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

**SUBJECT: PROPOSAL FOR THE EXTENSION OF CONTRACT N5ori-06002,
DIC PROJECT 6782**

To: Dr. F. L. Foster
From: Jay W. Forrester
Date: June 20, 1951

1. Introduction

1.1 A meeting was held here on May 18, 1951 with representatives of the Computer and Armament Branches of the Office of Naval Research to discuss the status and future of Contract N5ori-06002, DIC Project 6782, which expires on June 30, 1951.

1.2 ONR desires that work should be continued on the problem of applying digital techniques to naval antiaircraft fire control. We pointed out that further general study would not be very profitable, but rather that some specific areas should be investigated in detail. It was agreed that we would submit a proposal for contract extension with about the same budget as that for 1950-51 to support specialized work in various fields that will contribute to the naval gunfire control problem and at the same time fit in well with the Air Defense work of the Laboratory presently under Contract N5ori-06001.

2. Work to Date

2.1 Our work during the past year has consisted of a fairly general survey of the problem of applying digital techniques to naval fire control. The following topics will have been considered in varying degrees by the end of June:

- 2.11 Digital coding of Mark 47 analog solution
- 2.12 Radar and guns in a system with a digital computer
- 2.13 Firing table data generation

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2.14 Smoothing and prediction

2.15 Tactical questions

2.16 Demonstration with the Whirlwind I computer

2.2 The work performed so far is described in the three quarterly reports issued during the year: Memorandums M-1118, M-1169, and M-1212 of the Electronic Computer Division of the Servomechanisms Laboratory.

3. Scope of Proposed Work

3.1 In addition to concluding that a digital computer of the type of Whirlwind I could accomplish the functions of a present analog system and that some combination of digital and analog equipment may be desirable, our final report will cite several problems that would require more work before digital techniques could be applied to naval fire control. Some of these problems, to which our efforts might be directed, are mentioned below.

3.11 Much still remains to be done in developing digital computers to the point where they would be satisfactory shipboard equipment. Speed, storage capacity, reliability, ease of maintenance, compactness, and sturdiness all need to be improved. Computer logic and special-purpose units should be reconsidered to determine what special characteristics computers should have so that they can control gunfire adequately and also be useful in some of the associated tactical control functions.

3.12 Development work is required to obtain suitable terminal equipment for digital computers working in a system that supplies and uses analog data. This is a problem that must be solved for any control application of digital equipment.

3.13 On the theoretical side there is the broad field of study concerning the behavior of control systems operating on intermittent data; a serious problem of stability is involved. A start has been made in applying some of the concepts and methods of analysis in the frequency domain to the discontinuous case. Tied in with this are questions of the character and efforts of quantizing and observational error (noise). A better understanding and improved methods of smoothing and prediction are expected to result.

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3.14 Several programming problems related to the digital computer's ability to make decisions require more effort. There are the questions of correlation of information from different sources, evaluation of target threat, assignment of weapons, and choice of tactics depending on battle conditions. Work on these would be general enough in its nature to benefit immediately the work now covered by Task Order 1 of N5cr1-60.

3.15 Finally, the question of the digital computer in the simulation of other equipment is one whose study will be of fairly widespread importance.

4. Magnitude

4.1 It is proposed that the contract be continued for a year with additional funds of \$32,000.

4.2 The following is an estimate of the cost breakdown for the next year:

| | |
|---------------------------------|----------|
| 2 DIC Staff @ \$5,200 | \$10,400 |
| 3 Research Assistants @ \$2,400 | \$ 7,200 |
| 1 Secretary | \$ 2,200 |
| | <hr/> |
| | \$19,800 |
| M.I.T. overhead @ 42% | \$ 8,300 |
| | <hr/> |
| | \$28,100 |
| Material and Services | \$ 3,900 |
| | <hr/> |
| | \$32,000 |

Signed

Jay W Forrester
Jay W. Forrester

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