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MIT
Computation Center

COMPUTATION CENTER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Mr. William C. Cobb
Office of Publications
The Rockefeller Foundation
49 West 49th Street
New York 20, New York

Dear Mr. Cobb:

I enclose two pictures of the Computation Center, which I hope will be of use to you in getting up your report. I also enclose rough draft of parts of our first Annual Report, which may provide you with useful material.

If you have further questions, please let me know.

Sincerely,

Philip M. Morse

Philip M. Morse
Director

PMM:LWH

Photos filed 23220A-B

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HISTORICAL SUMMARY

This report is the beginning of a new series of Progress Reports, on the activities of the MIT Computation Center in education and research in the general area of the utilization of high speed digital computing equipment in science, engineering and management practice.

Previous Activity at M.I.T. - It is not the first Progress Report on the subject to have been issued at MIT, for the Institute has had a long history of activity in the construction and utilization of computing equipment. For example, in 1936, the first model of the Bush Differential Analyzer was put into use at the Institute; many problems in physics and engineering were solved with its help. In (see FV) the more accurate, electronically controlled Rockefeller Differential Analyzer was put into use. During World Warr II it was of great assistance in solving many scientific problems arising out of war work. In (see WWfiles) construction was started on a high-speed digital computer, which came to be called Whirlwind I. Design and construction was supervised By Dr. J. Forrester and the work was financed by the ONR, under Contract No.

Whirlwind I came into operation in
Although most of its activity has been in support of the Air Defense Project now consolidated in MIT's Lincoln Laboratory, up to 40% of its time has been available to staff and students at the Institute, for general research. The machine

has pioneered a number of major new developments in machine design and use. It was the first general purpose computer to have magnetic core memory in routine use and its programming research staff was the first to develop techniques for making the machine do its bookkeeping and program checking, by making available, for the general user a set of utility assembly and post-mortern programs.

The Office of Naval Research supported this development of ways to make Whirlwind easier to use and of programs for the use of the computer in a wide variety of applications. Research Assistants, from nearly all the departments at the Institute, worked with the full-time staff to make this broad advance possible. The Quarterly Progress Reports, published by the Whirlwind Project from to the end of this year, give the details of the work.

Increase in Research and Educational Needs - To supervise the general research and educational use of Whirlwind I, the Institute set up in 1952 a working Committee on Numerical Analysis and Machine Computation, composed of faculty members from interested departments. This committee has reviewed the instructional courses, offered at MIT, in this general field, and has recommended others in order to widen the coverage. It undertakes to supervise graduate thesis in this general field, if requested by a department or a student and it has helped the Whirlwind

staff set priorities and general policies of operation, for that portion of machine time available for general use. With its support and encouragement the use of Whirlwind by staff and students has grown phenomenally in the past three or four years. By now the majority of the Ph.D. thesis in theoretical physics, in applied mathematics, in operations research and in theory of structures add many of the thesis in radiation theory, in aerodynamic theory and in chemical engineering design use machine computation as a matter of course. When one adds the research projects carried on by faculty members, it is not surprising that the demands had outgrown the time available on Whirlwind.

What was needed was a machine planned, installed and run primarily for research and education use. With the very rapid increase in the number of large computers (more than a hundred large ones to be installed in 1957 alone!) every scientist and graduate engineer, in the future, would have to know how to use one in his work. MIT would have to have a computation center, supplied with a variety of computing machines of the most up-to-date type, operated by persons who could teach operating techniques and supervised by a research and educational staff interested in working out better methods of machine utilization and in research on the basic logic of machine programming.

The staff, in addition to machine specialists, should include scientists and engineers, of a variety of backgrounds, who could work with various students and

faculty members who desired to use the equipment for research in their own special fields. This research-educational-consulting staff should provide the "impedance match" between the machines and the research worker in any of the fields of the physical or social sciences, of engineering or of administrative practice. And the machine and staff must be set up and financed in a way so that access to the machine and to the advice of the staff will be free to those students and faculty members who have a worth-while research problem which requires computational assistance appropriate for machine solution.

Arrangements with I.B.M. Corporation - Discussions with Dr. Cuthbert Hurd of the International Business Machines Corporation (IBM) and, later, with Mr. Thomas J. Watson, Jr., President of the Corporation, showed that IBM was aware of these educational problems and was willing to contribute toward their solution. With their enlightened and forward-looking aid a contract was negociated between IBM and MIT by which:

1) An IBM 704 plus its auxiliary equipment is given, rent free to MIT, to be installed in the new Compton Laboratories at the Institute, IBM to provide maintenance and two operators per shift. On the average, one shift will be for the use of students and staff of MIT, one shift for the use of other colleges and universities in New England, cooperating in the use of the equipment (the cooperating institutions) and, for the time being, the

third shift for the use of IBM for some basic research of its own.

2) IBM provides up to $60,000 per year for the appointment of Research Assistants and Associates to spend part of their time learning to use the equipment and then helping their colleagues to use the equipment. Half of these funds will go for appointments made among graduate students or staff at MIT and the other half goes for similar appointments made to graduate students or staff at the various cooperating institutions in New England.

3) MIT will provide the educational and research staff of the Center, in part by assignment of regular faculty to part-time duty at the Center, in part by soliciting funds from other sources for research into machine use and in part by contributions from other research projects at MIT, which will use the equipment in their educational and research activities.

4) IBM will reimburse MIT for additional expenses involved in making the equipment available to the cooperating institutions.

5) No classified research is to be carried out on the equipment. Every computation done during the two (MIT and cooperating institutions) Shifts must be a part of some research which may be published in some scientific journal or be apart of some regular educational activity of MIT or the cooperating institutions, open to regular students of these institutions. Since no charge will be made for machine

time the oriterion for allocating machine time to publishable research or educational projects will be the importance of the objectives, the appropriateness of machine use to the attainment of these objectives and the degree to which this use will contribute to the education of students or faculty in the most effective use of computing equipment. This allocation will be made by the Director of the Center, with the advice of the MIT Committee on Numerical Analysis and Machine Computation, for the MIT shift, and of a Committee of the Official Representatives of the Cooperating Institutions, for the cooperating New England Institutions shift.

Formation of the Computation Center - This generous and constructive contribution has made it possible to establish a Computation Center at MIT, with some of the characteristics of a Department, to implement the contract and to serve as a center for research into new and better ways of utilizing high speed computers and for education in these new and better ways. During the year covered by this contract, since the equipment was not yet installed, activity has been largely confined to orgainizing the Center, setting up the communication links with the cooperating institutions, arranging for the additional support for the staff and planning for training courses and research activities, though a certain amount of research has actually been started. Each of these aspects of activity will be

reported in detail, later in this Report.

Future issues of these Progress Reports, which will be published twice a year, will of course be devoted more to accomplishments than to plans, more to results than to organization. The present Report in expected to serve as an introductory description of organization, policies and initial plans, which will be referred to by later Reports. Succeeding Reports will, in the main, discuss the educational activities of the cooperating institutions in the field of computer use and will report on each of the research problems which used machine time.

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ORGANIZATION

The Computation Center at the Institute is an interdepartmental and inter-divisional activity with a Director, who reports to the Chancellor of the Institute. The Center does not offer regular courses of instruction nor does it give degrees, but it has an academic budget and academic appointments, with the rank of Visiting Fellow, Research Associate or Research Assistant may be assigned to it. Part of its staff are also faculty members of various academic departments, who teach courses in various aspects of computing machine utilization and operation, offered by their departments. The Center also offers special courses of training, without regular academic credit, from time to time, to persons from the cooperating institutions and from industry. It also sponsors special conferences on various aspects of machine computation.

Reporting to the Director of the Center is an Assistant Director for Operations, who is responsible for the day-by-day operation of the equipment, the scheduling of machine runs and other administrative activities; and two Assistants to the Director, one in charge of the Programming Research staff and the other in charge of the IBM Research Assistants and Associates. Members of the staff of the Center, part or full time, report to one or the other of these three officers.

Advising the Director, in regard to the work of the Center with regard to MIT, is the Institute Committee on Numerical Analysis and Machine Computation, consisting of faculty representatives appointed by the heads of those departments of the Institute with active interest in machine computation. Advising the Director, in regard to the cooperative program at the Center, of the other colleges and universities in New England, is the Cooperative Program Council, consisting of faculty members (called Institutional Representatives) appointed by the Presidents of the cooperating institutions.

Arrangements to have computation done at the Center by a student or faculty member of a cooperating inttitution are made through the appropriate Institutional Representative, by a student or faculty member of MIT are made through the appropriate department head. Details of the procedures are outlined later in this Report. The duties of the staff of the Center are:

1) To carry on research in numerical analysis, in the logic of coding and in the development of programming techniques.

2) To investigate procedures for recording and processing of large-quantity experimental data or operational records or other information, and to develop programs for the statistical analysis of such data and its display or presentation in quickly understandable form.

3) To aid in instructing students and others in these subjects, and to help supervise student research in these fields.

4) To build up a library of useful sub-routines for the solution of often-encountered problems, to prepare instruction manuals, lists of routines, tables of functions, etc., which will improve and extend the utilization of computing equipment at MIT and elsewhere.

5) To participate in conferences and other joint activities with staffs of other computation centers, so that knowledge of this rapidly changing field can be exchanged with other workers.

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SUPPORT OF RESEARCH AT THE CENTER

In addition to the basic support of the work of the Center, provided by IBM, it is expected that other grants of funds for research in machine utilization will be made available. Two such grants have already been made to the Center, and others are under discussion.

The National Science Foundation has granted a sum of roughly $35,000 for the coming academic year, under Contract NSF , with the option of extending the grant, with equal yearly amounts for an additional two years. The research to be carried out under this grant is for research into the utilization of digital computers in the physical sciences, and will include the following:

1) Investigation of Structure and Syntax of input languages; the possibilities of coding directly in mathematical or logical language.

2) Development of routines capable of translating from algebraic notation to computer code and vice versa, including possibly automatic selection of numerical techniques and automatic error analysis.

3) Development of numberical analytic techniques particularly suitable for use by digital computers; such as more general expansions, truncated Chebyshev polynomials sums for simulating standard functions by a common block

instructions but small separate blocks of coefficients and cycle counters and methods of automatic determination of best grid spacing, by trial plus Richardson extrapolation or other means.

4) Investigation of Monte Carlo techniques for large problems.

5) Extension and/or improvement of present techniques for communication between machine and operator and for the more flexible control of machine operation, including possible improvements in input-output equipment.

6) Experimental analysis and control using data transmitted directly between computer and experiment.

7) Investigation of microprogramming and other methods for increasing the flexibility of computer design. The possibility of inclusion of a very flexible control unit in a large-scale computer which would permit ready alteration of an order code.

8) Investigation of techniques for intercommunication between computers, including the possibility of cycles different in length or kind running simultaneously with frequent comparison, e.g. several single-accumulator computers with common memory and the behavior of a computer with multiple accumulators. Some of these properties cna be simulated on a 704 by utilization of additional drums and magnetic core banks.

9) Computer estimation of problem time. In linear problems, estimations of bounds of certain functionals, and thence convergence criteria for terminating iteration,

or switching to a different iteration.

The Rockefeller Foundation has granted a sum of $98,000 for three years for corresponding research on the utilization of computing machines in the social sciences. Some of the proposed directions for research are:

1) The adapting of machine processes to the special logical processes encountered in research in the social sciences. In particular the development of programs for the special statistical analyses required in many social science studies. (Corresponding to item 1 of the NSF grant).

2) Research in the field of the storage and rapid access to infomation, such as is needed in the problems of language translation, historical research and library classification. The development and testing of special equipment for facilitating storage and rapid search of such data, and the methods of print-out or other display of the sought-for information.

3) Development of the use of computing machines in the general field of controlled social science experiments, sometimes called "gaming procedures". Programming the machine to be a referee in "games" testing management or operational organization, with controlled channels of communication. Also programming the machine to be an opponent, to play against human "players", in order to gain a more complete conception of the rules of stratergy of the game and of the nature of the possible outcomes.

Some of the funds provided by these grants will go to support staff appointments of persons trained in various fields of physical or social science, who join the Center staff to learn machine operation for use in their field, and who are then available, when some other specialist in their science wishes to use computing machines in his research, as matches", knowing something of the problems of the science and also of the problems of machine programming.

Future issues of these Progress Reports will be consolidated reports of research done under these and other grants, as well as reports of the general research and educational activities participated in by the Center. It has been agreed that an inclusive Report of all of the Center's activities will be more useful than a series of special reports, each covering but a single aspect of the work.

Much of the research planned for the Center could not be started during the past academic year, because the quipment was not yet operative. Details of the research already started will be reported later in this Report.