Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: GROUP 61 BIWEEKLY REPORT, December 26, 1952

2.0 EQUIPMENT ENGINEERING

(N. Alperin)

A second light gun, Model II, is being built and two channels on the panel are being modified in preparation for the coming display evaluation.

(H.J. Kirshner)

Scituate S.D.V. terminal equipment will be modified during the coming biweekly period for the incorporation of a video mapper.

There apparently have been some anomalies in the performance of the Bedford D.R.R. receiving equipment. A thorough check of the equipment disclosed no equipment malfunction. Errors evidenced themselves as azimuths appearing out of proper sequence and although they did not appear on the 12" D.R.R. scope, they were detected by a computer program written for the purpose of error detection. Similar errors could be produced by detuning the various channels of the D.R.R. and by incorrectly phasing the timing channel. Whether or not detuning was the cause of the trouble has not been conclusively proved.

(J.H. Newitt)

The past period was spent in setting up the framework for keeping a detailed schedule of outside and inside physical equipment progress for the WWI new equipment program. It is apparent that the summary schedule alone will not be sufficient to properly coordinate the activities of our various groups. The reasons for this lie in the fact that some of the groups do not keep detailed schedules and thus have no accurate way of predicting trouble in advance. By the time detailed difficulties exert their effect on the summary schedule it is usually too late for efficient corrective action. Further, the lack of good communication between groups with regard to the progress of critical details has been a sizeable factor in slowing our progress. Since it is recognized that under present pressures most group members do not have time to devote much effort to coordination, record keeping, scheduling, procurement, expediting, and other semi-technical details, I will try to perform this function for them. In addition, I expect to function as special expediter for both outside and inside activity whenever it appears that progress will be slowed by the neglect of certain key items.

2.0 EQUIPMENT ENGINEERING (CONTINUED)

(J.H. Newitt) (Continued)

Air conditioning installation work is continuing and since the proposed control system now seems to be satisfactory, this work will require very little of my time from now on.

(F. Sandy)

Rm. 156 Power Distribution. The motor-generator set for the Drum Bays in Room 156 has arrived. However, the starter was not with it. Ed Rich is checking with ERA to find out what happened to the starter. Bob Jahn is testing the M-G set to see if it is in proper working order.

Gavitt Mfg. delivered some more cables, but has not delivered them all, yet.

A temporary marginal checking setup has been installed so that Ken McVicar can test the Auxiliary Drum. An improved design is to be built for him. Due to a special rheostat that had to be ordered this improved system will not be installed before January 23, 1953.

(A.V. Shortell, Jr.)

I am presently planning mounting of the video mapper scope and associated circuitry in a 6-foot rack so that the equipment may be moved into 224 for testing with the S.D.V. equipment.

The Teletalk installation is essentially complete with the exception of the masters in Room 222. Two master stations will be installed in that room during the next biweekly period.

A rather serious defect in the design of the Teletalk system has been noted. If two masters should have the same speaker station selected simultaneously, the signal from the speaking master overdrives the amplifier at the listening master. This difficulty will be investigated further.

(G.A. Young)

A report describing the operation of the paper tape units and readers is being written.

On December 31, Ed Rich and I visited AFCRC to discuss the ground-to-air link unit which they are constructing for the laboratory. We were informed that the unit will be ready well before March, the date previously set for completion. Several methods of connecting this unit to the computer are being considered.

3,0 BEDFORD EXPERIMENT

(F.M. Garth)

After three cancellations due to non-operational weather, an automatic initiation flight test was again atttempted during the afternoon of January 2. However, before a fighter could be picked up by MEW all operations had to be stopped because of communications failure between Grenier Air Base and the Barta Building.

Final work was done on a program which was designed to increase the display flexibility of program 2187 (Basic Two Aircraft Tracking and Interception). It will allow a choice of two or three sizes in displaying information on as many scope lines. Additional sizes, scope lines, and positions can be introduced by a minor modification of the program.

Improvement in the technique of automatic initiation has been considered. It is felt a more elongated search area during the take-off period would assure a better chance of the desired aircraft being accepted by the computer.

(C.H. Gaudette)

A program to check the MEW data has been written and operated successfully. The program was written hurriedly in order to have available some means of checking the data. The program did indicate that azimuths were occasionally coming in out of sequence on both live and recorded data. This partially explains the erratic results recently obtained with the two aircraft interception program. The radar data analysis program will be rewritten to provide a more thorough check of the MEW data.

Work has been started on a new display program which will demonstrate display techniques.

(F. Heart)

A January flight test schedule, M-1775, has been published.

Efforts are being made to improve photographic recording of final-phase interceptions. The Lincoln Photo Lab is assisting in this problem.

An attempt to improve radio security has been inaugurated by the Lincoln group in charge of radio. Groups using radio links were assigned code names and call letters.

Work is continuing with S. Knapp and A. Ward on the four-pair interception program.

Effort has been made (with J. Cahill and Group 22 personnel) to incorporate the Scituate TPS-10 height-finding radar into our experiments. So far only preliminary tests have been made.

3.0 BEDFORD EXPERIMENT (CONTINUED)

(F. Heart) (Continued)

Repeated attempts to run a successful automatic initiation test from Grenier Air Force Base have failed; troubles with radio, weather, and aircraft procurement are responsible. Further attempts will be made.

(S.C. Knapp)

The revised version of the Sixteen Aircraft Initiation and Tracking Program, including automatic sequencing for height-finder data and information display, has been completed.

Some progress has been made on the Four-Pair Intercept Program.

(C.A. Zraket)

In conjunction with D. Israel, a rough draft was drawn up of the duties and equipment needs of the Intercept Monitor in the proposed Cape Cod System for September, 1953. Study of the overall room space, layout, and equipment needed for this system has been initiated.

A Final-Turn Interception was conducted on December 31 using a B-26 as interceptor and a B-17 as target. Three runs were made; the first two were tail attacks, the third a nose attack. The first and third runs were fairly successful, although the turn was made slightly too soon in each case. The second run was highly successful, and it is hoped that the pictures taken of this run from the interceptor aircraft turn out well.

4.0 DATA SCREENING

(W.S. Attridge, Jr.)

I have been helping Peterson with his magnetic tape data storage program. We plan to use this program to store data from the maximum effort flight test scheduled for 9 January.

I am continuing work on the Lincoln Summary Report.

(J. Levenson)

Using test parameters, all errors have finally been located in the parts of MTP #2 which we have been checking out. Now the way is clear to begin a further study of correlation methods employing the drum and eventually Whirlwind II.

4.0 DATA SCREENING (CONTINUED)

(D. Goldenberg)

In connection with some of the phases of the problem outlined in the last biweekly, the following results have been found:

a) The distribution of probable returns about the predicted positions is nearly a Gaussian distribution due to the convolution of the distributions for the accuracy of the predicted positions, quantization errors and the distortion and displacement of the track based upon slant range instead of the ground range.

b) The probability of returns occurring within overlapping areas of search is a function of the distance between predicted positions, the probability of multiple returns, the number of radar which can "see" a target and the switching time of the buffer drum, which is the time interval for sampling.

c) Using data recorded for "blip-scan" ratios while tracking F51, F94, and F80 aircraft, the frequency distribution of the number of returns from one radar for one scan was calculated to be:

Number of Returns	% of Scans
0 (a miss)	21
1	65
2	13
3	1

d) Assuming the distribution of coverage for the Cape Cod System determined by W. Clark for 12 radars (5 x 32 miles), the probable number of returns from a target for one scan was calculated to be:

Number of Returns	% of Scans
0 (a miss)	8
1	30
2	24
3	17
4	11
5	6
6	3
7	1

(J. Ishihara)

The correlation section of the Muldar Tracking Program #2 (MTP #2) has now been completely checked out using test parameter tapes to simulate operational conditions. As a final check a test tape will be made up which will transfer the subprograms of this section from magnetic tape and check the operation of the program.

4.0 DATA SCREENING (CONTINUED)

(H. Peterson)

During the biweekly period, I have written the program I discussed in the last biweekly and a display program to go with it. They are both on tape and awaiting opportunity to run on the computer.

(H.H. Seward)

A second checking parameter for Ishihara's track sorting section of Muldar Tracking Problem #2 was run successfully on the computer last week. A more complete checking parameter is now being written.

5.0 TRACKING AND CONTROL

(B.R. Stahl)

TRASACT Single Position, Best Fit, although not tracking satisfactorily, is still being checked out.

Work has been started on a two-radar multiple-aircraft tracking program.

(W. Lone)

The program which attempts to remain fixed on an aircraft being tracked when another aircraft crosses its path has been written and tried on the computer. It contains a number of errors, some of which have been discovered. Work on this will continue.

The two-radar single-aircraft tracking program which averages time and positions has been run with most of the data tapes. A. Mathiasen is analysing the results.

(M. Frazier)

The simulated data two-radar single aircraft tracking program using the common velocity-separate track method of data combination was run successfully with all data tapes.

Work continues on the study of semi-real time programming. In terms of what can be done in absolutely worst possible cases, this method has little, if any, advantage over more straightforward methods. However, it is possible with this method to allow slight deterioration with considerable increase in tracking capacity. Thus, three aircraft may be tracked with no loss in correlation in the worst case, although some clutter may not be displayed. This compares with two aircraft and three radars using straightforward methods, with all data displayed. However, with slight deterioration, probably as many as six or eight aircraft may be tracked with three radars, and the direction of deterioration may be allowed for in advance, if desired.

6.0 AIR DEFENSE CENTER OPERATIONS

(D.R. Israel)

The past biweekly period was entirely spent in the preparation of a rough draft proposal of the non-track-while-scan function of a non-buffer-drum Cape Cod System to be operative by September. This proposal is essentially complete in rough draft form and hectographed copies have been prepared for interested people. During the next biweekly period the proposal will undergo detailed investigation and evaluation.

(M. Brand)

Cape Cod System. Work has continued on the identification section of the Cape Cod System. On the basis of work in conjunction with P. Cioffi, I have designed an identification clerk's console which provides means for recording and processing incoming flight plan data, time storing this data and reading it into the computer.

Further conferences with R. Davis of Group 22 and more visits to Truro are planned for this biweekly period.

Display Program. I have been working with C. Gaudette in the writing of a simulated tracking and identification display program. This program will illustrate different methods of transferring displays from one scope line to another, the use of various flicker rates to identify types of displays and the use of various types of activation buttons and switches to change displays.

(J.J. Cahill, Jr.)

Poor results in recent AA Guidance and Height-Finder Calibration tests have been tentatively laid to trouble discovered in the incoming data as a result of the use of C. Gaudette's data analysis program. The trouble seems to have been corrected, and the results of tests to be run in the next biweekly period are eagerly awaited.

Preliminary proposals for the use of AAA and Height-Finding in the September 1953 Cape Cod System have been prepared in conjunction with D.R. Israel and G. Rawling. Work on final proposals is progressing.

The TPS-10 Height Finder will be exercised during all coming flight tests using the MPS-4. At first the computer will not be used to generate range-azimuth information, but the aircraft can be used to assist in calibrating the weapon, the pilot's radio reports on his location being compared with the locations found by the weapon.

(P.O. Cioffi)

Work on the identification phase of the Cape Cod Air Defense System continued this period. Details of this work are reported by M. Brand.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(F.A. Webster)

I have been out sick during half of this biweekly period. During the remainder of the time further consideration has been given to some problems of automatically adapting systems. An attempt is being made to develop a simple symbolism that expresses the required (program) functions graphically. Such functions may be considered as lumped groups of operations that have a distinct functional purpose. Essentially this leads to a type of flow diagram where form and position indicate symbolically the nature of the required operations.

7.0 ASSOCIATED STUDIES

(W.A. Clark)

Special Displays. At the suggestion of B. Morriss, a program has been written and demonstrated which displays randomly placed points with a basic rate of flicker generated by introducing a program delay between points. This effectively simulates a display taken directly from a magnetic drum. The total number of points may be selected and is either 8, 16, 32, or 64. By means of light gun action, any point may be forced into a display mode in which it subsequently appears with one of eight different pulse rates (stepped by powers of 2) and one of 32 different degrees of brightness (produced by multiple-intensifications, also stepped by powers of 2). These parameters are introduced by means of the GOC box.

The program is designed to answer several questions:

1) Under "flicker-free" conditions, how many different "categories" may be resolved by the visual detection of differences in pulse-rate and brightness? What are the numerical values of these parameters?

2) How does this resolution depend on the basic rate?

3) For what values of the basic flicker rate is operator fatigue limiting?

Further study of all of these questions is indicated by the few demonstrations of this program which have already been run. One tentative result is that brightness seems to be a more important attention-calling parameter than does pulsation.

7.0 ASSOCIATED STUDIES (CONTINUED)

(E.J. Craig)

A new and simpler method has been devised for using the method of "descent" for the solution of linear and non-linear problems. (I say "new" advisedly since I really mean that I have never seen it in print.)

The only serious disadvantage of the method is that it is no faster than the method of "vector-step descent" described by J.M. Ham in his thesis, though it is simpler and can be extended to non-linear simultaneous equations.

It is felt that the author now has real insight into methods of descent, but that the results themselves are not exciting enough. Current work is directed along two lines: 1) An attempt to find solutions in a finite number of steps, and a correlation between the method of steepest descent with continuous servos, and steep descent with sampled-data systems.

(R.C. Jeffrey)

An investigation of the error in computing sin and cos by the difference equations

$$s(i + 1) = s(i) + mc(i);\ s(0) = 0$$

$$c(i + 1) = c(i) - ms(i);\ c(0) = 1$$

for small m (e.g., $m = 2^{-5}$), indicates that the truncation error is about 2^{-5} for $\sin \frac{\pi}{2}$ and reaches a maximum slightly beyond $3\pi/2$. A program is being written to determine the effect of roundoff error and to test schemes for reducing the total error.

(W.I. Wells)

The ideal detector for smoothing sampled data where the second derivative of the function is normally distributed, and the noise is normally distributed has been derived. This detector is exactly the same form as the linear smoothing equations that have been in use here. This constitutes the vigorous demonstration of their validity. I hope now that the method used for this problem can be used on more general problems, such as correlation.

8.0 COMPUTER OPERATIONS

(M. Brand)

Commencing January 5, 1953, our computer time will be re-shuffled so that three days a week two hours in the morning and in the afternoon are available for flight tests. Under this arrangement all time available due to cancellation of flight tests will be turned over to Adams' group. This implies that all our program checking and testing will now be done on our scheduled night time.

The following is a summary of scheduled computer time used by Group 61 during the past biweekly period.

MEW Tracking and Control	
Flight Tests	2.00 hrs.
Magnetic Tape	1.08
Data Screening	4.00
Multiple Radar Tracking and Control	14.60
Indoctrination Programs	0.40
Miscellaneous	0.83
Calibration	0.91
Equipment Characteristics	0.42
Total Time Used	24.24
Time Lost to Computer	2.25
Time Not Used	2.58
Total Assigned Time	29.07

DATE	TIME	SCHEDULED TEST A/C	SCHEDULED TEST Description	TEST ACTUALLY RUN A/C	TEST ACTUALLY RUN Description	REASONS FOR CHANGES OR COMMENTS
12/23	1000-1200	B-26 B-26	FINAL PHASE INTERCEPTS	-	Cancelled	Weather
12/24	1000-1200	T-33 F-80	TAKE-OFF INITIATION	-	Cancelled	Checking data
12/29	1400-1600	F3D	NAVY JET COVERAGE	F3D	As Scheduled	
12/30	1000-1200	F-51 B-25 C-47	TWO-ON-ONE INTERCEPTS	-	Cancelled	Only two aircraft available
12/31	1000-1200	B-26 B-17	FINAL PHASE INTERCEPTS	B-26 B-17	As Scheduled	

* Added to schedule during week of test

9.0 FLIGHT TESTS (CONTINUED)

(A.P. Hill)(Continued)

Dec. 29 1400-1600 NAVY JET COVERAGE

A Navy F3D was used to determine coverage in the southeast sector at altitudes ranging from 6,000' to 12,000'. In general the results looked favorable, a blip scan ratio will be taken from the Ampex Tape for detailed results.

Dec. 31 1000-1200 FINAL PHASE INTERCEPTS

A B-26 was used as the interceptor equipped with AI and a movie camera to film the final phase of the intercept. Three runs were made with the interceptor starting over Concord at 8,000' and the target (B-17) starting over a point 15 miles east of Rockport at 8,500'.

Results:

Run #1 Tail on
Fighter rolled out 2500 yards to the left of the target. No AI lock on.

Run #2 Tail on
Fighter rolled out 2000 yards directly to the rear of target. AI locked on at this point. Pictures were taken of this run.

Run #3 Head on
Fighter rolled out 10° left and 6000 yards ahead of target. Closest separation - fighter passed 2000 yards to right of target.

10.0 PUBLICATIONS

(M.R. Susskind)

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

LABORATORY REPORTS

1. "Group 61 Biweekly Report, December 19, 1952," M-1773, pp. 1-17.

   CONFIDENTIAL

2. "Flight Test Schedule for the Month of January, 1953," M-1775, A.P. Hill, December 29, 1952.

   CONFIDENTIAL

3. "Summary of Group 61 Flight Test Activity, April 1951 to November 1952," D.R. Israel, M-1765.

   CONFIDENTIAL

4. "Flight Test Activity Report of November 1952," Heart, Hill, M-1758, December 16, 1952.

   CONFIDENTIAL

5. "Design and Construction Schedule, WWII Prototype," Kromer, Mayer, Taylor, M-1753, December 11, 1952, pp. 1-6.

   CONFIDENTIAL

TECHNICAL REPORTS

1. Radar Interceptor, Monthly Newsletter, Research & Development Laboratories, Hughes Aircraft Company, November-December 1952, Lib. No. 1763C.

2. "Integrated Fire Control System for Terrier," Monthly Progress Report, October 1952, RCA, Camden, New Jersey, Lib. No. 1951C.

   CONFIDENTIAL

3. "Variable-Order Prediction in Airborne Fire Control," North American Aviation Inc.,Downey, California, March 1, 1952, Lib. No. 2218C.

   CONFIDENTIAL

10.0 PUBLICATIONS (CONTINUED)

(M.R. Susskind) (Continued)

4. "Combat Ready Aircraft," An Air Force Staff Study Prepared by Deputy Chief of Staff, Development, USAF, April 1951, Lib. No. 2201.

CONFIDENTIAL

5. "An Apparatus for Providing Radar Data to a Remote Digital Computer," Report R-8, University of Illinois, Control Systems Laboratory, November 1, 1952, Lib. No. 2199C.

CONFIDENTIAL