M-1408
Quarterly Report, Contract N5ori-06002
July through September 1951
Project NR 232-001
Abstract: This report describes work performed during July, August, and September, 1951 on the extension of Contract N5ori-06002. All of the work is directed toward an analytical study of control systems involving digital computers as components.

1.0 INTRODUCTION

This is the first quarterly progress report submitted under the extension of Contract N5ori-06002 covering research performed during July, August, and September 1951 in application of digital computers to control systems. As proposed in Memorandum L-28 the research was to be directed toward:

(a) Further development of the digital computer itself.
(b) Development of suitable terminal equipment.
(c) Theoretical work investigating the behavior of a system involving a digital computer.
(d) Programming problems related to the Computer's ability to make decisions.
(e) Use of the digital computer in simulation of other equipment.

The bulk of the work done during the last quarter was directed toward (c). Work in areas (a) and (b) was done during this period at Project Whirlwind but under different contracts. Since it is more applicable to other projects than this it is not at present supported by our funds. Work in areas (d) and (e) will be done at a later date.

2.0 STATUS

The problems involved in analyzing the behavior of a system involving a digital computer arise because most components of a
system receive, operate on and transmit continuous signals. The
digital computer receives, operates on, and transmits sampled (discrete)
signals. Thus a system involving a digital computer is a mixed sys-
tem with some parts operating on continuous signals and with some
parts operating on sampled signals. If the computer interacts with
the rest of the system, the analysis of both sampled-data and con-
tinuous-data parts should be carried out in the same terms.

On the basis of work done on sampled-data control systems
at Project Whirlwind some time ago, sampling is comparable to amp­
litude modulation, desampling comparable to demodulation. Mixed
systems involving partly sampled and partly continuous data may be
analyzed in much the same way one would analyze an analogous but
simpler mixed system involving some parts operating on unmodulated
or direct signals and other parts operating on amplitude-modulated
signals. A doctoral thesis completed during the last quarter described
all linear digital computer programs by transfer functions
in the frequency domain. A master's thesis done during the last
quarter showed how the Wiener-Lee optimum linear system theory can
be applied to digital systems. An investigation has been started
on the problem of smoothing a computer output with a small phase
lag in the signal. One of the unique advantages of using the com­
puter as a control system element is derived from its ability to
make choices. Work is started on describing this operation but no
significant results have been obtained as yet.

Signed William K. Linvill

References:
1. Salzer, J.M., Treatment of Digital Control Systems and
Numerical Processes in the Frequency Domain, 1951,

2. Katz, Abraham, Computer Program Synthesis Based on Statistical
Communication Theory, 1951, M.I.T., S.M. Thesis
in Electrical Engineering.