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Memorandum M-2113

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Digital Computer Laboratory  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

SUBJECT: AIR DEFENSE BIWEEKLY REPORT, April 24, 1953

CAPE COD

CLASSIFICATION CHANGED TO:  
Auth: D.D.254  
By: L.L. Everett  
Date: 2-1-60

1.0 GENERAL

(C.R. Wieser)

An Air Force camera crew under Major Paterson is making a movie concerning programming. Additional movies are under consideration.

2.0 EQUIPMENT ENGINEERING

(S.H. Dodd)

The Cape Cod installation is progressing satisfactorily and is approximately on schedule. The room preparation is well advanced and completion of this phase of the work is expected within a week. The power wiring for all of the panels in the computer room will be completed by next Monday, and some of the signal wiring between the remote station distribution box and these panels are completed.

It is expected that a major portion of the equipment and installation associated with the control center will be completed in three weeks, and system testing can start at that time.

(N. Alperin)

The High Voltage power supply for the video mappers is almost completed. Means for distributing this power are now being worked in.

(H.J. Kirshner)

Group 24 has changed the Truro S.D.V. equipment so that data is now transmitted on two, rather than three, telephone lines. This change permits us to record Truro data on our two track magnetic tape recorder.

Group 22 has been requested to add two target marker pulses at the 64th and 65th counts of the S.D.V. signal for the purpose of enhancing ease of S.D.V. receiver timing. The M.I.T.E. will not permit these signals to appear as bona fide target pulses.

Work is proceeding on the design of equipment Group 61 will supply for V.H.F. and U.H.F. ground-air communications.

Plans are being made for centrally locating, for purposes of monitor and test, data lines, recorder switching, and radio equipment

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SECURITY INFORMATION

2.0 EQUIPMENT ENGINEERING (CONTINUED)

(H.J. Kirshner) (Continued)

at a small console in Room 224. It is hoped that such an arrangement will provide flexibility without confusion.

(G. Young, B. Morriss)

The desirability of moving the scope camera from position si 500 was mentioned in a previous biweekly report and comments were received other than those initially indicating the desirability, so in the near future (two to four weeks) the camera will be moved to the new position si 004 (octal).

The first draft of a note on the operation of the indicator light and intervention registers which will be installed as a part of the in-out system has been completed. A similar note on the operation of the scope display system is being prepared by H. Benington.

A large amount of time was spent on drawings of the buffer drum system. These drawings will be necessary for C. Zraket's thesis.

Two meetings were held with all of the people working on the new in-out equipment. How all of the equipment will operate and be connected together was the topic.

The MITE unit handling data from the N. Truro radar set has been temporarily disconnected from the computer and the reconnection of the MITE unit with 5 registers of buffer storage will begin Saturday, April 25. The new equipment should be in operation by the end of the month.

(J.H. Newitt)

The progress of the September Cape Cod program has been outlined in my recent inter-office memo of April 22. In this memo I stated that work was progressing substantially on schedule (plus or minus a week for most items).

In fairness to all concerned with this program I wish to point out that I am making reference to my latest revised schedule. This schedule has been revised to earlier completion dates twice so far. By examining present progress with the present schedule, a false impression might, at first, be gained. For the most part, work has been completed ahead of my original estimates which I considered fairly tight at the time. When engineering got ahead of schedule, I took up the available slack and rescheduled drafting, shop, and installation work to earlier dates. In the case of a number of shop items, I arranged for paralleling of operations and overtime, thereby shortening original fabrication estimates at the expense of extra manpower expenditure. Every facility has thus been pushed to the limit to meet my revised (shortened) schedule. There are certain dangers involved by such a procedure. First of all, our original estimates were based

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2.0 EQUIPMENT ENGINEERING (CONTINUED)

(J.H. Newitt) (Continued)

to a large extent on parts delivery promises and earlier schedule revisions caused shortages to occur. We were very fortunate to be able to meet these contemplated emergencies by special expediting plus a lot of luck. Paralleling of operations in the shop normally causes a manpower tie-up which reduces the flexibility available for emergency work. A third danger that exists is that an unorthodox procedure, such as we have been employing, generally creates a certain amount of confusion and misunderstanding in addition to a great number of new problems that require special handling.

Under these conditions, it should not be at all unusual for certain items to occasionally fall a week or two behind. Our original estimates contemplated a cushion for rework and the normal amount of mistakes that inevitably will be made but our revised schedules which have been shortened to the limit may not have provided sufficient cushion for rework.

The above procedure might sound slightly unrealistic; it certainly is risky to say the least. We felt, nevertheless, that it was worth the try and the effort in order to shorten the program. So far we seem to be ahead by using such tactics. The only apparently unjust point is that my repeated schedule revisions to earlier dates mask the hard work and excellent cooperation of the purchasing, drafting and shop facilities.

Thus in a schedule report, it might seem that the shop is just about holding its own or is slightly behind when they are actually considerably ahead of the originally estimated conditions. I trust everyone concerned will appreciate this latter point when my revised schedules are examined against actual progress.

I have completed the design of most of the station mounting panels but there are others yet to be designed (those requested by R.L. Walquist). There has been a moderate amount of special work thrown into the program recently. Most of this can be taken care of and will be included as soon as possible. We no doubt will have more special requests for various equipment items as installation progresses. People needing special equipment should bear in mind that it normally takes a minimum of one and a half months to reduce an engineering specification of a simple panel or circuit to practice. Nebulous ideas take even longer so all outstanding items must be completely defined very soon if they are to be included in our September system.

(F. Sandy)

The wireways for the new control room have been completed. A connecting wireway from the Remote Station Distribution Box to the new control room wireways is to be completed by April 27.

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2.0 EQUIPMENT ENGINEERING (CONTINUED)

(F. Sandy) (Continued)

Power wiring in the wireways has been about 70% installed. Rack J1 is nearly completely wired for power distribution and control for the new control room.

The signal wire cables from the remote station distribution box to AX row in the computer have been installed and connected at the RSDB end. The computer end will be connected as the panels arrive.

The signal wire cables from the RSDB to the new control room are being prefabricated. About 18 of the 96 cables needed have been prefabricated. These 18 used all of the 20-conductor cable now on hand. 9500 feet of the cable is due to arrive April 27. This will be cut into prefabricated cables as rapidly as possible. An estimate of the cable needed showed that we will probably run a little short of that needed for the complete installation. Consequently, another 8000 feet has been ordered.

The 2 1/2" diameter holes for pulling the feed wires up through the floor to the individual pieces of equipment are being cut in the floor of the new control room. It is expected that this work will be completed by the end of next week.

(A.V. Shortell, Jr.)

Construction of the hood and photoelectric pickup for four Pathfinder scopes is scheduled to be completed by May 8.

A construction requisition has just been initiated for the amplifier and pulse generator panel and construction work should start on that next week. This panel will contain amplifiers and pulse generators for 8 mappers, so that this panel and an identical one to be built at a later date will handle all mappers which have been planned for and will allow two or three spare channels.

Present work includes tying down loose ends such as power wiring to mapper scopes, video cabling, switching circuits, and modifications to Pathfinder video amplifiers and azimuth drive units.

Construction of a high voltage supply is nearly complete.

3.0 BEDFORD EXPERIMENT

(D.R. Israel)

Operation of the Bedford MEW will cease on May 15. Shortly after that date, the radar shack will be removed prior to removal of the hill on which it stands. Plans have been made to give priority to MEW flight tests for the next three weeks. It is hoped that within this time it will be possible to successfully run and record collision course intercepts involving a dog-leg target maneuver. Priority is

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3.0 BEDFORD EXPERIMENT (CONTINUED)

(D.R. Israel) (Continued)

also being given to tests of the four-pair interception program, beam approach final-turn attacks and height finding operations with the 6-B at North Truro.

New programs involving the N. Truro data are being completed. One will be ready for testing on Monday, April 27, when the MITE will be available; other programs will be ready for testing by the end of next week. There is a good chance that these programs will be available for use in actual flight tests shortly after the fifteenth of May.

(M. Brand)

The latest command tracking program which simplified the rather sophisticated logic of the original command tracking program was completed and tested by F. Garth. The results were good and in some respects better than the original results. The results were plotted up in the form of computed heading, smoothing heading, and command heading versus time for all three programs. Presumably the next step in the development of this system will be the incorporation of this program with my original aided smoothing program which has already run successfully. The two together would be incorporated in the combined interception program, run with magnetic tape data and checked by the magnetic tape print-out program which has been written for the interception program.

(F. Garth)

A sizable portion of this biweekly period has been spent in conference both in discussion of the interception flow diagram to be used in the demonstration this fall and in the rewriting of the Combined Single-Pair Program.

Experiments have been completed on the simplified command tracking technique. These have been graphed and a report is being written.

(F. Heart)

A considerable part of the last biweekly period was spent with Knapp, Murray, and Curby, finishing the "Truro version" of the Four-on-Four Interception Program. The actual program writing is now complete..

Some time was spent preparing for and assisting in the demonstration of April 25.

A conference was held on April 24 between several Group 61 members and Major Baldwin of the 652nd Wing. Interceptor turn and bank characteristics were discussed.

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3.0 BEDFORD EXPERIMENT (CONTINUED)

(W. Z. Lemnios)

The various sections of the Combined Two-Aircraft Interception Program being written with C. Gaudette and F. Garth have been completed. The sections are now being combined, and the program should be ready to be checked out quite soon.

Three conferences have been attended with various people relative to three-dimensional interception. Procedures to be followed for the cases of regular interceptions or "foldback type" interceptions have been worked out. A flow diagram is now being constructed.

Various characteristics of the F-94B as functions of altitude have been obtained and tabulated. These will be used in making three-dimensional interceptions.

A conference with Major Baldwin from Bedford was attended. Major Baldwin presented curves showing maximum allowable banking angles as functions of altitude, true air speed, and radius of turn. It is expected that these angles will be incorporated in the interception programs so that they will never be exceeded.

(C.A. Zraket)

Relative to single-pair interceptions, the following schedule will be carried out until the Bedford MEW Radar is disconnected on May 15:

- a) An interception with a standard target maneuver.
- b) Final-turn interceptions employing beam attacks.
- c) An interception using the 16-digit VHF data link only if the Instrumentation Lab's F-94 is available for this purpose.

During the next few weeks data from the Truro set will be studied in order that a new set of standard flight plans may be drawn up for the period after May 15. C. Gaudette and I will visit Truro on April 28.

4.0 DATA SCREENING

(R.L. Walquist)

The N. Truro CPS-6B SDV equipment has been changed so that data is transmitted over two phone lines instead of the former three lines. The present 2-channel Ampex recorder has been checked out for recording this data and appears satisfactory. N. Truro data is being recorded so that programs requiring this data may be run at night when the SDV link is not operating. The buffer storage for the N. Truro MITE is being installed and should be operative by about May 1.

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4.0 DATA SCREENING (CONTINUED)

(R.L. Walquist) (Continued)

A group from Burroughs visited the lab to discuss our plans for the Cape Cod System. Their primary interest concerned tying together the man and the machine and the utilization of antiaircraft batteries in air defense.

(W.S. Attridge, Jr.)

I have written Memorandum M-1984, Timing Operation in the 1953 Cape Cod System, which describes the operation of the clock and the timing subprogram.

I have made a more detailed flow diagram of the master control section of the 1953 Cape Cod Program. I have reached a point where little further logical planning of this section can be done until more definite decisions are made on the characteristics of the subprograms both in the TWS and non-TWS functions.

The latest word received by me is that a 12-second frame time will be used to correspond to the 12-second scan time of the CPS-6B. If this is done, it will be imperative that more subprograms be placed in the "low priority" category, i.e., all subprograms that can be used whenever time is available (as opposed to those subprograms required to be used at regular, specified times).

The contents of test storage for the 1953 Cape Cod System have been fixed. A memo will be written with J. Ishihara describing this.

(H. Frachtman)

The data-mapping program was run on the computer but a number of parity alarms occurred which made it difficult to determine whether the program was operating properly. However, a review of the program disclosed a few errors, as well as an inconvenient arrangement of orders.

Some time has been spent studying flow diagrams of the data-screening programs of the September system in order to devise effective display programs.

(D. Goldenberg)

The calculations to determine the overall errors in the earth curvature problem are being carried out.

Study of the problem of cross-telling from one system into another has been started.

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4.0 DATA SCREENING (CONTINUED)

(J. Ishihara)

Work continues on flow diagrams and programs for the correlation section of the 1953 Cape Cod System - TWS.

(J. Levenson)

The reason for most of the unexplained behavior in the Track Monitor Program was found to be a tape error. Since this has been corrected, all computer assigned time has been spent waiting for computer repairs. Consequently the program is still not checked out.

Further study has been made of the details of programming for the two sections of the September Cape Cod TWS for which I am responsible. New flow diagrams and more extensive descriptions have been written, and I am awaiting a general meeting in which they will be discussed by all concerned before issuing a memo.

(H. Peterson)

I spent the last biweekly period increasing my knowledge of the new scope techniques for next fall. I have written tentative programs to display trouble tracks for monitor action; to show uncorrelated data for manual initiation; and to give the tracking officer information concerning the direction and overload condition of the correlation strips (sector).

I also spent some time with J. Levenson conferring on the interpretation of activate button and light gun action.

(N.S. Potter)

Though during the second half of the past biweekly period I have been away on vacation, work on the report concerning the probability of storage of information on the magnetic drum has proceeded satisfactorily. It is now largely completed and should be issued shortly.

(H.H. Seward)

The program for sorting 64 tracks into 128 rectangular strips (4 mi. x 128 mi.) has been written. Another program to determine the frequency with which uncorrelated data is to be displayed awaits computer time.

(W.M. Wolf)

Some time was spent in checking out a correlation program which will correlate the returns from one scan with those from a previous scan.

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4.0 DATA SCREENING (CONTINUED)

(W.M. Wolf) (Continued)

The correlation will be performed by computing the distance between each return on the comparing scan with each return on the scan being compared, selecting the smallest distances, and quantizing them as a measure of correlation.

Trouble was encountered in the computation section. The distance between returns as mentioned above is computed according to the following approximate formula:

$$D^2 = (r_1 - r)^2 + (r_1 (\theta_1 - \theta))^2$$

where D is the distance sought,  $r_1$  and  $\theta_1$  refer to returns in the comparing scan, r and  $\theta$  refer to returns in the compared scan.

It was found that using an "azimuth gate" of  $180^\circ$  was not sufficient to prevent overflow giving false results. An "azimuth gate" of  $90^\circ$  gave better results but was not completely satisfactory. Introducing a "range gate" as well as an "azimuth gate" will correct this difficulty. These "gates" by definition are placed about the return from the comparing scan.

It was noticed that on a day in which N. Truro transmitted about 9,000 returns the correlation as programmed took around fifteen minutes to correlate 33 returns.

The changes in programming mentioned above plus video filtering will greatly increase the speed of correlation.

The N. Truro data in one-mile increments was recorded on Friday, April 24. The tape number is TT-198. The data was considered unseasonably good as pertains to the clear definition of ground clutter. Next week a permanent mask will be made of the associated ground clutter on the video filter.

5.0 TRACKING AND CONTROL

(J. Arnow)

An attempt is being made to furnish Boeing Aircraft Company with data on a comparison of tracking an aircraft separately with two radars. No significant data has as yet been obtained with live radar data due to cancellation of flight tests due to weather and the inability to obtain aircraft. Data using simulated tracks has been obtained.

(W. Lone)

The program described in the biweekly report of April 10 which converts standard tape to 5-36 had a few minor errors which have been found and corrected. It will be put through more extensive tests

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5.0 TRACKING AND CONTROL (CONTINUED)

(W. Lone) (Continued)

to determine its reliability.

Much time has been spent in participating in the Air Defense motion picture being filmed by Major Patterson and his crew.

(B.R. Stahl)

The results of A. Mathiasen's program analysis of certain smoothing techniques are still being worked on and will receive priority over any further programming on my part until they are completed.

A major portion of this period has been spent in cooperation with the Air Force personnel assigned to motion picture work in the laboratory.

(H.D. Neumann)

During this biweekly period I investigated what information would be required in the evaluation of final results of the September Cape Cod System tests, and in writing up the final report. With the aid of the "Sign Post" report the information desired from Sector Command Post and Information Direction Center personnel before, during, and after the test was determined and some thought was given to how to obtain this information most effectively.

(A. Mathiasen)

Work is continuing on preparing data on the worth of tracking as far as position is concerned. To this end, the deviations between predicted positions and both observed quantized and actual non-quantized positions are being studied.

Persistent ill fortune has prevented any study being made of live data tracking. In one short-lived test with Foxboro and Scituate, however, the data from Foxboro appeared excellent and that from Scituate much improved over previous observations.

(M. Frazier)

Programming the scheme for non-linear smoothing without interference from random clutter has been halted temporarily in an effort to cut down on the large number of storage registers required for each track with the present system. A new slant is being tried on the detailed programming and looks as if it will be successful.

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5.0 TRACKING AND CONTROL (CONTINUED)

(S. Best)

An error existed in Group 61 radius vector subroutine #8 as written in M-1631. It may be corrected as follows:

113	slh 16
203	1.63060
204	0.70660

A subroutine has been written to evaluate the function  $(\sin 2\pi x)/2\pi x$  for  $(-1/4 < x < +1/4)$  revolutions. It uses 12 orders, 3 constants, 1 temporary storage register and is accurate to about .0005. One of its uses is to compute the ratio between a chord of a circle and its subtended arc.

During the programming of an input routine for MTC, the interesting point arose that it is possible to write programs which may be placed anywhere in the memory at the discretion of the computer operator by using the 2 extra digits which occur in every 3 lines of 5-56 type tapes. This could be used for print-out programs, etc.

The crossing track simulated program has been used to study the crossing track problem for angles between lines of flight in the range of  $6^\circ$  to  $20^\circ$ .

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6.0 AIR DEFENSE CENTER OPERATIONS

(D. R. Israel)

On Wednesday, April 22, a visit was made to N. Truro where Wieser, Boehmer, Major Gault, Captain Marks and I, spoke to Major Woody, Commanding Officer of the 762 AC&W Squadron. Major Woody was briefed on our flight test plans for September and he offered his fullest cooperation. Most of the points discussed with him will be included in a proposal outlining the liaison between the 762nd and Group 61 during future flight tests. This proposal is presently being prepared.

On Tuesday, April 14, I attended a briefing at Evans Signal Corps Laboratory, Belmar, New Jersey. At this meeting various phases of the 414 Projects were described for the benefit of visitors from Lincoln.

M-1979, Frame and Panel Layouts, is an up-to-date tabulation of the various panels and frames for the Operations Rooms. This memo, which has been reviewed with Gus O'Brien, supercedes a previous hectographed tabulation which received only limited distribution. Preparations are presently being made to specify the exact wiring of the switches to the available intervention registers. Separate sheets will be prepared for each of the push botton panels listed in M-1979.

On Tuesday, April 21, a meeting was held to discuss the location of equipment and partitions in the Operations Rooms. No major changes were made in previously issued floor plans, although several consoles and tables were moved one or two feet. Definite decisions were made on the location of visitors scopes in the Operations Room and in Room 250. It was decided at this meeting to omit, temporarily, the semi-permanent partitions which were planned for acoustic reasons. Definite dates were established for the erection and removal of two permanent, ceiling height, partitions.

Many additional section meetings have been held to discuss various phases of the non-TWS activity. The work is proceeding on schedule and it has been possible to settle many details during the past two weeks. Identification, Height Finding, Anti-Aircraft Liaison, Weapon Assignment, and Track Situation Displays have been reviewed in some detail and are ready for preparation of flow diagrams. The bulk of the remaining work is concerned with the direction of interceptors and the preparation of various displays.

A review of the ground-to-air communication problem for September indicates that presently-planned facilities will not be sufficient. One difficulty here is that we do not yet know whether UHF or VHF facilities will be needed. Additional meetings are planned to consider this problem.

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6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(D. R. Israel ) (Continued)

Herb Benington has drawn up a proposal for the various display categories to be made available at each scope console. This material will form part of a memo which Benington is writing.

Major Paterson and his crew from the First Photo Squadron have arrived and are in the process of making a film described in previous biweeklys. Horn and Rathbone are working very closely with Major Paterson on the script and on details connected with the making of the picture.

(H. D. Benington)

During the past biweekly period most of the time has been devoted to completing Memorandum M-1999, a description of scope facilities in the 1953 Cape Cod system. This memo covers most aspects of the visual system without specifying the exact nature of each particular display. It summarizes the work done so far on adapting Group 61 display demands to the enlarged computer scope facilities which should be available by July 1.

A program has been written to investigate simulated digital information displays as regards intelligibility and visibility. Photographs of sample displays will be taken and circulated among interested persons for their comments. This should enable specification of character displays before the character generator is working with the computer. A similar program will be written during the next period to investigate the situation displays of points, vectors, and characters.

More thought has been given the problem of writing the program for display of the track situation in September Cape Cod.

(M. I. Brand)

The simulated identification program (phase II) is virtually completed. The program is written in five tapes, T-2565, the Master Control program, T-2566, the Data Processing program, T-2567, the Correlation and Digital Display program, T-2568, the Vector and Symbol Display program, T-2569, the Flight Plan and Track Extrapolation program and T-2570 the Data Read-in program. The program was written in this fashion so that the individual parts could be tested somewhat independently or tested all at once in conjunction with the master control program and the drum. The master control program is written in a general enough way to permit inclusion of other non-TWS programs into the system. We hope to test this program during this coming biweekly period.

Several meetings have been held with other members of the Identification Group and D.R. Israel to attempt to freeze some of the methods and concepts for the September System. We have arrived at some thoughts with regard to the types of displays and storage techniques which will be used. We have also decided the manner in which cross-tell

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6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(M.I. Brand) (Continued)

reports and early warning reports will be used. We have decided not to extrapolate these reports but merely to show a position and characteristic vector with an altitude designation. The results of these meetings will be published in a memo sometime during this biweekly period.

On April 22 I attended a meeting with Howard Kirshner at Building "B" in Lexington. Representatives of the Navy, Air Force, Goodyear Aircraft, General Electric and Lincoln Laboratory had gathered to hear a progress report of Goodyear and General Electric's Airship AEW project. A memo describing this meeting is now being written by H. Kirshner and me and should be available this biweekly period.

On April 23 I spent some time with Joseph D. Mountain of the J.D. Mountain Laboratories. We discussed the utilization of digital computers for use in air traffic control and identification systems. I discussed with Mr. Mountain some of the data storage and extrapolation techniques for flight plans which have evolved in our identification studies. Mr. Mountain is now working on a Bell Labs subcontract for the study of applying digital computer techniques to air traffic control problems.

(J.J. Cahill, Jr.)

The Eight-Aircraft AA-Guidance and Height Finder program (T-2574) has been completed and will be tested as soon as Truro data is available.

The AAA & H-F flight test of April 15, delayed 20 minutes because the printer had been removed from Room 222, was ended before a run could be made when the test aircraft developed gas-line trouble. The AAA features of the test of April 22 were successful. Two batteries acquired the target, F-3-D maintaining 400 knots, each of a range of about 25 miles. One battery succeeded in simulating engagement of the target. The attempt to simultaneously exercise the height-finding feature of the CPS-6B failed, however, largely because the Vertical Lower Beam was cut off from the Quick-Fix scopes and the Vertical Middle Beam greatly weakened by a test being run by Group 21 at the same time. W.R. Martin of Group 22 has been advised of the situation and has promised early action.

The H-F Raid Size Discrimination flight test, without the computer, held on April 17, produced no useful results, due largely to the failure of the Rockport MPS-4 operator to track the target. Since the new N-F program will permit Discrimination Tests to be performed simultaneously with AAA and other Height Finder tests, it was decided to postpone further Discrimination Tests until the computer can be used to assist the Height Finder in tracking targets. This should be possible in two or three weeks.

Proposals for the programming of the AAA & Height Finder sections of the September program are being prepared by M.A. Geraghty and J.J. Cahill and will be the subject of an interoffice memo to D.R. Israel that will be issued in a day or two.

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## 6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(P. O. Cioffi)

The various phases of the simulated ID program referred to in previous reports have been written and are now being readied for testing. A description of the identification feature of this program will be prepared during the next period. This description will include the composition of the displays associated with this program and will to some extent indicate the appearance of the displays for the September system.

(O. T. Conant)

Discussions with various members of the group during this period have been concerned with: flow diagram and type of computation for interceptions and assignment assistance; intervention register assignment; display programs; and telephone and radio communications.

General agreement has been secured from persons interested in the standard Digital Information Display as to format, presentation, and means of selection; insertion register digits for selection have been assigned.

Final requirements for external telephone lines and associated terminal equipment at Barta are being determined. Summaries of internal and external lines, equipment, and locations are being prepared for a memo on the complete telephone intercommunication system for September, which is to be written in the near future.

(A. W. Curby)

Work has continued on the ID phase of the September system. Tapes are being prepared for programs which will process ID data and extrapolate Flight Plans, and these programs will be tested next week. Data which will simulate seven tracks and seven flight plans has been computed to be used with the above programs. In lieu of an input box feeding into four registers, this data will be stored in ES and a program written by M. Brand will sequence through it, transferring four registers every 8 seconds to the proper place for processing.

The processing and extrapolation programs will next be amplified to handle GOC, Cross-Tel, and Early Warning reports in the manner decided upon in meetings held with M. Brand, P. Cioffi, and D. R. Israel.

(C. H. Gaudette)

The new Combined Interception Program is nearing completion. Most of the sections are now written, and a flow diagram is being constructed to aid in checking the programming logic before these sections are assembled.

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6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(C. H. Gaudette) (Continued)

A Wind and Interceptor Velocity(-ies) Subprogram has been written and is available for use with North Truro Programs. This program eliminates the need for the operator to convert the wind direction and speed to (x,y) coordinates and then to binary.

(M. A. Geraghty)

A successful AA run was held with height finding. It is described in J. Cahill's report. A raid-size discrimination test was held with J. Cahill taking Pigeon Hill and the writer the Scituate TPS-10. Results were almost impossible to evaluate, since the position of the flight was a matter of doubt during most of the run. Tests without the computer seem to be principally dependent on luck for semi-reliable results. Therefore, future tests will probably be held in conjunction with tests of the Eight Aircraft AA and Height Finder guidance program just completed by J. Cahill and the writer.

Further progress was made in defining the frame requirements for the September System. Insertion register space allocation is ahead.

(F. Heart)

I continued to participate in discussions relating to Cape Cod planning.

Some time was spent, with several group members, discussing information flow for the Cape Cod interception calculations. This discussion will continue towards the objective of a comprehensive flow diagram.

Additional time was spent considering acquisition of weather information, both at present, and for Cape Cod. Warrant Officer Crow expedited the following arrangement with the system weather officer at Bedford (Capt. Killory): twice per day, at about 0830 and about 1230 someone at Barta will call Bedford and a standard set of weather data will be transmitted by phone. This data will be duplicated, and a copy posted both in 222 Barta and in the Whittemore office of Capt. Sullivan's section. This data will include airport surface conditions and winds aloft. This practice will start immediately.

(S. C. Knapp)

A proposal for procedure in weapon assignment has been drawn up. Meetings to discuss this and the interception problem have been attended.



6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(S. C. Knapp) (Continued)

Work on the Four-Pair Intercept Program continued and is almost completed. Lack of ES registers has forced us to put part of the program on the magnetic drum.

Since it is now possible to record North Truro data, work on checking out the eight aircraft tracking program will commence next week.

(L. J. Murray)

The Four-Pair Intercept Program is now in the final stages. It is hoped that this program will be able to utilize the North Truro data when it is available.

During the past biweekly period several conferences have been held. Flow diagrams for the interception phase of September System have been started. Also, the varying conditions of interception are being carefully studied. At present it is felt that a three dimensional interception subprogram will satisfy all of the requirements.

I have also completed a tentative display for the Radio Communicator. The proposed display minimizes the required display program. A description of the duties of the above will be postponed until decisions have been made concerning radio communications.

(F. A. Webster)

Most of the time has been spent on a memo to explain and coordinate the drawings made during the several previous periods. It is intended partly as a supplement to the note written for Division 5 on non-radar tracking and in part to help analyze information-flow in the 1953 System.

Specific work on simulated attacks has been largely suspended while waiting for the aeronautical charts that were ordered last week.

(C. A. Zraket)

In conjunction with members of the group, work on the weapons direction phase of the 1953 Cape Cod System is continuing. The first of a series of meetings was held to draw up an overall flow diagram of the program.

The two memos mentioned in the last biweekly report, Non-Track-While-Scan Data Storage Allocation and UHF Automatic Ground-to-Air Data Link, have been completed and are being proof-read. They should be issued during this biweekly period. It is believed that all the pertinent information needed to write a program for the 31-digit UHF data link has been obtained.

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7.0 ASSOCIATED STUDIES

(W. I. Wells)

The calculation of the complete non-linear filter has been completed. It is not proposed that this filter be used in place of that one now in use however. The reason is that our present filter is such a close approximation to the optimum that the cost of slight improvement would be too great.

Work has begun on consolidating the gains in filter design and I hope to be able to show how the conventional ideas can be extended, in a rigorous manner, to so-called learning devices. Already some of the ideas used fall into the field of learning devices.

(E. J. Craig)

An n-step procedure has been obtained which will produce the characteristic equation of any real or complex non-singular matrix.

The previous iteration procedure developed by the author applied to any non-singular matrix. This procedure has been programmed for Whirlwind I by Mr. Ralston, a student of Prof. C. W. Adams (Course 6.537). Results will be discussed later.

This procedure has been extended by the author to non-singular complex matrices. The extension is simple, and its application to non-linear equations good.

The Doctoral Thesis Proposal is nearing completion, but some wrinkles remain to be ironed out.

8.0 COMPUTER OPERATIONS

(M. Brand)

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

MEW Tracking & Control	
Flight Tests	6 hrs 55 min
Magnetic Tape	3 hrs 40 min
Data Screening	10 hrs 30 min
Radar Analysis	6 hrs 45 min
Multiple Radar Tracking & Control	30 min
Miscellaneous	2 hrs 15 min
Equipment Characteristics	1 hr 0 min
Conversion	10 min
Calibration	1 hr 15 min
Demonstration	3 hrs 15 min

Total Time Used 36 hrs 15 min

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8.0 COMPUTER OPERATIONS (CONTINUED)

(M. Brand) (Continued)

Time Lost to Computer (parities, etc.)	6 hrs 0 min
Time Given to Magnetic Drum	10 hrs 0 min
Time Given to Mathematics Group	<u>9 hrs 0 min</u>
 Total Time Lost	 25 hrs 0 min
 Total Assigned Time	 61 hrs 15 min
 Percentage Assigned Time Used	 59%

(C.A. Zraket)

Demonstrations:

No standard demonstrations were held during the past biweekly period.

A demonstration is scheduled for members of the MIT faculty on Saturday, April 25, and for IBM people on May 4.

9.0 FLIGHT TESTS

(P. Dolan, Art Hill)

April 15 1000-1100 Final Turn, Gaudette

T-33 #067 (camera) holding Concord 8,500', IAS 300k  
 F-80 #462 holding Provincetown 9000', IAS 250k  
 Run #1: Fighter picked up target at about 5 miles at 2 o'clock, then made procedure turn, rolled out about 1 1/2 miles to the rear of the target, bearing 12 o'clock to fighter.  
 Run #2: Picked up target at 5 miles, 11 o'clock.

1100-1200 AAA, Cahill

F-9F (Navy jet) holding Portland at 16,000', test inconclusive; cancelled due to tip tanks not feeding on jet, returned to base.

April 17 1300-1500 Height Finder Calibration, Cahill

Four multi's operating as a unit, holding Portland, 16,000' Rockport MPS #4 had great difficulty tracking; no information as to the trouble, returns seemed to fade. Scituate operated well but reliability of reports was questionable.  
 Radio commands were given only to one aircraft; he in turn directed the formation (method ideal for this test)

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9.0 FLIGHT TESTS (CONTINUED)

(P.Dolan, Art Hill) (Continued)

April 21 1000-1100 Final Turn, Zraket

F-94 #502 holding Concord 8500', IAS 300k (AI Radar)

F-80 #462 holding Provincetown 9000', IAS 250k

Run #1: beam attack, Target was sighted but no AI pickup was effected.

Run #2: head on, still no AI pickup.

1100-1200 Coverage, Mathiasen

B-17 #9281 holding Scituate, 6000'

Data from Scituate and Foxboro good; about twenty minutes data recorded.

1400-1600 Two Pair, Knapp

Due to Air Force aircraft procurement trouble and Air Force aircraft radio trouble, with no substitute aircraft available, the test was cancelled; all other aircraft (Navy) returned to base.

April 22 1100-1200 AAA & H.F., Cahill

F-3D (Navy) holding Portland at 16,000'

F-80 #377 holding Isle of Shoals at 16,000'

#1: exercised CPS-6B results poor, marginal operation

#2: AAA runs were good

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APPROVED FOR PUBLIC RELEASE. CASE 06-1104.

DATE	TIME	SCHEDULED TEST		TEST ACTUALLY RUN		REASONS FOR CHANGES OR COMMENTS
		A/C	Description	A/C	Description	
4/10	1300-1400	2	Final-Turn Intercepts	-	Cancelled	Weather
	1400-1500	1	Coverage	-	Cancelled	Weather
4/14	1000-1200	2	2 A/C Tracking	-	Cancelled	Weather
	1400-1600	4	2 Pair Intercepts	-	Cancelled	Field Conditions (snow)
4/15	1000-1100	2	Final-Turn Intercepts	2	As Scheduled	
	1100-1200	1	AAA	1	Held 1/2 hour	A/C returned, lack of fuel
4/16	1300-1400	2	2 A/C Intercepts	-	Cancelled	Weather
	1400-1500	1	Coverage	-	Cancelled	Weather
4/17	1300-1500	4	Height Finder Test	4	As Scheduled	
4/21	1000-1100	2	2 A/C Intercepts	2	As Scheduled	
	1100-1200	1	Coverage	1	As Scheduled	
	1400-1600	4	2 Pair Intercepts	-	Cancelled	A/C radio trouble and a/c procurement
4/22	1000-1100	1	Coverage	-	Cancelled	A/C procurement
	1100-1200	2	AAA & H.F.	2	As Scheduled	

\* Added to schedule during week of test

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9.0 FLIGHT TESTS (CONTINUED) (P. Dolan, Art Hill) (Continued)

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9.0 FLIGHT TESTS (CONTINUED)

(F. Heart, M. Brand)

The following statistics apply to the last biweekly period:

1) Computer hours scheduled for flight tests	22
2) Computer hours used for flight tests	7
3) Computer hours returned due to flight test cancellations	8
4) Total Aircraft Hours Flown	16 1/2
5) Aircraft hours flown by 6520th Wing at Bedford	14
6) Aircraft hours flown by Navy (Quonset-based Squadron)	2 1/2
7) Aircraft hours flown by M.I.T. Instrumentation Laboratory	0

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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. "Air Defense Biweekly Report, April 10, 1953," M-1976, pp. 1-30.  
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2. "Timing Operations in the 1953 Cape Cod System," M-1984, W.S. Attridge, Jr., April 14, 1953.

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TECHNICAL REPORTS

1. "Secret Aspects of the Development of Sparrow III," Report No. 5 SECRET, Progress Report, 1 July to 30 September 1952, Raytheon Mfg. Co., Missile & Radar Div., Lib. No. 2266R.
2. "Temperature Recovery Factors on a Body of Revolution at MACH Numbers of 1.79 and 4.50," Guided Missiles Dept., G.E., Schenectady, N.Y., Lib. No. 2338R.
3. "Performance Characteristics of Type SCA-2300 Servo Analysis and Synthesis Equipment," Final Report, U.S. Naval Air Development Center, Bureau of Aeronautics, Johnsville, Pa., February 5, 1953, Lib. No. 2337R.
4. "Wind Tunnel Tests to Determine the External Drag of the Hermes RV-A6 (B-1) Ramjet at M=3.30 and 3.89," Guided Missiles Dept., G.E., Schenectady, N.Y., December 1952, Lib. No. 2339R.

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WHIRLWIND II

(N. H. Taylor)

The following paragraphs present short summaries of current activity in the various sections of Group 62.

1) Memory Test Computer

The control section of MTC has been torn down and is now being rewired to facilitate trouble-shooting and general accessibility.

2) Coincident-Current Memory

The first plane of the MTC memory has been subjected to marginal checking, with quite satisfactory results. Margins are very acceptable on almost all of the patterns which have been tried. However, one or two patterns have indicated somewhat lower margins than others, and a study of these is under way. It has not yet been possible to determine whether these low margins are due to the memory or to the circuitry. A second and third plane of the memory have been added and are performing in a manner similar to plane #1. It seems quite reasonable to expect that a full 17,000-bit memory will be running within the next month.

3) Basic Circuits

Plans are under way to overhaul the list of basic circuits needed for the WWII system, and a meeting next week in Hartford with the IBM group is planned to help stimulate activity in those areas which have been lying dormant for the last two or three months.

4) Arithmetic Element

The arithmetic element activity at MIT has been fairly stagnant, as this load is now being picked up by the IBM Corporation at High Street. Members of this section are now turning their attention to control.

5) Control

After considerable debate, we have finally decided on the nature of the control of the WWII system, as follows:

a) The orders will be separated into 8 categories, which will be selected by an 8-position matrix switch.

b) Subcategories of each of these 8 main selections will be determined by a cluster of gates selected from 4 flip-flops which are in addition to the initial 3 mentioned above.

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WHIRLWIND II (CONTINUED)

c) A time pulse distributor will sense these gate tubes and provide a chain of 2-megacycle pulses which will become the gating commands to the rest of the system.

d) The check register system as we know it in WWI will not appear in the WWII system, and instead a special "wave-of-ONES" will be incorporated which will check periodically as to whether all is well within the system.

6) Input-Output

As a result of a fairly intensive study of the IBM magnetic drum situation, it has been tentatively decided that magnetic drums have reached a level of development such that they can be used in the input-output portion of the WWII system. We expect them to find their use in the input buffer portion of the computer, in the auxiliary drum memory, and in the output display.

It has been decided to try to make use of the 5965 triode in the slow-speed circuitry associated with both drums and input phone lines. This will increase the demand for the tube and will allow us to concentrate our activity on making one very good tube to go in the system.

A revised list of input-output topics and scheduling proposals has been agreed on with the IBM organization, and a schedule of activity in each of these areas will soon be issued by the respective engineers assigned to them.

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(G. Briggs, H. Rising)

Design of the video mapper is well under way at IBM. H. K. Rising has been conducting experiments with a method of video mapping utilizing a sheet of lucite viewed from the edge by photomultipliers. The amount of light from a scope spot passing through the lucite without reflecting totally at the surface of the sheet of lucite can be altered by a factor of 2 or 3 by placing water on the lucite surface. The internally-reflected light diffuses to the edge of the sheet, where it is detected by the photomultipliers. This method makes it possible to map with a liquid such as water; also, using this method, the process is not upset by the presence of the mapper's hands in front of the screen. The resolution is very poor, however.

I have been block-diagramming the counter and input drum circuitry using IBM 701 circuitry modified for lower-speed operation to save cathodes wherever possible.

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WHIRLWIND II (CONTINUED)

(W. Clark)

During the subject period a short dissertation was prepared and presented at the general IBM-MIT meeting at Hartford. In it, I outlined the essential future of the September Cape Cod demonstration and described the current equipment layout with the help of the M-1815 report series illustrations.

At the Hartford Input-Output meeting of the 22nd, the discussion centered around the drum display systems proposed by Ross of IBM and von Buelow of MIT. Bennington's work on the Cape Cod displays and Grandy's analysis of display categorization were presented in summary form, and it is expected that an intercomparison will be made during the next period and presented at a future meeting.

Most of the people doing WWII programming at Project High came to Cambridge on the 23rd for a joint meeting with the Group 61 WWII programmers. Methods of time and storage analysis for TWS programming were described and discussed in some detail. It is expected that a technique can be evolved and suitable track-data ratio criteria developed which will enable both groups of programmers to carry out time and storage analysis independently with results which can be directly compared. Toward this end, the elements of current Group 61 thinking on the TWS problem were presented, including some of the advanced techniques of tracking proposed by Gaudette and Ishihara.

With R. A. Nelson and C. R. Wieser, the problem of organizing Group 61 comments on WWII proposals was discussed, and a procedure for processing Group 62 requests for comments was developed.

(M. Epstein)

I spent the biweekly period designing one method of doing the In-Out orders in WWII. This method allows for asynchronous drum control, cyclical operation control, and In-Out breaks..

(C. Grandy)

During the past biweekly period the track monitoring program mentioned in the last report has been programmed in the proposed WWII order code, and an analysis of the program is currently being made. It appears that the major portion of the track monitoring function (that of checking track against track) will consume about one-half second of computer time if the system is tracking

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WHIRLWIND II (CONTINUED)

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(C. Grandy, con'd.)

1,000 aircraft. Some additional work needs to be done to complete the interpretation and assignment-to-monitors section of the program and to finish the analysis.

Some time was spent in discussion with programmers from IBM explaining details of work we have done to date on WWII programming.

Work on the track monitoring program, initiation program and a track extrapolation program will continue during the coming week.

(J. Hayase)

The automatic initiation scheme in the sixteen-aircraft tracking program in WWII code mentioned in previous bi-weekly reports is being modified. Originally, automatic initiation was performed on all or a major portion of the returns received during the initial scan. This tracking program assumes that 64 returns are received during a scan and correlation is performed 4 times a scan, smoothing and prediction once a scan. The original scheme initiates on all or nearly all of the tracks within the range of radar coverage at the time of the initial scan and provides sufficient storage space to initiate on uncorrelated returns in successive scans. This method wastes storage space tracking clutter, so other methods are being considered. One method is to initiate automatically on 16 returns initially and in subsequent scans to cessate on successive misses immediately after correlation to provide space to initiate on uncorrelated returns during the next quarter scan. This method will probably require some time to initiate on all of the tracks, but the other methods considered require a fair amount of book-keeping.

(J. Jacobs, R. Jeffrey, R. Mayer)

The last two weeks were spent -

1) in cooperation with the IBM group working out block diagrams of equipment counts for a delay line type of central control versus a flip-flop time pulse distributor version;

2) in cooperation with the IBM and WWI groups comparing the WWI type of transfer checking scheme with alternatives which do not use a check register, e. g., a separate order which reads ONES into all flip-flops and then checks to see that this has actually happened.

These studies were undertaken to provide data to the group which made the decision on April 24 on the type of control and type of checking to be used in WWII.

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WHIRLWIND II (CONTINUED)

(G. Rawling)

This bi-weekly period has been spent studying phases of output from Air Defense Center to various agencies and weapons.

The type of information transmission, encoding-decoding, application of error detecting and correcting codes, receiving devices, and overall organization have been investigated. Two preliminary flow diagrams have been prepared, and one is now being consolidated and augmented.

Discussions with D. McCann and B. Housman of IBM concerning these outputs have been held. A list of reports\* read is included.

(R. von Buelow)

Display. The last Input-Output meeting was concerned entirely with the display system. A proposal was made of a possible system, and all of the problems were enumerated.

The only decision thus far which is fairly firm is that an auxiliary drum for display will be used. It also seems likely that all information to be displayed can be done so serially. Intensification lines to each display scope will determine what is to be seen at each display console.

Investigations are being carried out on an improved overall system, tube types and character generators, as well as on a more firm definition of the basic requirements.

- \* 1. "NIKE I, A Surface-to-Air Guided Missile System," Bell Telephone Laboratories, Inc., May 1, 1951. - SECRET
2. "Preliminary Study of a Missile Defense System," University of Michigan A. R. C. UMM-50, Boeing Document D-10705. - SECRET
3. "Proposed Automatic Evaluator," H. Sherwin. Watson Laboratories Engineering Division, Memorandum Report No. WLEPL-1-4. - SECRET
4. "Summary of British Air Defense Program," Carl B. Lindstrom. AAF AMC Technical Report #F-TR-2171-ND AB Volume 3, #9, Part II.-SECRET
5. "Preventative Measures Against Jamming of Command Transmission Systems," Dr. Theodor Sturm. Interrogation Report for Captured Personnel (1945). - SECRET
6. "Error Detecting and Error Correcting Codes," R. W. Hamming. Bell System Technical Journal, April, 1950. - SECRET

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