THE

Digital Computer LABORATORY

of the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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History of the Laboratory

Until late 1951 the Digital Computer Laboratory at MIT operated as a division of the Servomechanisms Laboratory, which was established in 1940 to develop automatic control systems and military fire control. During World War II the Servomechanisms Laboratory carried new control principles through the development, design, and testing phases, and into production in manufacturing plants. At the end of the war, a gradual transition to new research in aircraft systems, atomic-pile control, and digital computation kept together and gradually expanded the key staff group of the war period.

The work in servomechanisms led naturally into digital computers for real-time control applications, where the logical nature and performance requirements of the job are often beyond the capability of analog systems. In 1951 the Digital Computer Laboratory became an independent laboratory in the Electrical Engineering Department for research and development in digital computers and their application to engineering, both industrial and military.

Later the Digital Computer Laboratory became the nucleus for formation of Division 6 of the Lincoln Laboratory for air defense when the latter was established at MIT.

Whirlwind I

Project Whirlwind, sponsored by the Office of Naval Research in the Digital Computer Laboratory, culminated in 1950 with successful operation of the Whirlwind I digital computer. The basic logical plans of the machine had been published in 1947. During the intervening three years, components were developed, basic circuits established, and the mechanical and electrical details designed. The computer, employing some 5000 vacuum tubes, was constructed and the electrostatic-storage tubes for internal memory carried from idea to pilot production. The machine operated successfully in November 1950. By September 1951 it had attained a reliability above 85% where it has operated since. The Whirlwind I computer soon achieved its three principal objectives by demonstrating that:

(1) Ultra-high speeds (above 20,000 arithmetic or logical operations per second) are possible.

(2) High reliability of large electronic systems can be obtained.

(3) Digital computers are feasible for real-time control systems in civilian and military operations.

A booklet, *Whirlwind I*, describing the computer and digital computation was published by the Laboratory on August 15, 1951.

The Laboratory Program

The Digital Computer Laboratory has pioneered in real-time control applications of digital computers. In these applications, computers receive a continuous flow of incoming data to be processed into results for controlling the systems of which they are a part. Studies of the control of civil air traffic and factory processes have been undertaken but postponed for currently more urgent military applications. In real-time control, high speed and reliability are essential and have been correspondingly stressed in the Digital Computer Laboratory. The Laboratory undertakes research for which its facilities are unique — research which is not or cannot be adequately handled elsewhere.

The past has been devoted to constructing, testing, and improving the Whirlwind I computer. Of the available operating time, 50% is sponsored by the Office of Naval Research and is devoted to engineering, scientific, and industrial applications; the remaining 50% is given over to military research.

The future will include a broad program of research into the applications of digital computers, the extension of the capacity and terminal facilities of Whirlwind I for its widening research assignments, and the development of new computing equipment.

Digital computers will be studied for a wide range of applications in research, industry, and military problems. These studies of computer applications will show the direction for future research on components and development of equipment.

In the expansion of Whirlwind I, magnetic-tape and magnetic-drum units have been added, along with a more complete system of input-output equipment. A new memory has recently been incorporated employing magnetic cores in a coincident-current selection system which was first conceived and developed at the Laboratory.

Since Whirlwind I was constructed, many new digital techniques have appeared. These will be explored and evaluated for use in future computing devices. Principal among these new techniques are circuits using transistors, magnetic and crystal gates, high-speed random-access magnetic storage, and ferroelectric elements. "Marginal checking" for anticipating approaching failures of components has made the high reliability of the present computer possible. Quality control, use of test problems, and improved design — in conjunction with marginal checking — will further benefit reliable operation of digital computers and other electronic systems in a wide range of applications.

The People

Although it is customary to discuss equipment, it is not the machines but the people that are the top asset of a laboratory. Digital computation is a new and growing field and a young and rapidly developing profession. The average age of the Digital Computer Laboratory staff is 29 years. Staff members have come from 29 states and have been trained in 104 colleges and universities; 19 came directly from military service, 56 from industry, and 21 from staff positions in the educational field, from which some are on leave of absence for a period of study and new associations. The staff has grown gradually with the work of the Laboratory to about 201 persons trained in engineering, science, and mathematics. In addition, 79 former staff members have studied and received training before leaving for other academic or industrial positions.

The staff is made up of persons on two types of appointments:

(1) Full-time DIC (Division of Industrial Cooperation), DDL (Division of Defense Laboratories), and faculty staff members who provide continuity and leadership.

(2) Research assistants who receive working experience and make a major contribution to the success of the Laboratory while studying for advanced degrees.

The staff member of the Division of Industrial Cooperation or Division of Defense Laboratories has a full-time professional position. Whenever the nature of his assignment permits, he is encouraged to advance his professional ability by registering as a Special Student at the Institute for one pertinent course per semester. Salaries are similar to those for research and development work elsewhere; Social Security, a pension plan, and group Blue Cross and Blue Shield are available, as are MIT medical, recreational, library, faculty club, and academic facilities. The DIC or DDL appointment is most attractive to those who are seeking a full-time professional position and who value the pioneering nature of the field and the academic and professional contacts and atmosphere of the Digital Computer Laboratory.

The research assistant is a staff member of one of the academic departments, most often Electrical Engineering, although his studies may be in other departments. He is a candidate for a degree, takes two courses per term, usually does his thesis in connection with the work of the Laboratory, and devotes his time when not in class to his staff duties. The salary is lower than that of a full-time staff member. There are fewer openings for research assistants than for full-time staff, but several outstanding men are appointed for research and graduate study at the start of each academic term (September, February, and June).

Atmosphere of the Laboratory

The staff of the Laboratory are attracted and held by the opportunities for professional development. There is freedom to choose work in which the individual is most interested, with sufficient supervision and coordination of activity to insure a useful and rewarding outcome of his effort. In the Laboratory are found both the atmosphere of academic research and systems-development engineering. As a laboratory in a new field, it must perform fundamental research; as an engineering laboratory, it stresses reliability and engineering quality. In addition, there is some opportunity for planning and supervising the manufacture of equipment. The work is guided by continuing analysis and study of the applications of digital equipment. The Laboratory is associated with the Electrical Engineering Department; faculty members and graduate students of the Department do research and theses at the Laboratory; and Laboratory staff teach courses in which new research results are incorporated.

The Laboratory actively circulates its research results. Several of the staff members give talks before national technical conventions each year, articles are published in the technical press, and reports and memoranda are distributed in response to requests from other laboratories.

Digital computation is a focal point of present-day technical interest. In one year the Laboratory was visited by 350 scientists, engineers, and executives from 95 industrial companies; 450 from 40 government organizations; 100 from 35 academic institutions; and 90 from 23 other countries. Digital-computing equipment has been founded on scientific and commercial endeavors. Urgent military applications are taking temporary precedence. However, unlike many other devices developed for military use, digital computers may be expected to assume more importance in peace-time applications than in military applications. The digital method of handling and processing information is expected to be one of the technical and scientific fields showing greatest activity and progress during the next fifty years.[1]

Digital computation is a new field which has been successfully entered by men of good ability having no prior experience in the work. Of the present Digital Computer Laboratory staff, about 20% have transferred from other professional pursuits, the remainder having chosen this work for beginning their careers. New staff learn through Laboratory spon-

[1] *Digital Computers as Information-Processing Systems*, Jay W. Forrester, Director, Digital Computer Laboratory, Report R-166-1, June 1, 1949, revised September 28, 1951.

sored training, academic courses, trips to other laboratories, and seminars conducted by the Laboratory and by the departments of Electrical Engineering, Physics, and Mathematics. In a short time, an able man from any field of engineering or scientific training can reach new frontiers in digital-computer research, design, or application.

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