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Memorandum M-1132

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SUBJECT: BI-WEEKLY REPORT, PROJECT 6782 November 24 1950

To: J. W. Forrester

1. GENERAL

(R. A. Nelson)

I continued reading the reports on Task 2 of the BTL Mk 65 project. We shall consider some of the points investigated in that work, from the point of view of digital techniques. They have done some analysis of the target-threat evaluation problem in the case of multiple-aircraft attacks. This might later be useful to us. They have also done some experimental work on the nature and magnitude of tracking and gun errors for different conditions and equipment.

In the light of the information available from the Mk 65 work, and because the coding for the Mk 47 computer is nearly done, I am reconsidering our next steps and overall program.

(A. Katz)

I have continued attending the weekly Numerical Analysis seminars being conducted by Prof. Z. Kopal. These have been concerned with the round-off and truncation errors one might expect when solving, by the Heun method, the differential equations:

$$x' = f(x,y)$$
$$y' = g(x,y)$$

This naturally brought up the question of what limitations must be placed on the minimum size of the increments, Δt, into which the interval of integration, t_0 to T, is to be divided. There is a lower bound to the magnitude of Δt if the round-off error is to be truly random. Some necessary (but not sufficient) conditions for randomness were established and evaluated.

M-1132

3. CODING

(J. M. Dodd)

All eight sections of the Mk 47 Computer solution having to do with the steady-state problem (as opposed to target acquisition) have been coded. A preliminary check has been made of the first four, and the others will be checked soon.

In addition to the program now completed in preliminary form, some additional orders will be required for a section having to do with target acquisition. The Mk 47 counterpart of this section is known as the "Set-up Computer".

It now appears that scale factors in parts of the present program will have to be readjusted to allow a more accurate solution, with variables (such as target range, velocity, and acceleration) limited to more reasonable values.

The continuous solution as now coded requires storage approximately as follows:

Main program	1000	stored orders
Subprograms	100	stored orders

(over 40% of the MP orders are required to evaluate the 12 "ballistic functions", each of 2 variables). Approximately 1700 consecutive operations are required for one solution.

4. DATA CONVERSION

(A. Katz)

For some time we have been in doubt as to the validity of considering the Gunar Mark I system as a typical gun drive. An essential difference between this and the more conventional drives is that, in the Gunar system, the gun is stabilized in space by means of rate gyros within the loop, while the other drives position the gun only with respect to the deck -- the compensation for ship's motion being done in the computer. As a result of discussions with G. R. Wieser, Prof. W. K. Linvill, and J. O. Silvey, this difficulty has been resolved: because of the limitations on bandwidth placed on the servo drive by the equivalent inertia and elastance of the turret and gears (about 8 to 10 cps),

4. DATA CONVERSION (continued)

it was concluded that a more conventional drive would not differ too markedly in its frequency characteristics from the Gunar system, about which we have detailed information.

Preliminary coding of the Mk 47 computer has shown that solutions (with ship's motion compensated) may be expected at a repetition rate of at least seven per second. Since a typical gun positioning system has a bandwidth of about 10 cps, we can draw the following conclusions:

a) the gun drive will experience undesirable transients if discrete signals are fed to it at this minimum solution repetition rate;

b) clamping alone of the signals will not completely eliminate those transients;

c) the use of computed gun velocity and acceleration orders would not improve the transient response so long as these were supplied at a minimum rate of only seven per second.

d) the transient response will be materially improved by extrapolating two or three solutions, so that the resultant solution repetition rate is about three or four times the servo loop bandwidth.

e) if practicable, the compensation for ship's motion should be done within the loop so as to reduce the time required for each solution.

f) the use of digital devices as error sensing and servo compensation elements is not only practicable but also desirable if the digital computer's capabilities are not otherwise more profitably utilized.

Having reached these conclusions regarding the gun servo, I now propose to abandon this phase of our effort temporarily and begin a study of the characteristics of and methods for smoothing the raw radar data.