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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

OFFICE OF NAVAL RESEARCH • MATHEMATICAL SCIENCES DIVISION

Vol. 4, No. 3 July 1952

TABLE OF CONTENTS

DIGITAL COMPUTERS

OCT 16 1969

LIST OF COMPUTING SERVICES

A future issue of the Newsletter will contain a list of organizations able to furnish computing facilities and services. It is requested that directors of computing centers supply the Newsletter editor with the following information: name and address of organization, available computing facilities, mathematical and coding services, and whether available generally or only to government agencies and contractors.

WHIRLWIND I

Scheduled application time on the Whirlwind computer has more than doubled since last reported in the Newsletter. During the week of March 31, 1952, the number of hours was increased from 30 to 50; during the past month the weekly average has been approximately 70 hours. An additional 70 hours per week are spent in installation, maintenance, computer improvement, and training.

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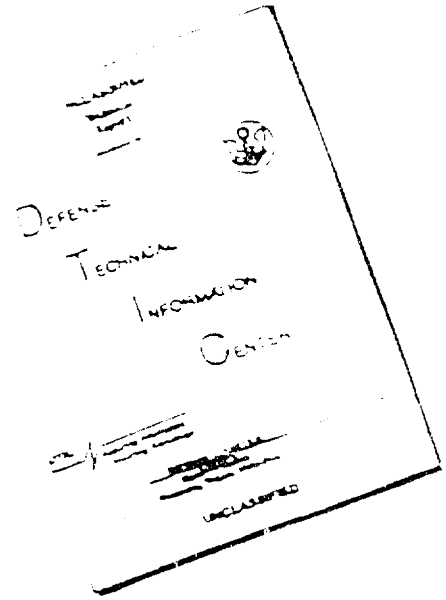

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The developmental model of the equipment required for printing information from magnetic tape has been constructed and is now undergoing tests. This output equipment operates from recordings made by the computer in 6-digit printer code. Sixty thousand typewriter characters (decimal digits, symbols, etc.) can be recorded by the computer on a 1000-foot reel of magnetic tape in less than 7 minutes; 2 hours are required for the printing-out equipment to transcribe this quantity of information at ten characters per second.

The magnetic-tape unit has been an effective external memory despite the fact that it is purely temporary and lacks the automatic-control features which are to be incorporated in the final system. However, by means of subroutine procedures, the applications group has been able to include some automatic control. It is thus not necessary for each programmer to know the details of magnetic-tape utilization. The subroutines were initially developed as test programs for the unit and therefore include certain check points which indicate to the programmer whether or not information is being correctly stored on the tape.

Magnetic tape has been used as external memory in solving equations for such problems as gust loads on rigid airplanes in two degrees of freedom and optimizing the use of water storage in a combined hydrothermal electric system. Magnetic tape has also been extremely useful for retaining information which has been read into the computer. For example, it is possible to diagnose errors automatically by having the computer compare the initial information on tape with the contents of electrostatic storage and print only those registers which have changed.

General problems which have been given to Whirlwind I for solution since April, 1952, together with the department or agency that initiated them, are:

Problem	Originator
Correlation of Solvolysis Rates	(Chem. Dept., M.I.T.)
Calculation of Beta-Ray Spectrometer	(Oak Ridge Nat'l Lab.)
Acoustical Scattering from Cylinder	(Phys. Dept., M.I.T.)
Calculation of Deuteron Energy Levels	(Phys. Dept., M.I.T.)
Optical Lens Systems	(O.N.R. Project)
Energy Levels of Oxygen Molecule	(Phys. Dept., M.I.T.)
Autocorrelation of Sunspot Data	(Phys. Dept., M.I.T.)
Turbine Design Tables	(Industrial)

THE SEAC

A compression feature that permits greater utilization of magnetic wire and tape has been successfully installed in the SEAC. It allows the coder the choice of having large or small gaps between groups of information. A fourth reel-less tape-handling unit has been made an integral part of the machine. Its unique feature is that the tape falls free into a tank instead of being wound on a reel.

The circuitry for the special three-address mode of operation has also been completely installed and checked out. However, it has not yet been used in actual problem solution, but a check routine which checks all operations was coded and run. The prime number routine was also programmed in for the three-address code and run on the computer.

The recent operating record of the system has been adversely affected by a change in power lines supplying the building in which the SEAC is located. Variations in line voltage have been as great as 10% during a 24-hour period. It is anticipated that this situation will be alleviated on the receipt and installation of voltage regulators on the lines to the machine.

Average "good" operating time for the first quarter of 1952 was 76 percent for a 168-hour week with 8 hours scheduled for preventive maintenance. This was about the same as the previous yearly average of 77 percent. ("Good" time is defined as that time during which problem solutions, coding checks or productive engineering were turned out correctly or the machine was in good operation condition but idle.) The following table indicates the utilization of time in hours on SEAC for the three-months period from January to March.

	Good	Down	Idle	Total
Problem Solution	1305	370	14	1689
Engineering	336	40	0	376
Scheduled Maintenance	118	0	0	118
Unassigned	0	0	1	1
	1759	410	15	2184

NAVAL PROVING GROUND CALCULATORS

The Aiken Relay Calculator (Mark II) has been employed on various problems relating to ballistic research. Operating efficiency continues above 80%. Certain improvements in components are being investigated to increase its capacity, speed, and reliability. Design is now underway to provide IBM card input-output in addition to tape, so that Mark II will be more adaptable to ballistic work and to problems involving large amounts of data reduction. This addition will also improve the coordination of work between Mark II and the various IBM calculators.

The Mark III Electronic Calculator has produced a large amount of accurate output, although its operating efficiency is still below that of Mark II. Reliability of certain components of the machine is being improved, and emphasis is being placed on improving the reliability of input-output and intermediate magnetic storage. Certain refinements have recently been made in design which show promise of providing increased operating efficiency.

MOORE SCHOOL AUTOMATIC COMPUTER (MSAC)

The Dispatcher Memory Loop has been operating for over 250 hours. During this period, no errors or malfunctions have been observed. One of the two Algebraic Units of the MSAC is being constructed and tested. This unit will consist of approximately four racks of equipment. Two of the racks have been completed, and are ready for test.

Three single-word mercury acoustic delay line memories are needed in conjunction with the Algebraic Unit. Work has begun on the design and construction of prototypes of the memory amplifiers and gating circuits.

THE LOGISTICS COMPUTER

Engineering Research Associates, Inc., of St. Paul, Minnesota, have under construction a special-purpose electronic digital computer. The Logistics Computer is designed to be useful in mass data-handling and logistics problems. The main storage is a magnetic drum capable of storing approximately 180,000 excess-three binary coded decimal digits. Through the use of the non-return-to-zero recording technique, a packing density of 140 bits per inch is obtained. The drum will spin at approximately 3450 rpm. Another special feature of the drum storage is that number length is to be variable in the range of 4 to 12 decimal digits, inclusive, to suit the requirements of various problems. Five electronic shifting registers provide a total of 41 digits of rapid-access storage. In addition, 6 digits of constant storage and a 5-digit electronic counter will be provided. The computer is a serial machine operating at a basic decimal-digit repetition rate of 220 kc. Negative numbers are represented by the ones complement of each binary digit in the excess-three representation of the corresponding positive numbers. All numbers are considered integers within the computer with the digit in the most significant binary place representing the sign. Addition is performed serially on decimal digits; subtraction is accomplished by the addition of the complement of the subtrahend.

The input device will be a photoelectric tape reader capable of continuously reading information from 5 levels of punched paper tape at a rate of approximately 325 tape frames per second. The computer will be a fixed-sequence machine, repeatedly performing one of two sequences of operations on successive tape data entries, depending on tape codes which precede the data. The sequence of instructions is determined by the wiring of a removable control panel; no instructions are stored on the drum. Up to 40 program steps, divided in any way between the two sequences, may be wired on a single panel. Among the available instructions are: transfer, add, subtract, multiply, shift, advance the counter, conditional jump depending on the number in the counter, sign jump, unconditional jump, punch, and stop. Ease of coding and reliability have been emphasized in the design of the machine.

The computer is being constructed under contract with the Logistics Branch, Office of Naval Research. It will be used primarily as a research instrument by the Logistics Research Project at the George Washington University. Preliminary testing of the complete machine is scheduled for September 1952. Initially, the computer is designed to drive a standard tape punch at approximately 8 digits per second. Attention is being directed toward the use of magnetic recording media in high-speed input-output equipment and also high-speed printing to accelerate the data-processing system.

Aberdeen Proving Ground Computers

THE ENIAC

The access time of the four Eniac function tables (control panels) was reduced from 5 AT to 1 AT (1 AT is 1 addition time = 200 microseconds). This changes the rate of operation of the arithmetic instructions to the following: (1) addition, 1666 per sec.; (2) subtraction, 1000 per sec.; (3) multiplication, 294 per sec.; and (4) division and square rooting, about 40 per sec.

During the period 1 November 1951 to 31 May 1952, the Eniac completed computations for 37 different problems. Most of this work was connected with ballistic tables; however, one important program related to the design of planar flexible-throat wind-tunnel nozzels was completed. Machine production averages about 100 hours per week.

THE EDVAC

During the period 15 April to 31 May 1952, the Edvac was in use for 341 hours. Seventy hours were used by the Rand Corporation on the solution of a problem in neutron shielding. The remaining time was spent in checking various codes for subroutines as well as certain ballistic problems. Also the eigenvalues of a group of 36 matrices were obtained.

THE ORDVAC

The Ordvac was moved from the University of Illinois and installed at the Aberdeen Proving Ground during the middle of February. It passed its acceptance tests and was turned over to the Computing Laboratory on 9 March. During the period 9 March - 31 May it has been used for the solution of various military problems for 578 hours.

The Ordvac in a binary machine using a bank of 40 cathode-ray tubes operating very satisfactorily at a density of 32 x 32 spots (1024 words). Punched-paper teletype-tape input is used at present, with a high-speed reader, and teletype printed or tape output. The use of teletype tape has the advantage that input data can be transmitted by commercial or military teletype equipment. This method of sending problems to the Ballistic Research Laboratories is being used successfully by the University of Illinois.

Plans are being completed for two instruction periods for outside groups to learn coding procedures so that as much of the unused available time as possible can be utilized. Tentatively these periods of instruction are scheduled for 7 - 18 July and 18 - 29 August. Interested groups who have defense problems suitable for Ordvac solution should address inquiries to: Director, Ballistics Research Laboratories, Attn: Chief, Computing Laboratory, Aberdeen Proving Ground, Maryland, for further information.

THE CIRCLE COMPUTER

Machines currently in production at Hogan Laboratories (155 Perry Street, New York, New York) include a standard (1024-word memory) model for the Westinghouse Electric Company (Atomic Power Division), and a larger (4096-word memory) computer for Johns Hopkins University (Operations Research Office). A library of subroutines is in process of preparation for use with these machines.

ELECTRONIC COMPUTER CORPORATION (ELECOM-100)

On Saturday 7 June 1952 the Electronic Computer Corporation ran the first actual problem on the Elecom-100 computer, which is to be delivered to the Aberdeen Proving Ground. This small binary computer, now in the final stages of engineering test, has a magnetic-drum memory of 512 words capacity. This problem involved the computation of a table of octal-decimal conversion equivalents required in connection with work to be done for the purchaser. Several additional test problems have also been run.

THE CADAC (CRC 102)

The CADAC (CRC 102) general-purpose computer built by Computer Research Corporation, Hawthorne, California, for the Air Force Cambridge Research Center, Cambridge, Massachusetts, was recently moved from Cambridge to Lexington. It was put in operation after the move with eight man-hours of labor. This included the adjustment of reading and recording heads and the actual running of a test problem.

As of 15 May, the CADAC has been operated for approximately 170 hours with only three failures, all diagnosed and repaired by local personnel.

THE ACE PILOT MODEL, ENGLAND

A brief description of the ACE Pilot Model, designed and built at the National Physical Laboratory, Teddington, was given in Newsletter No. 4, Vol. 2, December 1950. Though it was intended only as a trial model for experiment in design, the Pilot Model has proved to be both fast and effective as a computer. It has been found possible to maintain it at a sufficiently high level of reliability to meet some of the existing pressing requirements for high-speed computation. Early this year, therefore, it was dismantled and transferred to the Mathematics Division of the Laboratory for regular service. Full operation was resumed within two weeks after the removal and has been continuous ever since, mainly on defense problems.

As it was not originally intended for service the machine has rather limited storage capacity—less than 9000 binary digits—but this is supplemented, when necessary, by using the Hollerith card input and output, as an intermediate store. The relatively high speed of input, 1200 binary digits per second, due to the effectively parallel nature of the process, makes it quite practicable and effective as an intermediate store, both for data and for subroutines. This is, however, only a temporary measure as it is intended to incorporate an auxiliary magnetic-drum store in the machine as soon as the development and construction of this has been completed.

An analysis of the first eight weeks of operation, involving 370 power-on hours, gives the following figures:

Routine testing and maintenance	92 hrs.	25%	
User training, program testing, etc.	175 hrs.	47%	75%
Paid-for work	103 hrs.	28%	

An engineered version of the Pilot Model is being built by the English Electric Company, Ltd. It is intended that it will include improved test and maintenance facilities and auxiliary magnetic storage.

THE FERRANTI COMPUTER AT MANCHESTER UNIVERSITY, ENGLAND*

In July of 1951 the Mathematical Laboratory of Manchester University, Manchester, England, took formal possession of the first high-speed automatic digital computer built by Ferranti, Ltd. After a few weeks transient period during which faulty tubes, maltreated by the initial testing, and probably all dry junctions were eliminated, the machine has now reached a steady state of performance which it has maintained for the past three months. During this time only one resistor had to be replaced, and tube failures occurred at an average rate of about three per week and then usually in panels which recently has had some work done on them.

During the work-week of 5 November the machine was in productive operation for a little over sixty hours, unscheduled down-time was four and a half hours, and close to fourteen hours were used for routine maintenance, demonstration, and taking photographs. The down-time was principally caused by four tube failures, each of which could have been remedied in a matter of minutes if, instead of spending time on locating specifically the burnt out tube, an entire block of about a dozen tubes, known to contain the faulty one, had been replaced. On the average the machine had been running for about 75 hours per week and has given satisfactory service during roughly 90 percent of this time. Tube failures generally occurred no more frequently than about 3 or 4 times per week. Since there are 4000 vacuum tubes in the machine, their estimated life expectancy, if assumed to be independent of age, turns out to be about 85,000 hours. This remarkable performance can perhaps be ascribed to the fact that the 100-kilocycle basic rate of the machine gives the individual computing circuit a period of about 2 microseconds between completion of the data-input phase and the instant at which the result is being called for—a "meditation" interval during which it is left alone to seek its new steady state, which is well established by the time the element is once more in communication with the rest of the machine.

The computer continues to be serviced by the Ferranti team who built it. At present there is always an engineer on hand during the daytime, but 24-hour servicing is to go into effect in the near future. One morning a week the engineers take over the machine completely for routine maintenance checks and further installations; currently the number of tracks on the magnetic drum is being increased to reach the full complement of 256.

The operating time of the machine is being shared at present by three parties; the members of the Manchester Laboratory and such university people as gain access to it through them; the Ministry of Supply, who are buying the second computer of this kind; and the computer group of Ferranti themselves, who have the use of the machine for one day every week. In addition there is an agreement giving them the right to use the machine on University time if it would otherwise stand idle. This has recently happened for the first time, owing, no doubt, to the fact that the Mathematical Laboratory is very much understaffed. The machine, once it had hit its stride, began to wear out completely the few mathematicians in attendance by perfect runs far into the night.

For the most part, the problems on which the computer has been working during this time are of the expected variety, e.g., modified potential equations arising in the study of ion mobility in colloidal solutions; missile trajectories in aerodynamic and geometric idealizations, but with sophisticated guidance mechanisms affected by noise and scintillation; etc. Less conventional, however, is a program composed by Dr. D.Prinz on the staff of Ferranti, Ltd., which allows the machine to solve simple chess problems. A position is fed into the memory by listing the pieces serially and giving their locations. The machine derives from this a serial listing of squares with their occupants and stores this also. Moves are selected on the basis of geometry alone—in terms of direction and length—and are checked by the machine for legality before execution. The mode of play is essentially the testing of all possibilities and the rejection of unsuitable choices.

A copy of the computer has been shipped to the University of Toronto.

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*Abstracted from ONR London European Scientific Notes 1 December 1951. A more complete account can be obtained from "REVIEW OF ELECTRONIC DIGITAL COMPUTERS," JOINT AIEE-IRE COMPUTER CONFERENCE (FEBRUARY 1952).

DATA PROCESSING AND CONVERSION EQUIPMENT

DIGITAL TO ANALOGUE CONVERTER

The Model 417 Digital-to-Analogue Converter, developed by Electronics Associates, Inc., Long Branch, New Jersey, is designed to accept digital information, such as obtained from IBM punched cards, and convert that information to analogue form so that a representative point-plot can be made on a conventional dc plotting board such as Electronic Associates, Inc. Models 205E or 205F Variplotter.

Conversion of digital information, which is held in a temporary storage, is accomplished by means of thyratrons operating sealed relays. The relays switch precision wire-wound resistors to achieve a voltage-divider effect. The resultant voltages from the divider are then summed in dc amplifiers. The output of the dc amplifiers is applied to the Variplotter.

The plotting speed varies with the proximity of successive points. If the points are spaced 4 inches or less, the plotting speed will be 50 points per minute. If, for example, the points are 15 inches apart, the plotting speed will drop to 20 points per minute. The accuracy of the Digital-to-Analogue Converter is 0.02% of full scale. Since each point is plotted after the plotting board reaches the null position, the static accuracy of the Variplotter (0.05% of full scale) is achieved. Therefore, the combined maximum error will be no greater than 0.07% of full scale, or 0.021 inch.

OSCILLOGRAPH TRACE READER

The Oscillograph Trace Reader, available from the Benson-Lehner Corporation, 2340 Sawtelle Boulevard, Los Angeles 64, California, is a small, portable reading machine designed to expedite the analysis of various continuous trace records appearing either on film or paper. Film or paper records from 35 mm to 12 inches wide may be accommodated in the unit. While the actual alignment of the traces is performed manually, the machine automatically applies both linear and nonlinear calibrations to the amplitude measurement and furnishes a dc voltage output proportional to the calibrated amplitude. This output can be used as an input to several different plotters, or, with the addition of a dc-to-decimal conversion unit, fed directly into an automatic tabulator.

FLYING TYPEWRITER

The Potter "Flying Typewriter," discussed in the July 1951 issue of the Newsletter, is a high-speed electronic printer consisting of two major assemblies—the printing mechanism and the electronic storage.

The physical components of the printing mechanism are shown in Figure 1, and the simplified schematic of Figure 2 illustrates the operation. The relatively simple mechanism features a single, continuously rotating, type wheel. Around the periphery of this type wheel, and parallel to it, are 80 solenoid-controlled hammers arranged in an arc. The type impression is registered on standard paper which is fed intermittently upward from a roll, passing between the type wheel, inked ribbon, and row of hammers. The hammers strike the selected characters "on the fly" as instructed by the electronic storage unit.

Of the possible 63 character combinations that can be used, the present printer uses 51. These consist of the alphabet, numerals 0 to 9, and 15 special characters. Any six-binary-digit coding can be used simply by interchanging the location of the individual type faces.

VACANT POSTS AT THE INTERNATIONAL COMPUTATION CENTER

The International Computation Center, which will be starting operations shortly, will be the first United Nations Laboratory. Its establishment was decided at a recent conference called in Paris by Unesco from 26 November to 6 December 1951. This conference adopted a Convention establishing the Center and it selected Rome as its seat. The Convention will enter into force with its ratification by ten States, and the first General Assembly of the Center will be convened within

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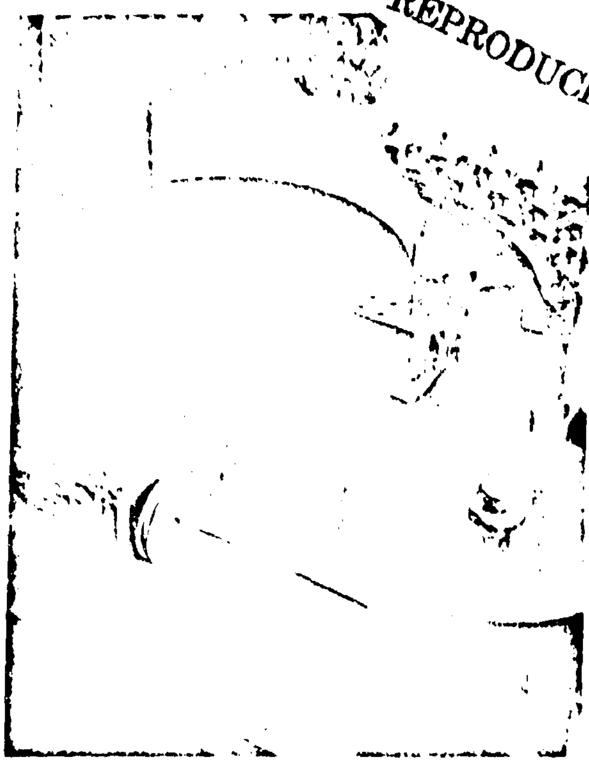
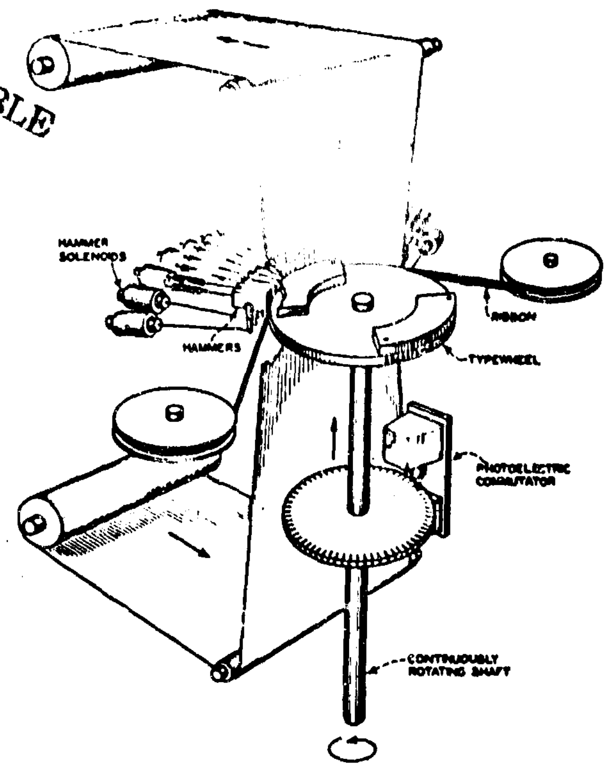


Figure 1



POTTER INSTRUMENT CO. "FLYING TYPEWRITER"

Figure 2

three months of the coming of the Convention into force; that Assembly will elect the Executive Council and Director of the Center; appointments to posts other than the Director's will be made by the Executive Council at the proposal of the Director, in the case of important posts, and by the Director himself in the case of all other posts.

The Center, as established by the Convention, will have three functions: (1) scientific research; (2) education; (3) an advisory and computation service. The staff of the Center must possess a high standard of scientific and technical competence and will be recruited on as wide a geographical basis as possible.

In order that the Center might begin to operate as speedily as possible, it was decided that Unesco would at once invite applications for the post of Director and for the other scientific posts at the Center.

It is of course understood that the appointments will be made by the Center's organs in the manner set forth above and not by Unesco; the submission of an application and correspondence exchanged with Unesco will constitute no promise of an engagement. Furthermore, the number of posts to be filled beside that of the Director and the qualifications to be asked of candidates both for the Director's and other posts will also be determined by the organs of the Center; they cannot therefore be known with certainty until the First General Assembly has met. However, in order to give prospective candidates some idea of likely openings, there is set forth below the qualifications which will probably be required for the different categories of posts. These particulars may be altered by the International Computation Center.

(1) Post of Director:

Candidates must have wide experience in scientific research and administration; they must be recognized experts in the field of computation. The appointment will be for a period of four years subject to renewal.

(2) Posts of Heads of Departments:

Candidates must have carried out important scientific research connected with the work of their department; the degrees required will be equivalent to those held by university professors in the world's principal scientific centers.

(3) Specialists' posts:

Candidates must hold the degree of Ph.D. in science or an equivalent degree; they must be experts in computation.

(4) Assistants' posts:

Candidates must have the degree of Bachelor of Science (licencie-es-sciences) or an engineering or equivalent degree.

Appointments to the posts mentioned in paragraphs (2), (3), and (4) will be made by a fixed-term contract.

Candidates should apply to the Director, Natural Sciences Department,

Unesco House,
19, avenue Kleber,
Paris (16e).

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