current market for the 6600 is viewed as being particularly in the field of weather forecasting research, biomedical computing, astronomical studies and nuclear reaction calculations....areas almost entirely funded by government and foundations. A full-scale marketing effort is under way on an international scale according to George Hanson, V-P Marketing for CDC.

CDC President Norris expects to achieve an industrial sale of the 6600 within two years. However, the development of a full line of data communications equipment is seen to be the prerequisite before a private organization can assemble enough work to make economical use of the computing power of the 6600.



6600 COMPUTING SYSTEM

Main frame (center) -- contains 10 peripheral and control processors, central processor, central memory, some I/O synchronizers.
Display console (foreground) -- includes a keyboard for manual input and operator control, and two 10-inch display tubes for display of problem status and operator directives.
Control Data 606 tapes (left front) -- ½ inch magnetic tape units for supplementary storage; binary or BCD data handled at 556 bpi.
Control Data 626 tapes (left rear) -- 1-inch magnetic tape units for supplementary storage; binary or BCD data handled at 800 bpi.
Disc file (right rear) -- Supplementary mass storage device holds 500 million bits of information.
Control Data 405 card reader (right front) -- reads binary or BCD cards at 1200 cards per minute rate

CALENDAR OF COMING EVENTS

Oct. 14-15, 1963: Materials Handling Conference, Chamberlain Hotel, Newport News, Va.; contact R. C. Tench, C & O Rlwy Co., Rm. 803, C & O Bldg., Huntington 1, W. Va.

Oct. 14-16, 1963: Systems and Procedures Association, 16th International Systems Meeting, Hotel Schroeder, Milwaukee, Wis.; contact Systems & Procedures Association, 7890 Brookside Dr., Cleveland 38, Ohio

Oct. 17, 1963: 4th Annual Technical Symposium, University of Maryland, College Park, Md.; contact Hugh Nichols, Dunlap & Associates, Inc., 7220 Wisconsin Ave., Bethesda, Md.

Oct. 21-23, 1963: East Coast Conference on Aerospace & Navigational Electronics (ECCANE), Baltimore, Md.

Oct. 24-25, 1963: Symposium on Automatic Production in Electrical and Electronic Engineering, The Institution of Electrical Engineers, Savoy Place, London W. C. 2, England

Oct. 28-30, 1963: 19th Annual National Electronics Conference and Exhibition, McCormick Place, Chicago, Ill.; contact Prof. Hansford W. Farris, Electrical Engineering Dept., Univ. of Mich., Ann Arbor, Mich.

Oct. 28-Nov. 1, 1963: Business Equipment Manufacturers Assn. Exposition and Conference, New York Coliseum, New York, N. Y.; contact Richard L. Waddell, BEMA, 235 E. 42nd St., New York 17, N. Y.

Oct. 29-31, 1963: 10th Annual Mtg. PGNS 2nd Intn'l Symposium on Plasma Phenomena & Meas., El Cortez Hotel, San Diego, Calif.; contact H. A. Thomas, Gen. Atomics Div., Genl. Dynamics, San Diego, Calif.

Nov. 4-6, 1963: NEREM (Northeast Research and Eng. Meeting), Boston, Mass.; contact NEREM-IRE Boston Office, 313 Washington St., Newton, Mass.

Nov. 4-8, 1963: 10th Institute on Electronics in Management, 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.

"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

TABLE OF CONTENTS

NEW APPLICATIONS

COMPUTER PROCESSES DESIGNED TO SPEED WEATHER FORECASTING

Cloud pictures, transmitted by an orbiting satellite, were automatically processed recently at General Dynamics/Astronautics, San Diego, Calif., in the first demonstration of computer processes designed to speed up weather forecasting with meteorological information sent back from space.

Cloud pictures, especially those taken over isolated areas, have proved to be a valuable source of information for forecasters. Until now the pictures have been processed by manual and machine techniques, and meteorologists have been pressed to process the 32 pictures a Tiros satellite takes in one orbit before it is back again (about 88 minutes) with 32 more. The computer processes, developed at General Dynamics by R. F. Klawa and W. A. Marggraf under a contract from the Air Force Office of Aerospace Research, overcome this film handling problem, effecting the processing automatically in minutes.

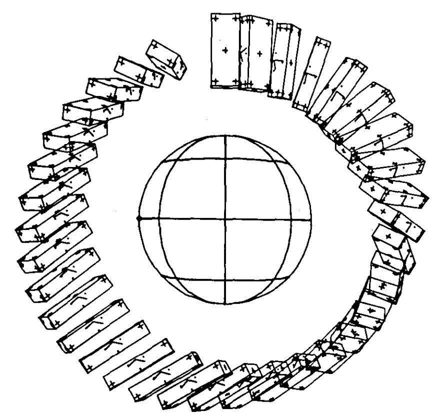
The computers flatten the oblique photographs of the spherical earth to conform with any ordinary map. The pictures are then assembled along the orbit in a continuous mosaic with longitude and latitude lines superimposed. In the next step, the cloud cover on the mosaic also is computed and plotted as it would appear to the observer on the ground. It corresponds to a strip of the earth's surface covering thousands of miles.

The system was tested successfully for the first time on April 10, when a video tape transmission from Tiros 6 was automatically processed in 12 minutes -- a task that had previously taken about an hour and a half to accomplish manually. The process has been repeated with tapes of pictures sent from other Tiros orbits. (For more information, circle 21 on the Readers Service Card.)

COMPUTER-MADE MOVIES AID SATELLITE RESEARCH

Perspective movies, computed and drawn by an electronic data processing system, are helping scientists at Bell Telephone Laboratories, New York, N.Y., in visualizing the motions of an orbiting communications satellite. The computer-made movies also provide a way of communicating the results of mathematical research with greater clarity than with a written report.

The animated movies are computed by an IBM 7090 data processing system. The IBM 7090 digital computer is programmed to generate a magnetic tape containing the data necessary for describing sequential perspective drawings of the satellite's position and attitude. A General Dynamics/Electronics SC 4020 high-speed computer-recorder accepts digital magnetic-tape signals and converts this binary information into line drawings on both microfilm and photo-recording paper. The SC 4020 uses a special type of cathode-ray tube as a generator for characters, lines, or curves. Images on the face of the tube are photographed by a motion picture camera. When



-- Closely-spaced drawings of a domino-shaped box, in the manner of rapid-sequence photography, give an idea of what Bell Telephone Laboratories' computer-made movies look like. The box represents a communications satellite making one orbit of the earth.

the film is developed, a movie is obtained, ready for viewing, with each frame an accurately-drawn perspective picture of the satellite. (For recording the information simultaneously on paper, another camera is optically aligned with the tube screen.)

In addition to depicting satellite motions, computer-made movies are useful for depicting other sequential events, such as

simulation of shock waves and explosions, missile trajectories, wave propagation, and flow processes.
(For more information, circle 22 on the Readers Service Card.)

RESTAURANT ORDERING SIMPLIFIED WITH DATA TRANSMISSION BY TELEPHONE

A regular telephone network is used to transmit data from 63 locations directly to a centralized computer by Hot Shoppes, Inc., a nationwide restaurant and hotel chain. This new ordering and inventory-control system has greatly simplified the administrative operations. The new system has cut paperwork procedures, reduced the number of clerical personnel needed, and improved food processing control for the company.

Orders for more than 5000 line items a day are now being transmitted on punched cards by telephone from company locations in Virginia, Maryland, Pennsylvania and the District of Columbia to the computer center of Hot Shoppes, Inc., Bethesda, Md. There, the orders are automatically processed and invoices prepared.

Each branch in the new system is equipped with Bell System Data-Phone data sets connected to IBM 1001 card readers. The data sets convert pulses received from the reader to tones suitable for transmission over the regular telephone network at 20 characters a second. Data-Phone data sets, at the receiving end, convert the tones back to pulses, activating business machines which duplicate transmitted information on IBM cards. In effect, the data sets enable the business machines to communicate with each other by telephone.

To handle the massive number of incoming orders daily, the Bethesda computer center can accept information without human beings in attendance. Four Data-Phone data set receivers feed incoming data directly to IBM 026 key punch machines which automatically produce punched cards exactly duplicating the information transmitted. The cards then are fed into an IBM 1401 computer for final processing.

Ultimately, the company plans to expand the system to process payroll and sales statistics as well as inventory-control data for nearly 150 locations from Dallas to New York. Of the 63 installations now in the system, 50 are within the metropolitan Washington area and include restaurants and drive-ins, several hospitals as well as Washington National and Dulles International airports, where the firm provides airline catering services.
(For more information, circle 23 on the Readers Service Card.)

GOLF MOVES INDOORS, COURTESY OF COMPUTER

An invention called Golf-O-Tron uses: a special screen and projector that shows a golf course in color; a computer; and photo electric cells to measure a shot. On the special nylon screen, a projector flashes the view a golfer would see on the course. The Golf-O-Tron player then swings with the same club and motion that he would use if he were on the course driving the ball. But the ball goes into the nylon net screen, and an electronic system measures where his shots go and a computer calculates how far.

After each shot, the player pushes a button to change the view, moving himself visually closer to the green. After he reaches the "green", he goes to the front of the Golf-O-Tron booth and putts on a thick carpet. He plays the entire 18-hole course in this way.

The inventor of Golf-O-Tron is Richard M. Speiser, an electromechanical designer, president of S&M Products Co., Inc., New York, N.Y. Mr. Speiser, who never has played a real game of golf, has been working on Golf-O-Tron since 1958. The rugged nylon net -- tough enough to stop hard hit balls but reflective enough to serve as a projection screen -- was designed by Du Pont. Eastman Kodak Co. developed the projection system and assisted in perfecting a special lens for photographing golf courses in full color with a distortion-free technique.

A Golf-O-Tron facility opened recently in Lansing, Mich., joining two experimental facilities which opened earlier this year in Port Chester, N.Y., and Worcester, Mass. Four new centers are under construction in the U.S., and one has opened in Norway and in London. The most enthusiastic reception to the game has come from Japanese franchisers. Speiser has an agreement with the Asian International Corp. to install 6000 to 10,000 machines in Japan.
(For more information, circle 24 on the Readers Service Card.)

HIGHWAYS 25 YEARS IN THE FUTURE BEING PLOTTED BY ELECTRONIC DRAFTSMAN

The state highway departments of Pennsylvania and New Jersey are conducting a study (the Penn Jersey Transportation Study) of the public and private transportation system requirements 25 years hence for a nine-county area centered near Philadelphia, Pa. These requirements are being determined in part by an electronic draftsman that mechanically draws existing and proposed highway and rail networks.

Since the Study began work in 1959, a wealth of material was gathered from more than 65,000 households in the area, from businessmen, managers of industries, vehicle, bus and taxi operators as well as people in charge of rapid transit and bus lines. In addition, physical inventory of every main thoroughfare was also made. From the information more than half a billion punched cards have been made and trip origins and destinations have been carefully coded.

The electronic draftsman, a Dataplotter, developed by Electronic Associates, Inc., Long Branch, N.J., reads data fed to it by punched cards and transmits continuous signals to the mechanical hand that automatically draws the information on a 30 x 30-inch sheet of graph paper. The information, in this case, consists of the existing and also the proposed alternative transportation networks of the Philadelphia, Camden and Trenton areas. The basic areal unit used by the Study is the quarter square mile grid identified by three digit x y coordinates.
(For more information, circle 25 on the Readers Service Card.)

NEW CONTRACTS

SDC AWARDED CONTRACT BY NEW YORK STATE

System Development Corporation, Santa Monica, Calif., has been awarded a contract to study and define requirements for an "Integrated Selective Information Processing System" for New York governmental agencies responsible for law enforcement and the administration of justice.

Under terms of the 6-month award, SDC scientists and New York

State personnel, together, will establish requirements for a system which will serve New York police departments, prosecutors, correction, probation and parole agencies. The system, when implemented, will be capable of receiving, processing, storing, and retrieving the information required by local and State agencies in the course of discharging their responsibilities. (For more information, circle 26 on the Readers Service Card.)

SEL EQUIPMENT ORDERED BY NASA HOUSTON

Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., has received a contract valued in excess of $180,000 from the National Aeronautics and Space Administration. The contract calls for SEL to design and build two large data acquisition systems for the new Manned Spacecraft Center at Houston, Texas.

The systems, described as standard "SEL 600" analog-to-digital equipment, are similar to other units purchased by NASA and now operating at the Marshall Space Flight Center, Huntsville, Ala. Delivery of the first system is scheduled for early November; the second for mid-December.
(For more information, circle 27 on the Readers Service Card.)

FAA AWARDS CONTRACT TO LFE ELECTRONICS

The Information Systems Department of LFE Electronics, a division of Laboratory For Electronics, Inc., Boston, Mass., has been awarded a contract by the Federal Aviation Agency's Systems Research and Development Service. The contract calls for the design and construction of a feasibility model of a Weather Data Storage and Retrieval System to be used in the nation's aviation weather system. It will be used as part of the FAA's over-all National Airspace System.

The LFE Electronics subsystem will receive, store and display in words, numbers and pictures, current and future weather data needed by pilots, air traffic controllers and other aircraft operational personnel. The equipment will provide both television-like display and printed form output of the operational aviation weather.
(For more information, circle 28 on the Readers Service Card.)

CONTRACT FOR MILITARIZED HIGH-SPEED PAGE PRINTER

Data Products Corporation, Culver City, Calif., has been awarded a contract in excess of $750,000, by the Dept. of the Navy, Bureau of Ships. The contract is for the development of a fully militarized high-speed page printer. All work will be performed in the Culver City facility.
(For more information, circle 29 on the Readers Service Card.)

MULTI-MILLION DOLLAR CONTRACT FOR URS INCORPORATED

United Research Incorporated, Burlingame, Calif., has been awarded a $6.2 million contract to provide expanded research services to the U.S. Army Materiel Command in its development of the Command Control Information System for 1970 at Fort Huachuca, Ariz. The URS work is part of a $23.5 million, five-year contract awarded to Thompson Ramo Wooldridge Inc. to develop five separate subsystems -- Fire Support, Intelligence, Operations Center Systems, Logistics, and Personnel and Administration -- under the supervision of the Automatic Data Processing Department at Fort Huachuca. URS will provide the technical capability to accomplish the technical design and implementation of the Logistics and Personnel and Administration sub-systems.
(For more information, circle 30 on the Readers Service Card.)

JAPANESE AIR DEFENSE CONTRACT AWARDED TO HUGHES

A major international contract, the development and manufacturing of an air defense system for Japan, was recently awarded to the Hughes Aircraft Company ground systems group, Fullerton, Calif. The Hughes system, known as TAWCS (Tactical Air Weapons Control System) is composed of high-speed general-purpose and special-purpose computers, command and control consoles, a multicolor large screen display, and the communication and buffering equipment necessary to achieve a functional system. The amount of the contract is approximately $36 million.
(For more information, circle 31 on the Readers Service Card.)

NEW INSTALLATIONS

UNIVAC 1218 INSTALLED AT JET PROPULSION LABORATORY

The Jet Propulsion Laboratory of the California Institue of Technology has selected a Univac 1218 military computer for processing test data for the Mariner-type spacecraft system managed for the National Aeronautics and Space Administration by JPL. The Univac 1218 (see Computers and Automation, February, 1963) and special purpose devices will be used in a new real-time automatic check-out system.

The Univac 1218, delivered to JPL, has 16,384 words of internal core memory. The system includes paper tape and magnetic tape units.
(For more information, circle 32 on the Readers Service Card.)

A.E.C. 3600 COMPUTER SYSTEM INSTALLED AT LIVERMORE, CALIF.

A Control Data 3600 computer system has been installed in the Lawrence Radiation Laboratory of the U.S. Atomic Energy Commission, Livermore, Calif. The $3 million system joins a $1.7 million Control Data 1604-A computer system, installed in April of this year.

The two new Control Data computer systems will be used, along with seven other computers now at Livermore, in solving complex scientific problems in weapons research and development projects.
(For more information, circle 33 on the Readers Service Card.)

LOS ANGELES CITY BOARD OF EDUCATION INSTALLS BURROUGHS B5000

A Burroughs Corporation B5000 information processing system has been installed at the Los Angeles City Board of Education administrative offices. The primary application for the new system is the processing of the 46,000-employee payroll -- one of the largest and most complex centralized payrolls in the nation. The Los Angeles school system payroll has been processed on a Burroughs 205 computer system for the past three years.
(For more information, circle 34 on the Readers Service Card.)

PILLSBURY COMPANY TO INSTALL NEW DATA COMMUNICATIONS SYSTEM

A data communications system, soon to be installed by The Pillsbury Company, Minneapolis, Minn., will be centered around General Electric's recently announced Datanet-30 (see Computers and Automation, August, 1963). The system will provide a link between Pillsbury's Minneapolis data processing center and the company's 128 sales offices, feed mills, processing plants and warehouses across the nation. The Pillsbury Company expects the "on-line" system to cut in half the normal order-processing cycle.
(For more information, circle 35 on the Readers Service Card.)

BRITISH FOOD PRODUCTS CO. INSTALLS NCR 315 SYSTEM

Spillers Limited, London, Eng., a food products manufacturer has installed a NCR 315 EDP system at its headquarters in London. The system will eventually handle most of the paper work previously done at five area offices. Spillers' products include grocery items, flour, and animal and pet foods.
(For more information, circle 36 on the Readers Service Card.)

AMERICAN BIBLE SOCIETY INSTALLS IBM EDP SYSTEM

The American Bible Society, New York, N.Y., has installed an IBM 1401/1428 at its Park Avenue South offices. The system combines a computer with an optical scanning unit. Four IBM high speed magnetic tape units complete the complex. The new equipment will be used primarily for handling mailing lists numbering more than two million persons in the USA.
(For more information, circle 37 on the Readers Service Card.)

FRANCE LEASES RECORDER FROM GENERAL DYNAMICS/ELECTRONICS

The Commissariat à L'Energie Atomique, Paris, France, has leased an S-C 4020 high speed computer recorder from General Dynamics/Electronics-San Diego. Results of calculations on an IBM 7090 computer will be recorded by the recorder on to 35mm microfilm or 9½-inch wide photorecording paper. The recorder will "speak" French in Paris -- results will appear in the French language on the face of the CHARACTRON® Shaped Beam Tube.
(For more information, circle 38 on the Readers Service Card.)

MIDLAND-ROSS TO INSTALL HONEYWELL 400 COMPUTER

A Honeywell 400 data processing system is scheduled to be installed in the Cleveland, Ohio, headquarters of Midland-Ross Corporation early in 1964. Initial use of the computer includes plans for servicing several of the company's 13 divisions in the areas of payrolls, billing, sales analysis, inventory control and production scheduling.

The computer includes a central processor with 2000 words of memory, four magnetic-tape units, a card reader punch, and a 900 line per minute printer.
(For more information, circle 39 on the Readers Service Card.)

RCA 301 INSTALLED BY CHAIN DRUG STORE

Stineway-Ford Hopkins, division of General Stores Corporation, has begun operating a new semi-automated warehouse in Melrose Park, Chicago, Ill., using an RCA 301 computer for continuous analysis and control of inventory. In this application in the chain drug store field, the computer provides simultaneous control of incoming orders, inventory and shipments.
(For more information, circle 40 on the Readers Service Card.)

DEPARTMENT STORE CHAIN INSTALLS HONEYWELL 400

The Arlan's department store chain has installed a Honeywell 400 data processing system at its New Bedford, Mass., headquarters. The new system is being used to process weekly merchandise reports and daily and weekly sales audit reports on the firm's chain of 40 stores. In addition, it prepares the weekly payroll for Arlan's several thousand employees.
(For more information, circle 41 on the Readers Service Card.)

JAPANESE NATIONAL RAILWAY INSTALLS UNIVAC 490 COMPUTER

A Univac 490 real-time system -- first of its kind to be delivered to Japan -- was recently installed in the Tokyo headquarters of the Japanese National Railway. The system includes a 32,768-word memory, a magnetic drum memory, Uniservo tape units, punched card reader, high-speed printer and paper tape units. The government-sponsored Japanese National Railway will use the new system for material stock control, freight analysis, daily income reports, employment analysis, and continuous updating of the current status of all freight and passenger train operations.
(For more information, circle 42 on the Readers Service Card.)

UNIVAC 1107'S DELIVERED TO OSLO, NORWAY AND PARIS, FRANCE

The University of Paris School of Sciences, about ten miles beyond Paris limits, and the Norwegian Computer Center, Oslo, Norway, have recently installed Univac 1107 thin film memory computers. Both will use their respective computers for the solution of scientific problems. In each instance, the peripheral equipment includes magnetic tape units, punched card readers, high-speed printer and punched paper tape equipment.
(For more information, circle 43 on the Readers Service Card.)

DU PONT INVESTMENT HOUSE TO INSTALL CONTROL DATA MESSAGE SYSTEM

Francis I. duPont & Company, New York, N.Y., will install a Control Data 8050 Message and Data Switching System in its headquarters in New York City. The system is being built by Control Data's Industrial Group.

Two computers, each with magnetic core memory, will control the system. One of the computers will handle incoming orders and inquiries, and control the switching required to route messages. The other computer will automatically monitor the entire operation while performing other computation functions. The system will speed up communication between duPont's branch offices, its New York operations, and the stock exchange floor.
(For more information, circle 44 on the Readers Service Card.)

ORGANIZATION NEWS

INFORMATION PRODUCTS CORP. MERGES WITH RENWELL INDUSTRIES

Information Products Corporation, Inc., Cambridge, Mass., has recently merged with Renwell Industries, Inc., South Hadley Falls, Mass. The merger brings Renwell Industries into the peripheral data processing market.

Information Products Corp. manufactures a product line of interrogators and interrogator systems which are used in high-speed communications between man and machine. Renwell produces numerical control machines, capacitors, filters, wiring harnesses, metal cabinets and chassis in the electronics industry.
(For more information, circle 47 on the Readers Service Card.)

AUERBACH FORMS EUROPEAN SUBSIDIARY

Auerbach Corporation, Philadelphia, Pa., has announced the formation of a wholly-owned Swiss subsidiary, Auerbach AG, with headquarters in Zurich, Switzerland. The subsidiary was established to provide closer technical liaison with Auerbach's clients in Europe and nearby countries.

Auerbach AG is patterned along the lines of the parent corporation. It is a technical services organization specializing in the development, design, and implementation of systems for the collection, storage, retrieval, processing, and management of data and information.
(For more information, circle 48 on the Readers Service Card.)

COMPUTER APPLICATIONS ACQUIRES EBS CORP.

Computer Applications Inc., New York, N.Y., has acquired Electronic Business Services Corporation of New York City.

Computer Applications provides programming and analysis services to both government and industry on advanced data processing systems and techniques. EBS operates a data processing center. The acquisition involved the issuance of 30,000 of Computer Applications common shares, so that approximately 330,000 shares are currently outstanding.
(For more information, circle 49 on the Readers Service Card.)

NEW CONSULTING FIRM FORMED

Computer Systems Analysts, a new data processing consulting firm, has been established in Pennsauken, N.J. The organization is headed by Charles H. Margolin, formerly with RCA as technical director of the programming effort for the Comlognet (now called Autodin) project.

Computer Systems Analysts will undertake programming effort of all kinds, and will specialize in developing programming systems for computer-controlled communications systems.
(For more information, circle 50 on the Readers Service Card.)

PACKARD BELL AND COMPUTER PRODUCTS INC. ANNOUNCE HYBRID COMPUTING PACT

Packard Bell Computer and Computer Products Inc., have announced an agreement to undertake joint marketing and systems engineering effort in design, manufacturing and installation of large hybrid computing systems.

Computer Products Inc., South Belmar, N.J., is a two-year old firm engaged in design, development, and manufacture of analog computing equipment. Packard Bell Computer, a division of Packard Bell Electronics, Los Angeles, Calif., designs and manufactures general and special purpose digital computers, complete data systems and data equipment.

The growth of hybrid computing applications requires a more intimate combination of the analog and digital elements of the computing system than has hitherto been available. The association of the two firms makes it possible for a customer to contract for complete responsibility for hybrid computing system design, construction, software, installation and service to a single supplier -- instead of three different sources as is often the case.
(For more information, circle 51 on the Readers Service Card.)

NEW RESEARCH FACILITY ANNOUNCED BY BUDD COMPANY

The Budd Company, Philadelphia, Pa., has announced that the new research facility of its Electronics Division opened on September 15th, in Westgate Industrial Park, McLean, Va. The new facility contains almost 15,000 sq. ft. of laboratory and engineering office area. It will house a staff of about 40 scientists and engineers working in the fields of data processing and display, pattern recognition, communications and physical research.

The Electronics Division (which is located in Long Island City, N.Y.) also has facilities in Mountainside, N.J., and Arlington, Va.
(For more information, circle 52 on the Readers Service Card.)

COMPUTING CENTERS

ADDRESSOGRAPH-MULTIGRAPH OPENS NEW DATA PROCESSING CENTER

The Addressograph-Multigraph Corp., New York, N.Y., is moving its midtown Manhattan office to new, enlarged quarters on East 42nd Street, to provide a new Data Processing Center and expand its sales and service operations. VariTyper Corporation, a subsidiary of A-M, now located on Park Avenue, will also come to the new location.

The Data Processing Center, operated by the Electronics Div. of A-M, will provide complete EDP service including card-to-paper-tape, magnetic-tape-to-paper-tape, list maintenance and file updating services. The center will also be used for executive orientation, program testing and operator training before machines are installed in customers' offices.
(For more information, circle 45 on the Readers Service Card.)

EDUCATION NEWS

DATA PROCESSING EXAMINATION TO BE GIVEN NOVEMBER 23

The Data Processing Management Association (DPMA) will offer the 1963 Examination for the Certificate in Data Processing at 56 colleges and universities on Saturday morning, November 23, at 8:30. This year's test will be revised and expanded to three hours in length. The subject areas of mathematics, statistics, accounting, computer and unit record concepts and equipment, and general systems design, will again be covered.

The examination is open to anyone who: (1) completes the prescribed course of academic study; (2) has at least three years of direct work experience in one or more punched card and/or computer installations; and (3) has high character qualifications. Until 1965, specific course requirements may be waived. Applicants need not be members of DPMA.

The Certificate in Data Processing is the first move by this organization to establish professional standards and certify members of the growing data processing profession.
(For more information, circle 46 on the Readers Service Card.)

PLAN FOR EDUCATIONAL INSTITUTIONS OFFERED BY GENERAL PRECISION, INC.

In an effort to broaden the use and understanding of general-purpose digital computers, General Precision, Inc., Burbank, Calif., is offering the LGP-30 electronic computer in a plan for educational institutions, bringing it into a price range where it can be afforded by the average high school. The LGP-30 is about the size of an office desk, has a large memory, is simple to program, and is a binary machine.

General Precision will give the same service and support to users taking advantage of the educational plan as to other customers. This includes training assistance, continuous consultation, supplying the hundreds of programs developed for the LGP-30, and giving membership in POOL, the users group set up for exchange of technical in information.
(For more information, circle 53 on the Readers Service Card.)

NEW PRODUCTS

Digital

FOUR-IN-ONE COMPUTER WITH BILLIONTH-SECOND MEMORY ANNOUNCED BY RCA

The Radio Corporation of America has announced one of the most advanced all-purpose computers so far developed. The system, called the RCA 3301 REALCOM, merges four basic types of data processing -- scientific, real-time, business, and communications -- in one "functionally modular" design. "Functional modularity", as a design concept, permits a computer to grow, as applications require, by incorporating new units or "modules" which add not only computing speed and capacity, but functions as well.

The system uses a very fast core memory, and a new "scratch pad" micromagnetic memory operating at 250-billionths of a second. The systems core memory can range from a unit with a capacity of 40,000 letters, numerals or other characters up to 160,000 characters. In one second, the processor can perform up to 148,000 eight-digit additions or subtractions, 32,000 multiplications or 18,000 divisions.

The RCA 3301 is geared to accept magnetic tapes from a majority of data processing systems now in use. It is compatible with the RCA 301, which may serve as a direct-line satellite computer for the 3301.

The RCA 3301 uses an electronic input-output "foreman" called the File Control Processor (FCP), which reduces programming time and clerical errors. An Executive System makes possible automatic program loading, segmentations, sequencing, console typewriter control, interrupt servicing and inter-program linkage.

A full-scale 3301 system would include: the processor with 160,000 characters of magnetic-core, high-speed memory; arithmetic unit; up to 24 magnetic-tape stations for data storage; Data Disc File for random-access storage; punched-card and paper-tape equipment; interrogating typewriter; printer for finished data reports; and communications equipment for local or long-distance interchange of information.
(For more information, circle 54 on the Readers Service Card.)

MODEL 2100 DIGITAL COMPUTER BY ADVANCED SCIENTIFIC INSTR.

Advanced Scientific Instruments, a division of Electro-Mechanical Research, Inc., Minneapolis, Minn., has announced the new type 2100 high-speed general-purpose digital computer. The 2100's high operational speed, expanded input/output capabilities, and low cost-to-answer ratio, make it suitable for a wide variety of applications, including those requiring on-line systems control.

The ASI 2100 has a 2 microsecond total memory cycle 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 55 on the Readers Service Card.)

Digital-Analog

COLOR COMPUTER SHOWN AT CHICAGO'S ISA SHOW

A new color computer was shown for the first time in this country, at the Instrument Society of America show in Chicago, by the Tokyo Shibaura Electric Company (Toshiba). It can separate over 8 million shades of red and can distinguish 100 million different colors in about two minutes.

The new CC-1 color computer, an improved version of the unit developed in 1961 at the Toshiba Central Research Laboratory, combines a recording spectrophotometer and a digital electronic computer. The device automatically draws a spectral curve of an object's color in two minutes and then calculates and prints the results in 5-digit numbers on tape in 25 seconds.

The CC-1 computer can be used for color control or to select new shades for lipsticks, household furniture, fabrics, etc. It can also be used to detect incipient disease by analyzing skin color. (For more information, circle 56 on the Readers Service Card.)

Data Transmitters and A/D Converters

MAGNETIC TAPE-TO-MAGNETIC TAPE DATA TRANSMISSION TERMINAL

A new high speed magnetic tape-to-magnetic tape data transmission terminal, G-E TDS-91, has been developed by General Electric Communication Products Department, Lynchburg, Va. It is especially applicable to long-distance communications. Voice or broadband channels, with private or leased facilities, may be used.

The TDS-91 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. Off-line tape-to-tape transmission provides flexibility where a large volume of data is competing for computer time. Tape densities of 200, 556 or 800 pulses per inch may be used at either end.
(For more information, circle 57 on the Readers Service Card.)

Information Retrieval

RCA 301 TRANSIT SYSTEM

An RCA 301 computer is used as the building block of a fast, expandable system, developed by the Radio Corporation of America, New York, N.Y., to help deal with the banking industry's heavy flow of transit checks and documents. The RCA 301 Transit System is capable of reading, sorting and listing up to 180,000 documents an hour.

The basic equipment includes a 301 electronic processor with 10,000 characters of memory linked to a single six-tape transit lister printing at any speed up to 1900 lines a minute, a document sorter and a paper-tape reader.

When controlled by the RCA 301, the multiple-tape lister prints at speeds more than matching the rate at which the document sorter can read encoded checks and other items. The six-tape lister prints a master tape, four transit tapes and a tape for miscellaneous items selected for the re-sort pocket on the first pass through the sorter. (The twelve-tape lister, used in the expanded system, prints one master list and eleven detailed tapes.)

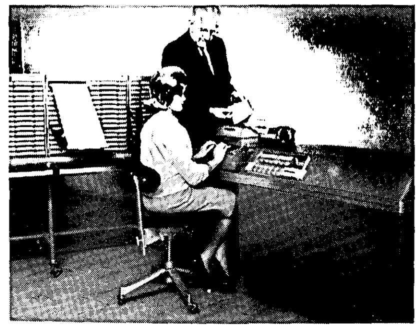
The system is designed to grow with the customer's needs and is expandable into several configurations. The final configuration, for extremely large volume transit, correspondent and float analysis, demand deposit and other banking applications, is comprised of an RCA 301 electronic data processor, a Hi-Data Magnetic Tape Group, two document sorter-readers, two 12-tape listers and a high-speed printer.
(For more information, circle 58 on the Readers Service Card.)

Software

FUEL-OIL ROUTE DELIVERY AND CONTROL SYSTEM

General Precision, Inc., Glendale, Calif., has developed a computer-based programming system that can automatically schedule and "keep the books" on fuel-oil deliveries. The system, called FORDACS, uses a desk-sized LGP-30 electronic computer equipped with a special program that directs the machine through its route-accounting procedures.

The computer can perform many jobs automatically for the fuel-oil distribution companies. It can: (1) prepare a report of required customer deliveries, computed from the degree-day figure entered once a day; (2) recompute and update the K factor of each customer after delivery; (3) prepare up-to-the-moment listings of accounts receivables; (4) prepare a total accounts-receivable balance; (5) alert the operator as to any required delivery not yet made; and (6) prepare a report on the delivery schedule of an individual driver.



-- Charlotte Carlson enters fuel-oil delivery data into an LGP-30 computer equipped with the newly developed FORDACS program. Art Karbach points out information on customer's fuel record card.

The system can be operated by a clerical employee after a short, on-the-job training period. It can be installed in a dealer's office and the program can be adapted for special route-distribution jobs or to perform other functions such as payroll and fleet-cost accounting.
(For more information, circle 59 on the Readers Service Card.)

COMPUTER PROGRAM FOR CIVIL ENGINEERS

IBM Corp., White Plains, N.Y., has developed a program for civil engineers who are unfamiliar with the language of programming. The new computer program called COGO I (COordinate GeOmetry) permits the engineer to state a problem in his own professional language, feed it directly into a computer and receive solutions with greater speed and accuracy than was possible with past methods.

COGO I is applicable to most phases of horizontal geometrical design, and to a broad range of all engineering design because the concepts involved are based on generic geometric terms. Civil engineers using COGO I write out the problem in an easy-to-learn format. The engineer can enter the problem into the computer through a typewriter -- or the problem may be punched into cards and then entered into the computer.

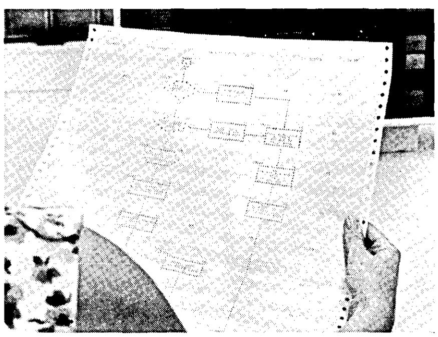
COGO I can be used with a basic IBM 1620 system equipped with punched card input and output. (For more information, circle 62 on the Readers Service Card.)

Newsletter

PROGRAM ENABLES IBM 7070/7074 TO "DRAW" FLOWCHARTS

AUTOCHART, a programming system that enables a computer to automatically "draw" a flowchart in about 15 seconds, was recently announced by IBM Corp., White Plains, N.Y. Three primary advantages of the system are: (1) time saved in the original manual preparation of a flowchart; (2) to speed changes on a flowchart; and (3) provision of a permanent retrievable documentation of a program.

Use of the new system requires no extensive programming experience. A programmer prepares a conventional rough, hand-drawn layout of the flowchart. This rough layout can then be coded by clerical personnel using AUTOCHART coding sheets which locate and define each symbol and all the text on the chart. From these code sheets, a deck of cards is punched and processed on the computer to produce the AUTOCHART, which is written on magnetic tape for off-line printing. The flowchart is pre-



-- A programmer examines a flowchart that was automatically prepared in about 15 seconds by an IBM 7074/1401 data processing system using a new programming system, AUTOCHART.

pared by an off-line printer such as the IBM 1403. Because the flowcharts are recorded on magnetic tape, it is easy to transmit them by IBM Teleprocessing systems to several different locations simultaneously. Or -- using regular telephone lines for data transmission -- charts prepared at different locations can be processed at a centralized computer location. (For more information, circle 60 on the Readers Service Card.)

COMPUTER DYNAMICS ANNOUNCES 1410 PERT/TIME PROGRAM

Computer Dynamics Corp., Silver Spring, Md., has developed a PERT TIME and COST program for the IBM 1410 computer. This new program meets DOD/NASA processing specifications and can be used to process networks containing up to 2000 events. It provides for alphabetic coding of documentation backup for each event and activity. The program is written for a 40 K IBM 1410 with on-line card-reader-punch and printer with six tape drives.
(For more information, circle 61 on the Readers Service Card.)

"PLINK" PROGRAM PERMITS COMPUTERS TO SWITCH FROM ONE "LANGUAGE" TO ANOTHER

PLINK, a new computer program, for transmitting data over telephone lines in computer-to-computer link-ups, has been developed by the ITT Data and Information Systems Division, Paramus, N.J. PLINK, for Phone LINK, is written for the IBM 1401 computer in conjunction with the 1009 data transmission unit. Any organization in the United States that has a 1401 and a data link can have direct access to an IBM 7090, such as that at the ITT center.

The new program is able to send both pure binary data and decimal alphanumeric data in binary code in intermixed records in the same message. Also, PLINK is modularly constructed. Inputs to a 1401 computer at one end of the link can be in the form of magnetic tape or punched cards while the output can be punched cards, tape or continuous-form printed sheets, at the option of the correspondents. The program also can specify that output be in more than one form, e.g., cards and tape.

PLINK is expected to prove useful to large corporations with computer installations at more than one location.
(For more information, circle 63 on the Readers Service Card.)

Memories

HIGH-SPEED DYNAMIC DATA STORAGE MEMORY

A high-speed dynamic data storage memory, using a recirculating loop at 15.3 megacycles per second, has been developed by Stromberg-Carlson, a division of General Dynamics, Rochester, N.Y. The new module, designed for use in electronic switching telephone systems, also has many data processing applications.

The circuitry employs a single dynamic storage element with a capacity of 1530 bits, each occupying a 65.4 nanosecond time period. The total of 1530 bits constitute 102 words, each containing 15 bits of information. Each word occupies 980 nanoseconds and is presented in parallel at the module output terminals every 100 microseconds. Word presentation persists for 785 nanoseconds.

The 15.3 mc/s storage element consists of a sonic delay line using zero temperature coefficient glass, input distributor, output distributor and time pulse generator. The input distributor converts the parallel 1.02 mc/s bit information into 15.3 mc/s bits for storage in series. The output distributor performs a complementary function by converting the series 15.3 mc/s bits into parallel 1.02 mc/s bit information. A buffer store, containing 15 flip-flops, applies each information word to the external system at a 1.02 mc/s rate.
(For more information, circle 64 on the Reader Service Card.)

HONEYWELL 1800 COMPUTER MEMORY EXPANDED TO 65K

Honeywell EDP, Wellesley Hills, Mass., has expanded the magnetic core memory capacity of the large-scale Honeywell 1800 series computer to 65,536 words. (Previous maximum memory had been 32,768 words.) Memory modules to boost 1800 series computers to the new maximum are available in increments of 16,384 words each. Honeywell machine words are 12 decimal digits, or 48 binary digits in size.
(For more information, circle 65 on the Readers Service Card.)

SUBMINIATURE MEMORY BY DI/AN

DI/AN Controls, Inc., Boston, Mass., has developed a new, subminiature 30,096-bit sequential access memory. It is designed for aerospace data storage and retrieval systems.

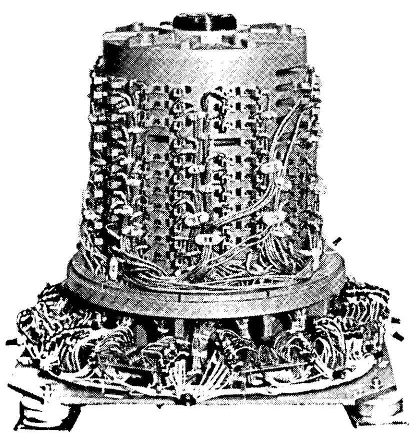
The new memory, called MSA-1A-INT-30,096, weighs just 40 ounces and occupies less than 70 cubic inches. It is a coincident current core memory with internal addressing and counting. Solid-state magnetic drive and control

circuitry is used, with no internal heating or temperature control required. Temperature range is -20°C to +95°C. Data input and output are asynchronous -- one bit at a time at any rate up to 20,000 bits per second.
(For more information, circle 67 on the Readers Service Card.)

METALLIC-PLATED MEMORY DRUMS WITH HIGH-DENSITY STORAGE

Metwood Manufacturing Co., Gardena, Calif., has developed a series of metallic-plated memory drums with reportedly twice the bit storage capacity of comparably-sized, oxide-coated units. Recording surfaces are electrolytically plated with a cobalt alloy.

The drums are designed to operate for 40,000 hours at 3600 rpm, with cylinder concentricities as low as .000008-inch. Double bit density permits running drums at half the speed required by conventional devices.

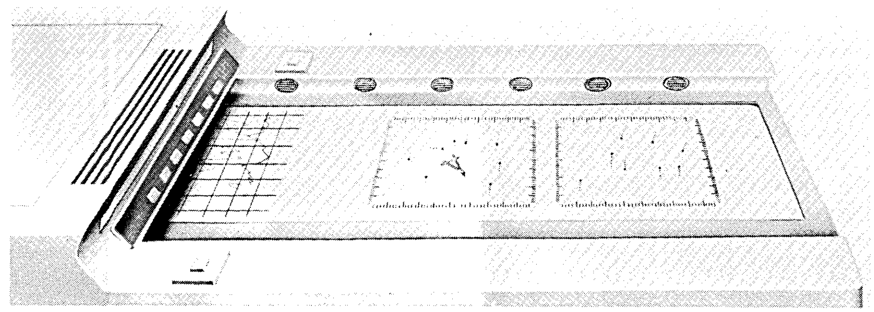


These memory drums, designated series 1200, are 13" in diameter, with heights from 11.375" to 21.875". Drum speeds range from 900 to 12,000 rpm. They are supplied with from 55 to 540 tracks. Storage capacities range from 50,000 to 3,500,000 bits.
(For more information, circle 66 on the Readers Service Card.)

Input-Output

"ON-LINE" ANNOTATING PLOTTER

A new, high-speed, "on-line" annotating plotter has been developed by Drexel Dynamics Corp., Horsham, Pa. The new plotter, named Drexamatic High Speed Annotating Plotter, Model 1065-1-ONL, is capable of reading digital information from an IBM 7090 computer and translating it into graphic plots with annotation and line printing. The device has been developed to permit group viewing of "quick look" status information on near-real-time data that has been reduced and organized by a computer.



This plotter is a high-resolution (100 points per inch) facsimile electrolytic type recorder that produces hard dry copy suitable for pencil marking notations. It is completely self-contained within a desk type console. The plotter logic is operated at 100KC at a paper speed of 10" per second. It will accept, decode, and mark a maximum of 100 10-bit plot words per millisecond. When operated on-line with a computer, the computer cycle time must be added to the 10 milliseconds plot time to determine the maximum plot rate.

Typical applications of the new plotter include hard copy displays of annotated radar plots, air traffic prediction plots, presentation of contour maps, and other high-density plots of mixed variables with identifying annotation.
(For more information, circle 68 on the Readers Service Card.)

IBM 1460 PRINTING SPEED INCREASED TO 3300 LINES/MINUTE

IBM Corp., White Plains, N.Y., has increased the printing speed of the IBM 1460 data processing system to 3300 lines per minute. This has been achieved by linking three high-speed printers to the computer. Using the additional printers increases the speed of producing different reports from the same information -- and multiple copies of the same report.
(For more information, circle 69 on the Readers Service Card.)

UPTIME OFFERS 1500 CPM SERIAL READER

The Uptime Corporation, Golden, Colo., announces the addition of the Speedreader 1500 Punched Card Reader to their peripheral equipment line. The Speedreader 1500 reads 80-column punched cards, column by column at a rate of 1500 cards per minute. Both reading and timing is done photoelectrically. All circuitry is checked on each card cycle to insure reliability.

A change to read 51-column punch cards can be accomplished by the operator. This card is read at a rate of 2000 cards per minute.
(For more information, circle 70 on the Readers Service Card.)

HAND RECORDING UNIT USES MAGNETIC TAPE

The Type 303 Hand Unit, a portable, data recording unit which records alpha-numeric information directly onto magnetic tape, is being offered by the Electric Information Company of Broomfield, Colo. By setting dials, and then pressing a button, the unit's operator can record data in a fifteen-character field upon a ¼" magnetic tape contained in a cartridge in the device. Each tape cartridge has a capacity of 1200 15-character words.

To place the recorded information into a computer, the tape cartridge is placed in a Mark I Input Unit which buffers the taped information for high-speed entry into a computer. The Mark I is also made by EI.

The cost of the 303 Hand Unit, using numeric data only, is under a thousand dollars. Applications are expected in inventory recording, medical record keeping, meter reading, etc.
(For more information, circle 71 on the Readers Service Card.)

NEW COMPUTER ENTRY KEYBOARD ANNOUNCED

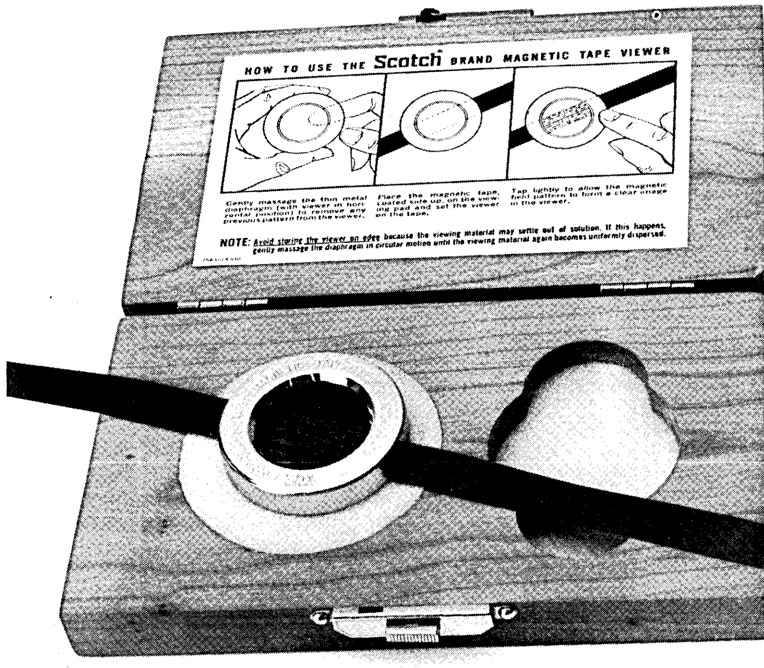
The C-DEK, a new computer data-entry keyboard is announced by Colorado Instruments, Inc., Broomfield, Colo. The unit affords up to 18 columns of information to be placed on the keyboard, with each depressed key being visibly illuminated. A paper tape record of fixed field length is made on command after the operator has verified the accuracy of the depressed keys.

Application for the C-DEK is seen where quantities of numeric information must be organized and prepared quickly for computer processing....frequently by the accountant or engineer originally handling the information. Also, C-DEK is especially suited to the preparation of data to be forwarded to a computer via teleprinter transmission circuits.
(For more information, circle 72 on the Readers Service Card.)

Components

3M COMPANY'S MAGNETIC TAPE VIEWER No. 600

A precision instrument which makes visible the data recorded on magnetic tape, without damaging the tape, has been developed by the 3M Company, St. Paul, Minn.



-- Newly developed instrument which makes it possible to check the recorded data on magnetic tape.

The viewer, called No. 600, can be used to check recorder head alignment, track placement, pulse definition, interblock spacing and dropout areas in computer and instrumentation work. It can be used to examine and synchronize the audio track on video tape and the pattern of recorded sound on audible range tapes. It also will determine whether tools, heads or guides are magnetized.

The magnetic tape viewer requires no exterior chemicals and no preparation to use.
(For more information, circle 73 on the Readers Service Card.)

DIALCO® SINGLE PLANE NUMERIC READOUT — SERIES R-100

Dialight Corporation, Brooklyn, N.Y., is offering single plane numeric readouts with the choice of: neon or incandescent light sources; circuit voltages; and plus-minus module, decimal point or colon.

The light-cell system produces high-brightness segments that are seen against a flat black background with approximately 100% contrast. The luminous elements lie in a single plane and permit wide-angle viewing. The digits are close-spaced. Suitable switching of modules permits display of floating decimal point or colon anywhere in the readout.

These numeric readouts apply to computer console readouts, frequency counters, digital clocks, oscilloscopes, airline displays, aircraft channel indicators, stock quotation displays, etc.
(For more information, circle 77 on the Readers Service Card.)

LOW COST 60 CHANNEL SWITCHING DEVICE

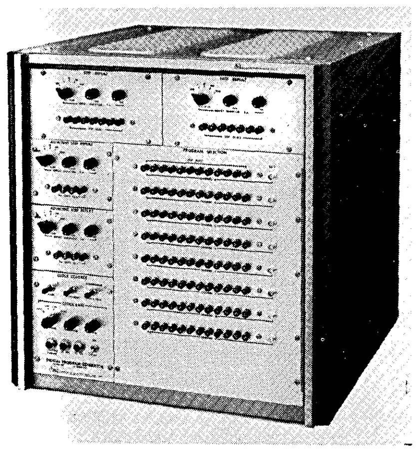
A high-speed, general-purpose switching device, known as the Series 5700 Data-Point Scanner, has been introduced by Electronic Associates, Inc., Long Branch, N.J. The device adds increased flexibility at low cost to digital data acquisition systems. It is designed to automatically sequence inputs to provide address information to a printer or similar output device.

The instrument uses cross bar switching, driven by mercury wetted relays, to provide scanning of up to 60 two-wire or 40 three-wire analog voltage data points. Con-

tinuous scan, single-cycle scan or single step may be selected from front panel controls, or by remote control. Maximum switching time is 30 points per second. The instrument includes 2-digit readout of address plus electrical outputs for remote channel position readout.
(For more information, circle 78 on the Readers Service Card.)

DIGITAL PROGRAM GENERATOR

Computer Control Company, Inc., Framingham, Mass., has introduced a solid-state, variable-frequency Digital Program Generator. The new device is a multichannel source of programmed pulses. It has up to 10 independent output channels and clock rates from 2 kc to 20 mc in four overlapping decade ranges. The fastest test system can be programmed while retaining full versatility in medium- and slow-speed applications. A 12-step program is standard.



The Digital Program Generator is designed for high-speed test of memory cores, twistors, and thin film devices. It also may be used independently for development of computer circuits and logic as well as for a high-speed clock or for word generation.
(For more information, circle 79 on the Readers Service Card.)

CIRCUIT ANALYZER AUTOMATICALLY TESTS UP TO 5000 POINTS

The Electronics and Space Division of Emerson Electric, St. Louis, Mo., has developed an Automatic Circuit Analyzer (ACA Model 3614) that automatically conducts continuity/leakage tests at the rate of three per second. This new device does not need skilled or specially trained operators.

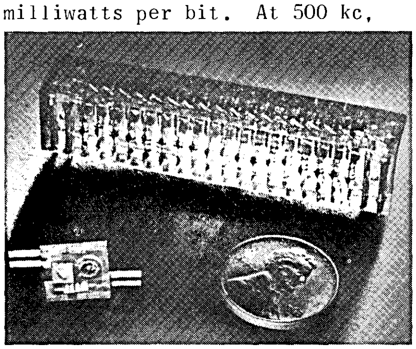
The tape-operated ACA has programmed capacity of 5000 terminals; it automatically energizes relays, positions stepping switches, and selects multiple excitation voltages. The device normally conducts the entire series of tests by itself, stopping only at circuit faults for recording by operator or inspector. Operator intervention is possible, however, at any point in the program.

The new device applies to production, quality control, and maintenance of electrical assemblies in computers, industrial controls, aircraft, missiles, and commercial electronics.
(For more information, circle 80 on the Readers Service Card.)

MINIATURE, LOW-POWER MAGNETIC SHIFT REGISTER

A new miniature, low-power magnetic shift register has been developed by General Electric's Specialty Devices Operation, Syracuse, N.Y., for missile and space-vehicle applications.

The new serial-driven, gated-shift device provides speeds up to 500 kc per second. It is made up of as many as 25 bits; volume is less than 0.03 cubic inch per bit. Average operating power of the shift register is as low as 17 milliwatts per bit. At 500 kc,



average power is 55 milliwatts, but there is no increase in package size. The device is designed for operating temperatures ranging from $-55^{\circ}C$ to $+100^{\circ}C$.

The new shift register can be used in advanced computing and data processing equipment such as guidance or navigation memory, and in counters and data transfer buffer storage.
(For more information, circle 81 on the Readers Service Card.)

AUTOMATION

COMPUTER DEALS AT NEW ENGLAND BRIDGE TOURNAMENT

Over the Labor Day weekend, a high-speed electronic data processing system shuffled and dealt all hands for the New England Regional Bridge Championships, held in Chicopee, Mass. More than 1000 bridge experts from New England, New York and Canada took part in the tournament.

The value of the computer in dealing lies in its ability to generate long series of random numbers having no discernible, prearranged sequence. When hands have been dealt by human players, there is a tendency for a preponderance of freak distributions. Under these conditions, players need to rely more on guesswork than on skill and knowledge.

The computer, operating under the control of special programs, assigns each playing card to one of the four hands (North, South, East or West) according to each group of random numbers in the series. All 52 "cards" are electronically "dealt", 13 to each hand, at very high speeds within the computer itself. The "deal" is then printed in the usual bridge format by the computer's high-speed printer. While one hand is being printed, another is already being prepared inside the computer in the same random fashion as before. This, in turn, is also printed out.

Within a few minutes, a complete set of "deals" has been produced in a more truly random manner than could be achieved by the usual hand shuffling, cutting and one-at-a-time dealing. From then on, the records of hands to be played are kept under the control of the tournament director who arranges to have each hand reproduced in actual playing cards for bidding and play at the tables.
(For more information, circle 82 on the Readers Service Card.)

Newsletter

STANDARDS NEWS

AUTOMATIC CONTROL FIELD STANDARDIZES ITS TERMS

At the 1963 Spring Joint Computer Conference, Isaac Auerbach, president of IFIPS, declared that it was a sad fact of life that after seventeen years, people in the computer field had yet to agree on the meaning of simple English words. Automatic Control engineers overcame this disquieting situation recently, when 43 engineering experts (from 22 national organizations) hammered out the language blueprint known as the American Standard Terminology for Automatic Control, C85.1-1963. The American Society of Mechanical Engineers pioneered the effort through the procedures of the American Standards Association.

According to ASA, a total of 281 definitions as well as general block and functional system diagrams are provided in the standard that, when applied, should contribute to the effectiveness and clarity of communications about problems stemming from automatic process control, feedback control, regulating and other automatic systems that are devoid of human intervention.

Copies of American Standard C85.1-1963 are available for $3.00 each from the ASA, Room 906, 10 East 40 Street, New York 16, N.Y., or the ASME, 345 East 47th Street, New York 17, N.Y.

MEETING NEWS

ACM MEETING EX POST FACTO PROFILE

What? Association for Computing Machinery Annual Meeting

Where? Denver Hilton, Denver, Colo.

When? August 27-30, 1963

Who was there? Over 1500 registrants, and an additional 500 visitors to the exhibits

Copies of the papers? Abstracts of the papers can be obtained from the ACM, 211 East 43rd Street, New York 17, N.Y. Complete papers are available only from the authors.

Highlights...

- Alan Perlis, President of the ACM, proposed the formation of a national computer center, saying "the trouble with our field is that the AEC buys up all the interesting gear before anyone gets a chance to play around with it. We are lagging if we do not get set to start a U.S. National Computer Center".

- William C. Norris, president of Control Data Corp., predicted in his keynote address that by 1970 the value of computer systems installed in the United States would be between $20 to $30 billion, an increase of 4 to 6 times over 1962. He also stated that "present input/output equipment is very primitive compared to the sophistication of the computer itself". He predicted greatly increased use of visual output devices such as cathode-ray tubes, increased use of film to store information, and increased use of audio communication equipment for I/O functions.

- George G. Heller, chairman of the ACM's Education Committee, announced the initiation of a special education program to train blind people as computer programmers. Heller stated that techniques by which the blind can learn and practice programming have already been established. In fact, a computer can be programmed to "print out" the solution to problems in a modified form of braille. The primary need of the new program, according to Heller, is to find experienced computer programmers who are willing and able to serve as instructors. Heller has appointed Dr. Theodor D. Sterling, director of the Medical Computing Center at the University of Cincinnati, as chairman of a special subcommittee to develop the program.

- E. E. Zajac, of the Bell Telephone Laboratories, showed what is probably the first movie ever completely created by computer produced data. The film showed the complex motions of a satellite tumbling through space (for more details, see New Applications, this issue).

....Four gifted high school students from Denver demonstrate their computer prowess in a special ACM exhibit "Computer Education in the Secondary Schools", sponsored by Control Data Corp. Each student has created an original program based on training received during the previous year in a special education program in computery given by R. L. Albrecht of CDC to interested students before and after regular school hours. The programs include a prime number generator, a least common multiple generator, a prime number factors generator, and a logical interpreter and evaluator. The programs are being run on a CDC 160A computer.

BEMA SHOW/CONFERENCE TAKES SHAPE AS BIGGEST EVER

The 1963 Business Equipment Exposition is the largest ever sponsored by BEMA (Business Equipment Manufacturers Association). Over 90 exhibitors will show an estimated $30 million in business equipment and supplies. An attendance of over 60,000 is expected during the week-long show being held in New York at the New York Coliseum, October 28 through November 1.

Leading business equipment executives will give industry members an insight into the present problems and future prospects of their industry during Business Equipment Week in New York, which has been scheduled to coincide with BEMA's 1963 Exposition. The week will begin with official opening ceremonies at the New York Coliseum at 1:00 p.m. on Monday, October 28.

On Tuesday, officially designated "Business Equipment Day", Dr. Louis T. Rader, president of the Univac division of Sperry-Rand Corp., will speak at the Sales Executives Club of New York, on the impact of computers on management.

On Wednesday morning, at the New York Hilton Hotel, Everett S. Calhoun, senior industrial economist at Stanford Research Institute, will report on the problems caused by the "paper work explosion". A well known designer will present a look at the changes office furniture and systems people are making to cope with the needs of today's modern office. Norman Ream, director of systems planning at Lockheed Aircraft Corp., will give a rundown on Lockheed's experiences in integrating computers into the decision-making process in a corporation.

Business Equipment Week will close Friday with a series of seminars sponsored by the Eastern Business Education Association. Three BEMA staff members, Charles A. Phillips (Data Processing Group director), Charles E. Ginder (Office Machines Group director) and Richard E. Utman (DPG standards director) will chair the sessions.

BUSINESS NEWS

PROFITS UP 99% IN YEAR

Control Data Corp. reports net sales, rental and service income, for the fiscal year ended June 30, 1963, was $63,111,401, up 54% from $41,034,009 in 1962. Net profits after provision for taxes were $3,064,751, up 99% from $1,542,622 in the previous year.

During the past year, Control Data recorded expansion in foreign markets and the establishing of subsidiaries in Canada, Switzerland, West Germany, Sweden, Australia, Holland and France. The company also acquired several domestic businesses, including the formation of Meiscon Corporation; the business and principal assets of the Computer Division of The Bendix Corporation; Beck's Inc., a printed circuit manufacturer; and the Digigraphic System business of Itek Corporation. During the year, Control Data also purchased the majority of outstanding shares of Electrofact N.V. of Amersfoort, The Netherlands, to expand its industrial control activities and to provide facilities for the manufacture of computing equipment for sale in the Common Market area.

BURROUGHS HALF-YEAR EARNINGS DOWN

Burroughs Corporation has reported earnings for the first six months of 1963 of $3,407,000, which compares with six months earnings of $4,454,000 last year. Revenues for the six months were $185,180,000 compared with $207,031,000 in 1962.

The company said this decrease is entirely attributed to lower billings of defense products as certain old programs are phased out and new programs are in a start-up stage. Defense billings are expected to increase in the last quarter of the year.

Ray R. Eppert, president, stated that demand for commercial systems and machines is very strong and commercial backlogs are currently 16 per cent greater than last year. He also said shipments of the new electronic computer systems are being made at a rapidly accelerating rate.

PACKARD BELL REPORTS INCREASE IN SALES AND EARNINGS

Packard Bell Electronics has reported net income for the nine months ended June 30 was $805,000, compared with a net loss of $333,000, for the same period last year.

Sales for the first nine months reached $37,967,000, up 6% from last year's record-breaking $35,931,000 for the same period.

AMPEX UPS PROFITS 6% IN QUARTER

Record sales, earnings and order backlog for any first quarter were reported by Ampex Corporation in the three months ended July 31. Sales for the quarter totaled $23,413,000, up 9 per cent from $21,513,000 last year. Net earnings after taxes increased to $933,000, up 6% from $878,000 last year.

New orders received during the quarter reached $26,307,000, representing the second highest level for any quarter in company history.

SALES OF GENERAL KINETICS DOUBLE

General Kinetics Incorporated, Arlington, Virginia reported that for the year ended May 31, 1963, consolidated sales and rental income were $1,017,696 as compared to $448,958 for the previous year -- or a 127% increase.

Noting a year of "excellent and steady progress," Mr. Gutterman said that a sound 75-25 ratio of commerical to government sales had been maintained; and that sales of its equipment and tape rehabilitation systems and services to large-scale users of magnetic tape had been expanded.

Net profits after taxes of the company were $22,192 for the 12-month period, a 29% hike over the $17,246 for the previous year.

Orders received during the year showed a sharp rise to $1,475,000 as compared to last year's $540,000 -- a 173% increase. An important part of these orders received, according to Robert P. Gutterman, president, was the result of a good sales showing by its subsidiary, Computer Test Corporation, which manufactures magnetic core and memory test equipment.

COMPUTER CONCEPTS SALES EXPAND

Gross sales for the first half of 1963 for Computer Concepts, Inc., Washington-based consulting firm, totaled $605,137 compared to $147,472 during a corresponding period of 1962.

In the same period, the two-year-old company earned $89,687 before taxes, compared to $2,361 last year.

Howard I Morrison, president, declared that the company had a backlog of approximately $1 million in contracts on July 1.

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.

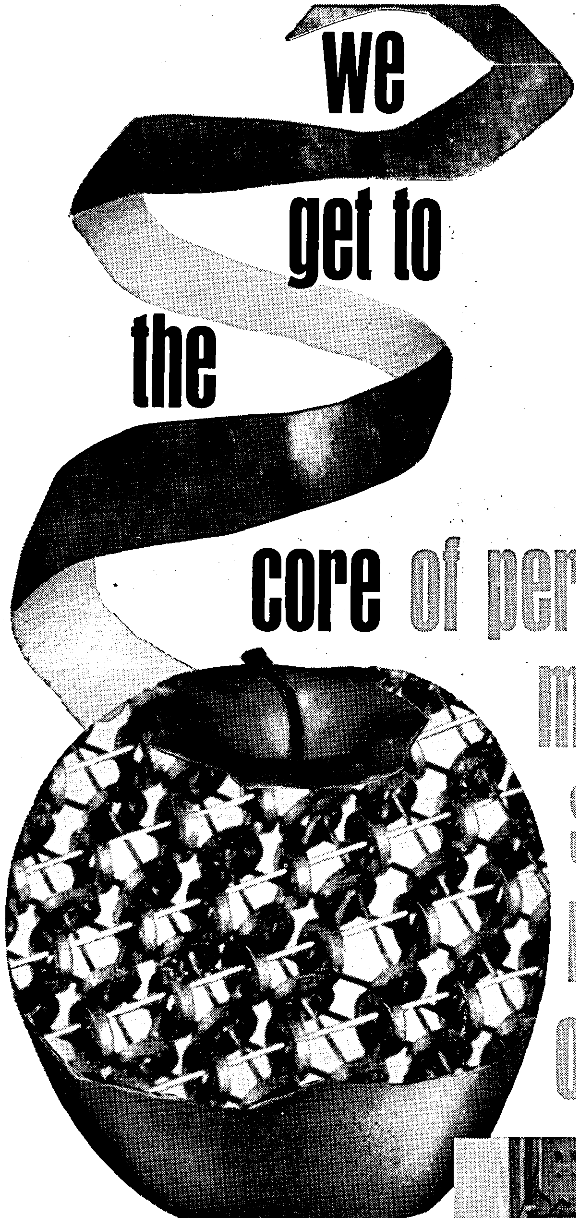
AS OF SEPTEMBER 20, 1963

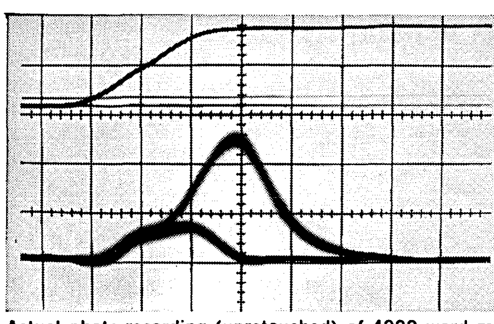
NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	18	10
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	11	3
	ASI 2100	Y	$3000	12/63	0	3
	ASI 420	Y	$12,500	2/63	1	X
Autonetics	RECOMP II	Y	$2495	11/58	115	X
	RECOMP III	Y	$1495	6/61	28	X
Burroughs	205	N	$4600	1/54	60	X
	220	N	$14,000	10/58	46	X
	E101-103	N	$875	1/56	148	X
	B250	Y	$4200	11/61	56	28
	B260	Y	$3750	11/62	44	40
	B270	Y	$7000	7/62	31	22
	B280	Y	$6500	7/62	30	22
	B5000	Y	$16,200	3/63	9	20
Clary	DE-60/DE-60M	Y	$525	2/60	129	1
Computer Control Co.	DDP-19	Y	-	6/61	3	X
	DDP-24	Y	$2750	5/63	1	16
	SPEC	Y	$800	5/60	10	0
Control Data Corporation	G-15	N	$1000	7/55	300	1
	G-20	Y	$15,500	4/61	23	2
	160/160A	Y	$1750/$3000	5/60 & 7/61	320	27
	924/924A	Y	$11,000	8/61	14	16
	1604/1604A	Y	$35,000	1/60	53	8
	3600	Y	$52,000	6/63	3	9
	6600	Y	$150,000	2/64	0	1
Digital Equipment Corp.	PDP-1	Y	Sold only about $120,000	11/60	42	9
	PDP-4	Y	Sold only about $60,000	8/62	16	10
	PDP-5	Y	Sold only about $25,000	9/63	2	1
	PDP-6	Y	Sold only about $50,000	-/64	0	0
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	32	X
General Electric	210	Y	$16,000	7/59	78	5
	215	Y	$5500	-/63	0	23
	225	Y	$7000	1/61	143	55
	235	Y	$10,900	-/64	0	7
General Precision	LGP-21	Y	$725	12/62	42	27
	LGP-30	semi	$1300	9/56	476	5
	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	6/60	10	1
	H-400	Y	$5000	12/61	61	41
	H-800	Y	$22,000	12/60	53	9
	H-1400	Y	$14,000	5/64	0	7
	H-1800	Y	$30,000 up	11/63	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	2
IBM	305	N	$3600	12/57	660	X
	650-card	N	$4000	11/54	570	X
	650-RAMAC	N	$9000	11/54	140	X
	1401	Y	$3500	9/60	6000	2500
	1410	Y	$12,000	11/61	230	280
	1440	Y	$1800	4/63	70	1310
	1460	Y	$9800	10/63	0	125
	1620	Y	$2000	9/60	1351	190
	701	N	$5000	4/53	2	X
	7010	Y	$19,175	2/64	0	30
	702	N	$6900	2/55	2	X
	7030	Y	$160,000	5/61	6	X
	704	N	$32,000	12/55	71	X
	7040	Y	$14,000	6/63	12	41
	7044	Y	$26,000	6/63	8	14
	705	N	$30,000	11/55	125	X
	7070, 2, 4	Y	$24,000	3/60	450	125
	7080	Y	$55,000	8/61	54	24
	709	N	$40,000	8/58	20	X
	7090	Y	$64,000	11/59	270	35
	7094	Y	$70,000	9/62	24	45
	7094 II	Y	$76,000	4/64	0	12
Information Systems, Inc.	ISI-609	Y	$4000	2/58	19	1
ITT	7300 ADX	Y	$35,000	7/62	6	3
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	176	4
	Monrobot XI	Y	$700	12/60	270	213
National Cash Register Co.	NCR - 102	N	-	-	22	X
	- 304	Y	$14,000	1/60	29	0
	- 310	Y	$2000	5/61	43	35
	- 315	Y	$8500	5/62	89	125
	- 390	Y	$1850	5/61	320	300
Packard Bell	PB 250	Y	$1200	12/60	148	14
	PB 440	Y	$3500	11/63	0	10
Philco	1000	Y	$7010	6/63	3	18
	2000-212	Y	$52,000	1/63	2	7
	-210, 211	Y	$40,000	10/58	22	7
Radio Corp. of America	Bizmac	N	-	-/56	4	X
	RCA 301	Y	$6000	2/61	310	200
	RCA 3301	Y	$15,000	7/64	0	2
	RCA 501	Y	$15,000	6/59	70	8
	RCA 601	Y	$35,000	11/62	2	3
Scientific Data Systems Inc.	SDS-910	Y	$1700	8/62	20	39
	SDS-920	Y	$2690	9/62	15	15
	SDS-9300	Y	$8000	1/64	0	1
Thompson Ramo Wooldridge, Inc.	TRW-230	Y	$2680	8/63	6	6
	RW-300	Y	$6000	3/59	37	2
	TRW-330	Y	$5000	12/60	11	18
	TRW-340	Y	$6000	12/63	0	4
	TRW-530	Y	$6000	8/61	18	6
UNIVAC	I & II	N	$25,000	3/51 & 11/57	49	X
	Solid-State II	Y	$8500	9/62	27	9
	III	Y	$20,000	8/62	28	20
	File Computers	N	$15,000	8/56	58	0
	60 & 120	N	$1200	-/53	840	5
	Solid-state 80, 90, & Step	Y	$8000	8/58	390	20
	490	Y	$26,000	12/61	16	25
	1004	Y	$1500	2/63	300	1880
	1050	Y	$7200	9/63	1	12
	1100 Series (except 1107)	N	$35,000	12/50	23	X
	1107	Y	$45,000	10/62	8	11
	LARC	Y	$135,000	5/60	2	X
X -- no longer in production				TOTALS	15,966	8194

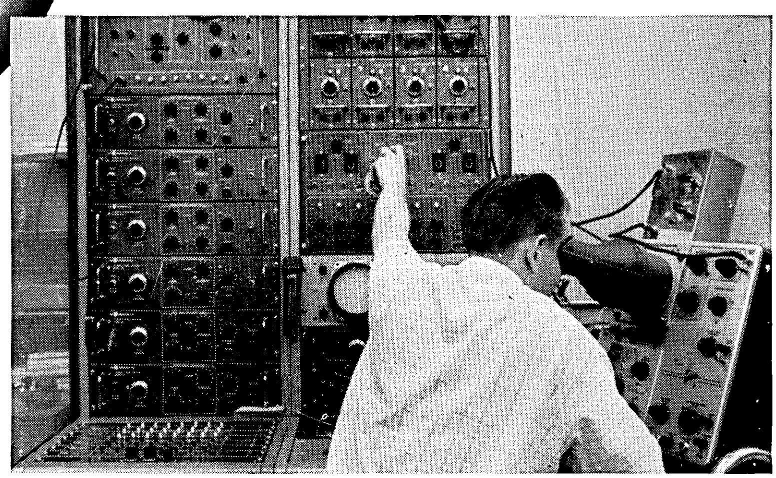
Mr. Richard M. Citron
Hal Stebbins, Inc.
599 N. Mathilda
Sunnyvale, Calif.
204Ba

we get to the core of performance in memory planes and stacks to assure maximum system operating margins





Actual photo-recording (unretouched) of 4000 word memory plan utilizing 30FC01 cores. Worse case pattern.



Some very good memory cores are thrown out at Ferroxcube simply because they do not meet the extra stringent requirements of performance in or out of the memory plane assembly. Only the best, closely matched to overall electrical requirements of the plane and stack, are delivered to our customers. Ferroxcube makes cores under precise batch kiln conditions and individually tests each core before assembly. After wiring in planes, cores are again submitted to advanced techniques of performance evaluation. Cores not up to Ferroxcube's specifications are replaced, until the entire assembly provides the **operating margins of performance** that means better overall memory characteristics, longer service life, and surprisingly, **you benefit by lower costs.**

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