DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange among interested persons of information concerning recent developments in various digital computer projects. Distribution is limited to government agencies, contractors, and contributors.

OFFICE OF NAVAL RESEARCH · MATHEMATICAL SCIENCES DIVISION

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COMPUTERS AND DATA PROCESSORS, NORTH AMERICA

PERCEPTRON — CORNELL AERONAUTICAL LABORATORY, INC. — BUFFALO, N. Y.

The concept of the first non-biological system capable of perceiving, recognizing and identifying its surroundings without any human training or control, has been successfully demonstrated and proven by Dr. Frank Rosenblatt, research psychologist at the Cornell Aeronautical Laboratory, Inc. of Buffalo, N.Y., under contract for the Office of Naval Research, Information Systems Branch, Washington, D.C.

Although the pilot model of a machine designed specifically for these functions is about one year from completion, the "Perceptron" system has been effectively simulated on an IBM 704 computer many times in proving its concept and practicability. It has in each case demonstrated the ability not only to "learn" what it is "shown," but also a capability of spontaneously "teaching itself."

The perceptron will consist of interconnected units, which are capable of responding to appropriate signals, or impulses, and which deliver output signals analogous, in many ways, to nerve impulses. While the basic organization of the perceptron is similar to that of a biological system, certain differences and simplifications should be noted. For one thing, the projection area, which is found in all advanced biological systems, is not essential for the perceptron, although it does serve important functions in some models. In simplified models, the retinal points are assumed to be connected directly to randomly selected units (A-units) in the association system. Second, the responses (R-units) of the perceptron are typically binary devices which are either "on" or "off," or which may sometimes have a third "neutral" condition. At the present time, little attention has been given to responses which must vary in intensity, the R-units of the perceptron being used merely to signal the state of the system. Third, the responses of the perceptron actually combine the functions of the second association layer with those of the motor cortex. The R-units transmit feedback signals to the association system, with some essential constraints which are similar in effect to the constraints in local feedback loops between layers of the association cortex. The feedback connections from an R-unit, like those from the deep cortical cells, return to the same A-units which are responsible for activating the unit in the first place. (In some models alternative constraints are possible, but this rule appears to be one which is most generally satisfactory.)

The responses of the perceptron might best be interpreted as the analog of certain association cells which represent the brain's "recognition response" to particular visual forms, or types of stimuli, rather than the cells in the motor cortex which regulate speech or movement. The activation of a particular response, for the perceptron, might mean, for example, that a triangle is present, or that a man's voice is being heard. Each response is thus capable of representing a particular concept, or abstraction, in terms of which the environment is organized. At the outset, when a perceptron is first exposed to stimuli, the responses which occur will be random, and no meaning can be assigned to them. As time goes on, however, changes which occur in the association system cause individual responses to become more and more specific to particular, well differentiated, classes of forms, such as squares, triangles, clouds, trees, people, etc.

The theoretical bases were well established during 1957, and at that time, the simulation program was started, using the IBM 704 computer, to try to find out how well the theory would hold up in practice. While the 704 could not possibly rival the perceptron in speed and flexibility of performance, it is possible, by examining each connection and A-unit of the system in turn, and computing the appropriate signals which would be transmitted in a physical network, to calculate the performance of a perceptron, in response to a series of visual forms. A large number of such simulation experiments have now been completed, and all main predictions of the theory have been substantiated.

Although there have been many theoretical "brain models" before the perceptron, the main points which set it off from other attempts are:

1. The perceptron is the first system which appears to be economical, in the sense that it can operate successfully, on non-trivial problems, with a smaller number of units than are present in the human nervous system. All previous system designs, which are in any way compatible, are of a completely prohibitive size.

2. The perceptron is not built to rigid logical specifications, in which the failure of a particular unit is likely to cause a breakdown of operation. The design of the system is based on a small number of statistical parameters, and some general logical constraints, but within these limits the actual connections can be drawn from a table of random numbers.

3. The perceptron does not recognize forms by matching them against a stored inventory of similar images, or performing a mathematical analysis of characteristics. The recognition is direct, and essentially instantaneous, since the "memory" is in the form of new pathways through the system, rather than a coded representation of the original stimuli. There is, in fact, no way of reconstructing the original stimuli from the memory, with any absolute certainty. Nonetheless, the probability of obtaining an appropriate recognition response, or "naming response," can be made virtually perfect.

4. As a model for the biological brain, the perceptron does not violate any known information about the central nervous system. Its size, the logic of its connections, the degree of reliability required of individual units, the permissible random variation in its "wiring diagram," and the kinds of signals employed, are all consistent with known anatomical and physiological data. The differences from the nervous system are generally in the direction of simplification, rather than complication, since it is often possible to achieve effects in an electronic model which would require many cells and connections in a biological system. At only one point—the assumed "value" of the A-units—is there an assumption which does not have a clearly identifiable counterpart in the biological brain, and this appears to be due to difficulties of measurement, rather than incompatibility of the concept.

5. The perceptron is the first system which has been proved capable of spontaneous organization and symbolization of its environment, along lines which bear some definite relationship to the human concept of "similarity." While statistical schemes for the correlation and differentiation of patterns have been proposed previously, and might be implemented by a digital computer, the perceptron appears to be the only system which inherently operates in this fashion, as a property of its organization, rather than through the execution of a logical program.

ALWAC III-E — EL-TRONICS, INC. — HAWTHORNE, CALIFORNIA

Since the merger of ALWAC Corporation with El-Tronics, Inc. in March, ALWAC has become the "ALWAC Computer Division, El-Tronics, Inc."

One of the recent installations and computer applications involves the ALWAC III-E which was installed at the Menasco Manufacturing Company, Burbank, California. In addition to the standard accounting and payroll applications, Menasco will employ their III-E for the numerical control of machine tools. A general purpose numerical control routine (NUCOP I and II) has been developed by the ALWAC applications staff. This routine is designed to prepare, from blueprint information, a punched paper tape that will direct a three dimensional numerically controlled milling machine in a continuous path operation through any mathematically definable or approximable surface. The Air Frame Industry has stated that NUCOP represents a significant contribution to the advancement of numerically controlled milling machine techniques.

Recent III-E systems delivered early this year or scheduled for installation within the year include David Taylor Model Basin (Data Reduction); Broadview Research Corporation (Service Bureau and Operations Research) and the Technical Research Group, New York, who will use their system for research projects including nuclear physics, chemistry, and electronics. III-E systems are scheduled for installation at Liggett Drug Co., Connecticut, and Pharmaceuticals, Inc., New Jersey, in the first quarter of 1959. They will be used for inventory control, accounting, and other commercial applications.

The first magnetic tape system for the III-E has been installed at the Personnel Research Board of the Adjutant General's Office, Washington, D. C. The fast (21,000 character per second), buffered (32 word magnetic core) and flexible magnetic system was delivered in February of this year, and was quickly checked out. It is now in productive operation for the voluminous record keeping functions of the PRB. Litton Industries has also recently received and accepted their Magnetic Tape System which will be used with its now extensive III-E for business applications as well as the design problems which have long been associated with the Litton installation. Litton reports that during the month of April, their system has operated a total of 380.8 hours. This represents a remarkable 97.5% of up-time and productive operation.

MANIAC II — LOS ALAMOS SCIENTIFIC LABORATORY — LOS ALAMOS, NEW MEXICO

The MANIAC II, designed and built by the Los Alamos Scientific Laboratory (see Digital Computer Newsletter January 1955), is now in operation with its 12,288 word barrier-grid cathode ray tube memory. Its novel facilities for easy and effective human intervention have already proved valuable.

Work is in progress on a formula coding technique allowing direct entry into the computer of formulae typed on an 84 character Flexowriter. This Flexowriter will be modified for automatic half-line advance and retract, without carriage return, to permit completely general sub and superscripting.

PRINCETON (IAS) COMPUTER — PRINCETON UNIVERSITY — PRINCETON, N. J.

Princeton University (see Digital Computer Newsletter October 1957) will terminate operation of its present computer (formally IAS) by 30 June 1958.

The IAS computer had originally been designed and built by the late John von Neumann and his group at the Institute for Advanced Study. It was the first general purpose stored-program computer and the fastest computer at that time. The IAS computer was copied by several institutions, with slight modifications, and the IBM 701 was largely based on its design.

In July 1957 the IAS computer was taken over by Princeton University after the computer staff had been drastically reduced. The decision to abandon the computer is due to the increasing difficulties in its repair and maintenance, and to the availability of reliable commercial machines. The possibility of exchanging codes between organizations owning one of the widely distributed commercial models has also contributed to Princeton University's decision.

An IBM 650 has been ordered as a temporary replacement but it is felt that Princeton University, together with its various research projects, will soon need a bigger and faster machine presumably an IBM 704.

OFFICE OF RESEARCH AND DEVELOPMENT — U. S. PATENT OFFICE — WASHINGTON, D. C.

Since the middle of May of this year, the Patent Office has been employing the ILAS machine (see Digital Computer Newsletter October 1957) operationally to perform patent searches. Novelty searches of applications for patents directed to polyethylene resins and their methods of synthesis are being performed by ILAS on a group of 246 U. S. patents and 30 foreign patents directed to this field. Future work will expand the search file to include additional foreign patents as well as periodical literature. ILAS permits the asking of questions which have a more complex logic than is possible with conventional card sorting equipment. The search file contains 6,219 cards, which averages about 22 cards per patent. Sorting is at the rate of approximately 500 cards per minute. A complete search, including programming of the machine, requires approximately 22 minutes.

COMPUTING CENTERS

DATA REDUCTION LABORATORY – AIR PROVING GROUND CENTER – EGLIN AFB, FLORIDA

With the merging of the Air Force Armament Center and the Air Proving Ground Command at Eglin Air Force Base, Florida, digital computer facilities have been consolidated under the Data Reduction Laboratory (PGVLD) of the 3208th Test Group (Technical Facilities), Air Proving Ground Center.

An IBM 704 Computer was delivered in March joining the Univac Scientific Model 1103, the Datatron 205, and the IBM 650's in the Laboratory's computer complement.

COMPUTER STUDY – STATE OF MINNESOTA – SAINT PAUL, MINN.

The 1957 Legislature appropriated $50,000 to the Commissioner of Administration for the purpose of conducting a study to determine which administrative activities might be profitably placed under electronic computer operation. It is believed that this is the most comprehensive study of this type undertaken to date by a state government.

The completed study report states that installation by the Minnesota state government of an electronic computer will yield an estimated annual savings of $600,000 to $1,000,000. The study is the first of its kind, covering all operations, ever undertaken by a state government. It grew out of the Minnesota Self-Survey, a comprehensive analysis of all state administrative operations launched in August 1955 by Governor Freeman under direction of Commissioner of Administration Arthur Naftalin.

The report recommends the establishment of an electronic computer center that would initially embrace eight major applications, including:

1. The general statewide accounting function. This is now performed on a decentralized basis by the various state departments. Under the computer program the function would be performed centrally under direction of the State Auditor.

2. Income tax collection. Now partially mechanized, this function would be fully converted to electronic computing, enabling greatly accelerated processing of returns with vastly improved accuracy and more extensive auditing of individual returns.

3. Gasoline tax collection and refunding. While partly mechanized, it is still a burdensome manual operation. Under computer operation the function would be performed more rapidly at reduced cost and with fewer errors.

4. Motor vehicle registration. This function is now in the process of shifting from a wholly manual operation to tabulating machines. It would be further mechanized under the computer program, resulting in a more economical procedure and improved service with fewer errors. It would also provide important statistical and tabulating byproducts and improved reference files which are in constant use. The program would remain under direction of the Secretary of State.

5. Gathering and reporting of welfare statistics. This activity is now performed separately under five reporting systems. Under the computer program, these systems would be integrated into one reporting procedure, thus eliminating duplicate files and consolidating all information pertaining to an individual case in one record.

6. Highway cost accounting. This is now performed on tabulating equipment, but under the computer program it would be accomplished more economically and at greater speed, because the present system, according to the report, requires a multitude of sorting, collating, summarizing and other handling operations, whereas the computer can produce all the required reports in one operation.

7. Payroll preparation. This activity has been the subject of a separate management improvement program which has already resulted in extensive mechanization and partial centralization. Under the computer program the payroll would become fully centralized with greater speed and accuracy.

8. Highway engineering computations. Now partially performed on an electronic calculator of limited capacity, this function under the computer program would be given wider machine application, relieving engineers for essential professional activities, such as designing and research and construction supervision. It is estimated that use of the computer would reduce construction costs by as much as $600 per mile.

The eight functions now require 727 full-time and 348 seasonal employees at an annual salary cost of $3,331,000. With the computer operation they would required 453 full-time and 152 seasonal employees at an annual cost of $2,252,000. The conversion would save 274 full-time and 196 seasonal positions now costing $1,079,000.

The computer would permit abandonment of a number of machine rentals, providing additional savings of $144,647, for a total savings for both personnel and equipment of $1,224,000.

Against these savings, however, must be applied the cost of the computer center itself. This is estimated at $633,751 per year, leaving net annual savings of $590,000.

The computer center would require 38 full-time and 36 seasonal employees for the eight applications, which means that a total of 491 full-time and 188 part-time employees would be needed for operations that now require 727 full-time and 348 seasonal employees.

In addition to these savings, the survey showed that an estimated $271,000 would be saved by extending computer use in highway engineering.

Also, in income tax collection it is conservatively estimated that $141,000 in additional annual revenue for the Income Tax Fund would result because of improved automatic auditing procedures.

The eight functions that would be converted initially represent approximately 60 per cent of the state's data processing load. After these applications have been completely installed, other functions could be readily converted, adding still further savings.

Installation of the computer will require legislative action. This action is planned for 1959.

COMPUTATION LABORATORY — NATIONAL BUREAU OF STANDARDS — WASHINGTON, D. C.

The capacity of the IBM 704 installation at the NBS's Applied Mathematics Division has been augmented by the addition of an 8,000 word magnetic drum. This will facilitate the use of FORTRAN.

TRICE AND MULTIVERTER — PACKARD-BELL COMPUTER CORPORATION — LOS ANGELES, CALIFORNIA

The prototype TRICE system (see Digital Computer Newsletter April 1958) was delivered to the Army Ballistic Missile Agency at Redstone Arsenal in May. This system has generated stable sine waves as high as 8,000 cycles per second in realtime.

An analysis has been made of open form of the Impact Prediction problem using TRICE as a computer. The equations of motion for a 5,000 mile ballistic trajectory can be completely integrated in approximately one second with a step size in range of 1/20 mile. This should give, considering the trajectory solution only, an error in range of approximately one part in 25,000 or 1/5 of a mile. Copies of this report are available, for those interested, by writing V. A. van Praag, Packard-Bell Computer Corporation, 1905 Armacost Avenue, Los Angeles 25, California.

An interesting application of TRICE and MULTIVERTER components has been made in the area of a Realtime Coordinate Conversion. This use is in connection with the new missile tracking equipment which requires digital accuracies and high rates of speeds.

COMPUTATION AND DATA REDUCTION CENTER — RAMO-WOOLDRIDGE CORP. — LOS ANGELES, CALIFORNIA

In January 1958, the former Digital Computing Center of the Ramo-Wooldridge Corporation became the Computation and Data Reduction Center of the Space Technology Laboratories, an autonomous operating division of the Ramo-Wooldridge Corporation. The Center's activities are handled in four major departments: Data Processing and Operations Department, Computer Programming Department, Mathematical Analysis Department, and Data Analysis Department.

In addition to the UNIVAC Scientific Model 1103A Computer and the Epsco ADDAVERTER described in the July 1957 Digital Computer Newsletter, the facilities include an extensive Data Reduction Center as well as an IBM 704 Data Processing System. The 704 went on rental at the Research and Development in Hawthorne, California, on January 6, 1958. This new computer has 8,192 words of core storage and 8,192 words of drum storage. There are 8 magnetic tape units on-line. The extensive peripheral equipment installation includes facilities for off-line card-to-tape, tape-to-card, and tape-to-printer information transfer.

The Center's 704 computer usage has increased steadily since January. During the fourth month of operation (April), productive time totaled 336 hours. Excluding time for preventative maintenance, during April the computer was available 98.1% of the power-on time. The 1103A computer usage remained fairly constant during the first four months of 1958, at an average of 450 hours of productive time per month. Excluding time for preventative maintenance, the computer was available for 95.6% of the power-on time. Three Uniservo tape units now on order for the 1103A computer will soon supplement the existing 7 tape units and will considerably improve the operating efficiency.

RAYDAC — U. S. NAVAL AIR MISSILE TEST CENTER — POINT MUGU, CALIF.

The capabilities of the RAYDAC input system are being further expanded to provide for the processing of digital radar data recorded on magnetic tape. This data can be processed into the computer at rates up to 40 samples per second with the capability of accepting data words either high-order-first or low-order-first. The input system is currently capable of processing paper tape at 200 characters per second, IBM cards at 240 cards per minute, and digital telemetry magnetic tape at rates up to 1000 samples per second.

NAVAL AIR TEST CENTER — U. S. NAVAL AIR STATION — PATUXENT RIVER, MARYLAND

The operating statistics for the Datatron installation at the Naval Air Test Center for the five month period ending 31 March 1958 are as follows:

	Nov. Hrs.	1957 %	Dec. Hrs.	1957 %	Jan. Hrs.	1958 %	Feb. Hrs.	1958 %	Mar. Hrs.	1958 %
Production	159.8	112.1	111.1	74.3	114.7	69.5	73.9	49.3	90.9	63.8
Code Checking	87.6	61.5	16.4	11.0	88.5	53.6	64.2	42.8	59.0	41.4
Idle	1.5	1.1	2.2	1.5	4.0	2.4	0.3	0.2	1.4	1.0
Down Time	4.7	3.3	69.0	46.2	11.2	6.8	16.0	10.7	5.8	4.0
Total	253.6	178.0	198.7	133.0	218.4	132.3	154.4	103.0	157.1	110.3

The first hour of each workday is utilized for preventive maintenance. The remainder of the workday, 7-1/2 hours, is used as the basis for computation of the operating statistics. Percentages in excess of 100 arise when the computer is used for production or code checking after the regular workday. Idle time includes time lost during the basic 7-1/2 hour day due to power failure or air-conditioning malfunction. The large amount of down time during December was the result of primary power equipment failure.

NAVAL ORDNANCE COMPUTATION CENTER — U. S. NAVAL PROVING GROUND — DAHLGREN, VIRGINIA

The 16,000 character per second Charactron printer-plotter (see Digital Computer Newsletter, January 1958) for on-line use with the NORC was delivered and is now undergoing checkout. It is expected to be available for use in June 1958. A Technical Memorandum No. K-13/57, High Speed CRT Printer Programming Manual, has been published for guidance of prospective users.

Construction of the Universal Data Transcriber (UDT) is in progress with a scheduled completion date of January 1959. A contract has been awarded to the Computer Control Company for the 8192 character magnetic core memory to be used in the UDT.

Plans are underway to connect the Computation Laboratory directly, by teletype, to the Vanguard Computing Center and the Naval Research Laboratory in connection with planned increased use of NORC for satellite orbital computations. Programs are now being written and checkout is progressing.

The Computation Laboratory is interested in discussing computational programs for the NORC. The rate for good machine time is $195 per hour. Contact the Director, Computation and Exterior Ballistics Laboratory, U. S. Naval Proving Ground, Dahlgren, Va., Ext. 235.

ELECTRON COMPUTER BRANCH (CODE 280) — BUREAU OF SHIPS — WASHINGTON, D. C.

Bureau of Ships. Calculations of "circular frame strength for submarines" have been performed on the IBM Card 650 in the Bureau.

Applied Mathematics Laboratory, DTMB. Preparations are in progress for the installation of an IBM 704 at the Applied Mathematics Laboratory, David Taylor Model Basin, Carderock, Maryland with turn-over to the Laboratory about August 1. This computer will replace one of the two UNIVAC I's presently installed at the Laboratory. The 704, with 32,000 words of core storage, will be used to further the laboratory's program of scientific computations and to permit greater use of the remaining UNIVAC I for business data processing applications. The 704 will be an interim installation, ultimately to be replaced by the Remington Rand LARC.

AEC COMPUTING AND APPLIED MATHEMATICS CENTER — NEW YORK UNIVERSITY — NEW YORK, NEW YORK

The day shift use of the IBM 704 system at the AEC Computing and Applied Mathematics Center at New York University has rapidly grown in recent months and reached 100% utilization of available time in April. This time is primarily reserved for research problems and is divided between the Center and outside users.

In addition, a second (night) and part or all of a third shift (week-end) is currently being used for production running by contractors of the Naval Reactor Branch of the AEC.

In April, the magnetic core storage capacity of the 704 was increased to 16,384 words. Three additional tape units were installed to bring the total to 12 with 10 units on-line. The new equipment was installed primarily to meet the needs of NRB users, however, by arrangement, it can be used by other groups with access to the machine.

COMPUTERS, OVERSEAS

DATA PROCESSING SYSTEM — THE AUSTRALIAN WEAPONS RESEARCH ESTABLISHMENT — SALISBURY, S. AUSTRALIA

In 1953, the Weapons Research Establishment (WRE) in Australia found it necessary to consider improved methods of data processing to handle the increasing missile trials load and the more stringent demands of the missile contractors.

On analysis it was found that some 70% of the effort in the manual processing of trials information was used in converting the data on various film records into numerical form while the remainder was spent in actual calculation and display of results. It was also noted that data processing could be separated into the distinct phases of data recording, data conversion into digital form, calculation, display, and information assessment.

From these and other similar considerations it has been possible to introduce an automatic digital system at WRE in which all phases of processing have been coordinated and designed to operate at the required speed and precision. Thus some 90% of the data gathered during a trial is now recorded on magnetic tape together with a constant reference frequency on another track. Since most of this data is in the form of frequency, by accumulating the (suitably multiplied) reference frequency for a given number of data cycles one obtains a count proportional to the data frequency. Clearly this count is independent of the original recording or replay speeds so that this form of data recording is suitable for direct automatic digital conversion. The remaining 10% remains on film but is converted semi-automatically into digital form. All digital data is read into an automatic computer which undertakes most of the monitoring, checking, sorting and calculation, thereby reducing processing effort, increasing speed of processing, and transferring most of the standard analysis and assessment from scientific staff.

Generally, one can say that all information from range instrumentation, with the exception of that from theodolites, airborne and high-speed behaviour cameras, is recorded on magnetic tape in such a way that the recording equipment at the range is a minimum and can be operated by remote control. These magnetic tape primary records, if necessary, are changed to digital secondary magnetic tape records by appropriate automatic digitizing converters at WRE. The 3 or 4 types of instruments still providing film primary records are converted by semi-automatic film readers of the BOSCAR and Telereader type into secondary digital records on punched paper tape. These secondary digital records are read by the computer which performs all the necessary checks and calculations and finally displays the results on an output magnetic tape, punched paper tape, or printer, as required. The output magnetic tape is then supplied to a high-speed display unit which gives the necessary graphs and/or tabulations. All the processing equipment such as film readers, automatic converters, etc., have been made as flexible as possible to cope with the records from new or "ad hoc" instruments which may be used in some trials. Similarly, data from other sources may be fed into the computing system at any processing stage, or data may be displayed for supervision without passing through the computer.

It should be noted that the system has been designed to handle the average missile firing rate in one shift operation - peak loads are handled by working extra shifts and weekends. This will be clear from the details of the system described below.

Data Recording

The methods of recording data from theodolites and other telescopic instruments on film are well-known and need not be discussed here.

For the frequency-modulated and time-multiplexed 24-channel telemetry, multi-track magnetic tape is used as the recording medium at a speed of 75 in./sec. On one track of this tape a 100 kc. reference signal is written during the trial, the zero time (or Z.T.P.) being denoted by a 100 microsecond burst of another standard frequency instead of the reference signal. The frequency band of the demodulated signal from each telemetry receiver is recorded on other tracks after the band has been translated to a nominal 30 to 90 kc. The reference signal serves two purposes on playback: after multiplication, it is used for all digitizing and counting so that wow and flutter effects are insignificant; after dividing down, it provides the elapsed time of observation of the 24 telemetry channels. As part of the normal range facilities this tape can be played back to give a compressed "quick-look" film record or a high-speed frequency-time histogram on 35 mm. film of the 24 channels against time.

For doppler instrumentation, multi-track magnetic tape is used in a similar fashion to that for telemetry. In this case the tape speed is 7.5 in./sec., and the frequency band is either d.c. to 300 cps. or 50 cps. to 3000 cps. The lower frequency band is utilized when the signal is modulated on to a carrier before recording on a track and the higher band is utilized when recording directly. In either case the reference frequency is 10 kc.

The most important factors resulting from the use of magnetic tape have been that any "quick-look" records can be generated after the trial thus reducing the complexity of the receivers particularly in down-range sites, and that the reference frequency recorded in parallel with the range data has made automatic conversion into digital form a relatively simple process.

Data Conversion

Semi-Automatic Film Reading Equipment. The equipment for reading film primary records consists of three BOSCAR's, two Telereader-Telecordex's, and one OSCAR modified to supply 5-hole punched paper tape output in a form directly suitable for input to the digital computer system. All are standard commercial equipment.

Telemetry Converter. This converter was designed and manufactured by WRE to give a digital representation proportional to any frequency lying in the band 30 to 90 kc. by sampling at rates of up to 3 kc. The sampling may be either contiguous or of varying mark-space ratio.

For converting telemetry, the primary record is played back at 7.5 in./sec., or one-tenth recording speed, and the equipment supplies groups of 24 eleven bit numbers to the secondary tape in a format suitable for direct input to the computer system using a tape speed of 100 in./sec., and a packing density of 100 bits/in.

The telemetry conversion relies on the provision of the special synchronizing frequency in the first of the 24 channels. Successive sync frequencies (which may occur at 40 to 140/sec.) are used to provide 24 gating strobes which may be manually set in relation to each other. These strobes gate the data frequency into a counter which is preset to the number of data cycles over which the average frequency is to be determined. While these data cycles are being counted, the multiplied reference frequency (now effectively 3.2 mc.) is accumulated in the reference counter and eventually producing a count inversely proportional to the data frequency. This count is then recorded on the secondary magnetic tape as an 11 bit number, the most significant bit of which is zero while the next ten give the count for frequency. Since the synchronizing frequency is of no further use after separation of the switch cycles, the elapsed time of this channel is accumulated in another and is recorded on the secondary tape in the channel 1 position as an 11 bit number, the most significant bit of which is always unity while the next ten give the time to 600 microseconds. The display on the secondary tape therefore consists of repeated groups of 24 eleven bit numbers, 23 having zero in the most significant position and the elapsed time code having unity in this position. This coding permits the computer to perform the required sorting and monitoring processes on the data. Facilities also exist on the converter for digitizing only portions of the primary record by comparing with preset switches the total elapsed time accumulated from the reference frequency.

The accuracy of conversion varies with the number of data cycles counted, the frequency being digitized, and the noise distribution and level in the data frequency, but is never worse than 1% full-scale and, for normal records, is less than 0.5%. The conversion is usually repeatable to within 0.3%.

Doppler Converter. This equipment was designed and constructed at WRE and uses a conversion process similar to that adopted for the telemetry converter. In this case a preset number of doppler cycles is set up and the time for each group of cycles is provided by counting the multiplied 10 kc. reference signal. This count is recorded as a 13 bit number on magnetic tape as before, and provides both a measure of the frequency, and, by accumulation in the computer, the elapsed time. Suitable switching arrangements are made between a pair of counters to ensure that the elapsed time is never lost and that overcarries are noted by a special code bit as in the telemetry converter (i.e., 12 bits of elapsed time and 1 code bit).

To ensure that adequate signals are received for counting, a tracking filter with a range of 50 to 3000 cps. is used on the input. In the case of a d.c. to 300 cps. signal, the primary tape is played back at 75 in./sec., or 10 times recording speed, and the carrier frequency removed prior to passing the signal through the tracking filter which then covers the effective range. For a 50 to 3000 cps. input signal, the primary tape is supplied to the converter at 7.5 in./sec. In both cases the output is at 10 kc. on a secondary tape moving at 100 in./sec. A graph of frequency variation with time is also provided independently from the filter for supervisory monitoring.

The accuracy of the converter is such as to ensure that, after inverse interpolation in the computer to provide the number of cycles for equal increments of time, a maximum error of 0.1 cycle is achieved.

Computer

The WREDAC (WRE Digital Automatic Computer) is the computer used in the system and was originally constructed to a WRE specification by Elliott Bros., London, in 1955 as the 403 computer. The present basic features are:

Digit Frequency and Type	333 kc., Single Address, Serial.
Word Length	34 bits or 102 microseconds.
Order Length	17 bits or 2 orders per word.
High-Speed Store	512 words consisting of 127 four word and 4 one word nickel delay lines. The latter are B-lines which are also part of the store.
Backing Store	16,384 words on a magnetic disc rotating at 2,300 rpm. There are 64 tracks of 256 words and each track is accessible for the reading or writing of 64-word blocks.
Auxiliary Store	Three 1/4" magnetic tape units operating at 100 in./sec. with a stop-start time of 10 milliseconds, and a packing density of 100 bits/in. 2,400 foot spools are normally used.
Input	1. Punched 5 hole teletape via 2 high-speed readers at 200 characters/sec. 2. Magnetic tape via the auxiliary store.
Output	1. Punched 5 hole teletape via 2 perforators at 25 characters/sec. (To be replaced by 200 character/sec. punches.) 2. Magnetic tape via the auxiliary store.
Radix Representation	Binary, operating in range -2 to +2.
Instructions	32 arithmetic and logical, 32 transfer (i.e., inter-store and input/output).
Operation Times	Addition, Logical, etc. 102 to 408 microseconds. Multiplication, 1,738 microseconds. Division, 3,468 microseconds. Square Root (Programmed), 7 to 15 milliseconds. Circular Functions (Programmed) 14 to 16 milliseconds.

The machine is now autonomous in that the transfer from, or to, any physically distinct stores or input/output units can occur simultaneously without affecting calculation. Further, the whole high-speed store can be used as a buffer store for 64-word transfers. For the disc store only 64-word transfers can occur. For the magnetic store either single words, 64 whole words, or 129 half words can be transferred to any block of the high-speed store. A word for magnetic tape transfer is greater than 17 bits, a half word is less than 18 bits. Thus the words from the automatic data conversion equipment are always treated as half words in tape transfers.

Three extensions are at present being applied to the WREDAC by means of special orders. These are:

1. "Use B-lines." For the original computer it was thought that 4 B-lines would be sufficient for normal purposes. However, it became obvious that these facilities must be increased so that programming conventions need not be restricted. It is proposed, therefore, to introduce the "Use B-line" order which will allow for further groups of 4 B-lines. Four of the groups will allow each B-line to modify the others in sequence before obeying the order, while the other four will be independent as at present.

2. "Use Logic." The procedure proposed is that, on receipt of the order "Use Logic n," $O<n<16$, the succeeding orders will be obeyed using the machine as if it were a computer operating in the mode of the prescribed logic until the next "Use Logic" order is received. The first two logics will be floating binary arithmetic and character operation with built-in checking. Both of these permit the present store and most of the arithmetic unit to be used. Generally all the extra hardware associated with the logic will be supplied in external cabinets which can be manually switched into or out of the normal computer system.

3. "Use Units." By a similar process to that described in 2 above it is proposed to introduce a transfer order which causes unit n, $O<n<16$, to be used as input/output unit type m, $O<m<8$. This permits groups of two magnetic tape units, teletape readers, or punches to be used simultaneously and does not introduce extensive modifications to the transfer order code. Similarly, facilities will exist for attaching new input/output systems as they are developed.

Output

Low Speed. The input medium used for this type of output is 5-hole teletape. Tabular format obtained by standard teleprinters at 7 characters/second. Graphical display is obtained by means of the low-speed plotting unit. This consists of a 14 row/sec. Lorenz reader, Librascope plotter and relay storage. Up to 8 numbers can be read at a time, any two of which can then be selected as the X and Y coordinates for the plotter. The plotting speed is about 12 points per minute.

High Speed. This unit supplies graphic and/or tabular outputs from the digital magnetic tapes generated within the processing system and consists of a 100 in./sec. magnetic tape unit, line printer, 4 digital plotters, and the electronics and storage necessary to link this equipment. Usually the magnetic tape records consist of repeated blocks of up to 34-bit words in binary form with a space of at least 1 inch between blocks and .08 inches between words. The action of the display unit is as follows:

> The number of words, 1 to 24, to be treated at each stage of output is preset by a switch on the control panel. The types of output, i.e. graphical or tabular, or both, and the number and distribution of words to be supplied to each output unit are also set up independently by selection plugboards on the control panels. When started, the converter reads the required number of words from magnetic tape, transforms them into binary-coded decimal form for printing, and then stores these words in serial registers using a selection plugboard. The selected numbers are then supplied to the output display units, and, when the display is completed, a new block of data is read. The whole process repeats twice a second.

The output equipment consists of a line printer and 4 graphing units. The line printer is manufactured by Bull, Paris, and is used at 2 lines/sec., 92 characters/line. Each of the 92 wheels in the line is set up for printing by the printer selection plugboard from the possible

8 x 24 = 216 tetrads stored during the binary-decimal conversion. The symbols " . ", " * ", " , ", and " % " can be supplied on demand from special pulse emitter sources in the plugboard.

The graphing units consist of 4 modified Mufax 11" facsimile recorders. For plotting purposes the receivers have the following features:

1. The full scale deflection of 11", or 1 helix revolution, is represented by 1,024 counts.

2. Plotting densities of 40 or 20 points/in. are available.

3. A graticule is generated and displayed automatically during operation and is fainter in intensity than the plotted points.

4. Marker points are displayed at the beginning and end of each helix revolution.

5. Either 4 x 2.75 in. graphs or 1 x 11 in. graphs can be plotted on any unit.

6. Numbers to each unit, or to any of the 4 channels of each unit, can be multiplied by 1, 2 or 4.

7. Numbers for plotting must be in the range -1 to +1 or 0 to 1 prior to scaling.

Two points on each of up to 16 graphs can be plotted twice a second and this may be with, or independently of, the printer.

Facilities exist on the control panel for reading every second, third, or fourth block of words from the tape. Using this feature it is possible to decrease the plotting density on the graphing units to 5 points/in. and, since the vertical graticule is generated every 10 points, this means that its dimension can vary from 0.3 x .25 to 0.3 x 2.0 in.

For rapid reproduction of results an Ozalid or Dyline process is used for both graphs and tabulated results.

Operating Statistics, 1956—1958

Parenthetically it is worth noting that all the equipment for the system was delivered and installed by the middle of 1955 but that about 18 months and 30 man-years of effort were required before the automatic system completely replaced the corresponding manual processes. The total elapsed time between a trial and the presentation of final results has been reduced to one-tenth of that required by the manual system, the cost of processing trials information has been reduced by a factor of at least 20. The peak load capacity of the automatic system is about 50 times that of the manual system, and the complete cost of the automatic system has been recovered in the first two years of operation.

Data Recording. No data is available on reliability of the film recording processes, but in the magnetic tape recording procedures however there have been only two failures in obtaining tape records in the past 18 months, and these were due to faulty setting of the reference signals in the first two months of operation. In general it has been found that tape recording is more reliable and can be more precisely processed than the equivalent film records.

Film Reading Equipment. These units have been operating on a single shift of 7 hours per day for the last 18 months and have been effective for 85% of the total time switched on. At least three-quarters of the remaining 15% down-time has been ascribed to electro-mechanical output troubles, particularly in punching of teletape.

Automatic Converters. For single-shift operation of 7 hours per day over the last 18 months these units have been 95% effective. In no case has processing been delayed by any more than 5 hours because of converter malfunction. Most of the 5% down time can be ascribed to malfunction of 12AT7 and 12AU7 valves in binary counting stages.

Digital Computer WREDAC. From July 1956 to March 1957 the computer was switched on for a 5-day 40-hour week. From March 1957 to December 1957 the period was a 5-day 57-hour week, while from December 1957 to March 1958 a 5-day 70-hour week has been used on the average. For these periods the statistics are:

Period	July 1956-Mar. 1957	Mar. 1957-Dec. 1957	Dec. 1957-Mar. 1958
Average Total Time Available/Week	40 hrs.	57 hrs.	70 hrs.
Average Scheduled Maintenance/Week	10 "	10 "	10 "
Average Unscheduled Maintenance/Week	8 "	6 "	8 "
Average Effective Time/Week	20 "	40 "	50 "
Average Standby/Week	2 "	1 "	2 "
Efficiency Factor $= \frac{\text{Effective Time}}{\text{Total Time}}$	50%	70%	72%

Display Units. In the past 12 months these units have been switched on for the same periods as the WREDAC. During this time they have been about 90% effective and in no case has display been delayed for any more than 4 hours. The main cause of down-time has been printer and plotter breakdown.

FINAC-FERRANTI MARK I COMPUTER — ISTITUTO NAZIONALE PER LE APPLICAZIONI DEL CALCOLO — ROME, ITALY

Computer Maintenance. During the second year of operation (June 1956 — June 1957) the total useful time was 2,089 hours and the average weekly efficiency of the computer was 91.2%. Corresponding values for the first year: 912 hours and 89.1 (see Digital Computer Newsletter, January 1957).

The rates of valve replacement and fault time causes are given below in approximate figures and show the corresponding values for each year. One magnetic drum has been replaced after one and a half years of operation.

Type of Valve	Replaced % 1st yr.	2nd yr.
6AL5	5	12
EF55	15	12
EF50	45	40
12AT7	35	40
EF91	35	35
C.R.T.	70	25

Type of Fault	Fault Time % 1st yr.	2nd yr.
Power Supplies	23	1
Valves	17	18
Other Components	3	9
Construct. Failures	3	1
Basic Waveforms	3	12
C.R.T. Store	19	21
Drum	4	18
Input-Output	12	9
Other Causes	5	2
Unidentified	11	3
Parallel Printer	-	6

During the first three quarters of the third year (June 1957 — March 1958) the useful computing time was 1,096 hours and the average efficiency 90.4%.

Scheduled engineering time has been 657 hours, since large modifications have been carried out.

New equipment installed and new order codes. On September 13, 1957 a new Creed Model 25 Perforator was installed. The acceptance test of the perforator consisted in punching about 108,000 characters, which it did with no errors. The average punching speed is about 26.5 characters per sec., with activated check contacts. 7 months experience has shown that the punch is very reliable when properly set. Only occasional adjustments have been necessary.

Before the end of the summer a second Model 25 Perforator and 2 Ferranti 35 mm. Magnetic Tape Units will be installed.

In connection with the installation of the magnetic tape units, new circuits have been added to be used for double precision arithmetic. These two new features are expected to be particularly useful for the solution of large systems of linear equations, especially in cases of ill conditioning.

For double precision operation two orders are used to set or reset a flip-flop. When the flip-flop is in the reset state the computer works as usual, that is, the instructions regarding accumulator and multiplier refer to 40 bits. When the flip-flop is in the set state the same instructions refer to 80 bits.

A "jump if overflow occurred" instruction controls both simple and double precision arithmetic. This allows fixed point operation also in case of ill conditioned systems of linear equations, speeding up computing time.

For the new circuits 106 valves have been installed and 37 removed.

MUSASINO-1 — NIPPON TELEPHONE AND TELEGRAPH PUBLIC CORP. — TOKYO, JAPAN

The first large-scale digital computer with the Japanese invention, "the Parametron," made its debut at the Electrical Communication Laboratory of the Nippon Telephone and Telegraph Public Corporation (the Japanese equivalent of the American Telephone and Telegraph Company) in March 1958. The computer, to be used mainly for scientific purposes, has been designed and constructed by Saburo Muroga with S. Yamada, K. Takashima, and others since 1955.

Operation	Parallel, fixed point, binary 40 bits, single address.
Instructions	Approximately 130.
Speed	Repetition frequency 10 kc, 2.5 milliseconds average for an addition order and 10 milliseconds average for a multiplication order.
Arithmetic Features	Carry detection circuitry and high speed multiplication.
Components	5,356 Parametrons for logical operation and memory selection. 519 vacuum tubes for high frequency source and neon indicators.
Memory	256 words. Ferrite cores with non-rectangular hysteresis. Information is written into and read from cores upon an alternating current principle.
Power	Stabilized dc output of about 5 kw.
Input-Output	6 hole paper tape with odd parity check. Photoelectric reader and teletype equipments.

The Parametrons are driven by a 2.4 mc. high frequency current, modulated by a three-phase low frequency. The repetition frequency of the latter will be modified upward soon to increase the computer's operation speed. Also magnetic drum, magnetic tapes and CRT display will be installed soon.

The computer has many unique features. Because of the expected long life of the Parametrons, there should be little need for component replacement. Therefore the maintenance and operating expenses should be about one third that of a comparable vacuum tube computer with almost no maintenance personnel. After a 10 minute warm up, the computer is always available for computation.

The initial cost of the computer is very low since the Parametron consists simply of a pair of ferrite cores, a capacitor, a resistor, and a coupling core. The computer has worked very successfully without faults since its completion, because of the high stabilities of the Parametrons and the magnetic memory of cores with non-rectangular hysteresis.

The only difficulties have been bad soldering. After eliminating this problem, there has been no component trouble during the recent few months, and it is expected to be a trouble free computer before long.

G 1, G 1a, G 2, AND G 3 — MAX-PLANCK-INSTITUT FÜR PHYSIK — GÖTTINGEN, GERMANY

All four types of computers have been or are being developed by the Arbeitsgruppe Numerische Rechenmaschinen at Göttingen which forms part of the Max-Planck-Institut für Physik (director Prof. W. Heisenberg), astrophysics division, and are installed at the institute itself. There has been a previous report on the G 1 and the G 2 in the Digital Computer Newsletter July 1955.

The punched tape controlled computer G 1 has operated 33,000 hours to date of which 27,000 have been productive. Because programming of this computer is very simple and easy to learn, G 1 has proved—in spite of its low speed (3 operations/sec.)—to be especially valuable for the younger members of the institute.

G 1a. During this year the G 1 will be replaced by the G 1a, the development of which has just been completed. The trial runs have been successful. G 1a is much faster, larger, and more convenient than the G 1, and is one of the modern paper tape controlled computers. It's specifications are:

Input. Control and input from one of ten photoelectric tape readers, which operate with a maximum speed of 200 characters/sec. and can be stopped at the next character.

Order representation. An order consists normally of 4 characters: one for 24 different operations, two for sector selections on the drum and one for track selector input (see below).

Internal number system. Serial binary, floating point, mantissa 43 bits plus sign, exponent 7 bits plus sign, 1 bit to mark a number.

Storage. Magnetic drum, max. access time 20 milliseconds, capacity 1800 words (30 tracks times 60 sectors) with 3 characters selectable, 40 words with 2 characters selectable, 44 words dead storage for conversion between binary and decimal system at the input and output.

Output. Electric typewriter (10 to 17 characters/sec.), tape punch (50 characters/sec.) with output buffer.

Speed. Average 20 operations/sec. with floating point arithmetic.

Special features of the order code. Arithmetic operations addition, subtraction, multiplication, division, and square root by preorders adjustable to computation with simple or double word length both floating or fixed point. At double word length computation the average speed is reduced only slightly (to 16 operations/sec.).

Transfer orders. Transfer to another tape; transfer to the tape operating before the one carrying the transfer order; conditional skip orders depending on sign mantissa, sign exponent, marked number, and 2 manual switches on the control panel.

Address modifications. In a tape controlled machine they are not impossible, but time consuming. To overcome this difficulty there are two extra features:

1. Cyclical shift shifts the contents of a selectable part of a track on the drum (the part begins with the first sector of the track) one word to the lower address cyclically, e.g. contents of cell numbers 1, 2 ... 23 is restored in cell numbers 23, 1 ... 22.

2. The fourth character of an order (0 to 9) can call up any of the 30 tracks on the drum determined by the settings of the track selector, with 10 independent inputs and 30 outputs controlled by a preorder.

Address modifications are possible by substitution of marked characters from the order tape by figures from the accumulator via the output binary-decimal conversion.

G 1a contains 524 tubes and about 3000 germanium diodes. 3 copies of the machine are almost completed.

G 2. The drum controlled computer G 2 has been in service since 1955. Since the fall of 1956 it has been in operation almost 24 hours per day (including weekends). 3 hours of the day are reserved for maintenance and further improvements of the machine. The total of the productive machine time of the G 2 has been 14,500 hours up to the present. During 1957 G 2 has been in operation 7,900 hours. 95% of the scheduled time (6,800 hours) have been productive. Because the mechanical paper tape reader of the input unit is too slow, it is being replaced by a photoelectric reader of the type used with the G 1a.

G 1 and G 2 applications. The machines G 1 and G 2 are being used exclusively for pure research by members of the scientific staff of the MPI für Physik, of the MPI für Strömungsforschung, and other scientific institutes. The problems dealt with belong to a large number of fields of research, e.g., astronomy and astrophysics (esp. theoretical), cosmic radiation, plasma physics, fluid dynamics and magneto-fluid dynamics, quantum mechanics and field theory and nuclear physics.

G 3. The high speed parallel computer G 3 is still in the state of development. The core memory for 4096 words and the arithmetic unit are completed. This machine will be reported upon in a later issue.

It has been announced that the institute will be transferred to Munich in September 1958.

PROVISIONAL INTERNATIONAL COMPUTATION CENTRE — ROME, ITALY

The Provisional International Computation Centre was established by a bi-lateral agreement concluded in September 1957 between Unesco and the Italian Institute of Higher Mathematics (Instituto Nazionale di Alta Matematica), pending the establishment of an International Computation Centre on a permanent basis. The Provisional Centre has been created for a period of two years but will automatically cease to exist when the intergovernmental Convention establishing an International Computation Centre comes into force.

The Provisional Centre commenced its activities in January 1958. It is located in a modern building on the outskirts of Rome, in the so-called Zona dell'Esposizione Universale a Roma.

The premises available will permit the installation of several machines and will provide adequate staffing facilities when the Centre is fully developed.

The main function of the Centre will be to ensure mutual assistance and international collaboration between existing bodies dealing with computation and information processing, in particular as regards scientific and technological studies. The Centre will promote the exchange of information both on scientific matters and on the facilities existing in various countries. The Centre will also help, on request, the countries which do not possess their own computation equipment. This assistance may consist either in undertaking certain computation tasks with the help of existing services or in giving advice for the creation of national centres. The Centre will also help international organizations which require its assistance. The Centre will promote the training of specialized staff. It will also endeavour to be a link between the users and the designers of computation equipment.

COMPONENTS

ELECTROGRAPHIC RECORDING — BURROUGHS CORP. — DETROIT, MICHIGAN

Burroughs Corporation, Detroit, has announced a production prototype model of a high-speed data recorder that can translate electronic impulses into an immediate plain-language, hard, dry copy. The device can receive messages automatically and assemble into printed characters and words at a speed of 30,000 matrix characters per second. Their technique, labeled "Electrographic Recording," lends itself to producing either matrix or preformed characters. The printing process utilizes a controlled source of electricity to form small charged areas on a high-resistivity surface such as a coated paper. The electrostatic latent image formed by the charged areas is made visible by application of powdered ink, permanently fixed by the application of heat. The recording head comprises 35 tiny wires leading into and through an odd, triangular-shaped piece of plastic. The wires are polished flush with one corner of the "triangle" or printing head, to form a rectangle seven wires high by five wires wide.

72 of these heads in a row form a matrix printing lines. They do not touch the paper but are maintained at a fixed distance from the paper surface. Electric pulses selectively charge all 35 wires or any combination of these in each head.

A normal line of type is made possible by setting up the first character in the line across all 72 heads. The only head that prints is the one selected by a coincident pulse to the back plate, or "anvil." The electrostatic charge can be deposited in one microsecond.

The second character in the word would be set up across the line and printed serially in a similar manner.

The size of the image depends mainly upon the polarity, the electric field strength and the surface coating used on the paper. A relatively low negative voltage applied to the point electrode gives small, round dots.

Features of the technique are:

1. High Speed. A mark can be put on paper in a duration as small as one microsecond and printed characters formed by a five-by-seven dot matrix have been recorded at rates of 1,050,000 dots per second. Plain language messages can be produced at speeds of 300,000 words per minute and more. The only limitation is the speed at which paper can be handled.

2. Highly reliable. By going directly from electronic impulses to static charges on the final usable copy, many intermediate steps are eliminated. This results in a high order of reliability, absence of errors and low maintenance cost.

3. Limited motion. The only mechanical motion involved in the technique is the handling of the continuously moving paper under the printing head. Little wear of the pin electrodes or the like is involved, since they never touch the paper itself but merely send a charge through the paper from the pin to the grounded metal plate (anvil).

4. Inexpensive. The system is basically low in cost and consumes very little power. The power required to print 5,000 characters per second, serially, is about 5 watts in addition to that necessary to move the paper and fix the recorded images. The paper is a little more expensive than ordinary writing paper.

5. Practically noiseless. It is relatively quiet; the only noise is due to the moving paper. No mechanical hammer action is involved.

6. Clean. The printing does not involve any messy, wet or damp processes. An immediate hard, dry, readable copy is obtained on odorless, non-toxic paper.

7. Permanent. Permanent recording with no fading is achieved. By eliminating the inking and fixing steps, the paper can be erased and used over again or can be "read" electronically by picking up the electrostatic charge.

The electrographic ink consists of a single powder without electric charge. To ink the latent image on the paper's surface, the paper is passed through an inker containing the dry powder to give a visible image with virtually no background discoloration. The image is made permanently visible by passing the inked paper over a temperature-controlled hot plate. The three steps in the process are consecutive and are performed as the paper moves at the appropriate speed for the particular recording application.

The high pulsing rates made possible by this printing technique allow reasonably high recording speeds to be obtained in a small-sized, low powered, low-cost recording device. If straight parallel printing is used (line-at-a-time page printer) then phenomenally high speeds are made possible.

Applications for the electrographic recording device can be readily visualized for labeling or strip-printing, digital computer output systems, page-printers and plotters, teletypewriting and telemetering, high-speed strip charting and facsimile. The technique applied to the New York Stock Exchange, for instance, would completely eliminate the "ticker-lag" behind sales on a busy day.

RASTAD — LABORATORY FOR ELECTRONICS, INC. — BOSTON, MASS.

The Computer Products Division of the Laboratory for Electronics, Inc. has been awarded a contract by the U. S. Army Corps of Engineers for a Random Access Storage and Display System, called RASTAD. This RASTAD consists of 3 high density file drums (Model HD-4), nine viewers with 21-inch storage tubes and one symbol generator (viewers and generator Model SM-2), multiplexing equipment, interrogation keyboards for each viewer, and central electronic equipment for tieing RASTAD to an Univac Scientific 1103A Computer.

In this installation, the viewers will display alphanumeric characters and/or map symbols. Each viewer is capable of displaying 12,800 alphanumeric characters or 25,600 map symbols. The file drums will each store 1,600,000 characters. Also, this system may be expanded from the original three to thirty-three drums.

For the first time it will be possible in a large computer system, using random access storage, to query the files without interruption of computer operation.

The LFE HD-File Drums and SM-Generator and Viewers are designed for operation with computers made by other manufacturers where rapid random access to bulk storage, or a rapid readout facility/or both are essential to the effective operation of the system.

SERIES 7000 DIGITAL DATA RECORDER — MINNEAPOLIS-HONEYWELL — BELTSVILLE, MARYLAND

The Davies Laboratories Division of the Minneapolis-Honeywell Regulator Company has in operation at the Beltsville facility a demonstration model of the Series 7000 Digital Data Recorder/Transcriber (DDRT). This system will multiplex all types of low-level transducers such as strain gages, thermocouples, potentiometers, at 10,000 points per second and higher, maintain overall system accuracy within 0.1 percent, staticize to a time resolution of 1/2 microsecond, perform analog-digital conversion to straight binary or BCD code, and arrange preselected information on magnetic tape in a format and record length suitable for computer input.

System reliability, speed, long term stability and accuracy have been proven in operation. Flexibility for modification, ease of maintenance and simplicity of operation are stressed in the system design. The DDRT is manufactured by Honeywell under agreement with North American Aviation, Inc.

HIGH SPEED ELECTRONIC PRINTER — STANFORD RESEARCH INSTITUTE — MENLO PARK, CALIFORNIA

A new system for high speed electronic printing has been developed at the Stanford Research Institute for the A. B. Dick Company, 5700 West Touhy Avenue, Chicago, Illinois. One embodiment of the system is a facsimile device which reproduces printed documents 8-1/2 x 11 inches at rates up to 3 per second. The documents are scanned in an electro-mechanical scanner and the resulting 4 megacycle video transmitted to a special cathode ray tube. The tube deposits a charge on the surface of ordinary paper by means of fine wires passing through the face plate. The charge pattern is "developed" with a powder and fixed to the paper. Extensive laboratory tests show that the resolution is adequate for the legible reproduction of type as small as that found in telephone directories. The A. B. Dick Company plans to have a prototype system in operation by the end of 1958.

Also under development is a low cost electronic decoder which accepts six parallel wire binary code at the rate of 10,000 characters per second and produces the appropriate video patterns of any of 64 characters and symbols for printout on the facsimile tube. Laboratory equipment for such printout is nearing completion.

The A. B. Dick Company invites inquiries from interested organizations as to the application of these techniques to such problems as high speed computer readout and large scale displays of radar and character information.

MISCELLANEOUS

CONTRIBUTIONS FOR DIGITAL COMPUTER NEWSLETTER

The Office of Naval Research welcomes contributions to the NEWSLETTER. Your contributions will assist in improving the contents of this newsletter, and in making it an even better medium of exchange of information, between government laboratories, academic institutions, and industry. It is hoped that the readers will participate to an even greater extent than in the past in transmitting technical material and suggestions to this Office for future issues. Because of limited time and personnel, it is often impossible for the editor to acknowledge individually all material which has been sent to this Office for publication.

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