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Fact Sheet on Project MAC

The Massachusetts Institute of Technology has been participating, since spring 1963, in a major national program of research on advanced computer systems and their exploitation sponsored by the Department of Defense. The contract of \$2, 220, 000 to initiate the effort was awarded by the Office of Naval Research on behalf of the Advanced Research Projects Agency of the Department of Defense.

The research is being carried out under the project name "MAC," an acronym derived from two titles: machine-aided cognition, expressing the broad project objective, and multiple access computers, describing its major tool. The project director is Dr. Robert M. Fano, Ford Professor of Engineering and Professor of Electrical Communications. The Project MAC program is being carried out adjacent to the M.I.T. campus in the Technology Square office complex. It occupies the eighth and ninth floors of the Beta building, 545 Technology Square, Cambridge, Massachusetts.

The broad goal of Project MAC is the experimental investigation of new ways in which on-line use of computers can aid people in their creative work, whether research, engineering, design, management, or education. Thus, an essential part of the project is the evolutionary development of a large, time-shared computer system that is easily and independently accessible to a large number of people, and truly responsive to their individual needs. The keynote is ease of access, both physical and intellectual, which must apply to the information stored in the computer system as well as to the computer's

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information processing capability. The goal is an intimate collaboration between the human user and the computer in a real-time dialogue on the solution of a problem, in which the two parties contribute their best capabilities--for the man, imagination, insight, inspiration and judgment; for the computer, enormous computing power, high-speed data retrieval from a vast store, and the ability to handle the details of very complex logical processes.

Project MAC is capitalizing on a long history of pioneering work on computers and information processing at M.I.T. and M.I.T.'s Lincoln Laboratory, which includes such milestones as the analog computer of Dr. Vannevar Bush prior to World War II, Whirlwind I, the SAGE System, and the TX-2 computer. More recently, the research of the Computation Center on time-sharing systems, and the work of the Computer-Aided Design Project, jointly conducted by the Electronic Systems Laboratory of the Electrical Engineering Department and the Design Section of the Mechanical Engineering Department, have provided the foundation on which the present MAC system is built.

The present MAC computer installation includes a specially modified IBM 7094 computer and a Digital Equipment Corporation PDP-1 computer. The IBM 7094 computer is the central part of the time-sharing system. The primary terminals of the system are, at present, 40 Model 35 Teletypes capable of 100 word-per-minute operation. Two of the Teletypes are located at Lincoln Laboratory in Lexington, the rest on the M.I.T. campus. Each Teletype can dial, through the M.I.T. switching central, either the MAC computer installation or the similar installation in the M.I.T. Computation Center. The supervisory program of the two computer installations may, independently, accept or reject the call.

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In order to provide Teletype access from outside M.I.T., the MAC system will be connected in the near future to the TWX and Telex networks operated respectively by the American Telephone and Telegraph Corporation and the Western Union Company. Experiments are being planned in collaboration with a number of universities participating in the national program to provide experience with long-distance operation of time-sharing systems.

MAC's initial supervisory operating system is the M.I.T. Compatible Time-Sharing System (CTSS). An evolving system of programs developed by the M.I.T. Computation Center, CTSS was first publicly demonstrated in 1961. It includes supervisory, scheduling, debugging, assembler/compiler and input/output facilities. The programming languages now or soon to be available to the MAC users on CTSS are FORTRAN, FAP, MAD, COMIT, LISP, COGO, STRESS, and ALGOL. Other languages, and particularly other common utility programs, are planned for future inclusion.

A typical session at a time-sharing terminal from the user's point of view might go as follows:

The user first must log in to the system, giving his identification. When he is accepted by the system he may then type in a subroutine, perhaps using the MAD language. He could then call for a printout of his input, edit it to correct errors, and then call for a compilation of this part of his program. The resulting binary program, together with other previously compiled programs, could then be loaded and run and the result or post-mortem data obtained. If necessary, the user may examine the contents of registers in memory, make corrections to the source program, recompile and so on, repeating the process as often as necessary. When the user chooses to terminate his

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work he may save the present state of all of his programs with the assurance that they will be ready for him to pick up the ^htreads at his next session at a terminal, perhaps hours or weeks in the future. When he logs out of the system, the user receives from the supervisory program accounting data indicating how much actual computer time he has used.

CTSS allows a conventional batch-processing load to be operated as "background." Any computer capacity which is not demanded by users at remote terminals is absorbed by the background load of the system.

While teletype or other typewriter-like terminals are adequate for many purposes, some applications demand a much more flexible form of graphical communication. An excellent example of graphical communication arose two years ago on the Lincoln Laboratory TX-2 computer in connection with the doctoral thesis of Ivan Sutherland. This work, in the general area of computer-aided design, is directed toward "tightening the loop" in the design process through use of a computer with appropriate terminal equipment. Using such a terminal, and aided by the computer, the designer might sketch in a drawing of a mechanical part using a "light pen" or other tracking device. Working with his visual display the designer could then modify his drawing as he worked and then perhaps subject the partially designed part to simulated testing by indicating at his display the application of loads and having the computer present the reaction of the part such as deformation, failure, etc. When the designer is satisfied, he might then press a button which causes the computer to produce a tape to control a machine tool to actually produce the part.

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The M.I.T. Electronic Systems Laboratory recently completed a visual-display terminal with flexible input-output facilities for use in such applications as those described above. The console which ESL has produced includes an oscilloscope display with character generator and light pen together with some local logical capability to simplify the task of the computer in maintaining the display. For communication from the console to the computer the terminal includes a variety of devices such as knobs, pushbuttons, toggle switches and in the near future a typewriter. The meaning of a signal from one of these input devices is entirely determined by the program in the computer. There is no "wired in" local significance. Thus, the terminal is an extremely flexible device which can be used in many fields of application.

While the time-shared computer system is the most visible part of the project at this time, the research activities which use it constitute a major part of the MAC effort and are also well underway. The details of the work are difficult to report at the present stage, but an indication of the level of activity is given by the heavy demands made by the research groups on the MAC computer. To satisfy the project's needs, the computer is operated on a five-day per week around-the-clock basis and will go to a full seven-day week later this month. When the compatible time-sharing system program (CTSS) is on--which is about 80 per cent of the total MAC computer time--as many as 24 persons can simultaneously use the machine from various remote terminals.

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January 16, 1964