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Memorandum L-20

Electronic Computer Division
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: PROPOSAL FOR THE STUDY OF DIGITAL COMPUTATION FOR NAVAL FIRE CONTROL

To: The Office of Naval Research

From: The Massachusetts Institute of Technology

Date: March 2, 1950

1. Introduction

1.1 This proposal follows recent discussions with technical representatives of the Office of Naval Research. Reference is made to a letter from Jay W. Forrester to Commander Gilbert H. Mitchell of the Armament Branch of ONR, dated November 25, 1949, and to the reply ONR:463S:bb, Serial No. 13, dated January 5, 1950.

1.2 The Electronic Computer Division of the MIT Servomechanisms Laboratory is now completing the assembly of a high-speed electronic digital computer developed as Project Whirlwind for the Office of Naval Research. For the past year we have been working on a contract for Watson Laboratories studying air traffic control, some aspects of which are relevant to the shipboard anti-aircraft problem. A proposal may be prepared for the Signal Corps Engineering Laboratories for a program of study on an integrated anti-aircraft land-based fire-control system.

1.3 We understand that it is because of our experience gained from logical planning, machine construction, and some applications studies already carried out that the Office of Naval Research has requested this proposal for a study of digital computer application to shipboard anti-aircraft fire control.

2. Scope

2.1 Our work would be a preliminary study of applications of digital computers to shipboard anti-aircraft fire control. After a brief initial survey of the over-all problem, our attention would be chiefly directed to the following objectives:

2.11 By coding typical mathematical functions and equations solved by the present anti-aircraft computer, establish the speed and capacity requirements for digital equipment suitable for use against a single high-speed target. This might later be extended to include the multiple-target case.

2.12 Determine whether it is more advantageous to compute ballistic data as needed, or to store the tables and search for the particular data desired.

2.13 Recommend where, in the process, conversions to and from digital information should take place.

2.14 Determine if it is possible to make provision for several types of prediction and to have the computer use the one most suitable for the particular target maneuver.

2.15 Estimate the type of data smoothing to be employed and the magnitude of smoothing time necessary.

2.16 Proceed as far as possible with the simulation of a digital fire-control system using the Whirlwind I Computer. This would include a plan for a suitable demonstration, coding of sequences for the computer, and preliminary tests. Until the nature of the demonstration is established, definite commitments for its complete execution should not be made.

2.2 In addition, preliminary consideration of the problem suggests the following points:

2.21 The over-all problem is one of information processing(i.e. collecting, sorting, interpreting, evaluating, and transmitting information; performing necessary computation; and generating appropriate instructions) and therefore subject to treatment by digital techniques.

2.22 Simulation by digital equipment can have a part in the design phase (simulation of proposed facilities and of operations against experimental or prototype equipment) and in training, tactical studies, and readiness tests.

2.23 The capacity of a high-speed general-purpose digital computer is likely to be sufficient for accomplishing several parts of the fire-control problem with one piece of equipment on a time-sharing basis.

3. General Remarks

3.1 A preliminary period of study and discussion with Navy personnel will be necessary to obtain information on the latest non-digital fire

control equipment. Liaison with the Bell Telephone Laboratories Mark 65 project and the work of the Naval Research Laboratory will be valuable.

3.2 Many of the applications of digital techniques have common foundations. Our work for the Office of Naval Research would be arranged to provide best balance and maximum mutual help among our various projects.

3.3 Sample coding, which is necessary for any estimate of the practicality of digital methods, would permit demonstration of certain solutions on the Whirlwind I computer.

3.4 Considering the long-range nature of both digital computation research and the anti-aircraft problem it is recommended that any work be planned as part of a continuing and coordinated program.

4. Magnitude

4.1 It is recommended that the contract begin about April 1950 and extend to April or June 1951 so that some time flexibility will permit assignment of the best available technical personnel to the study.

4.2 The following is an estimate of the cost of such a program for the first twelve months:

Direct salaries and wages			
Staff			
Assigned	$10,450		
Supporting	2,820		
Total		$13,270	
Non-staff			
Assigned	$ 2,585		
Supporting	3,990		
Total		6,575	
Total salaries and wages			$19,845
MIT overhead at 42% of salaries and wages			8,335
Materials and services			
Equipment (filing cabinets, etc.)		$ 200	
Expendable material (office supplies, etc.)		750	
Travel and services (telephones, telegraph, postage, printing, etc.)		2,150	
Total materials and services			3,100
Total estimated annual cost			$31,280

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4.3 Assigned staff includes one-fifth of the time of a supervisory senior engineer, full time of another engineer for the whole period, and full time of two junior engineers for about three-fourths of the period. Work would start on a one-man level and the other engineering personnel would join the project about three months later. Assigned non-staff includes secretarial and drafting help. Costs of supporting personnel are for over-all laboratory supervision and administration, and the services of guards, etc.

4.4 The MIT overhead rate is negotiated annually with the government and does not vary greatly. It covers heat, light, power, and maintenance for this laboratory, and costs of the accounting and administrative groups of the Institute's Division of Industrial Cooperation.

5. Personnel

5.1 Specific personnel assignment would depend on when work on this project began and on the staff available at that time. A typical arrangement might be as follows:

5.11 Direction of the work might be a part-time function of Robert R. Everett, who has been with the Servomechanisms Laboratory since 1942 and is a senior staff member directing work of the Electronic Computer Division.

5.12 Full-time supervision might be carried by either George C. Sumner or Robert A. Nelson, both of whom have completed master's degree study at MIT, have digital computer experience, and were radar officers during the war.

5.13 In addition, it is expected that two research assistants (candidates for master's degrees in electrical engineering) would join the project after the preliminary study had been carried out.

5.2 The following staff members would also be informed of the work and be available for consultation in their respective specialties:

J. W. Forrester (Associate Director of Servomechanisms Laboratory)

W. G. Welchman (mathematics)
C. R. Wieser (servomechanisms) } Project supervisors of air traffic control research

Prof. W. K. Linvill (servomechanisms)

Prof. P. Franklin (mathematics)

N. H. Taylor (in charge of electronic design and engineering on the Whirlwind I computer)

Signed Jay W. Forrester
Jay W. Forrester

JWF:RAN:lfu March 2, 1950