From the News Service
Mass. Institute of Technology
Cambridge 39, Massachusetts

For Release in MORNING Papers
of FRIDAY, June 21, 1957

The most versatile electronic computing machine in any educational institution in the world performed for the press yesterday at the Massachusetts Institute of Technology.

Called an "IBM 704," this $2,742,000 machine was built and installed by the International Business Machines Corp., for M.I.T.'s Computation Center. It is a high-speed data-processor similar to those used in many of the country's great scientific laboratories for secret work for the Armed Forces and the Atomic Energy Commission. This machine will be the first of these giants to be used wholly for teaching and unclassified research basic to man's understanding of himself, his environment and his machines.

704 Computer

The M.I.T. machine will participate, like a student, in efforts to improve its own components and usefulness. It will work on prodigious problems for the faculties of more than two dozen New England schools, and play both new and old games, but no routine work will be assigned to it.

One of its tasks will be to tell scientists where to aim their cameras to photograph the first man-made moons. It will compute the orbits of these artificial satellites of the earth from data supplied by volunteers participating in Operation Moonwatch. Another IBM 704,

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in Washington, D.C., will be used to keep track of the satellites similarly by means of radio signals. Predictions made by these machines will be rushed to the 12 special observatories which have been set up around the world to study the satellites.

This spectacular computation, however, will not require more than an hour a day of the giant machine's time. It will work eight hours a day for M.I.T.'s faculty and students, eight hours a day for the staffs and student of other schools in New England, and be used by IBM the other third of the day for maintenance, training of personnel, and special projects.

What You See

The M.I.T. Computation Center is an interdepartmental laboratory housed in the new $4,000,000 Karl Taylor Compton building. Dr. Philip M. Morse, Professor of Physics, is director of the center, which has a staff of more than 50 persons.

The computer fills a 70-by-46 foot room, in a glass-walled wing, of the new building. It consists of 23 devices housed in grey metal cabinets and electrically connected.

Glass panels on many of the units permit visitors to see the computer's moving parts, bundles of colored wires, and twinkling tubes. Brightly colored, illuminated buttons tell the operators what is happening, and a soft humming sound fills the room when the machine is working. The temperature and humidity of the whole room are held within narrow limits, as in an incubator, and a squad of specialists and maintenance men is on hand 24 hours a day.

In the central processing unit, 40,000 additions or subtractions,

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or 4,000 multiplications or divisions of numbers as large as 1,000,000,000 can be made per second. Connected to this processing unit are several "memories," in which numbers and instructions are stored by the machine, and a variety of devices for feeding information to it and recording the results of its computations.

The binary system, in which counting is done by twos rather than by tens, is used both to store information in the machine's memories and to make computations. Words as well as numbers can be expressed in binary digits, called "bits." These can be written into, or read out of, the machine's memories in microseconds.

The memory from which information can be recalled most rapidly will hold up to 8,192 words up to 36 bits long. This memory will be enlarged during the next year, at a cost of more than half a million dollars, to hold a total of 32,768 words of this length.

This very fast memory consists of thousands of black "doughnuts" about the size of pinheads, strung on the intersections of fine wires in plates about six inches thick. These plates are stacked like pancakes. Each doughnut will retain one bit of information magnetically. When enlarged, this memory will contain 1,179,648 of these rings.

The IBM 704 also has several other units for retaining data. One of these contains two magnetic drums, about the size of snare drums, that will each hold 4,096 of the 36-bit words. Ten magnetic tape machines also are directly connected to the processing unit, and each of these has a capacity of 10,800,000 such words. Reels of tape that whirl first one way then the other behind glass plates make these units the most fascinating to observe in operation.

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These colossal memories, a card puncher, a card-reading machine, and a printing device that resembles an enlarged automatic typewriter are part of the "on-line" equipment that takes up about two-thirds of the space in the main room.

The "off-line" equipment that fills the rest of the room consists of devices used for transferring information from one kind of storage or memory to another, or recording or withdrawing data from tapes, cards or tabulating machines. Three basic systems, requiring three units each, are provided for such work.

Sixteen auxiliary machines, housed in the basement, also are available for such purposes as punching cards, sorting cards, and reproducing either the instructions and data fed to the machine or the columns of figures that come out of it.

Work Cut Out For It

Some of the many assignments which M.I.T. has in mind for the new machine will involve participation in efforts to improve its own parts. Computers have been helpful in the development of transistors, and continuing research regarding the properties of certain atoms and molecules may lead to new and faster computers.

One way, for example, of evaluating metals is to measure the light that is reflected and that is transmitted through films of metal about a millionth of an inch thick. Prof. Louis Harris of the Department of Chemistry and Arthur L. Loeb of the Department of Electrical Engineering have been studying this method of determining some of the properties of metals for several years. Lengthy computations are required. These can be made with the new electronic digital computer

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in a small fraction of the time that would otherwise be required.

The machine also will assist in research supported by the National Science Foundation regarding ways to use such giant data-processors more expeditiously in the physical sciences. This will include study of the languages and techniques that men must employ to communicate with machines, and the possibilities of intercommunication between computers.

Similar research regarding the potentialities of digital computers in the social sciences will be supported by the Rockefeller Foundation. This will include study of the problems of language translation, historical research and library classification. The machine also will play games, and referee games, which have been devised not for fun but to test strategic decisions and shed light on the problems of management.

The IBM 704 already can play checkers, and efforts will be made at M.I.T. to teach it chess and the Japanese game of GO.

Plans are well under way for its use on problems connected with the building and operation of atomic reactors. Extremely complex equations involved in efforts to improve weather predictions also will be turned over to the new machine.

Cooperating schools have an equally staggering variety of tasks lined up for the big new machine. Prof. Guy H. Orcutt of Harvard, for example, is interested in simulating a model of the United States' socio-economic system with its help. Prof. Robert E. Scott of Northeastern University plans to use it to investigate the optimum design of electric-wave filters. Prof. Robert H. Owens of the University of New Hampshire will study a numerical method of determining the po-

sition of subterranean masses from small gravitational changes measured on the surface. Dr. Donald B. Devoe of Tufts University expects it to reduce the drudgery entailed in analyzing motion picture film used in a study of psycho-physiology, and Prof. Robert Creed of Brown University is exploring the possibilities of having it prepare a concordance of old English poetry.

"Undoubtedly," says Prof. Dean N. Arden of M.I.T., "continued use and development of high-speed computers will stimulate the investigation of many new problems, and greatly contribute to the solution of many problems which present great difficulties at this time."

Programming of the machine will be done by the "open shop" method, which means that each person who prepares an assignment for the machine will see for himself how it works out. Two machine operators employed by M.I.T. and a staff of six customer engineers employed by IBM will be on hand, however, to assist each researcher using the computer.

A Teaching Aid

M.I.T. has pioneered in the development of computers and computing techniques for many years. The Bush Differential Analyzer was put into use in 1935. Whirlwind I, the first digital computer to have a magnetic core memory such as is used in the IBM 704, was built at M.I.T. and has been in use since 1950. This memory was developed as a result of work done by Prof. J.W. Forrester of M.I.T. and is the fastest known type of memory.

Scores of machines comparable to the IBM 704 are being installed now throughout the country. IBM has built such machines for the

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Lincoln Laboratory of M.I.T., the University of California Radiation Laboratory, and many private companies such as General Electric, United Aircraft, North American Aviation and Esso.

Consequently, educators now consider it as necessary to introduce students to the use and potentialities of these machines as it has been in the past to familiarize them with lathes and slide rules. "Every student who leaves M.I.T. with an advanced degree in engineering or science," says Prof. Morse, director of the center, "ought to know how to code his own problems."

Many of the schools that will share the use of the new machine with M.I.T. will also offer courses in high-speed electronic computation. These schools include Amherst College, Bates College, Bennington College, Boston College, Boston University, Bowdoin College, Brandeis University, Brown University, University of Connecticut, Dartmouth College, Harvard University, University of Maine, University of Massachusetts, Middlebury College, Mount Holyoke College, University of New Hampshire, Northeastern University, University of Rhode Island, Tufts University, University of Vermont, Wellesley College, Wesleyan University, Williams College, Worcester Polytechnic Institute and Yale University.

The International Business Machines Corp., in addition to providing the machine rent-free for an indefinite period, will provide up to $60,000 per year for the appointment of research assistants and associates who will spend part of their time learning to use the equipment and helping their colleagues.

The Assistant Director of the Computation Center, Prof. Frank Verzuh, is responsible for day-to-day operation of the equipment.

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Prof. Dean N. Arden is in charge of programming research, and Dr. Fernando J. Corbato is in charge of the graduate student program. Dr. J.F. Blackburn, IBM's educational coordinator for New England, will serve as technical advisor to the users of the machine.

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