CONFIDENTIAL

UNCLASSIFIED
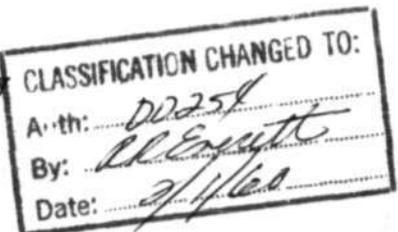
61
Memorandum M-1448

Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

CLASSIFICATION CHANGED TO:
Auth: DD251
By: _____
Date: _____

SUBJECT: GROUP 61 BI-WEEKLY, March 28, 1952

1.0 GENERAL
(C. R. Wieser)

Work with data from the Rockport radar has been temporarily discontinued while the terminal equipment is relocated in eight-foot racks. This move, which is being made to relieve congestion in Room 224, should be completed during the next bi-weekly period. In the meantime, two-radar tracking from simulated data has given good results.

Ed Rich visited E.R.A. and reports (see Section II) that progress on the two drums for WWI appears to be on schedule.

(W. S. Attridge, Jr.)

I have devoted a major portion of the past bi-weekly period to the indoctrination program. The present program seems to be a big improvement over previous programs mostly because of the slower pace. The results from the first group of problems are now being studied.

2.0 EQUIPMENT ENGINEERING

(E. S. Rich)

Considerable effort has been spent by Watt, Dodd, and myself to work out detailed time schedules for the design construction, installation, and test of the terminal equipment system needed for the Cape Cod experiments. The items included on these schedules have been carefully selected to include only those units necessary to make the 14-radar system operable. It will require at least another week to obtain a meaningful 1st approximation to the amount of time and manpower required for the overall job. However, the effort already has been valuable in helping to clarify the magnitude of the job. It is evident that more manpower will be needed and that certain phases of room layout and installation should be started immediately in order to meet the desired overall completion dates.

MAGNETIC DRUMS

I visited Engineering Research Associates, St. Paul on March 25 and 26 to discuss their progress on the two magnetic drum systems being constructed for this project. In general, it seemed that satisfactory progress is being made and that no bottlenecks of procurement are in sight. However, scheduled delivery dates of a few critical components are close to the scheduled dates for construction so delay is possible if delivery schedules are not met.

CONFIDENTIAL

UNCLASSIFIED

SECURITY INFORMATION

CONFIDENTIAL
UNCLASSIFIED

2.0 ENGINEERING EQUIPMENT (Continued)

(E. S. Rich) (Continued)

Their estimate for delivery of the Auxiliary Drum System was October 1952 and for delivery of the Buffer Drum System was January 1953.

Some information in the mechanical characteristics of the two systems was obtained to assist us in planning room layout and power distribution. They will cooperate in supplying us detailed information on circuits and their parts of the system as fast as they are available for use in my indoctrination program.

(J. H. Newitt)

Activity during the subject period consisted of:

1. Further study of the technical aspects of the buffer and auxilliary drum equipment.

2. Planning with E. Rich, S. Dodd and C. Watt for the scheduling of the in-out and terminal equipment for the air defense activity (overall equipment engineering construction, test and installation).

(F. Heart)

BLOCK DIAGRAMS -- IN-OUT

As a first attempt, a drawing was made of scope operation, including timing charts and a block diagram. An attempt is being made to see if other in-out units can be represented clearly in this fashion.

(H. J. Kirshner)

Rockport terminal equipment is in the process of being re-cabled after having been moved. A change in the mode of operation is being made to permit the use of separate read out gates to Whirlwind and enable the use of the B-scan display while the equipment is feeding data to Whirlwind.

Difficulty encountered with the ground/air link on March 26th was traced to the Telephone Company test equipment being used on the data line between here and AFCRC.

The installation of a beacon receiver at the MEW has been completed. Beacon response will be mixed with the radar video and as such will be sent to us as a normal D.R.R. transmission. In addition, beacon response will be coded as the least significant digit (formerly a mile) in range.

UNCLASSIFIED

CONFIDENTIAL

2.0 EQUIPMENT ENGINEERING (continued)

(A.V. Shortell, Jr.)

Work on the recorder multiplex system has been suspended. During the past bi-weekly period, I have been working on the installation of the Rockport radar terminal equipment in the 8 foot racks in Room 224.

(W.S. Attridge, Jr.)

I wrote a short program for H.J. Kirshner to check the automatic transmission link equipment. A PC end-carry pulse is generated for the "read-out" command.

3.0 BEDFORD EXPERIMENTS

(C. Gaudette)

The analysis of the Data Tapes with Printing While Tracking From Tape is continuing. Two new Data Tapes with 90° turns are now available.

A smoothing parameter analysis program, which selects the optimum parameters within a given range has been written and operated successfully. The true $(x,y,)$ positions are computed, converted to (r,θ), quantized, and reconverted to $(x,y,)$. Sets of parameters yielding errors less than the errors of a selected set of parameters are printed out. This method has been avoided in the past because of its length in both storage and time.

(S. Knapp)

DPO is now working.

The Three Aircraft Tracking and Interception program has been run on the computer. The tracking section seems to be working satisfactorily, but several errors were discovered in the interception calculations. Further study of P. Cioffi on the problem of the direct heading angle solution has disclosed that the method used did not always give the best solution. The program, therefore, is being modified to include a new criterion for a solution; that if $V_i \leqslant V_t$, then $(x_t - x_i) \cdot x_t + (y_t - y_i) \cdot y_t$ must be negative. I hope that the program will be ready for a second trial within the next few days.

(C. Zraket)

FLIGHT TESTS

A Flight Test was held on the afternoon of March 26 for the purpose of visitor demonstration. Voice transmission of heading angle was employed, with a B-26 used as the interceptor and a B-17 as the target. The two aircraft interception program with wind correction and NLS-2c smoothing was used, the test being recorded on Magnecorder #131. Despite

3.0 BEDFORD EXPERIMENTS (Continued)

(C. Zraket) (Continued)

the presence of other aircraft in the immediate vicinity of both target
and interceptor, thereby rendering the identification and tracking problems
more difficult, the interceptor passed directly underneath the target,
the altitudes being 9000' and 9500' respectively.

Mention of auto-pilot trouble in the previous bi-weekly was in
error; the trouble occurring in the data link instead.

(F. Heart)

Continued effort has been placed on writing and debugging various
modifications to the Interception Display program. The modification which
displays the target coordinates from Rockport as a base point is almost
working correctly, and the remaining mistakes will be out soon. Several
modifications were changed to make use of the new "s" scope.

A proposal was written regarding a more optimal use of the three
scopes now available. (Inter-office Memo of 3/14/52 to D.R. Israel). No
changes as yet.

With C. Gaudette and S. Knapp, time was spent in debugging a
version of the Data Punch Out (DPO) program which includes a particular
form of smoothing (NLS-2C). Renewed effort in this direction is being made
in order to get printed information about high velocity tracks -- which may
be recorded on Magnecorder some time soon.

The wind question was considered further. This work is an attempt
to find out whether the computer-plane-radar link can be used to determine
the wind. Data taken for a constant velocity path on a constant heading
was plotted and analyzed, (with aid of P. Cioffi). For a continuous run
of about 16 scans, the wind determined by the computer was in disagreement
with Weather Bureau data by about 10% in Heading and about 25% in Velocity.
Although perhaps not good enough, this result was a little encouraging, and
more data of this type will be taken. Additional flight test data was requested,
and will be forthcoming soon.

(C. Zraket)

The Final Approach Guidance Program T1073, has been completed
and sent to the tape room. This program will guide an aircraft to a mid-course
or off-set point with respect to the final guide point or objective. From
the mid-course point, the aircraft will make a turn at a pre-determined
angular velocity until it reaches a given approach angle. The aircraft will
then travel along this final approach angle until it reaches the objective.
The final approach angle, the distance travelled along this angle, and the
angular velocity during the turn are variables controlled by flip-flop
settings. The aircraft will be instructed by the computer when to make the

CONFIDENTIAL
UNCLASSIFIED

3.0   BEDFORD EXPERIMENTS (Continued)

(C. Zraket) (Continued)

turn and whether it will be to the right or left. Timing signals from
the Bedford Radar data.will be used to count the time to turn, this count
starting two scans before reaching the off-set point and being displayed
in FF3 in binary-coded decimal. Wind correction will be used.

The Interception Test Program (T-832) has been run with fairly
successful results. An inter-office memo is being written by P. Cioffi
fully describing the two explicit solutions for interception being used
and the programming requirements for each. The two methods are general for
any two aircraft flying straight-line courses irrespective of velocity ratios.
Since an interception calculation will be made once per scan (every 15 seconds)
in an operational program, the error introduced by non-straight-line courses
will be negligible, rendering the two methods entirely general for two air-
craft. Although the storage requirements are high in comparison with the
iterative method now used, the time duration should be considerably smaller
especially at small intervals of separation. Further study is continuing.

The Interceptor Assignment Demonstration Program has been run
unsuccessfully due to a tape preparation error when the three sections were
combined. This has been corrected.

The modification to the present Interception Display Program to
give automatic initiation on an interceptor based at Grenier was run with
poor results. The extrapolated position was some 10 miles away from the
aircraft when it was finally picked up by the radar after reaching altitude,
nullifying automatic initiation. A weighted extrapolation or some other
method will be tried.

(P. O. Cioffi)

An arcsine approximating function used in the Interception
Test Program has been prepared for the sub-routine collection.

The ITP has been run with a fair degree of success but is still
capable of furnishing additional information. The investigation will be
continued for a complete analysis.

I am completing the 1 a/c tracking staff indoctrination problem.

UNCLASSIFIED

CONFIDENTIAL

CONFIDENTIAL
UNCLASSIFIED

4.0 Data Screening

(W. S. Attridge, Jr.)

Several suggestions were made in a discussion concerning initiation and cessation of tracking. It is possible to make maximum use of the capacity of any one program by treating the two operations interdependently, other things being equal. More detailed discussion may be found in a memo being written by P. Bagley.

(J. Ishihara)

A draft of the "Three Stage Correlation" program has been completed. Further refinements will be made in conjunction with discussion with R. L. Walquist. Any "final" form will largely depend on methods used in other sections of this problem. With this in mind a rather flexible program is envisioned.

A portion of this period was spent in leaving computer operation in conjunction with the Staff Indoctrination Problem.

(P. R. Bagley)

Clutter Rejection. The stationary clutter rejection program for a single radar (T-716 mod 6 param 8) has been run successfully and the displays photographed. The stationary clutter rejection program for three radars (T-908-3) has been run with apparent success, utilizing a single radar to simulate three radars. The latter program has been adapted to operate with data from three radars, but the adaptation has not yet been run. The clutter rejection technique presently used removes only 70 to 80 percent of the stationary clutter in a ten-minute run. A slightly different approach is being considered which may provide a higher rejection figure.

Data Recording on Magnetic Tape. Data Recording for 3 Radars (T-909), a program to record filtered data on magnetic tape, has been coded.

A test program (T-910) to read and display the data blocks recorded on magnetic tape by the above-mentioned program (T-909) has been written with the co-operation of J. Ishihara.

Initiation and Cessation. Some practical ideas for dealing with initiation and cessation in the Muldar tracking system have been evolved by myself and others. I expect shortly to start programming to put these ideas to practical test.

A summary of the thinking to date has been included in an inter-office memorandum addressed to Wieser and Walquist.

UNCLASSIFIED

CONFIDENTIAL

CONFIDENTIAL
UNCLASSIFIED

4.0 Data Screening (continued)

(P. R. Bagley) (cont.)

Among the most significant concepts are the following: Attempt to auto-
matically initiate on all returns which do not correlate with existing
tracks. Tracks may be divided (not necessarily physically) into "tentative",
"high velocity" (aircraft), and "low-velocity" (cloud) tracks. A certain
number of scans after initiation, a tentative track is transferred auto-
matically to the high or low-velocity track group, or it is discarded.
All tracks are to be smoothed and predicted with the same techniques (probably
NLS-2B). A newly-initiated track can be installed in the place of a true
low-velocity track; in this way tracks will eventually be built up for all
aircraft from which returns are consistently received.

(N. S. Potter)

        A modified form of the straight line process of the statistical
tracking program has been written, and the tape has been prepared. It is
designed to provide for print-outs of the most probable heading and velocity,
computed to a greater number of significant figures than would normally be
employed in tracking, the greater accuracy being necessary for a determination
of the dispersion of the predicted quantities.

        Work has begun on a magnetic tape reading program which should be
finished shortly.

5.0 Tracking and Control

(J. Arnow)

        The telephone switchboard is in the process of being installed.
Present specifications call for the inclusion of talking lines to Rockport,
Scituate, MEW at Bedford, data link group at Cambridge Research Center and
the new Lincoln Laboratory. In addition two central outside lines will be
available, a tie line to the Barta Bldg switchboard and an MIT extension
will be included. Present estimates indicate that the system should be
functioning by the middle of April.

        Work on the two-radar program continues. No further studies on
live data were possible during the period due to the moving of the terminal
equipment for the Rockport Radar.

UNCLASSIFIED

CONFIDENTIAL

5.0   TRACKING AND CONTROL (continued)

(A. Mathiasen)

The two-radar single-aircraft tracking program (TRASACT I) was
run with eight simulated data tapes tracking with excellent results for
the whole "flight". Since linear smoothing was used, it did take an
average of ten "scans" to reach full velocity. No erratic behavior due
to the relative shifting of the two search sectors of the radars was
observed.

A second program (TRASACTII) of simpler concept was written.
It is similar to TRASACT I except that no predictions are made for the
individual radars. Instead a single prediction is made which (in double
coverage areas) turns out to be for a time approximately midway between
the times for the centers of the two search sectors. This program was
run with one data tape and tracked successfully. No comparison between
the two methods has as yet been made.

(M. Frazier)

Two programs are available for tracking a single aircraft from
the Bedford and Rockport radars. The first of these punches out range,
azimuth, and time for each radar once per scan, with an indication of
the radar and whether or not an initiation was performed. A program has
been written to type this information out. The second program does no
punching, but prints out the x and y components of velocity computed
from data from both radars and the smoothed position computed from the
above velocity and Bedford data alone. This program has been checked
out as far as possible for Bedford data alone, and awaits reinstallation
of the Rockport terminal equipment. Before writing a PWTFT for these
two radars, attention will be devoted to revising Polysmooth.

(B. Lone)

I have made a number of revisions on the two-radar tracking
program which predicts velocity on the basis of the first best fit in
a 15-second interval and hope to complete the program in the next bi-
weekly period.

6.0   AIR DEFENSE CENTER OPERATIONS

(D.R. Israel)

Colonel Robert Gould, Director of Civil Defense at EADF,
visited M.I.T. on March 24 and spoke at the Lincoln Seminar on the
general subject of the Ground Observer Corps. During this visit we
also had an opportunity to discuss with him our recent work and our
future plans for the use of GOC data. Colonel Gould has been exceedingly
cooperative and very helpful in our efforts; unfortunately during his
visit we learned that he will shortly be transferred to a new post and
that it will be necessary for us to make new contacts, particularly

CONFIDENTIAL
UNCLASSIFIED

6.0 **AIR DEFENSE CENTER OPERATIONS** (continued)

(D.R. Israel) (continued)

with officers of the 32nd Air Divison at Syracuse. The 32nd Air
Division has jurisdiction over the Manchester (New Hampshire)
Filter Center. It now seems quite likely that our future experiments
will be carried out in connection with that center.

The staff members now actively working on the GOC problem
are Donko, Gaudette, Israel, and Webster. Frequent meetings are
being held, and the basic philosophy of the first Single-Track
Program has been developed. Programming is getting under way.

The group listed above visited the Manchester Filter Center
on Monday, March 31. This filter center has not yet been modernized,
as has been done at White Plains, but this will be completed within
a month. Other visits have been scheduled to the Manchester Center
during actual exercises which will be held in the near future.

Richard Onanian, a part-time student, has finished the
processing and paper work necessary for our first plotting studies
of the data we obtained at White Plains. This data is not particularly
satisfactory, but Major Johnson at White Plains has promised more and
better data in two weeks. Our first plotting studies will be carried
out on the large blackboard constructed in Rm. 157. A device for
inserting GOC data into the computer is being engineered by Don
Morrison of the Systems Group. This device will feed data directly
into two flip-flop registers.

On Thursday and Friday, March 27 and 28, a visit was made
to the Willow Run Research Center of the University of Michigan.
Interesting discussions were held regarding both their and our work
in connection with the GOC. The group at Willow Run recorded a
complete exercise at White Plains and has punched this data on
IBM cards. We have made arrangements to secure a copy of these
cards.

(C. Gaudette)

A test program is being written to display vectors which
represent reports from Ground Observation Stations. Above each vector
the time of the observation in minutes will be displayed. The number
of planes, the type, and the altitude will each be represented by
a letter and displayed directly below the vector.

(F. Webster)

A preliminary survey of actual operations by observer
posts and filter centers has been started. Initial findings indicate
that under current operating conditions rather large orders of error
are likely to occur. This makes accurate tracking by any method
problematical. Consideration is being given to possible methods of

CONFIDENTIAL

CONFIDENTIAL
UNCLASSIFIED

6.0 <u>AIR DEFENSE CENTER OPERATIONS</u> (Continued)

(F. Webster) (continued)

improving the data, and what the significance of large variability
is for the design of tracking programs.

7.0 <u>ASSOCIATED STUDIES</u>

(R.L. Walquist)

The first half of this period was spent in preparing and
delivering to the new indoctrination group three lectures on computer
programming.

The second week was spent on vacation.

(F. Webster)

Some time has been spent with Mayer on the development
of schemas that will illustrate the nature of Whirlwind operation
with a minimum of verbal description. One principle being tried
out is a combination of block diagrams with timing diagrams. At
the same time an effort is being made to show the various functional
relations in such a way that successive degrees of detail can be
given without important rearrangement of the overall schema.
Indoctrination to the essentials of Whirlwind operation should be
appreciably speeded up by the use of such methods.

(A.J. Perlis)

I am still undergoing the indoctrination course in coding
techniques.

I am reading the reports of, and consulting with, Messrs.
Bush, Cooper, Katz, Potter, White, and Linvill preparatory to
engaging in research on the smoothing problem.

Round-off error analyses of two simple programs for the
arc-cosine and logarithm (base 2) have been made. Both maximum
and probable error have been evaluated. The calculations for the
logarithm code are being machine-tested.

A program for, and a round-off error analysis of, the
tri-diagonalization of matrices for a solution of the eigenvalue
problem is being worked out with J.W. Carr.

(I. Mann)

This period was spent in a struggle with the indoctrination
problems and associated studies. I also was one of a group of four
from the lab to visit the GOC filter center in White Plains, New York.

CONFIDENTIAL
UNCLASSIFIED

7.0 **ASSOCIATED STUDIES** (continued)

(P.R. Bagley)

Magnetic Tape Recording and Reading Subroutines.
Testing of the subroutines written by R. Walquist for recording
and reading single blocks of registers (T 988, T 989) has been
awaiting the installation of the cycle left order. Now that this
installation is complete, these routines will be tested in the
near future.

Interceptor Assignment Demonstration. The data input
section of the Interceptor Assignment Demonstration (T 948),
modified to accept data tapes punched in New Flexowriter code,
has been completely checked out.

(H.R.J. Grosch)

During this period I spent some time on general systems
considerations with the WWII logical design group. From March 19
to 22 I attended the meetings of the Optical Society of America
in New York

8.0 **COMPUTER OPERATIONS**

(J. Arnow)

Clutter Rejection	1.75 hours
Tracking and Smoothing	19.5
Aircraft Control	1.5
Miscellaneous	3.0
Calibration	0.75
Visitors	1.5
Usable Time	28.0
Time Lost	4.0
Total	32.0

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 Meeting of March 14, 1952," Taylor, N.H.,
     Mayer, R.P., M-1428, March 18, 1952, pp. 1-4.
                                                     CONFIDENTIAL

2.   "Whirlwind II Meeting of March 21, 1952," Taylor, N.H.,
     Mayer, R.P., M-1432, March 25, 1952, pp. 1-3.
                                                     CONFIDENTIAL

TECHNICAL REPORTS

1.   "Magnetic Development in Japan During World War II," Target
     Report, U.S. Naval Technical Mission to Japan, San Francisco,
     California, January, 1946, Lib. No. 1726.
                                                     RESTRICTED

2.   "A Beam-Rider Missile Guidance System Using CW Microwave
     Intelligence," Silver Spring Laboratory, Vitro Corporation of
     America, Silver, Spring, Maryland, January 23, 1952, Lib. No. 1733.
                                                     CONFIDENTIAL

3.   "The Aerodynamic Characteristics at MACH Number 1.57 of 10-,
     14-, and 18-Caliber Cylindrical Bare Bodies with Varying Head
     Shapes," Jaeger,B.F., deLancey, L.M., U.S. Naval Ordnance
     Test Station, Inyokern, China Lake, Cailfornia, October 31, 1951,
     Lib. No. 1734.
                                                     RESTRICTED

4.   "The Aerodynamic Characteristics at MACH Number 1.87 of 14-,
     and 18-Caliber Fin-Stabilized Rocket Models with Varying Fin
     Parameters," Jaeger, B.F., deLancey, L.M., U.S. Naval Ordnance
     Test Station, Inyokern, China Lake, California, October 10, 1951,
     Lib. No. 1735.
                                                     RESTRICTED

5.   "A Brief Description of the Digital Radar Relay Developed by
     the Air Force Cambridge Research Laboratories," Lynch, W.A.,
     Microwave Research Institute, Polytechnic Institute of Brooklyn,
     October 15, 1951, Lib. No. 1736.
                                                     CONFIDENTIAL