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6673
Memorandum M-2100

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

SUBJECT: BI-WEEKLY REPORT, Project 6673, June 8, 1951

1. GENERAL

(C. R. Wieser)

The first draft of Summary Report #9 is being prepared.

During preparation for the demonstration held May 25th, all programs which required the extra 48 registers of ES were eliminated because the additional registers were considered less reliable than the normal 256. This decision was based on lack of experience with the extra registers, not on unfavorable operation. Programming to utilize these registers as needed should be resumed, and operation should be observed carefully so that it may be evaluated.

The 16-inch display scope will be moved into Room 224 to be used for 6673 operations. Observations and comments on the new display should be forwarded at once since the display system design will be "frozen" soon in order to build additional scopes (see Section 2).

2. ENGINEERING

(H. J. Kirshner)

An amplifier panel, designed and built by AFCRL, for remote ground/air radio operation has been delivered and installed. Operation appears to be satisfactory.

A patch panel has been constructed which enables the various audio devices in room 224 to be tapped. This panel permits selected audio to be heard on loudspeakers in either 224, test control or both.

The operational intercommunication system described in previous bi-weekly reports is under construction and should be operative during the next bi-weekly period.

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2. **ENGINEERING** (continued)

(H. J. Kirshner) (continued)

Three of the four special display 5" scopes have been modified for flip-flop intensification, and the fourth will be modified during the next period. One of these scopes has provision for normal CRT grid intensification.

One week of this period was spent on vacation.

(C. W. Watt)

A meeting was held June 4th to discuss the design of the 16" display scopes and the display decoders. Details are covered in M-1225, dated June 6, 1951. Briefly, 3 more 16" scopes and critical parts for 3 more will be built, making a total of 4 scopes to be completed. It is expected that the 3 scopes will be completed by September 10th, and the new decoders by August 27th.

3. **ANALYSIS FOR BEDFORD EXPERIMENTS**

(D. R. Israel)

The majority of the past bi-weekly period was spent in connection with matters of indoctrinating new personnel and in setting up new procedures for the use of assigned computer time (see section 6).

Work is again being put into the long-delayed description of the first 6673 programs. It is now hoped that the description can be completed in time for use by the new personnel.

An S. M. thesis entitled "The Application of a High-Speed Digital Computer to the Present-Day Air Traffic Control System" has been completed.

Thursday and Friday, June 7th and 8th, were spent on vacation.

(W. S. Attridge)

The interception program has been rewritten using extra ES registers and now can use either the smoothed tracked velocity or the given velocity of the interceptor in the collision calculations.

3. <u>ANALYSIS FOR BEDFORD EXPERIMENTS</u>   (continued)

(W. S. Attridge)   (continued)

Some thought has been given to the incorrect right-angle collision of May 23rd. Checks have been made of the program used and the tape seems all right. We have run the same data from the magnecorder and used the same program tape as we used on May 23rd but we continually get different headings than those given during the actual flight test. This, to me, indicates that something was wrong in the program during the flight test, possibly something like losing a digit in one of the sl orders in the program.

The punched-tape program has tracked and punched data on two aircraft. It is still not in its final form.

I am now writing a direct solution for the square root. I expect it to take only about 20 orders duration and about 25 registers.

(Frank E. Heart)

The first week of this period was spent in continued checking of the program for printing from tapes. It appears that this program is now operating, but further changes may be made. Some time was also spent on the smoothing problem.

The second week of the period was used for a vacation.

(D. A. Kemper)

Several programs whose sums on tape did not check were corrected and all my tapes were generally brought up to date. One of John Salzer's arcsine programs was run using the Trigonometric Check Program; two constants were optimized but the results are inconclusive because of the large increment used.

The Data Transcription program was found to be erratic due to the fact that occasionally the azimuth at which it was supposed to start or stop scanning would be received twice in succession. This is now corrected and the program works satisfactorily.

Two memoranda have been written for the benefit of the Indoctrination Program to be held next week. M-1226 is an informal and probably incomplete attempt to bring R-173-1 up to date, and M-1227 is a syllabus of the Program itself.

3. ANALYSIS FOR BEDFORD EXPERIMENTS (continued)

(J. Rossbach)

The program which displays a circle or any of 13 fixed points (landmarks) has been run successfully. A modification which displays a point with variable coordinates, as well as the fixed points, was prepared and run successfully. This modification will be available in final form some time next week.

PWTWS-Triple Polar by Jack Arnow was modified slightly. Two attempts were made to run it, but no conclusive results were obtained because of computer trouble and difficulty in obtaining Magnecord data.

PWTWS, using the arithmetic mean of all pieces of data in the search area, was run unsuccessfully. It is still not clear whether the trouble was in the computer or the program, so it will have to be run again before any more work can be done with it.

4. THEORETICAL ANALYSIS

4.1 General Studies

(J. M. Salzer)

Interesting results were gotten in the study of prediction based on pure (non-quantized) data. The classical three-point prediction formula corresponding to parabolic extrapolation was improved many-fold in the least-squares and maximum error sense under the assumption of a uniform distribution of the input frequencies in the band

$$0 \leqslant \omega \leqslant \frac{\pi}{4T}$$

where T is the time between sampling points. The interpretation of the upper limit is that 8 readings (samples) are taken per cycle; or with reference to the aircraft problem, 8 readings while the plane flies a complete circle. The classical formula is

$$x_{n+1} = 3x_n - 3x_{n-1} + x_{n-2}$$

while the improved one is

$$x_{n+1} = 2.73x_n - 2.73x_{n-1} + x_{n-2} \ .$$

4.1 General Studies (continued)

(R. L. Walquist)

The Cape Cod Muldar system is still being studied. Several
ways of accomplishing the requisite data correlation and
r-θ to x-y coordinate conversion are being evaluated with
regard to time, storage, and added equipment. Discussions
with R. R. Everett, N. H. Taylor, and R. P. Mayer have
helped to clarify certain of the associated equipment
problems. As soon as the auxiliary equipment usages (magnetic
drums and other external equipment) are more clearly in mind,
a memo will be written discussing a possible solution to the
problem along with some of the alternatives.

(P. R. Bagley)

Joined the staff in the middle of the bi-weekly period.
The time has been spent principally in studying the problems
of a multiple radar system: particularly buffer storage,
conversion of coordinates, and correlation. The rest of the
time has been spent in orientation with respect to the
computer operation, input-output equipment, and aircraft
tracking programs.

4.2 Data Smoothing and Aircraft Control

(J. M. Salzer)

The smoothed-velocity based on the inverted Simpson's
3/8-rule and mentioned in the last bi-weekly was tried on
the computer and turned out to be unstable (divergent).
This experiment was an aid in furthering the analytical
study of the formula, which has since been stabilized at
the expense of some precision. The new program will be
tried out as time permits.

(C. H. Gaudette)

A linear smoothing program, which uses one half the distance
between the first and third observation as its initial smoothed
velocity has been written. A trial run indicated that the
program was error-free.

4.2 Data Smoothing and Aircraft Control (continued)

(C. H. Gaudette) (continued)

A program using a least-square velocity-smoothing method
has been run successfully. The results indicate that the
smoothed velocity contains an error dependent on the quantizing
error of the first observation. A program using the same
method modified to eliminate this error is being written.

4.3 Correlation Studies

(F. Van Wyk)

After my two week absence during the final examination
period I returned to the problem of correlating target infor-
mation received from a radar net.

I included the area covered by the Muldar in an octant of
a circle and then divided the octant into "s" equal sectors.
There exist two possibilities for storage of information on
this basis. One is to have "s" blocks of "r" registers per
block where "r" will represent an optimum number, i.e. the
most probable number that will be necessary for storing
information about what is contained in sector "s" (this
would involve a rather large number of idle registers).
The other is to have differing numbers of registers in each
block. The requirement here is that the address of the first
register in each block will change as the amount of information
found in each sector changes. In turn, this condition neces-
sitates some method of keeping track of and locating these
addresses when needed.

My attack is centered on the former of these two possibilities
and I am furthermore resorting to the following simplifications:

(1) There are no interceptors in the area, only targets.

(2) The distribution of targets in the area is completely
random.

6. RECORD OF COMPUTER UTILIZATION

(D. R. Israel)

As a result of the experience obtained during the past several months by the various computer applications groups, new procedures have been formulated and put into effect for the utilization of 6673 operating time. These procedures and methods are intended to limit the amount of program error detection and correction while programs are being operated upon the computer. The new methods and procedures were put into use during the past week; the results, which are summarized below, were quite satisfactory and have already enabled us to realize certain economies in the use of computer time.

As before, programs will be operated upon the machines by their authors. Fifteen minute periods will be assigned to all new programs or programs which have not yet operated satisfactory. If an error is discovered during the 15-minute period, the operator will be permitted to use such manual intervention techniques as are desired. If the source of the error has not been discovered and corrected within about 10 minutes, appropriate data (op-sp records, storage punch out, etc.) should be taken for further study at the desk.

A key requirement for satisfactory operation is that tape modification and preparation be speeded up. Modifications to the tape equipment have been made for this purpose.

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6. RECORD OF COMPUTER UTILIZATION

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1305 - 1400	Preparation for demonstration
	Satisfactory operation. Data taken on PWTWS.
1400 - 1415	Data Transcription
	Satisfactory operation after an error was corrected.
1415 - 1437	Data Punch-Out
	Program error. Storage punch-out.
1440 - 1500	2 a/c Interception-punched tape
	Satisfactory operation.
1503 - 1523	Simulated Combat
	Several photographs taken.
1523 - 1545	Locus Display
	Several photographs taken.
1545 - 1600	1 Coordinate Velocity Smoothing
	Program Error. Storage punch-out.
1600 - 1615	1 Coordinate Prediction Testing and Printing Program
	Program errors in printing subroutine.
1615 - 1630	Display of Circle and Fixed Points
	Satisfactory operation.

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1340 - 1600	Preparation for Demonstration
	Computer power failure. Only 15 minutes of actual computer operation.
1630 - 1645	Trig. Check
	Parameters adjusted.
1645 - 1700	Data Transcription
	Tape preparation errors discovered.

6. <u>RECORD OF COMPUTER UTILIZATION</u> (continued)

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  1400 - 1415 Punched Tape Analysis
         Satisfactory operation.

  1415 - 1430 Check Interception
         Satisfactory operation.

  1430 - 1500 2 a/c interception - calculated $\sqrt{v}$
         Tape preparation error.

  1500 - 1530 Display of Circle and Fixed Points.
         Unsatisfactory computer operation.

  1530 - 1600 Data Punch-Out
         Unsatisfactory computer operation.

  1600 - 1630 1 Coordinate Prediction Test Program
         Photographs taken and data typed.

  1630 - 1645 Linear Smoothing
         Satisfactory operation after program error
  corrected.

  1645 - 1700 1 Coordinate Velocity Smoothing Program.
         Program errors.

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  1400 - 1415 2 a/c interception-punched tape
         New mode tried. Results inconclusive.

  1420 - 1445 Display of Circle and Fixed Points
         Satisfactory operation.

  1445 - 1500 Data Punch-Out
         Magnecorder not available at the time.

  1500 - 1515 Trig. Check
         Photographs taken.

  1515 - 1545 Data Transcription
         Satisfactory Operation.

  1545 - 1700 Criteria Smoothing
         Data taken.