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Memorandum M-1460

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Digital Computer Laboratory  
Massachusetts Institute of Technology  
Cambridge 39, Massachusetts

SUBJECT: GROUP 61 BI-WEEKLY, April 11, 1952

1.0 GENERAL

(C. R. Wieser)

A group from the Rome Air Development Center (RADC) visited Lincoln. During the summer of 1952 RADC plans to flight test the Raggazini interception computer. This is an analogue machine which computes a guidance point offset from the target so that the interceptor can be given a final turn (also computed) to approach the target from the desired angle. The final phase technique sounds identical with the one which we are preparing. RADC will inform Lincoln of the flight test program when it has been finally decided.

On April 9, demonstrations were held for a group of officers from Air Defense Command and Headquarters, Eastern Air Defense Force (EADF) and later for another group from Evans Signal Laboratory and General Electric Co. General Minty, Acting Commander of EADF stated that the 32nd Air Division has been asked to cooperate in the Cape Cod experiments with the Ground Observer Corps (GOC). What this actually means is that Lincoln will be officially introduced to the Manchester, N.H. GOC filer center personnel, who will be asked to aid us in obtaining GOC spotter data.

The group from Evans Signal Laboratory is working on the anti-aircraft part of air defense. Since they now have all their experimental equipment operating in another part of the country, it seems premature to engage in any joint experiments. However, liaison will continue, and another meeting will be held on May 6-7 at Evans.

(R.L. Walquist)

A talk was prepared and given at a Lincoln division 2 and 6 meeting. Our use of the Buffer Drum as an intermediate storage device between a group of radar sets and the computer was discussed, along with the methods proposed for getting information onto and off the drum.

2.0 EQUIPMENT ENGINEERING

(R. L. Best)

The modified circuit for the Group 24 flip flop appears to be less sensitive to tube deterioration than the original. However, production is far enough along on the original so that the slight improvement is not worth the delays that would be necessary to change. The results are being written up for the record as an E-note.

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2.0 EQUIPMENT ENGINEERING (Continued)

(E.S. Rich)

TERMINAL EQUIPMENT PLANNING

The first draft of a set of schedules covering the foreseeable work for the next 15 months has been completed by Watt, Dodd, Newitt and myself. More detailed work on these schedules will be done now to obtain accurate estimates of manpower requirements (engineering, shops, and drafting) for the remainder of this year. Newitt will keep the master schedules for terminal-equipment installation posted and will revise them from time to time to keep them up to date. These schedules show that integration of the initial IO System (IOS, IOC, ICR, paper tape equipment and scopes) will be finished by September 1, 1952, and magnetic tape units will be added by the middle of November 1952. The two magnetic drum systems, phone-line input counters, and other equipment needed to operate with 14 radars will have integration completed by the Fall of 1953.

(H.J. Kirshner)

Rockport terminal equipment has been re-installed and is now in operating condition.

The Time-Register was installed during this bi-weekly period but did not operate in a satisfactory manner. It is being modified to provide satisfactory operation. Modification and re-installation should be completed on or before April 17th.

An Ampex "400" recorder has been obtained for the purpose of recording data from the Rockport radar.

The twin track Ampex 3066 is to be delivered during the coming week.

MEW terminal equipment is in the process of being moved to 8 foot racks. Moving of the various pieces of equipment is being scheduled to provide a minimum of outage time and to maintain near normal operation during the move.

(J.H. Newitt)

The subject period has been spent in further work on the scheduling of terminal equipment and the detailed write-up of the circuitry for this equipment. Simplified and detailed descriptions have been prepared (with sketches) for the telephone line terminal equipment and the buffer drum access circuits. These are in typing and will be available soon for checking and general comments.

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2.0 EQUIPMENT ENGINEERING (Continued)

(A. V. Shortell, Jr.)

Installation of the Rockport telephone terminal equipment in the eight foot racks was completed during the past bi-weekly period.

At present I am working on the recording of slowed-down-video on the two channel Ampex recorder. Initial recordings indicate that the recorder is driven to saturation by the north marker pulse. Work on recording will continue during the next period.

3.0 BEDFORD EXPERIMENTS

(C. Zraket)

FLIGHT TESTS

A 2 a/c interception was held on April 3, 1952 to test the auto-pilot on the B-26 used as the interceptor. A B-17 served as target. The test was satisfactory; a final separation of 100 yards being reported. This test has been recorded on Magnecorder #132. A single aircraft run was made and recorded on the latter half of Magnecorder #132 for purposes of wind study being conducted by F. Heart.

A 2 a/c interception to test the Interception Program's tracking and smoothing using a fast aircraft (F-51) as interceptor was cancelled on April 4 due to a poor communication link with the F-51.

Several single aircraft runs were made and recorded on Magnecorder #133 on April 5 using a jet aircraft (F-94). Data on these runs is available on Magnecorder #133 Tape Record.

(P. Cioffi)

The results of the interception problem that has been under study have been written up to appear in a memorandum soon. The two methods of computing an interception course angle are being written up as subroutines. These methods have been tested on the computer.

(F. Heart)

A program was written to test the proposed beacon response. It is expected that a beacon response from the plane will be triggered by the radar beam, and the "reply" will be coded to give a "one" digit in the 9th position of the range return. (This position is not now used for ranges, but is used for azimuths.) The program is designed to give an "s" scope display of dots connecting the specific return and the origin. The program (T-1083) has not yet been tried.

Additional time was spent in debugging a Rockport display version of the basic interception program. This program is still not completely checked out.

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3.0 BEDFORD EXPERIMENTS (Continued)

(F. Heart) (Continued)

In order to obtain more data on wind correction, data from a flight test at constant altitude, velocity, and heading was obtained by H. Kirshner. An attempt was made to track and analyse this data, but it was difficult to pick the correct target from among other extraneous returns. Another attempt will be made.

(S. Knapp)

The Three Aircraft Interception Program has been run and apparently is working satisfactorily. At least one more trial will be held, however, before it will be run operationally.

I am also going to write a four aircraft interception program which will handle two targets and two interceptors.

I have been considering the problem of multiple aircraft tracking as regards the maximum number of aircraft which can be tracked. It seems that there is time to track 10 aircraft. A rough flow diagram has been drawn up and a Ten-Aircraft Tracking program will be written.

(C. Zraket)

The Final Approach Guidance Program (T-1073) discussed in the previous bi-weekly has been run with hopeful results. The data input, tracking, and smoothing sections operated successfully but no attempt was made to test the accuracy of the turn calculations and the time count. Future runs will test the accuracy of the heading angle with and without wind correction, the off-set point, and the "time to turn" circuit. It is hoped that once this Guidance Program is checked out, the final phase calculation can be incorporated into an interception program.

Testing of the two explicit solutions for interception (T-832) is continuing. Elimination of various anomalies due to certain combinations of velocity ratios and separation of the two aircraft is needed before final check-out.

4.0 DATA SCREENING

(R. Walquist)

In order to check and evaluate several ideas on automatic acquisition of targets, radar-data-target correlation, and target storage requirements, a program is being prepared which will simulate the program to be used with the Cape Cod Muldar system. This program which has been referred to in previous bi-weeklies, will make use of the interim magnetic tape system in order to free itself from the restriction of "real time".

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4.0 DATA SCREENING (Continued)

(R. L. Walquist) (Continued)

Discussions of this program has been held with Attridge, Bagley, and Ishihara. These three will be responsible for the majority of the programming work involved. Attridge is to coordinate the work of this group and is responsible for its successful execution.

(W. S. Attridge, Jr.)

I have started to write a flow diagram for the first muldar tracking program. The program will be written in collaboration with P. Bagley and J. Ishihara.

(P. R. Bagley)

Data Recording on Magnetic Tape Data recording for 3 Radars (T-909) has been visually checked and revised, and will be run again soon.

Initiation The problem of automatic initiation of targets into the Muldar system has been talked over with Walquist, Attridge, and Ishihara. The techniques described in the last bi-weekly have been agreed upon as a basis for writing a muldar program which embodies correlation, tracking, and automatic initiation. Attridge, Ishihara, and myself have commenced work on this program.

(J. Ishihara)

Various modifications for the "Three Stage" correlation program have been investigated in an attempt to "minimize" operating time. Further changes are also being made to fit the correlation section into a muldar tracking program.

5.0 TRACKING AND CONTROL

(J. Arnow)

Work is continuing on obtaining some figures of merit for the various methods of smoothing and tracking using multiple radars. This should be greatly enhanced upon the arrival of the Scituate terminal equipment which is due to arrive some time next month.

Measurements were taken of the rotation rate of the antenna at Rockport and indicate that a considerable fluctuation exists. Over the day deviations of 1.25 seconds per scan were recorded with a gradual increase in time per scan noted as the day progressed. This variation could seriously affect all of the programs for two radars as presently envisioned.

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5.0 TRACKING AND CONTROL (Continued)

(A. Mathiasen)

The two tracking programs for two radars, TRASACT I and TRASACT II, have undergone further tests. Some results have been plotted as velocity vs. time. A comparison of some of the results show that the two methods of data handling are about equally good. TRASACT II does, however, display an anticipated jump in velocity when the situation changes from one of double coverage to one of single coverage. At 300 knots true velocity, this jump was a maximum of 15 knots. The effect of misses by a radar will be studied to test this phenomenon when both radars are capable of seeing the aircraft.

A comparison of results from TRASACT II with values of  $\alpha = 1/16$ ,  $a = 5/16$  and  $\alpha = 3/32$ ,  $a = 3/8$  shows a faster approach to velocity with the latter as expected, but no increase in the amplitude of the oscillations in the steady state.

(M. Frazier)

Polysmooth has been completely rewritten and remains to be checked out. Work has been initiated on writing a PWTFT for the data from Bedford and Rockport radars. This will be pressed in anticipation of the reintroduction of the Rockport link in the coming week. In addition to the above and debugging and operating the present fairly large group of programs, some thought will be given to the problem of two-radar-two-aircraft-tracking.

(B. Lone)

The TRASACT FF (Two Radar Single Aircraft Tracking, First Fit) program has been completed and is to be tested. This program will track from two radars and smooth every 14 seconds unless enclosed by a search sector in which case smoothing is done at the end of the sector. If both sectors enclose, the smoothing is done at end of later one. Velocity is predicted on the basis of the best fit from the first search sector in the 14 second interval if one exists; if none, then best fit from the second search sector is used. Separate positions are predicted for both radars.

6.0 AIR DEFENSE CENTER OPERATIONS

(D. R. Israel)

The plotting board in Room 157 has been completed and about 80 man-hours of work have already been spent by the GOC group in the plotting of various data. The primary objectives in this plotting are to give us experience with the filtering problems and to provide us with track data which can be used in preliminary tracking studies.

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6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(D. R. Israel) (Continued)

On April 10, AAA problems were discussed with representatives from Evans Signal Corps Laboratories. The most concrete results of this meeting were plans to hold another meeting in May and a decision that in the near future we would try to coordinate our experiments with the local AAA group at Fort Banks.

(C. Gaudette)

The test program for displaying GOC Data (Ground Observer Corps) will be ready for a trial run during the next period. Several changes in the methods of displaying the data have held up its completion.

(F. A. Webster)

A considerable portion of the present bi-weekly period was spent in analyzing observer data obtained from the White Plains Filter Center. Very few tracks could be established with certainty for a number of reasons. Contributing particularly, perhaps, were: spotty coverage (i.e., few active posts), roughness of heading and time data and the nature of the air traffic in the region. Near New York City the traffic was heavy and many of the aircraft were presumably flying curved courses. The approximate 8-mile by 8-mile quantal unit is not fine enough to permit tracking under these conditions.

7.0 ASSOCIATED STUDIES

(P. R. Bagley)

Magnetic Tape Subroutines The magnetic tape block recording and reading subroutines written by Walquist have been run successfully. I am revising the recording subroutine to increase the recording density to a safe maximum, and to take advantage of the change in the rc\* order.

Indoctrination problem My indoctrination problem, a Single-Aircraft Tracking Program (T-1074), has been revised and sent to Tape Preparation. The program will be tried in the near future.

Orientation Some time has been devoted to studying Computer Block Diagrams (R-127).

7.0 ASSOCIATED STUDIES (Continued)

(G. Cooper)

Work has been resumed on the thesis investigation. A formal extension has been made of White's approach (see M-1387) to treat a multi-dimensional variable consisting of the positional coordinates and the velocity components of the aircraft and including prediction as well as filtering. This result gives an expression for the probability distribution of the predicted position and the present velocity in terms of a general higher order conditional probability distribution describing the paths of aircraft (which is assumed to be known a priori) and the observed positions. Work is now being done on finding the appropriate expression when the conditional probability distribution is that of a Markoff process. It should be pointed out that we are dealing with a case in which signal and noise are not independent (as assumed in White's work) since the quantizing error (analogous to noise) depends very strongly on the position (the signal). This is being taken into account in the work.

(J. W. Craig)

About two-thirds of the first draft of the condensed form of John Salzer's thesis has been completed. Some of the proofs have been revised, and much of the repetition has been eliminated. It appears that the number of pages will be one-fifth that of the original.

(H. R. J. Grosch)

I have been discussing speed, word length, and special operation requirements of the air defense problem with the WWII group. One possibility of some interest involves incorporating a shift (right or left) or clear instruction into each pertinent single-address order. A complementing instruction could also be added. This assumes a word length of 32 bits, with many special half-word orders. Equipment required would be 1024 cores, a 64-way switch, and one or two extra drivers.

(F. Heart)

Some time has been spent assisting in the current indoctrination program.

A large proportion of my time has recently been spent writing a Master's Thesis entitled "Applications of Self-Checking and Self-Correcting Codes to Digital Computers." I am hoping to finish this thesis this month.



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7.0 ASSOCIATED STUDIES (Continued)

(D. R. Israel)

A group consisting of Walter Attridge, Jr., Sylvia Chaplain, Charles Gaudette, David Israel, and Ron Mayer will attempt to coordinate efforts directed towards the preparation of new literature to be used for future indoctrinations. This group must necessarily draw heavily upon the time and efforts of other staff members.

A very large proportion of time during the past bi-weekly period was spent in preparation for visitor demonstrations and in the interviewing of prospective candidates.

(I. Mann)

Most of this period has been spent on indoctrination problems. The problem of the comparison of two punched tapes is almost completed.

(N. S. Potter)

After several false starts and a good deal of confusion, the forward reading magnetic tape problem is well under way. The statistical tracking program was run, but because of several minor programming errors, which have been found, and, it is hoped, computer difficulties, the test was not successful. However, another trial will be made shortly.

(R. L. Walquist)

Some of the solutions to the indoctrination problems have been revised in order to bring them up-to-date. The present indoctrination group have completed all of the problems which do not require computer operation. Their solutions are being checked by Ishihara.

8.0 COMPUTER OPERATIONS

(J. Arnow)

Analysis

Data Screening	2.00
Tracking & Smoothing	15.75
Aircraft Control	2.75
Miscellaneous	3.25
Total	<u>23.75</u>

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8.0 COMPUTER OPERATIONS (Continued)

(J. Arnow) (Continued)

Total Analysis	23.75
Calibration	1.25
Installation	2.50
Flight Tests	3.25
Demonstrations	<u>3.75</u>
Total used	34.50
Lost Time	9.75
To Math Group	<u>3.75</u>
Total Assigned	48.00

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9.0 PUBLICATIONS

(M.R. Susskind)

The following material has been received in the Library, Rm. 217, and is available to Laboratory personnel:

LABORATORY REPORTS

1. "Whirlwind II Block Diagrams Meeting of April 8, 1952," Hosier, W. A., M-1449, pp. 1-3.

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2. "Whirlwind II Meeting of April 4, 1952," Taylor, N.H., Mayer, R.P., M-1453, April 9, 1952, pp. 1-6.

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TECHNICAL REPORTS

1. "Quarterly Progress Report," Research Laboratory of Electronics and Project Lincoln, Communication and Components Division, M.I.T., Cambridge, Mass., January 30, 1952, Lib. No. 231.

SECRET

2. "Radar Interceptor," Quarterly Review, Research and Development Laboratories, Hughes Aircraft Company, Culver City, California, March 1952, Lib. No. 1763.

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3. "Feasibility of Actuating Trainers by Digital Computers," Progress Report No. 1, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia 4, Pennsylvania, February 1, 1952, Lib. No. 1774.

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4. "Optical Guidance Problem," Project Cyclone, Reeves Instrument Corporation, 215 East 91st Street, New York, New York, Job. No. 57-1.1, Contractor: Bureau of Aeronautics, February 12, 1952, Lib. No. 1775.

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