Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: AIR DEFENSE BIWEEKLY REPORT, March 27, 1953

CAPE COD

1.0 GENERAL

(C.R. Wieser)

Mr. R. J. Horn has transferred from the personnel section to Group 61. He will assist me with administrative matters, and his services should be regarded as available to Group 61 as a whole.

2.0 EQUIPMENT ENGINEERING

(H.J. Kirshner)

Three two-way ring-down telephone circuits have been installed to N. Truro. These circuits are to be used for identification and manual height-finding purposes.

Room 222 is being re-organized and should be ready for operation by March 31.

A portion of this period was spent on vacation.

(B. Morriss, G. Young)

Several changes in In-Out Control (IOC) have been contemplated and discussed with R. Gould. The purposes of these changes are to eliminate superfluous components and to include the additions required for the expanded 1953 Cape Cod System.

The discussion in the last biweekly report about the rc instruction operating between computer storage and the in-out system instead of the accumulator and IOR for all output units should be disregarded. It is felt that the changing of many programs outweighs the equipment advantages and possible program advantages of such a change. Therefore, all units installed now will continue to operate exactly as at present. Only the operation of display scopes will be affected.

The scopes will obtain the additional information necessary for vectors and characters by referring to ES, and the setting of the horizontal and vertical decoders on the si and rc instructions will be reversed as described. So that previously written programs displaying points on the scopes will not be obsoleted and so that new programs written to display points after the decoders are reversed

2.0 EQUIPMENT ENGINEERING (CONTINUED)

(B. Morriss, G. Young) (Continued)

may be tested, a switch will be installed in the near future so that the connection from the decoders to the scopes may be reversed. This switch will be left in for a period of time after the new system is installed.

Several points of confusion seem to exist about the operation of the block transfer orders. On a bi or bo command the magnitude of the content of the last 12 digits in AC is transferred to the In-Out Delay Counter for counting the number of words transferred. This means that a maximum of 4095 words may be transferred on one bi or bo command. After a transfer has been completed, the accumulator will contain the starting address of the block transfer plus the number of words transferred.

(J.H. Newitt)

Scheduling and expediting of the Cape Cod Equipment is continuing. The overall project may generally be divided into three major critical phases:

1. Engineering and construction
2. Installation and wiring (power, signal wiring and cabling)
3. Testing, trouble-shooting and operating.

As each phase nears completion, the next may be rescheduled with higher accuracy. The schedules for phases 2 and 3 (above) are rough estimates at present.

It may be stated that phase 1 is sufficiently well under control to assure performance in accordance with schedule. At present I am doing some detailed scheduling of the second phase (above) so that the corrective steps required to make it come out on time may become evident as soon as possible.

As may be recognized, these phases somewhat overlap in time, and the above discussion makes reference to the preponderance of activity in each case.

Since we are still faced with two difficult phases, there is no room for complacency. While the first phase is under control, it may well prove to be the easiest. The schedules indicate the definite possibility of our troubles pyramiding in the remaining phases of the project. It is important that we gain every possible present advantage to meet these expected difficulties.

2.0 EQUIPMENT ENGINEERING (CONTINUED)

(F. Sandy)

The wireways for the new control room have been ordered. They are to be fabricated and installed by Metallic Arts of New England. Work will begin on the installation Saturday, March 28. The wireways are to be completed in four weeks.

The power wiring of racks in the computer is proceeding rapidly. It is planned to have the racks necessary for the in-out addition completely wired for power by April 13. The panels necessary for the power distribution and control for the new control room are on hand, except one which is expected next week. The wiring of rack J1, which contains the above equipment, will proceed next week.

(A.V. Shortell, Jr.)

Some improvement in recovery time of the phototube output signal has been made by placing a blue plexiglass filter between the scope and the phototube. This decrease in recovery time has enabled us to use a longer intensification time (40μs as compared to the former figure of 10μs) and this produces an increase in the signal amplitude by a factor of ten. The plexiglass filter, unlike the Wratten filter mentioned in the last biweekly report, does not attenuate the blue light appreciably.

As yet no completely suitable material has been found for use in mapping. Plexiglass moves too easily to be very practical. Our requirements for a mapping material seem to be:

1. fairly viscous and easily applied,
2. quick-drying (could be greasy or oily if not too messy),
3. easily removable,
4. semi-opaque (can be illuminated with red edge lights),
5. non-flammable, and non-poisonous,
6. must be yellow or green (possibly red but not blue),
7. must be sufficiently opaque to blue light to blank unwanted data.

Any and all suggestions of materials which might be suitable for mapping will be welcomed.

(N. Alperin)

Light gun drafting has been finished and construction has begun.

The design of the amplifier and pulse generator panel is almost completed. The work is being held up by the building construction now in progress at the Barta Bldg.

3.0 BEDFORD EXPERIMENT

(D.R. Israel)

Art Hill and Phil Dolan have taken some very good color motion pictures of the final few seconds of recent interceptions. These films are being edited; the better shots will be composed into a single film with captions.

(A.W. Curby)

Conferences with F. Heart, S. Knapp, and L. Murray were attended, at which modification of the Four-Pair Tracking and Interception Program to use Truro data was discussed. I will be working on the switch interrogation section of that program.

(F. Heart)

A group consisting of S. Knapp, A. Curby, L. Murray, and F. Heart has begun writing a "four-on-four" interception program which will operate with N. Truro CPS-6B radar data. Certain basic revisions in method are required, due to the following:

1. The data itself is different in character from MEW data, and the necessary timing is changed.

2. In using the MEW it could be assumed that aircraft would not fly in certain sectors of the coverage; this is not true using the N. Truro radar.

The program to produce a geography display with the combined intercept program has been rewritten and a tape made. It will be tried within several days.

(F.M. Garth)

At present new heading angles are given to the interceptor with every 2° change in its directed course. A part of Command Tracking requires that if twice the time to interception is greater than 10 minutes, a course change of 10° is necessary before a new heading is given. However, if twice the time to interception is less than 10 minutes, any change greater than 4° requires a new heading.

I have been conducting a study to determine how large the course change could be before a new heading must be given to assure a close interception. A tape break which occurred while I was using the computer delayed my results. So far I have found that 10° seems a safe criterion even up to the last stages of an interception.

William Lemnios and I have prepared a flow diagram which will determine the amount of safe flying time (in excess of the time required to land at the nearest airbase) an interceptor has left during any part of his flight. It will also make the decision as to whether the interceptor can make a proposed interception and again land at the nearest airbase.

3.0 BEDFORD EXPERIMENT (CONTINUED)

(F.M. Garth) (Continued)

A committee of which I am a member is rewriting the combined interception program for a single pair to include use of the new Truro radar data as well as to make a few improvements.

(C.A. Zraket)

Due to the unavailability of the Instrumentation Lab's F-94, a flight test utilizing this aircraft with the automatic ground/air data link has not as yet been held. The next scheduled one is for Tuesday, March 31.

A head-on final-turn interception was conducted on March 25 using an F-86A as interceptor and a T-33 jet as target. The Indicated Air Speeds used were 380 knots and 330 knots respectively. At this indicated speed, the interceptor was flying over 500 m.p.h. at the 9,500' altitude used. Although the radar data was exceptionally poor, the F-86A rolled out of his final turn about 8-10 miles ahead of the T-33 and, when in visual contact, saw the target at a bearing of 1 o'clock.

An inter-office memo describing the assumptions, equation derivations, flow diagram, and program of the current final-turn interception methods in use has been written and distributed to the interested parties.

A visit was made on March 26 to the AAA unit at Fort Banks with J. Cahill, M. Geraghty, and C. Gaudette. The facilities at the AAOC and at Battery C were shown to us by Maj. Derosa.

Some liaison is being carried out with Weiant Wathen-Dunn of AFCRC in regard to the 31-digit UHF automatic ground/air data link. A tentative digit utilization has been agreed upon.

(W.Z. Lemnios)

The Combined Two-Aircraft Interception Program is being written for the Truro radar with C. Gaudette and F. Garth. The program will contain several refinements over the present program for the Bedford radar.

A program is being written with F. Garth which will show the amount of fuel left for interceptors. Thus, information will be displayed on a scope in terms of flying time available before fuel exhaustion. The program will also give warning if the interceptor's fuel is nearing the amount needed for return to the nearest base and will direct the interceptor to the nearest base.

3.0 BEDFORD EXPERIMENT (CONTINUED)

(M.I. Brand)

Command Tracking. I have again associated myself with the Command Tracking problem. In conjunction with F. Garth I have considerably simplified the logic in the Command Tracking Program. Whereas before there was a rather sophisticated method for determining whether or not a heading would be given to an aircraft, based on the time to interception as a criterion and on certain minimum and maximum deviations, we have now evolved a much simpler criterion. The command tracking test program now gives aircraft all headings which deviate from previously given headings by a certain constant amount. This deviation criterion can be set into flip-flops. There are four parameters which Garth made up which can test this program in a variety of ways. It is proposed to test each of these parameters with a variety of deviation constants and plot and compare the results with those obtained by the more sophisticated method. Some of these tests have already been made and show promise. If the results of these tests are satisfactory, we plan further simplifications to the program..

4.0 DATA SCREENING

(R.L. Walquist)

Considerable time has been spent in further defining both the equipment and program requirements for TWS in the 1953 Cape Cod System. A critical study of the display line allocations indicated that both the number of display categories and the number of display switches could be reduced. Further effort has been put into defining exactly what the various indicator lights and intervention switches will be used for in TWS.

A tentative outline for the TWS program has been drawn up and distributed to the Data Screening group. Responsibilities for the various sections of the program have been delegated. Flow diagrams and brief descriptions of each section are being prepared by those responsible. It is hoped that actual programming can begin by the end of April.

(W.S. Attridge, Jr.)

The first attempt at "semi-automatic start over after parity alarm" was made using Data Screening Program #1. This proved quite beneficial despite some trouble with magnetic tape control which was attributed to faulty delay counts in the program. John Hughes thinks it is not too difficult to mechanize the "automatic start over after parity alarm" function mentioned in the last biweekly.

Scope lines and switches for the TWS function of the 1953 Cape Cod System have been revised with Walquist and Levenson. The requirements are 82 switches for the 13 scopes to be used or slightly more than 6 switches per scope.

4.0 DATA SCREENING (CONTINUED)

(W.S. Attridge, Jr.) (Continued)

I have written an inter-office memo describing MIV (manual intervention) and examine techniques for the auxiliary drum; it is posted on the Air Defense bulletin board.

(J. Levenson, H. Peterson)

Since the last biweekly, we have completed the Track Monitor Program previously described. In our allotted computer time, we have been unable to operate the program successfully, and as yet, cannot account for some of the errors. However, several parameters have been written which should indicate more clearly the sources of the trouble, and we are planning to use these as soon as computer time is available.

(D. Goldenberg)

1) The tangent plane at Truro has been chosen to be 1.383 miles above the radar site. The maximum positive and negative errors are thereby made equal to $\pm$0.074 miles at a maximum range of 128 miles.

2) The maximum distance between the two positions of a target reported by one long range and one short range radar has been definitely established to be less than 0.10 miles, each of the positions being in error from the true position by no more than 0.074 miles.

3) An extension of the analysis of errors to an earth which is an oblate spheroid has been completed to a point where it can be stated that the analysis for a spherical earth gives an extremely good estimate of the true errors. Therefore, any further analysis will be carried out with the assumption that the earth is a sphere.

4) The task of finding a probability distribution of errors based upon a homogeneous distribution of targets has been abandoned. The assumption of homogeneity of targets in height above the earth is too poor to justify the time and effort to do a rather complex analysis.

(J. Ishihara)

Between "alarms" some printed data and photographs were obtained from Data Screening Program #1. Close study of these results will be needed to determine if the program is now free of errors and to evaluate its tracking effectiveness. The program was rum with sub-program transfers from auxiliary drum instead of magnetic tape. This resulted in a considerable saving in operating time. A program to restart after an alarm (transfer track data from drum to E.S., sequence data tape back to the start of the scan and restart), failed to operate satisfactorily since the precaution of not stopping on a recorded block was not observed.

4.0 DATA SCREENING (CONTINUED)

(J. Ishihara)

Further study, modification, and operation of this program will be done on a low-priority basis. Program masters, records, and operating instructions have been brought up-to-date.

(H. Peterson)

In addition to work done with J. Levenson, I wrote a master program in cooperation with Attridge and Ishihara, for Data Screening Program #1. This program stores parts of the total program on the drum and brings them into ES when called for by the master program. It also stores the current track information on the drum each scan with a read-in program in Group 5. This and a number in a flip-flop register which tells us the section of the program we are in, (along with Attridge's "automatic start over after parity alarm" program in TS) makes it possible to continue the program with no loss of data or previous information due to the alarm.

I have also done some study on a program to print out the contents of certain consecutive registers by storing first on the drum and then printing out via magnetic tape. The purpose of this is to further minimize wait time while the program is operating.

(H.H. Seward)

The sequential display program described in previous biweekly reports was not run on the computer because of equipment irregularities which have since been adjusted.

A method of data screening using an ES tube to check returns against all tracks was discussed with F. Heart and R. Walquist. Upon its display a return would be separated into one of two categories; either it is near or within the search area of some track (which track is not designated) or it is not. In the former case box number determination and correlation proceeds as usual. In the latter case (dispersed clutter, temporary mapping difficulties, surges of noise or clutter, etc.), these operations are bypassed. The additional computer time amounts to one or two orders per return. The cost is about that of one ES tube unit with the consideration that normally rejected tubes with small surface flaws could be used. Data to estimate the amount of screening afforded will be taken at a future date.

(N.S. Potter)

The summary report on the effect of target altitude has been submitted and contains the primary results obtained to date. Attention has now turned to a revision of my earlier report upon the reliability of the buffer drum for storage of data arriving at time intervals whose lengths are randomly distributed over a given range.

4.0 DATA SCREENING (CONTINUED)

(W.M. Wolf)

Work has been continued on the correlation program mentioned in the previous biweekly report.

Experience using the video filter in Rm. 222 (Barta) was gained. Plastic chips were used but a more satisfactory method of performing the mapping seems desirable.

A program to count the number of quantized increments sent to Whirlwind by the CPS-6B at N. Truro was written and is awaiting computer time.

(H. Frachtman)

The program described in the last report was considered to be less useful than one which would count the data arriving in each of 64 squares. A new program to perform this analysis is almost finished.

Some time was spent with W. Wolf operating the video mapper.

5.0 TRACKING AND CONTROL

(J. Arnow)

Discussions were held with representatives from Willow Run Research Center concerning the guidance equations for Bomarc. Later, R. Reed from Boeing discussed the feasibility and use of Whirlwind in the guidance of Bomarc.

Data is now available from any of the following locations: Scituate, Foxboro, Chatham, and Martha's Vineyard.

(A. Mathiasen)

A third test of Foxboro repeated the theme of the other two with variations of detail. The radar itself appeared to be in good working condition. However, the terminal equipment here failed intermittently, preventing tracking most of the time. One good run was obtained.

The bulk of a report on results of tracking methods using simulated data has been written. The suggestion of R. Walquist to predict every 4 seconds and smooth every 16 seconds will be incorporated into a deviation averaging scheme. This, together with a similar modification to B. Stahl's best-fit program should complete the work in this area.

The program which compares results of various non-linear smoothing routines at extreme ranges has apparently checked out and will now be used to get the desired information.

5.0 TRACKING AND CONTROL (CONTINUED)

(M. Frazier)

Effort continues on the program mentioned in the past biweekly which combines most of the virtues of velocity-heading smoothing with most of those of x,y smoothing. This program should be completed soon.

Studies continue on a method suggested by Arnow for azimuth calibration of two radars relative to each other. Proper implementation of this suggestion has given rise to considerable complication.

(W. Lone)

Several errors appeared in the program written by S. Best and me which tracks both aircraft when a track-crossing situation develops and chooses the one whose velocity more nearly corresponds to the velocity of the originally tracked aircraft after a certain separation.

In order to obtain additional recorded data of crossing tracks, a flight test was conducted on March 18, 1953. The Rockport radar was inoperative, Scituate was filled with clutter, and when the aircraft were finally guided to Foxboro's range it was very difficult to distinguish them from the numerous tracks present. The heavy traffic in the range of the latter site prevented our conducting the desired tests.

Several afternoons were spent indoctrinating the Air Force personnel assigned to Group 61.

(B. Stahl)

The short-term prediction parameter, which was described as successful in previous reports, has been used to process more of the existing data tapes. For some unknown reason, however, the parameter refuses to track certain of these simulated flights, and there is no indication that speed or direction of the aircraft is any criterion for determining whether or not the program will track properly, if at all. For example, the program is designed to track on the basis of the best return received from either of two radars; at one point, with the new parameter, the program smoothed on the data received from the opposite radar. This situation is now under investigation.

The display program has been run once and is being modified to eliminate some error in the use of the sine-cosine routine. The new radar timer has not been checked out.

(S. Best)

For convenience in operation, some minor changes have been made in the program which simulates two crossing tracks. It has yielded some results, but not enough yet to analyze properly.

5.0 TRACKING AND CONTROL (CONTINUED)

(S. Best) (Continued)

The program written to determine satisfactory linear smoothing coefficients for the velocity-heading method of smoothing was tried twice and several programming errors were tracked down. It will be tried again March 27.

The program that is supposed to check the data of the Rockport and Scituate radar sets was tried, and a number of programming errors found.

(H.D. Neumann)

The fact that final-phase values are not dependent only on target height was established. Hence, the use of a simple pre-calculated table is impossible. The program was modified and run twice during this biweekly period with new parameters. No results were obtained the first time due to tape mistakes but good results were obtained the second time. The rest of the time was spent investigating thesis suggestions.

6.0 AIR DEFENSE CENTER OPERATIONS

(D. R. Israel)

The following work was carried out in connection with the 1953 Cape Cod System:

1. A revised proposal for the room layout of the operations center has been prepared and is available as SC-54334. This drawing includes changes which were discussed in the previous biweekly report. The proposal has been discussed with Davis and Enticknap of Group 22, and on the basis of several further suggestions made by them and others in Group 61, another drawing is being prepared. The new drawing will show positions of all scopes and side frames (which hold the switches, indicator lights, etc.) A scheme for numbering the operation positions and the various pieces of equipment has been worked out with J. A. O'Brien and will be incorporated in the new drawing. This should be available next week and will be issued with a memo explaining the numbering scheme.

2. A memorandum discussing the track symbols to be displayed for the Cape Cod System has been prepared and is ready to be typed on Multilith masters.

3. Captain Marks (6520th Wing) has been considering some of the problems arising in connection with our large-scale flight test activity this summer and fall. One of the most important considerations is that of the effect which our flight test activity will have on the existing Air Defense installations. The new Air Force identification scheme involving corridor flying will also affect our operations. Captain Marks is presently investigating the possibility of reserving certain areas and altitudes just off the coast for our tests.

4. Together with Ann Curby, Milton Brand, and Peter Cioffi, it has been decided that our work on the identification function during the next few months will consist of two major phases. The first phase will involve monitoring recently installed telephone lines and obtaining experience with handling and plotting identification information made available from these lines. The second phase, which will start before first is completed, is the preparation of an identification program similar to that planned for Cape Cod System. Insofar as it will be possible, an attempt will be made to develop and use the same sequences of orders and subroutines that might be used in September. Phase II will use identification data obtained during Phase I.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(D. R. Israel) (Continued)

5. Additional meetings have been held to discuss the storage of various types of data on the drum, and to discuss the types of programs and storage to be used in providing the different displays. Preliminary proposals for the track symbol, vector instruction, and digital information displays have been formulated. Work will continue on this during the next biweekly period.

6. On Saturday, March 14, a visit was made to a DER (destroyer escort radar) used by the Navy for picket ship duty. Efforts to obtain further information regarding present use of these picket ships and ways in which they might tie into the Cape Cod System are continuing.

7. Captain Paterson of the Air Force's First Photo Squadron (Alexandria, Va.) has visited the Laboratory. It has been decided that he will undertake to make some movies illustrating and explaining the use of the computer, flight test activities, Cape Cod System, and the Transition System. As a first task, a short film describing and showing program preparation will be made. Bob Rathbone and I are preparing descriptive material and the scenario.

(M. Brand)

Cape Cod System. I have constructed a plastic rule which can be used as an overlay to the flight plan pre-plot board and compute time, velocity or distance knowing any two. This rule will be used to convert incoming flight plans, GOC reports and cross-tell reports into a form for computer input.

In conjunction with P. Cioffi and A. Curby I am writing a simulated identification program. This program will be timed in the same manner envisioned for the September system. I have written a master control program which sp's to various programs at one-second intervals in a sixteen second period. I have also written the display set-up and display programs for the program. P. Cioffi is writing the correlation program and A. Curby is writing the data processing, flight plan extrapolation, and simulated track sections.

Using the pre-plot board, the three phone lines to Truro, and radar data phoned in from Truro, the three of us are attempting to set up a system whereby we can identify aircraft in a manner similar to that now used by GCI stations in this area, i.e. by correlating radar and flight plan reports on a pre-plot board.

I have spent some time this biweekly period studying ADC Operational Analysis Section reports about the new corridor system

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(M. Brand) (Continued)

which is being put to use in this area.

I have spent quite a bit of time in conferences with D. R. Israel, C. A. Zraket, C. H. Gaudette and F. Heart discussing storage, display, and time correlation techniques for the September system.

GOC. During this biweekly period I took a trip up to Manchester, N. H. to visit Major Hurlburt who is in charge of the Air Force GOC Filter Center. Major Hurlburt told me that the GOC coverage inland had improved since last fall but GOC coverage on the coast, manned primarily by Coast Guard stations, had diminished to practically nil. Because the Manchester area does not have a dense enough distribution of GOC posts and because no group of five to ten posts has a cumulative telephone bill of more than $1500.00 per month this area cannot take advantage of the new "hot wire" phone reporting service which the ADC has set up. Major Hurlburt feels that the abysmal failure of last fall's GOC tests was because we had selected poor routes for our target aircraft to follow. I would rather take exception to this statement in that at least two of our tests had aircraft zigzaging in such a way that they covered virtually every section of the area averaging about two reports per hour and with one accurate report per report.

The major suggested we hold some more tests. He suggests that if we use our own planes we attempt to fly them in the Georef "Dog" column which is their area of best coverage. He has agreed to provide personnel to monitor the phone to MIT if we desire.

Major Hurlburt suggested that we could get considerable use from the GOC for tracking and identification purposes if we would accept single GOC reports rather than use the Air Force's two-report track criterion. Two reports per six minutes are rather rare.

We no longer have a "hot" wire to Manchester. We do have a private phone there. The number is Manchester 56113.

(J. J. Cahill, Jr.)

There was no AA or height-finding flight test activity during this period.

Work on M-1804, which describes single-target AA Guidance efforts to date, was completed during the past week, and the final draft is now in D. R. Israel's hands.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(J. J. Cahill, Jr.) (Continued)

Considerable progress has been made in the Eight-Aircraft AA and Height-Finder program, in cooperation with Mike Geraghty. Brief conferences are being held from time to time with Sue Knapp to eliminate possible conflict with the eight aircraft tracking section that she is writing for use with both the four-pair and the AA and Height-Finder programs.

(P. O. Cioffi)

All necessary arrangements for the use of three special telephone lines to Truro in connection with ID work here have been completed this period. These lines, using field telephone units, have been set up at their assigned position in room 222 at Barta. It should be noted that one of these lines is connected to an operational military defense circuit and is intended for our monitoring use only. It is imperative that we do not talk or ring on this particular line. Anyone wishing to use or to know more about this new communication facility with Truro should consult A. Curby, who has responsibility for it. It has also been arranged with R. G. Enticknap of group 21 to have some of their personnel assist us in our work requiring people at the Quick-Fix site for the transmission of data and related work.

I visited R. N. Davis at Building B. He was not in possession of details of the new multiple corridor system installed in this area recently. He informed me, however, that the 762nd operational GCI at Truro had received official instructions for the use of this new system. Plans have been made and are being carried out to get from the 762nd as much knowledge of this system as is available. While at Building B, I went with Davis and Enticknap to Bedford Airport to see a new F-86 D assigned there.

A program to simulate the identification feature of the 1953 System is being completed and readied for testing. This work is being carried on jointly by members of the ID group.

(F. A. Webster)

A revised, provisional drawing has been made of the general communication paths in the 1953 Cape Cod System, and a D-sized set of 8 (simplified versions) has been drawn for use in analyzing typical sequences of events in a simulated attack.

A revision is being made of the simulated attack previously mentioned, using the 1:500,000 scale of the sectional aeronautical charts.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(A. W. Curby)

The Flight Plan Extrapolation Program mentioned in previous biweeklies is working satisfactorily and will be used with the master control program written by M. Brand. Time has been spent on a data processing program, which should also be available soon for use with the master control program.

Reports describing and evaluating a multiple-corridor identification system were studied in preparation for a trip to Truro to find out how the system now in use operates.

Plans for tests of the identification programs being written for September have been made, and it is hoped that preliminary tests can be held by the middle of April.

(O. T. Conant)

A chart showing the proposed allocation (as of March 24th) of the telephone communication lines in the 1953 Cape Cod System has been drawn up and given limited distribution. Copies may be secured from the author; any comments or disagreements should be submitted as soon as possible.

Information on the telephone key boxes required by each individual in the Defense Center was furnished to M. Geraghty for his use in designing the switch panels; the physical location of the keyboxes in the operations room is being determined for the assistance of the telephone company in engineering the system.

Some time was also spent in checking the locations of external sites in the 1953 System for a geography and calibration display program; this will be continued during the next period.

(M. A. Geraghty)

No further results on raid-size discrimination have been obtained, the scheduled flight test having been cancelled due to bad weather.

A memo on data insertion agencies tentatively assigned to each position in the September system has been distributed to various interested people. I have copies available and would be grateful to receive comments. First drafts of insertion register space assignment and of the panels occupying the sundry frames in the September Air Defense Center will be available in the next period.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(M. A. Geraghty) (Continued)

Work on the eight-aircraft AA and Height-Finder guidance program, with which I am assisting J. Cahill, progresses, and it should be ready for the N. Truro tests on time.

(C. A. Zraket)

Conferences with members of the group have been continuing in an effort to lay down the ground rules with respect to displays, weapons direction, allocation of storage, program interrelations, and switch inputs for the 1953 Cape Cod System. A rough draft of a memo describing "Non-Track-While-Scan Data Storage Allocation" has been written and will be issued as soon as modifications suggested by D. R. Israel are incorporated.

(F. Heart)

A revised floor plan and certain equipment connection changes for room 222 Barta, were proposed, approved, and modifications started. A memorandum describing these changes was issued as M-1935. It is expected that the arrangement thus obtained will remain largely the same through July or August.

A flight test schedule for April, 1953 was issued as M-1927.

I have continued to participate in conferences directed toward Cape Cod program planning.

Several discussions were held with J. Forgie, B. Morriss, and other members of the group in regard to the possibility of display generation from the auxiliary drum for the September system. Largely through J. Forgie's efforts, several rough block diagrams of such a system were produced and discussed. In the opinions of Heart, Forgie, and Morriss, such a system is certainly possible. It was felt that it might be possible by September, if engineers could be assigned to the job on a nearly full time basis. The major objections to this scheme were centered on manpower availability. The idea was discussed with E. Rich in some detail and was discarded on the basis that manpower would not be available, especially in light of the arrival date for the buffer drum.

(L. Murray)

The first group of subroutines for the September System have been checked and the results were very satisfactory. This group consists of the following: arcsine, arctangent, sine-cosine, square root, and radius vector.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(L. Murray) (Continued)

F. Heart, S. Knapp, A. Curby and I are rewriting the Four-Pair Interception Program so that it can utilize the data from North Truro. In particular, F. Heart and I are working on the interception and display sections. At present, no radical changes are anticipated.

(C. H. Gaudette)

F. Garth, W. Lemnios, and I have started to program the Two-Aircraft Combined Interception Program which will use the North Truro data. The program will be basically the same as the Bedford Two-Aircraft Combined Interception Program but will contain a few refinements now possible by making use of the magnetic drum.

Several meetings with D. Israel, C. Zraket, M. Brand, and F. Heart have been held for discussion of storage allocation and display symbols to be used in the September System.

(H. D. Benington)

During the past biweekly period I continued familiarizing myself with the display situation of the September Cape Cod System. Two inter-office memos are available which give a logical breakdown of all the anticipated scope displays in addition to defining terms that should prove generally useful. I have contacted all persons responsible for specifying the variety of displays available to any of the operators of the center; an inter-office memo will summarize the present consensus. Finally, J. O'Brien was consulted on possible means of incorporating a great variety of displays without exceeding the presently allowed 384 three-legged gates. A scheme is now being investigated that would use 32 of these gates for pre-sorting control outputs before feeding them to the 362 remaining scope switch gates. If this proves possible the display problem will be ameliorated.

(S. C. Knapp)

An eight-aircraft tracking program using the data from North Truro is almost completed. I have been working in conjunction with J. Cahill and M. Geraghty so that this program can be used as the tracking section of their AA program, and with F. Heart, A. Curby, and L. Murray, who are working on the Four-Pair Intercept Program. The same tracking section will be used for both programs.

Some notes on programming for the North Truro data were compiled and distributed to those people concerned with converting programs to use this data.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(S. C. Knapp) (Continued)

A subprogram to display characters (numbers, letters, etc.) has been completed and will be distributed soon. The characters will be made up of a 3 x 5 array.

7.0 ASSOCIATED STUDIES

(E. J. Craig)

A generalization of the aforementioned iteration procedure has been devised for the situation where one has more equations than unknowns. The solution to such a problem is defined as one which minimizes the squares of the residuals.

The past week has been devoted to the writing of a proposal for a doctoral thesis the title of which has been temporarily chosen as Iteration Procedures for Simultaneous Equations.

The tenor of the thesis is to be an exposition of the method by which iteration procedures can be devised, as well as many examples of procedures which the author and others have developed. In the course of writing the proposal the author devised another n-step procedure which involves multiplications by unity. This reduces round-off error to a large extent.

In addition, much emphasis will be placed on the practical value of solving problems with non-linear equations rather than using linear equations, with examples which it is hoped point up the advantages of this.

(W. I. Wells)

The study of the Wiener-Hopf approach to filter design has shown this to be identical in results, in the special case of normally distributed variables, to the more elaborate method I have devised. In the more general case this is not true. Recently I have been considering a method of combining simple solutions of a particular problem to produce solutions to more general problems. The generality is extended both as to the shape of distribution function to be considered and to non-stationary systems of a fairly general class.

(B. G. Farley)

As a result of an informal arrangement with K. H. Olsen, some time each day is being spent observing and working with the M.T.C. so as to gain experience with actual operation and fault-finding in computers, as well as simple experimental programs.

Thinking on pattern recognition is proceeding slowly, and some time has been given to proposing general problems of efficient use of decision-making elements in solving problems encountered in air defense.

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 and Control

Flight Tests	5 hrs 50 min
Magnetic Tape	2 hrs 40 min
Data Screening	9 hrs 55 min
Multiple Radar Tracking and Control	17 hrs 10 min
Air Defense Center Operations	2 hrs 35 min
Library of Subroutines	2 hrs 30 min
Indoctrination Programs	55 min
Conversion	10 min
Calibration	1 hr 0 min
Demonstration	1 hr 0 min
Radar Analysis (Data Screening)	5 hrs 10 min
Total Time Used	52 hrs 35 min
Time Lost to Computer (parities, etc.)	3 hrs 45 min
Time Given to Magnetic Drum	11 hrs 40 min
Total Assigned Time	68 hrs 0 min
Percentage Assigned Time Used	77.2%
Percentage Available Time Used	100.0%

(C. A. Zraket)

Demonstrations:

A standard demonstration was conducted for members of the Lincoln Advisory Board on March 18. The following programs were shown:

1. Combined Interception Program - Use of automatic ground/air data link. Ampex 238. (P-2466-1)
2. Multiple Aircraft Tracking and Initiation. Ampex 245. (T-2109-16)

9.0 FLIGHT TESTS

(P.F. Dolan, A.P. Hill)

March 17 1000-1100 Coverage Test, Mathiasen

A B-26 #586 holding over Foxboro at 6000 ft. was used for test, flying a triangular course to Scituate and Chatham, IAS 240. Tracked fairly well on Foxboro up to 27 miles out.

March 18 1000-1200 Two-Aircraft Tracking, Lone

B-26 #586 holding 6 miles north of Rockport
B-25 #423 holding 6 miles south of Rockport
Due to Rockport radar being inoperative, Scituate data was used, vectoring the aircraft so as to have crossing tracks. Due to excessive clutter on Scituate, switched to Foxboro, which showed numerous tracks. This made recognition of our aircraft difficult and hampered test.

March 20 1400-1500 Two-Aircraft Intercepts, Zraket & Gaudette

F-86 holding over Concord and F-3D holding over Rockport. Due to weather test was delayed until 1430, and a run was attempted. Due to sub-normal radar and weather test was cancelled and aircraft were returned to base.

March 25 1000-1200 Final-Phase & Automatic Intercepts, Zraket

F-86 #137 holding concord at 9.0, IAS 380 knots
T-33 #067 holding Rockport at 9.5, IAS 330 knots
One run was completed rather well, the F-86 picked up the T-33 at about three miles at one o'clock to him (Final Phase). Due to weather conditions, the rest of the tests were cancelled, and the aircraft returned to base.

9.0 FLIGHT TESTS (CONTINUED)

(A.P. Hill) (Continued)

DATE	TIME	SCHEDULED TEST A/C	SCHEDULED TEST Description	TEST ACTUALLY RUN A/C	TEST ACTUALLY RUN Description	REASONS FOR CHANGES OR COMMENTS
3/17	1000-1100	1a/c	Coverage (Foxboro and Scituate)	1a/c	As Scheduled	
	1400-1600	4a/c	Two Pair Intercepts	-	Cancelled	Weather
3/18	1000-1200	2a/c	2 A/C Tracking	2a/c	As Scheduled	
3/19	1400-1600	5a/c	Height Finder	-	Cancelled	Weather
3/20	1400-1500	2a/c	Intercepts	2a/c	Test started and a/c returned to base	Weather
	1500-1600	1a/c	Height Finder	-	Cancelled	Weather
3/24	1000-1100	2a/c	Coverage	-	Cancelled	Weather
3/25	1000-1100	2a/c	FinalPhaseIntercepts	2a/c	As Scheduled	
	1100-1200	2a/c	Automatic Intercepts	-	Cancelled	Weather
	1500-1600	1a/c	AAA Guidance	-	Cancelled	Weather

* Added to schedule during week of test

10.0 PUBLICATIONS

(M.R. Susskind)

LABORATORY REPORTS

1. "Summary of Trip to Evans Signal Laboratory, February 26, 1953," M-1919, D. McCann, J.O'Brien, H. Zieman, March 19, 1953, pp. 1-10.

   SECRET

2. "Air Defense Biweekly Report, March 13, 1953," M-1921, pp. 1-30.

   CONFIDENTIAL

3. "Flight Test Schedule for April 1953," Art Hill, P. Dolan, F. Heart, M-1927, March 24, 1953.

   CONFIDENTIAL

4. "Modifications to Room 222 Barta," F.E. Heart, M-1935.

   CONFIDENTIAL

TECHNICAL REPORTS

1. "Quarterly Progress, Div. 3 - Communications and Components," Lincoln Laboratory, M.I.T., January 15, 1953, Lib. No. 309/S.

   SECRET

2. "A Unified Approach to MTI and Doppler Radar," R.M. Fano, Research Laboratory of Electronics and Lincoln Lab., M.I.T., July 22, 1952, TR No. 10, Lib. No. 310/S.

   SECRET

3. "The Applicability of Generating Electrostatic Voltmeters to the Detection of Exhaust Trails of Aircraft," F.A. Rodgers, R.N. Dexter, Lincoln Laboratory, M.I.T., November 12, 1952, TR No. 17, Lib. No. 311/S.

   SECRET

WHIRLWIND II

(N. H. Taylor)

The following paragraphs present short summaries of current activity in each of the sections of Group 62. It is hoped they will aid the reader in getting an overall picture of WWII accomplishments to date.

1) MTC Computer

This program is moving along very close to the schedule which was predicted about six months ago. The computer is running on its test memory and has been doing so for about two weeks. A period of debugging and marginal checking is now in progress. The unavailability of SR 1470 vacuum tubes is extending this period unnecessarily. It is hoped that this problem can be overcome very shortly.

2) Coincident-current Memory

Cores are now available for all 17 planes of the memory which will eventually go in the MTC computer. About half of the memory planes are already constructed, and the rest will be in on schedule. The test set which has been planned to test the memory planes functionally before they are assembled for a final memory test has been delayed by engineering changes and shop construction. Every effort is being made to start testing the memory plane within the next biweekly period. This is one of the most important problems which is yet to be resolved in the WWII development program.

3) Basic Circuits

A list of 26 basic circuits which we anticipate including in the WWII computer has been made. Group 62 has assigned 10 engineers to work on twenty of these circuits. Encouraging results have been obtained in two flip-flop circuit designs which utilize the 5965 twin triode. The margins on this new design indicate that it will find a wide usage in the high-speed circuitry which we develop in the future.

4) Arithmetic Element

A tentative decision has been made to build a dual arithmetic element into the WWII computer, and a very fast scheme of multiplication has been proposed which will allow the WWII system to function with approximately 11 microseconds' single-address order time, including multiplication. These two decisions are presently under review by members of Groups 61 and 64. Every effort should be made to release formally these two decisions or appropriate modifications of them so that the IBM group in Poughkeepsie can start the detailed design, testing and construction of the WWII arithmetic element.

5) Control

Personnel of the arithmetic element section is now concentrating its efforts on study of the type of control system to be used with the WWII computer. We hope that IBM will take a more active part in the initial phases of this study and that within a month we will be able to make tentative decisions on just what the central portion of the control system will look like. Certain decisions will be necessary quite soon, however, in order that work may progress on the arithmetic element at an early date.

WHIRLWIND II (CONTINUED)

6) Input-Output Activities

A series of weekly meetings has been started with the group of IBM people who are assigned to the input-output portion of the system. Discussions to date have centered around the nature of the input buffer memory, the phone line terminal equipment, the method of slowed-down-video-to-r-θ conversion, the nature of the video mapper, and the general in-out control which the computer will use to accept data from the input equipment. No decisions have yet been made, but indications at present are that a rotating-coil PPI, working from r, θ data, is superior to an x, y PPI. We are about to attack the problem of input buffer memory; the main decision here will revolve around the choice of a small, high-speed core memory buffer versus the magnetic drum type of memory.

The in-out problem of the WWII system is a very large, complex and sprawling type of system. It is hoped that the weekly discussions will result in defining the system in such a way that a well-integrated, intelligent solution can be found to this rather involved problem.

7) Magnetic Circuits

The emphasis of those working on magnetic circuitry has been changed over the past month or two toward looking into those parts of the WWII system which may be able to use a slow (100 kc) type of circuitry. There are certain places in the computer, particularly in the in-out system, where magnetic-core circuitry in this speed range would save many thousands of vacuum tubes.

8) Transistors

The transistor effort is now aimed at studying those circuits which best use transistors in pulse applications in a manner to give optimum reliability. No effort will be made to use transistors immediately in the WWII computer, but it is hoped that this basic thinking on how they should be used and what their stability really is will give us enough knowledge of the problem so that at a later date we may use transistors intelligently wherever their application seems advisable.

9) Mechanical Design

A survey is being made of the several types of mechanical construction which may be employed in building the WWII plug-in units. Several samples of different types of construction used at IBM are available, and several modifications of the present plug-in units are being designed at Poughkeepsie with the hope that we may embody the best elements of the better efforts in a new design which will be acceptable for this new system.

Considerable thought is being given to the mechanical design of the magnetic memory for WWII. Every effort is being made to make this design small and compact in order to avoid the high inductance associated with large arrays, but it is difficult to meet this requirement and also make it possible to remove a faulty core from a large cluster once the array has been built. Ideas have been received from many individuals here and at IBM for construction of memory planes. It has not yet been possible to make a decision on this problem.

WHIRLWIND II (CONTINUED)

10) Logical Design

The logical design of WWII is so closely associated with the choice of techniques that this activity will be discussed as a portion of the arithmetic, control, and in-out sections of this report.

11) IBM Participation

The group of IBM engineers (associated with WWII) has been growing rapidly during the last two months. This growth has necessitated a large amount of education on the part of those engineers who are in the original group which started on the project last October. The burden of training these new people and getting them oriented to the job at hand has been so great that the IBM participation and the decisions being made on basic circuits, arithmetic and control logic, is less than it should be. Every effort is being made to encourage this participation, and it is hoped that the in-out discussions mentioned above will be the start of a vigorous liaison activity at a systems level.

12) Time Schedules

A list of 134 separate jobs has been made, which is a good start on defining the job that lies ahead. About 60 of these jobs have been assigned to people in Group 62, and schedules have been made indicating how long each of these activities will take to complete. We are now in the process of organizing and integrating these schedules so that the progress of the work will be evident to anyone who is interested. Many of the unscheduled activities will have to be relegated to the IBM group, due to the limitations on manpower at MIT. Schedules of the IBM group have not yet been made, but it is hoped that we can encourage them to participate more actively in this scheduling program.

(H. Boyd)

Diode-driving flip-flop II. As requested by IBM, a diode-driving flip-flop was designed which will have output voltage levels of +10 and -30 volts. The unit has not yet been built, but is expected that this flip-flop will have twice the resistor tolerance of the High-Speed (5965) flip-flop which was designed to drive 7AK7 gate tubes.

Low input-impedance diode-driving flip-flop I. Preliminary specifications for this diode-driving flip-flop have been written (M-1925) and will soon be published. WWI comments were received on this unit and no changes in design will be necessary.

High-speed flip-flop cathode-followers. Several cathode-followers were designed as appurtenances to the High-Speed (5965) flip-flop for driving heavy gate-tube loads. An M-note has been written (M-1928), which contains a collection of data taken on the load-driving cathode-followers.

WHIRLWIND II (CONTINUED)

(H. Boyd) (Continued)

High-speed (gate-tube driving) flip-flop. WWI comments were received on this flip-flop and no changes need be made on the unit. The flip-flop chosen was the flip-flop that is capable of being set, cleared, and complemented on either all positive or all negative triggers.

(C. Grandy)

During the past biweekly period I completed writing the first draft of a report on The Analysis of Display Categories of Track Information for a Coincidence Display System mentioned in previous biweekly reports. This report outlines the purposes of the study, explains the methods used in the analysis, discusses the results at some length, and proposes several features for incorporation in the WWII output display system. This first draft will be revised when time is available and put into more formal form; however, it is presently available to those interested.

Programming with several order codes applicable to WWII has been undertaken. A detailed study was made of the Bomarc guidance equations and a programmed solution written by H. D. Neumann for WWI. Also the latest program of the combined interception was reviewed, especially the intercept equations. I am concentrating on the programming of these guidance and intercept equations using order codes proposed for WWII. To date the mid-course guidance interception equations have been coded using the WWII order code proposed by IBM Project High. Work will continue on these equations. Some attention will also be given to converting the subroutines (square root, arcsine, etc.) for the September system into the proposed codes.

(J. Hayase)

The past biweekly period has been spent setting up a box correlation scheme to be used in the single-radar sixteen aircraft tracking program to be coded in WWII order codes. This scheme, in brief, subdivides the 256 square mile area covered by the radar into a total of 1024 fixed boxes of 8 square miles size. A table is made and an entry in the table corresponds to an 8 square mile box. If a track exists in the 8 square mile box, the right half of the double length table entry corresponding to this box contains the starting address of the block of registers assigned to this track. If two tracks exist in a box, the starting addresses of the track information blocks will be stored in the right and left half of the table entry and a one (1) will be inserted in the sign digit of the left half of the double length register. If three tracks exist in a box the right half of the table entry contains the starting address of one of the track information blocks and the left half contains the address of a second table entry in which the starting addresses of the track information blocks of the other two tracks are stored. Any number of tracks in a box is handled in a similar manner. The correlation is carried out by taking the x and y coordinates of a return and generating the register number of the table entries corresponding to four neighboring 8 square mile boxes. The four table entries give access to the track information blocks of tracks in these four boxes.

WHIRLWIND II (CONTINUED)

(G. Rawling)

In this biweekly period, the first draft flow sheet illustrating the relationship of the Computer Center to the Anti-Aircraft Operations Center (AAOC) at a particular Point Defense Site has been completed, and copies are available. It incorporates a flow chart for correlating Raid and Site, with suggestions for Raid-Site Tactical Evaluation. Included is a sub-flow chart for employment of a Talos-type missile. Provisions exist at the AAOC for requesting Automatic Target and Battery Evaluation (ATABE) service from the computer and communications to the low altitude class of defense weapons.

Also shown are schematic diagrams of five classes of medium and high-altitude weapons: Nike (with prelaunch check-out and computer outputs), Terrier and Talos missiles, Loki rockets, and 120mm guns, with accompanying acquisition, track, or command radars, auxiliary computers, and launchers.

The following references have been inspected:

Missile Lethality and Vulnerability (Secret) Rand RM-628

Communications for Naval Air Defense (Secret) Volumes I and II
JHU Institute for Cooperative Research

(H.K. Rising, G.R. Briggs)

In the past two weeks, meetings with IBM have led to the following tentative conclusions concerning handling of input radar data:

1) Radar mapper scopes will be deflected individually by radar set instead of by a time shared deflection generator.

2) Direct display of masked raw radar data on the output scopes will not be handled by the input devices to the computer but rather by a special converter especially designed for this purpose, to be considered separately.

3) Radar target information delivered to the drum will be in polar coordinates.

4) Radar information will probably be stored on the drum as it comes in, in random drum address positions because this method allows a much greater probability of storage than do any fixed address methods. To store radar data in this manner, each radar will have an identifying number which is stored on the drum with each of the returns from that particular radar.

WHIRLWIND II (CONTINUED)

(J. Hayase) (Continued)

This correlation scheme has been incorporated in the block diagram for this tracking program, and actual coding will be started shortly.

(J.F. Jacobs, R.P. Mayer, R.C. Jeffrey)

We have been working on a timing diagram, a flow diagram and block diagrams for control.

One scheme for control makes use of several small matrices (rather than one large matrix): one for specifying the instruction class (add, store, etc.), one for the instruction type (full, twin, etc.), one for the index register to use, and one for the specific instruction in the class (clear and add, add, subtract, etc.). This technique is expected to simplify control considerably, as well as to extend the operation code automatically. Flexibility is not sacrificed, partly because the unused digits L1 to L6 can be used to control some of these matrices. The object is to combine the advantages of the WWI and MTC types of controls.

Some earlier decisions appear to be not quite as firm as we had thought, and are under consideration.

(H.J. Platt)

Gate tube circuit. Initial investigatory work on the gate tube circuit (7AK7) has shown that the circuit will be able to handle the logic designed to date.

It appears that there may be two or more versions of the circuit for different applications. For light loads, a plate voltage of +150 volts and a 1:1 transformer in the output will suffice. For severe loads, +250 volts will be needed. One inconclusive experiment has shown that under heavy load, a 3:1 transformer, properly terminated, will give more output than a 1:1 transformer, properly terminated, under the same conditions.

The suppressor grid voltage and impedance are highly important factors in determining the output, as well as the type of load. The greatest effect of the suppressor voltage is in the region of large input pulse amplitude. So far, it seems desirable to have the suppressor grid returned to at least +10 volts.

Under heavy load, for a given input amplitude, the output appears to be somewhat insensitive to plate voltage whereas at light loads there is a fairly linear relationship between output and plate supply voltage.

Not much has been done in the way of marginal testing. This will be shelved until the operation of the gate tube circuit has been nearly optimized. Final optimizing will be dependent on marginal testing.

Much more experimentation is needed before we can arrive at a final circuit.