Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: GROUP 61 BI-WEEKLY REPORT, May 9, 1952

1.0 GENERAL

(C. R. Wieser)

Captain Widger from AFCRC visited us to discuss presentation of weather data. He is assigned to study this problem for air defense operations. We will exchange any ideas on this subject which come up.

It appears that Group 61 will move to the Whittemore Building (as planned) sometime in June. In the meantime, Stock and Purchasing will move (probably next week). The space which they vacate will be used by Group 61 to relieve the congestion in Room 156.

Boehmer, Whelan, Israel, and Wieser will visit Evans Signal Laboratory next week to discuss the integration of Antiaircraft weapons in the air defense system.

2.0 EQUIPMENT ENGINEERING

(E. S. Rich)

A revised block diagram of the terminal equipment for the phone line inputs has been prepared. The revisions were made after discussions with Harrington and Rosen of Division 2 as to details of the design of the slowed-down video discriminator and the CRT mapper for clutter rejection. Werlin is preparing a new block schematic of this system from which a revised list of plug-in units required will be obtained.

Work has been started by Shortell to evaluate the first model of a CRT mapper supplied by Division 2. The aim of this work is to determine what problems exist in developing a satisfactory clutter rejection device. Some questions to be answered are: What resolution can be obtained? Is a 5-inch CRT satisfactory? Is defection-amplifier drift a problem? What CRT phosphor should be used?

Wieser, Arnow, and I discussed the design of a 31 digit system for ground-to-air communication with Staples, Antman, and Zschirnt of AFCRC. This is to replace the present Blue Coder. There had been some confusion as to how the new system could be integrated with the computer since the radio transmitter to be used operates from its own source of time pulses. This confusion was cleared up in the meeting and specifications were set

2.0 EQUIPMENT ENGINEERING (Continued)

(E. S. Rich) (Continued)

on how the equipment should operate and what signals should be provided. The new equipment will be delivered next fall.

(H. J. Kirshner)

It is hoped that the majority of the difficulties which have impaired the proper operation of the "Time Register" have now been made small in number. Bench checking indicates that the "Time Register" should, when connected to the computer, operate properly.

A few malfunctions of the MEW terminal equipment were noted after this equipment had been moved to its new location. Among the difficulties was the improper operation of the digital P.P.I. Although, in theory at least, improper operation of this 'scope should not affect the success of a flight test, it was evident in practice that such is not always the case. This scope is very helpful in the period of time, during a flight test, when the computer is not operating. It is highly recommended that for the three radar systems a P.P.I., which is independent of the computer, be installed for each radar. The time and confusion saved will more than compensate for the additional cost and equipment. The B-scan anticipated for this purpose is a poor substitute for a P.P.I.

Rockport terminal equipment had its share of operating difficulties. These were cured by the replacement of a bad flip-flop panel.

A short glimpse of Scituate SDV was obtained on May 8th; the Scituate line was connected to the Rockport terminal equipment, and after some adjustment, a picture appeared on the B-scan. It is premature to make any comment regarding the quality of the Scituate data other than to say that the ringing which appears on the Rockport line is also in evidence on the Scituate line. It may be that an improvement of line balance or some compensating technique may improve the quality of transmission.

Attention to other details, as well as those mentioned above, has precluded devoting too much time to the multi-channel magnetic tape equipment. A more careful investigation than that noted in the previous bi-weekly report has disclosed that the playback amplifiers of this equipment are similar as to noise characteristics. It appears that an improvement in the playback S/N ratio can be made by reducing the rated bandwidth of the equipment. Fortunately we do not require a wide band recorder since we are interested in recording only one data channel (2K.C.) per track.

(B. Morriss)

The Timing Register (Real Time Clock) which has been installed may be placed at any of the Test Storage addresses by inserting the cable at Test Storage in the desired jack just as the flip-flop registers

2.0 EQUIPMENT ENGINEERING (Continued)

(B. Morriss) (Continued)

are assigned. As installed, TR may be read out by any order which is stored in ES (ca, ad, cs, mh, dv, etc.). The correct contents will be obtained in both automatic and normal modes, but an incorrect reading may be obtained if the computer is restarted on TP's 4 or 5 and the next TP 6 is to read from the clock, or if the order referring to TR is stored in TS. No provision has been made for reading to TR, or for resetting to any desired number. The TR may be cleared by push button at TR.

(J. H. Newitt)

During the subject period I have devoted a good deal of effort to the considerations involving the consolidation of all present and future air conditioning requirements for the Barta Building into a flexible and efficient arrangement. Since recommendations from the Carrier Corp. have not been forthcoming to date, I have assembled the essential parameters and have made calculations which accurately delineate the scope of the problem. From these figures, a plan which contains a few alternatives has been devised. This plan will be the subject of a memo to be issued soon. My calculations and recommendations, which form the basis of the plan, have been discussed with two professors at the Institute and the local Carrier representative. No objections or modifications were proposed by these men. Carrier is having my recommendations checked by their chief engineer in N.Y.C. They expect to submit their recommendations in a week or so and a specification for bidding purposes will be prepared as soon as general policy approval is obtained.

A small portion of the above period was devoted to reviewing the room arrangement and power installation recommendations for Room 156 which were compiled by R. Hunt. It is quite imperative to our schedule that Room 156 be vacated by the end of June at the very latest.

Further effort was devoted to the problem of rack cooling of the P.I.U. equipment to be installed in Room 156. After consultation with Profs. Holt and Kaye of the Institute, I feel quite sure that I have the correct solution to this problem. Prof. Kaye has offered to visit Barta in a few weeks to give the overall heat-exchange problem a little closer scrutiny.

(A. V. Shortell, Jr.)

Work on the voice channel multiplex equipment used with the Magnecorder has not produced any improvement in its operation. As mentioned in the last bi-weekly, the greatest source of distortion is in the demodulator chassis. Replacement of the crystals in the bridge rectifier produced little change. Poor filtering seems to be the greatest cause of trouble. Work on this equipment has been interrupted due to other matters, but efforts will be expended in this direction as time permits.

2.0 EQUIPMENT ENGINEERING (Continued)

(A. V. Shortell, Jr.) (Continued)

At present I am working with the video-mapper equipment to obtain some data on its operation for Ed Rich. Initial efforts have included some modifications of the azimuth decoder used with the equipment and the development of a scheme for masking out undesired clutter. At first the mask will consist of a negative print on a 3¼" x 4" glass plate.

Studies will be made to determine whether a shorter persistence screen should be used, whether it will be necessary to use a larger CRT to obtain better resolution, and how the circuitry may be improved.

3.0 BEDFORD EXPERIMENTS

(D. R. Israel)

Our flight test program is being accelerated. We have already tried, or will shortly try, programs involving a) use of the beacon, b) positioning height finders, c) final guidance, d) jet aircraft tracking, and e) interceptions with evasive targets and hi-speed interceptors.

(C. Zraket)

FLIGHT TESTS

A test was held on April 30 to check the following:

1. Beacon response from an aircraft equipped with a beacon transponder

2. Instructions (R,θ) given to the Rockport 584 in order to simulate putting a height finder on target.

The "beacon response" worked well only at short ranges. The 584 at Rockport was able to follow the aircraft satisfactorily after having been given his R,θ coordinates by us. Further tests will be conducted to check the above.

Four runs using an F-51 as interceptor and a C-47 as target were made on May 1, the target traveling on an evasive course in each case. Runs 1,2, and 4 resulted in final separations of 100ft., 50ft., and 500ft. respectively. The radar data stopped during Run 3 when the two aircraft were two miles apart. Further tests employing a high-speed interceptor and a target traveling on an evasive course will be held. Similar interceptions attempted on May 9 were inconclusive due to faulty data transmission or receiving equipment difficulties.

A Final Phase Guidance test was attempted on May 9 using a B-25, this test being inconclusive due to anomalies in the program.

3.0 BEDFORD EXPERIMENTS (Continued)

(P. O. Cioffi)

The program mentioned in the last report (T314-7, par. 4) has been run several times using Magnecorder data. The interception heading angles as computed by the lead angle solution method were quite satisfactory as compared to the heading instructions on the magnecorder tapes. The number of runs actually tested is small so that more testing is planned.

(F. Heart)

A program (T1083-2) to test an aircraft beacon transponder is now operating correctly.

The trouble which intermittently has disrupted the main interception program was located during the last week. (This trouble is described by C. Zraket.) This also explains the difficulty which bothered the program for display of target coordinates from Rockport.

With the assistance of C. Zraket and S. Knapp, Magnecorder data on F94 jet tracks has been processed. The data was recorded on MT 133. Processing was tried by two methods: (1) use of "data punch out" and "print while track from tape" programs (2) use of "guidance punching" and "single aircraft printing analysis" programs. These analyses used smoothing method NLS-2-C. The printed results indicated that the tracking and smoothing, while not exceptional, was quite satisfactory. Additional jet data will be taken in the near future, in preparation for a jet interception attempt.

(S. Knapp)

I have started work on a basic multiple aircraft tracking program. The program will track sixteen aircraft. The program will be kept as flexible as possible by making many of the sections into subprograms, so that it can be used to try new experiments such as automatic initiation for interception programs, etc. A rough flow diagram has been drawn up and much of the programming done.

(C. Zraket)

The Final Phase Guidance Program (T-1073) has been run operationally during the last two flight tests with erratic results. The main trouble seems to lie with an unstable offset point, resulting in large discontinuities in the heading angle. As a first correction, linear smoothing will replace NLS-2c.

The trouble occurring with the basic interception program (T-1000-5) when it is run with MT 130 was discovered after the last visitor demonstration. The difficulties lie in the fact that no immediate indication is given when there is no interception possible due to the relative positions and velocities of the two aircraft. Secondly, if

3.0 BEDFORD EXPERIMENTS (Continued)

(C. Zraket) (Continued)

$V_i < V_t$, two real solutions may exist, the iterative method then selecting the longest time solution. The large wind correction on MT 130 (80 knots) intermittently made $V_i < V_t$, thereby giving violent discontinuities in the heading angle. It is hoped that this anomaly will be eliminated when the explicit solution for interception is incorporated in the program. Work has been started on this program which will also include final phase calculations.

Study of explicit solutions for interception has been finished. Description of this work has been included in a memo and two subroutines written by P. Cioffi.

4.0 DATA SCREENING

(R. L. Walquist)

If all goes well, Muldar Tracking Program #1 should be operating during this coming bi-weekly period. Besides offering a check on "time" and computer storage requirements, this program will allow us to evaluate various methods of correlating information and carrying out automatic initiation. The first techniques being tried consist of a simplified two-stage correlation procedure and an initiation scheme which attempts to initiate tracking of each new return. Such an initiation scheme appears questionable due to the relatively large number of noise returns which may occur in the system. As soon as manpower is available, other initiation schemes will be studied.

Discussions with Wieser and Harrington indicate that an attempt is being made to introduce height data into the Cape Cod Muldar System via the Truro radar. If this scheme works, it requires that the computer send instructions as to the targets for which it desires height data. It will be possible to call for height data on more than one target per radar scan if the requests for height data occur in correct azimuth sequence (i.e. height data on targets at 30°, 60°, and 90° would be obtained in a single radar scan, whereas requests made in the opposite order would require 3 scans). Efficient use of such a scheme thus necessitates sorting the requests for height data into correct azimuth order. Initial study is being made of this problem.

(W. S. Attridge)

I have completed programming the smooth and predict section of Muldar Tracking Program #1. While working on this section, several interesting aspects of indexing procedures arose. Incorporation of this section with the sections written by Bagley and Ishihara is being done now.

I attended the A.C.M. convention in Pittsburgh on May 2 and 3.

4.0 DATA SCREENING (Continued)

(P. R. Bagley)

MULDAR DATA RECORDING

Clutter Table Construction for 3 Radars (T-908), Filtered Data Recording (T-909), and an associated test program, Recorded Data Display (T-910) are awaiting the successful completion of the computer clock.

CLUTTER REJECTION

Excessive parity alarms, tape reproducing errors, and Magnecorder troubles have resulted in virtually no progress with Stationary Clutter Rejection (T-716). The latest criterion for accepting returns as stationary clutter is the receipt of two identical returns, separated by at least two scans, within eight successive scans. The results of using this criterion are being analyzed.

(J. Ishihara)

A correlation section for the Muldar Tracking Program #1 has been completed and is now in the process of incorporation. Counters have been added to gain information about the operation of the program. "Time" requirements will be calculated on the basis of this data.

(N. S. Potter)

The forward reading magnetic tape program should be run this week. Work on a differential corrections process for use in the interception program is being done in collaboration with A. Perlis. Excluding large changes in the heading angle ψ created by reinitiation or large turns, increments in ψ may be expected to be reasonably small after the operation of the smoothing process on the information of several scans. These changes are approximable by rational processes of considerably shorter time duration than that required by an entire computation. A test program is now under preparation.

5.0 TRACKING AND CONTROL

(J. Arnow)

A flight test was held during this period to obtain an indication of the type of coverage that is available with the Rockport 584. A C-45 was used and flew two runs between Rockport and Scituate and return. The first run was made at 5000 feet and the target was observed out to a range about 25 - 26 miles. Initial pickup on the return leg was made at about the same range. The second run was made at 8000 feet, and there was never evidence of anything resembling a track.

(M. Frazier)

Computer and tape preparation difficulties have not expedited the location of some rather obscure faults in Polysmooth.

The Bedford-Rockport two-radar tracking program, having evinced some rather fundamental timing difficulties when run with data from two radars, has been completely rewritten and simplified from the timing point of view. It is hoped that more success will be achieved with the revised program.

Some further consideration was given to semi-real time programming, indicating that it would be quite easy to allow a slow depreciation of performance with overload by means of this technique and will probably have to be used if the potentialities of the present system are to be fully utilized in all except the exceptional "worst possible" cases.

(W. Lone)

I have introduced a parameter into the Trasact FF (2-radar single-aircraft tracking, first fit) program which enables the tracking to approximate true velocity at a faster rate. Since on initiation we predict the aircraft position on the next scan to be the same as the present observed position, the difference between the next observed position and the predicted position provides a reasonably good measure of true velocity. Using this method with simulated data, within 10% of the velocity is attained after the first scan. I plan to analyze this system further and run more tests.

(A. Mathiasen)

Tests of TRASACT I & II have continued. A comparison of results for one flight path using different values of α showed that for TRASACT I, with α of 1/16, 3/32, and 1/8, the deviation from true velocity after the initial transient was less than 3% (9 knots in 300). As expected α of 1/8 gave the best initial smoothing, both with respect to the time required to reach full velocity and to the amount of overshoot. For all flights tested, α of 1/8 gave the least maximum deviation after ten scans, but α of 1/16 gave a lower frequency of oscillation. For TRASACT II, there was no one value of α which gave the least maximum

5.0 TRACKING AND CONTROL (Continued)

(A. Mathiasen) (Continued)

deviation for all flight paths. In general, in both TRASACT II and W. Lone's tracking program, the maximum fractional change in velocity in the stable state is equal to α, so that a smaller value of α seems called for in these methods than in others.

A parameter for TRASACT II changing the treatment of D_x and D_y for the individual radars from one of averaging to a summation has been written. This has the advantage of simplicity. It remains to be seen how good or poor are the results.

Non-linear smoothing parameters are being written for both smoothing programs.

The calibration program for the SCR-584's (T-1045) was at last tested and worked satisfactorily.

6.0 AIR DEFENSE CENTER OPERATIONS

(C. Gaudette)

A large portion of the past period has been spent plotting the White Plains Ground Observer Corps data for the test exercise of December 1, 1951. Initially, all the information reporting one multi-engine aircraft during a 2 1/2 hour period was plotted. 62 tracks were obtained with an average of 2.4 reports per track. The same data was refiltered and this time 82 tracks were obtained with an average of 2.7 cards per track. Although a large number of reports were added to the original tracks, the average number of reports per track only increased a small amount because the new tracks were mostly two report tracks. We are now in process of plotting all the data reporting one aircraft (i.e. jets, unknowns, single-, multi-, and bi-motored planes) between the hours of 1100 and 1300. Although the process is much slower the results show considerable improvement. Several tracks have been formed with reports from different posts reporting different types of aircraft and several of the multi-tracks have been supplemented by including bi-motored reports.

The Ground Observer Corps Data Display Test Program has been operated twice but still contains minor errors. The size of the vectors and numbers will be cut in half in order to determine if the information will still be readable.

Two methods of storing the positions of the White Plains Observation Posts are being studied. A program will be written to display the posts on one scope and vector displays of reports at the proper post on the other scope.

6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(F. A. Webster)

Most of this bi-weekly period has been spent on Staff indoctrination problems and working on Ground Observer data. By the use of colored arrows (for position, heading, and type of aircraft), together with time and track indications colored according to type and track development, it has been possible to plot a great deal of simultaneous data without confusion. More complete tracking is thus facilitated.

7.0 ASSOCIATED STUDIES

(P. R. Bagley)

MAGNETIC TAPE

Considerable time has been spent in learning to utilize the interim magnetic tape storage unit and the magnetic tape output typewriter. One block-recording and two block-reading subroutines have been revised, successfully tested, and written up for the Library of Subroutines:

1. Record Block of N Registers on Magnetic tape (Air Defense version: T-988-7; Math version: T-988-8).

2. Transfer Block of N Registers from Magnetic tape to ES, I (T-989-1).

3. Transfer Block of N Registers from Magnetic tape to ES, II (T-1161-2).

A subroutine entitled Record Single Flexo Character on Magnetic tape (T-1192) has been written and partially tested. This subroutine replaces a qp (200 + n) order where it is desired to record Flexo characters on Magnetic tape for later printing out on the Magnetic tape output typewriter.

MISCELLANEOUS

Time was spent in preparing for the Whirlwind exhibit at M.I.T. Open House.

A talk on the use of electronic equipment for searching files is being prepared for an Industrial Liaison symposium.

The last three days of this period were spent on vacation.

(G. Cooper)

As an illustration of the application of the Recursive Smoothing method (described in M-1387), a numerical example using somewhat idealized sets of probabilities has been made up. While the results of this example

7.0 ASSOCIATED STUDIES (Continued)

(G. Cooper) (Continued)

should by no means be regarded as conclusive, they are encouraging. A straight-line course was assumed, and the correct value of velocity was obtained by this method after three readings. Absolute certainty in the value of velocity was obtained after five readings. It should be pointed out that this example was idealized to the point where absolute certainty regarding the velocity was possible. In actuality this does not hold if we are dealing with quantized position data.

It is also planned that a memo will be written describing the Limit-Mean Smoothing method.

(F. Heart)

A Master's Thesis entitled "Applications of Self-Checking and Self-Correcting Codes to Digital Computers", was, except for typing and assembly details, completed during the last bi-weekly period.

(D. R. Israel)

In conjunction with Attridge, Mayer, Taylor, and Wieser, a "Digital Computer Laboratory Training Course" has been outlined. This course, to replace our present indoctrination program, will be of a seven-week duration and is set up so that a good deal of the lectures are applicable both to programmers and designers. For the most part, the lectures to be given to programmers are those which form the basis of our previous indoctrinations. It is expected that the Training Course will be started during the week of June 16-20.

The Pittsburgh meeting of the Association for Computing Machinery was attended on May 2 and 3. I paid particular attention to those sessions dealing with the use of subroutines and related techniques. It is hoped that within the next several weeks it will be possible for several of the Group 61 staff members to meet and decide upon subroutine techniques applicable to the Air Defense applications.

(A. J. Perlis)

I attended the Pittsburgh meeting of the association of Computing Machinery in Pittsburgh May 1-3, 1952.

Several approaches to sub-routines suggested at the above meeting are being incorporated into a proposal for the creation of a library of sub-routines and their efficient use by members of the Air Defense group.

With N. Potter, a differential correction scheme for heading angle calculations has been evolved which will cut down the calculation time by a factor of $1\frac{1}{2} \sim 2$ if too frequent re-initiations of a track do not occur. A program is being written to test this procedure.

7.0 ASSOCIATED STUDIES (Continued)

(J. W. Craig)

About one-third of the final draft of the shortened form of John Salzer's thesis has been completed, and the remaining two-thirds is expected to come along rapidly.

8.0 COMPUTER OPERATIONS

(J. Arnow)

During the thirty six hours of time used this period for various analysis programs, fifty two tapes were run. Of these, twelve contained tape preparation errors which were discovered at the computer. In order to correct this and discover the cause of the errors, everyone should submit a tape preparation complaint when an error occurs.

Radar and Relay Link	0.25 hours
Data Sreening	5.25 hours
Tracking and Smoothing	22.5 hours
Aircraft Control	5.0 hours
Ground Observers	1.5 hours
Miscellaneous	1.5 hours
Total Analysis	36.0 hours
Calibration	0.75 hours
Equipment (installation and checking)	3.00 hours
Visitors	1.5 hours
Flight Tests	7.00 hours
Lost due to computer failure	4.00 hours
Time given to math group	4.75 hours
Total	57 hours

9.0 PUBLICATIONS

(M.R. Susskind)

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

LABORATORY REPORTS

1. "WWII Block Diagrams Meetings of April 16-17, 1952," Hosier, W.A., M-1466, April 28, 1952, pp. 1-5.
   CONFIDENTIAL

2. "Boundary Conditions for Whirlwind II Design," Forrester, J.W., M-1468 April 29, 1952, pp.1-2.
   CONFIDENTIAL

3. "Utilization of Magnetic Drum and High-Speed Random-Access Storage," Walquist, M-1473, May 2, 1952., pp.1-4.
   CONFIDENTIAL

4. "WWII Block Diagrams Meeting of April 24, 1952," Hosier, M-1475, May 5, 1952, pp.1-4.
   CONFIDENTIAL

TECHNICAL REPORTS

1. "The Integrated Electronic and Control System," Project MX-1179, Monthly Progress Newsletter No. 18, Research and Development Laboratories, Hughes Aircraft Company, March 1, 1952, Lib. No. 243/S.
   SECRET

2. "Progress Report No. 3, XSSM-A-14 (Major) Missile," January 1, 1952-March 31, 1952, Redstone Arsenal, Ordnance Corps, Department of the Army, Huntsville, Alabama, January 15, 1952, Lib. No. 242/S.
   SECRET

3. "Combined Bimonthly Summary No. 28A," Supplement to Combined Bimonthly Summary No. 28, December 30, 1951-February 29, 1952, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, March 31, 1952, Lib. No. 244/S.
   SECRET

4. "Probability of Detection of a Bomber and Conversion into an Attack by a Ground-Vectored Interceptor," March 1951 Method and Results, Ballantyne, F.P., Stillman, W.P., Lind, J.R., The Rand Corporation, Santa Monica, California, May 4, 1951, Lib. No. 245/S.
   SECRET

9.0 PUBLICATIONS (continued)

(M.R. Susskind) (continued)

5. "Afterburning Turboject Interceptor Capabilities," Aircraft Division, RM-561, The Rand Corporation, Santa Monica, California, May 11, 1951, Lib. No. 246/S.

SECRET

6. "Long-Range Surface-To-Surface Rocket and Ramjet Missiles," Reliability, R-176, The Rand Corporation, Santa Monica, California, May 1, 1950, Lib. No. 247/S.

SECRET

7. "Publications of the Jet Propulsion Laboratory, Memorandum JPL-9, Supplement 3," California Institute of Technology, Pasadena, California, February, 1952, Lib. No. 274.

CONFIDENTIAL

8. "Sky Brightness Measuring Instrument," A.F. Project MX-775, Report GM-561, Northrop Aircraft Inc,, Northrop Field, Hawthorne, California, October 1951, Lib. No. 1809.

RESTRICTED

9. "Maneuvering Barriers for an Offset Collision-Course Tactic," Ballantyne, F.P., RM-576, The Rand Corporation, Santa Monica, California, May 4, 1951, Lib. No. 1810.

CONFIDENTIAL