Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: AIR DEFENSE BIWEEKLY, March 13, 1953

CAPE COD

2.0 EQUIPMENT ENGINEERING

(J.A. O'Brien)

Work on the various phases of the Cape Cod terminal equipment program is proceeding more or less on schedule. A few items are ahead of schedule and a couple of items are slightly behind. The auxiliary drum and one of the M.I.T.E. racks are now being used with the computer. Most parts have now been ordered, and orders are being made out for the remaining. The Dumont type 304A scope has been selected for use as the auxiliary now, and an order for 20 has been placed. A suitable decode push-button switch has finally been located and different models of it will be ordered.

Details of panel locations and power wiring are now being worked out. The amount of installation work that has to be done to complete the expansion of the terminal equipment system is very considerable to say nothing of testing time. Efforts are being made to program the work so as to cause as little interference as possible with computer operation, but there will definitely be times in a few months when test operations will require a major part of the computer time. Just when and how much will depend upon equipment delivery and preliminary tests.

(H.J. Kirshner)

All telephone lines carrying S.D.V. data from Cape Cod System sites to the Barta Building, with the exception of the line from the Clinton site, were given a qualitative inspection during this period by Ovide Fortier and myself. All of the sites which were checked (eleven in total) have radars and S.D.V. transmitters installed, so it was possible to observe incoming S.D.V. wave forms. As was expected, distortion of the S.D.V. signal varied from line to line. It was found that by pre-distorting the transmitted signal, the received signal could be made to resemble the standard S.D.V. wave shape. Transmission loss on the various circuits was found to be not constant. In order to make the received signal level constant from all the sites, line driving power amplifiers may be added at the sites.

Two of the lines tested were found to have excessive hum and noise. Corrective measures were taken by the Long Lines Department

2.0 EQUIPMENT ENGINEERING (CONTINUED)

(H.J. Kirshner) (Continued)

of the telephone company. In this regard, it should be mentioned that the people within the telephone company with whom we deal have been extremely cooperative in investigating any trouble which we may report within a matter of minutes.

The line to the Nantucket site was found to be unusable since type "C" single-sideband suppressed-carrier transmission equipment was used. These facilities are to be changed.

Quantitative measurements of the transmission loss and noise level are to be made on all data circuits during the next week.

Cables have been built which will allow the G.O.C. box and display boxes to be connected to four separate flip-flop storage registers simultaneously.

A 48 V.D.C. power supply has been constructed so that equipment which requires such power may be operated during computer shutdowns.

The Chatham site is now operational.

(B. Morriss, G. Young)

An Inter-Office Correspondence note describing the planned program requirements of the 1953 Cape Cod Display System, insertion registers, and indicator lights has been written and distributed.

The new display system will be able to display points, vectors, and characters. The si command will select a line and type of display and transfer the content of AC to the vertical decoder. An rc x command will transfer the content of AC to the horizontal decoder. It will also transfer the content of register x to IOR to be used for a vector or character display.

In order to make the operation of the rc command consistent and to simplify design, the rc x command will record the content of of register x for all recorders. Since at present the rc command records the content of AC, all programs using an rc command will have to be changed when this new mode of operation goes into effect.

A new computer command, bc (block check), is being considered to facilitate checking block transfers from the auxiliary drum to ES. The command would operate similarly to the bi command, but would merely check the content of a section of the drum against the content of a section of ES. An alarm would be given if the check failed.

As on the bi command, the content of AC on an si command would determine the starting point on the drum, the content of AC on the bc command would determine the block length, and the address of the bc command would determine the starting point in ES.

2.0 EQUIPMENT ENGINEERING (CONTINUED)

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

At present it appears that the bc command would require, in addition to an order position, 3 CPO units and considerable cable changes.

With the proposed method of operation, this command would give a good check on the block transfer. However, if an alarm occurs, it would be difficult to determine the source of the error from the information available at the time of the alarm.

(J.H. Newitt)

New schedules have been issued during the past period. These substantially tie down the remainder of the September Cape Cod program. One or two additional schedules may possibly be issued in the future, but the preponderance of the work is now clearly delineated on a time basis.

The 2nd bank of ES will be installed prior to the September demonstration although there is no detailed schedule available for this at present. There are no schedules for the expanded scope facilities or the auxiliary scopes (procurement and modification) at present.

It is understood that the tote boards may be eliminated, consequently no schedule for this item has been set up.

Progress at the present time is remarkably good. This is no doubt due to a selective pushing of items through the drafting and shop facilities, together with the expediting of orders to outside vendors. A checkup of parts procurement indicates suitable delivery promises.

In order to maintain the present high degree of efficiency it is vital that vendors be constantly policed with regard to quality and promised delivery. It is also important that parts orders be closely expedited to assure that delivery will take place as promised. Records in production control are still not adequate to enable me to keep track of the latter situation although the people concerned with this activity assure me that procurement will not be a bottleneck.

During the past period the metal prototype of my original wooden scope conscle has been built. A few very minor structural improvements will be included on the remainder of the units. Since the present prototype is functionally satisfactory in every way, it can be used as one unit of the actual installation. The side mounting racks, panels, and the auxiliary scope bracket have also been designed and will be fabricated and attached to the present prototype during the forthcoming period.

2.0 EQUIPMENT ENGINEERING (CONTINUED)

(J.H. Newitt) (Continued)

Air conditioning installation work is progressing smoothly. We have devised a two-step changeover scheme to minimize down-time of the equipment. Both steps can be taken on Tuesday mornings so as not to interfere with computer operation. The first step will be taken on Tuesday, March 17. It is expected that the new system will be in operation at the end of March.

(F. Sandy)

The wireways have been designed and the drafting about completed for the new set of wireways for the Control Room. These wireways will be suspended from the ceiling of the first floor of the Barta Building and will run the length of the area. They will be approximately 90 ft. long and vary in width from 9" to 48". Equipment on the second floor will be fed by cutting a hole in the floor directly under the equipment and pulling wires through from the wireways below. The wireway construction will be such that a wireway can be put within a few inches of any hole that might be cut in the floor.

Several possible bidders have been interviewed and the scope of the work presented to them.

The power supply and control for this new room will be supplied via Room #156, power rack J1.

(A.V. Shortell, Jr.)

The 16-inch video filter for N. Truro was installed in Room 222 this past week and was operated with reasonably good results. Walquist was able to blank out all but about ten pieces of data within a two-mile range and all but about 60 pieces outside this range. Unblanked data averaged about 1100 returns.

The problem of a.c. ripple on the scope display has been investigated and seems to be caused mainly by the scope deflection amplifiers. Use of a blue Wratten filter near the cathode of the phototube did not improve recovery time and resulted in a transmission factor of about 20%. Some thought is being given to schemes for increasing illumination of the cathode ray tube surface. Red light does not seem to help illuminate the yellow plexiglass.

(N. Alperin)

The final light gun design has been completed and the model is available for viewing in my office. A revision of the circuitry is now in progress to make it possible to control all light guns with a flip-flop in the computer in order to make them inoperative when numbers and vectors are being displayed.

3.0 BEDFORD EXPERIMENT

(D.R. Israel)

Several days during the past biweekly period were spent in preparation for the visit of the Kelly Committee on Friday, March 13. The Committee's schedule did not permit them to watch a comprehensive demonstration or to see all of the more recent experiments and programs; the mid-course guidance and interception section of the Combined Interception Program and the initiation features of the Sixteen Aircraft Tracking Program were chosen for the demonstration. Poor weather on Friday eliminated the possibility of live tests, and previously recorded data was used. During the demonstration the visitors sat in the non-equipment part of Room 222 and watched a 16" scope which was placed near the curtain but was raised some six feet above the floor. This scope was made slave to the right-hand 16" scope in the control section of the room; a running description of the test was given from the latter scope. The curtain was parted during the operation of the programs, permitting the visitors to watch the activities in the back section of the room.

(F. Heart)

Continued time has been spent aiding in program planning for Cape Cod.

The Storage Punch-Out Program was used to punch out several versions of the main interception program. One such version was used during the demonstration of March 13, 1953. This punch-out procedure is a painless way to combine many modifications and several physical pieces of paper tape.

Attempts continued to display geography in combination with other major programs by use of the auxiliary drum. It is somewhat difficult to put such a combined program on one physical piece of input paper tape. (The program has operated in a crude form.)

Attempts are continuing to obtain various kinds of aerial photography in connection with flight test activity.

(F.M. Garth)

The checkout program to be used preparatory to flight tests and demonstrations is now operational in all its parts. William Lemnios and I have prepared an instruction sheet to go with it for operators who will do the equipment checking.

Since all future phases of interception have been assigned to William Lemnios, Leroy Murray, and me, I have spent quite a bit of this period's time studying current literature dealing with this topic. My particular concern has been to determine F-89 fuel consumption allowable during a complete interception sortie.

The practicability of command tracking has still to be established. I have recently relieved Milton Brand of this project.

3.0 BEDFORD EXPERIMENT (CONTINUED)

(S.C. Knapp)

The Four Pair Intercept Program seems to be working satisfactorily and will be used in a flight test in the near future. For the first test, only four aircraft (2 pair) will be used.

The Sixteen Aircraft Program is now operating satisfactorily with height insertion.

Two vector subprograms have been completed for the Cape Cod Library of Subroutines.

I have compiled a set of notes on the Truro data and have been giving considerable thought to the programming for this data.

(C.A. Zraket)

An interception using the automatic ground-to-air data link in conjunction with the Instrumentation Lab's F-94 (#486) is scheduled for Friday, March 20.

The majority of the interceptions to be conducted from now until the N. Truro data is available via the buffer registers will be of the final-turn variety. This should give us some operational experience with this type of attack until such time as the Bedford programs are rewritten for N. Truro data. Some of my time will be spent in the preparation of the Combined Interception and Four Pair Intercept Programs for the N. Truro set.

(W. Lemnios)

The check-out program has been completed. A short memo explaining its use is being written and will be circulated to the various people who will be concerned with it.

Work was continued on the effect of target maneuvers during final-phase interception. Studies were made of several reports dealing with this and related problems.

(M. Brand)

Command Tracking Test Program, T-2420, has been completed and now works successfully. I have turned over this project to F. Garth and W. Lemnios who will now be concerned with interception work.

4.0 DATA SCREENING

(R.L. Walquist)

Preliminary tests have begun on using the B-scan radar mapper with the N. Truro CPS-6B. On a day which might be classed as normal (a small amount of overcast), the total number of returns per scan from the 6B was around 4,000 using 1 mile quantization. With a computer-generated range gate of 20 miles, half of these returns fell within the range gate. By using the radar mapper, it was possible to reduce the total number of returns outside this range gate to less than 150. Since this was only a crude mapping operation with the possibility of some aircraft returns also being mapped out, further experiments will be necessary. It is obvious, however, that radar mapping will not be an easy task unless better methods are available for carrying out the masking operation.

(W.S. Attridge, Jr.)

I have been working out the programming details of the "automatic start over after parity alarm" function to be used in the 1953 Cape Cod System. A memo describing the test storage orders that will be used for this function as well as for the E&SC group's needs will be distributed shortly.

The communication line requirements in the TWS function have been tentatively worked out.

(H. Frachtman)

I have been working on a program which will determine the number of returns from the Truro radar in each of 128 rectangular strips four miles wide and 128 miles long.

(D. Goldenberg)

In the last biweekly it was stated that for the long-range radar the maximum positive error in position, which occurs by using $(S^2 - H^2)^{1/2}$ as the distance from the origin to the predicted position in the tangent plane was 0.12 miles. Further investigation has proved this to be in error and that the maximum value is near 0.4 miles. This error can be reduced to about 0.03 miles by moving the tangent plane about 1.4 miles above the earth. More exact values are being determined now.

The analysis for an oblate spheroidal earth is progressing slowly because of the extreme complexity. It can now be said that errors which arise by assuming the earth a sphere instead of an oblate spheroid are of the order of magnitude of the errors we are seeking to minimize. Therefore, the more exact analysis seems warranted.

A memo is being issued which contains the coordinates of all of the radars in the Cape Cod System projected onto a plane tangent to the earth at Truro. It will also contain corrections to the azimuth angles for each radar.

4.0 DATA SCREENING (CONTINUED)

(J. Ishihara)

Trouble-shooting on DSP#1 (Data Screening Program #1) continues. Short runs and test parameters have located program errors, and effort has been made to correct them. Malfunction of the computer during our scheduled period prevented running the program over an extended period. When we feel the program is operating satisfactorily, modifications will be made to use the auxiliary drum for program storage in place of one of the magnetic tape units.

(J. Levenson, H. Peterson)

The Track Monitor Program has been rewritten and is 80% completed. The new program uses the drum for storage of the subroutines, and this should effect a saving in time. Several minor changes in the function of the program have been made. Past positions of tracks are not displayed. As before, intersecting tracks are dead-reckoned, but now the monitor may order the computer to cease dead-reckoning a particular track.

A major change has been made in the handling of intersecting tracks. After consulting with Ishihara and Attridge, it was decided that the correlation program should not be interrupted when a return is found to correlate with more than one track. This had been our indication that tracks were intersecting. Instead, we do a pre-correlation of tracks with each other, and tracks within six miles of each other are grouped into "situations." There is no limit to the number of tracks in a "situation." The advantage of this over pairing two tracks is that the Tracking Officer or the computer may assign <u>all</u> tracks grouped too closely, and avoid having one pair of four intersecting tracks assigned to each of two different Track Monitors.

Although the pre-correlation of tracks is lengthy, it will shorten the time for correlation since tracks which are within six miles of any other tracks are not correlated. Also a "best fit" correlation is not needed since a return can only correlate with one, and <u>at most</u> one, track.

(N.S. Potter)

In conjunction with the study of the effect of errors introduced into the Cape Cod System through the use of uncorrected slant ranges, an upper bound to the expectancy of missing by virtue of the impossibility of proper correlation has been obtained. As opposed to the probability of locating the target within the wrong quantization box, which is not inconsiderable, missing by incorrect ranging has an expectancy of less than $3/10^3$ for a search circle of radius three miles. The figures which have been obtained are strong functions of the search area, and a rather complex expression for the expectancy of non-correlation has been developed to make it possible to extend these results to any reasonable modifications of the equipment.

4.0 DATA SCREENING (CONTINUED)

(H.H. Seward)

A program which displays Bedford data from the magnetic tape in sequential scans, with offset and expansion control, was run on the computer. The interval between successive scans was varied from 0 to 4 seconds to give a "moving picture" effect. Results indicated that this is not too satisfactory a method of recognizing tracks for initiation.

A similar program storing six scans of Truro data on the drum was scheduled twice for operation but was not run because of equipment difficulties.

(W. Wolf)

A program for the N. Truro data has been completed which will determine and print the following:

a) time per scan (to the nearest quarter second)
b) total number of returns per scan
c) number of returns in each quadrant per scan.

Work has been started on a correlation program which will correlate the returns from one scan with those from a previous scan. 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. It is hoped that this will prove a convenient way of determining the amount of stationary clutter and the amount of "noise" being received by a radar set.

5.0 TRACKING AND CONTROL

(B.R. Stahl)

A short term prediction parameter using a 3 1/2 second prediction interval instead of 13 seconds has been written for two-radar tracking and has been used successfully. Considerable time was spent preparing a more useful display program in anticipation of the demonstration on March 13, as well as any subsequent demonstrations. The remainder of the period was spent on the previously-described timing program.

(S. Best, W. Lone)

We have run the program described in the February 13, 1953 Biweekly Report in an attempt to solve the track crossing problem. Several flaws became apparent, the most important being the regulating of search circles to 3 or 5 miles depending on whether the aircraft was seen or missed respectively on the preceding scan. The frequency with which radar misses occur on the small radars causes tracks to switch in many cases before the corrective measure can be taken.

5.0 TRACKING AND CONTROL (CONTINUED)

(S. Best, W. Lone) (Continued)

We propose to make the size of the search circle equal to the speed per scan of the aircraft plus one-half mile. Also we plan to make the decision as to which track is the original aircraft after they have gotten 3 and 1/2 miles apart rather than after four scans. Also three consecutive misses on one of the two tracks is used as a basis for selecting the other track as being the original aircraft.

(M. Frazier)

Considerable thought has been expended on the problem of detecting the difference between a turn and a miss combined with a nearby piece of clutter without establishing a branching track every time there is doubt. So far no economical method has been discovered. Since the situation occurs relatively seldom, it is now felt that in a system capable of tracking many aircraft the addition of a small percentage of temporary branch tracks would not be too difficult, and this seems to be the most economical solution. For a system capable of tracking only a few aircraft, the additional load in correlation could be quite serious.

(A. Mathiasen)

The completion of the work on the two-radar tracking methods has been temporarily postponed in order to try to help find out how to track at long ranges where the quantization boxes no longer approximate squares. To this end a program has been written to track from simulated data using NLS-2, NLS-2b, and NLS-2c simultaneously to give a comparison of these methods. This will be done for various speeds at different ranges for both half-mile and mile quantization in range.

A second test of Foxboro data was a failure as the radar and associated equipment seemed to give random signals rather than track intelligence. In a half-hour's watching not one track was discerned although there were a number of airplanes in the area.

(H.D. Neumann)

The program mentioned in previous reports was run successfully twice. The second time a modified program was used, which resulted in better accuracy. The results showed that final-phase values are not dependent solely on height, as was assumed. New parameter tapes were prepared to study the results further.

6.0 AIR DEFENSE CENTER OPERATIONS

(D.R. Israel)

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

1. Together with Wieser and Arnow, discussions were held with Clark, Davis and Enticknap of Group 21. The details of the Cape Cod System were covered, including operational features and room layout. These discussions proved extremely valuable to us, and we are presently following up or studying the suggestions which they made. Among the major points brought up were:

   a) the elimination of the tote boards,

   b) reorganization of room layout, and

   c) renaming of the operating positions in the center.

   These three items are discussed in further detail below.

2. It was pointed out in the meeting with Group 21 that the need for central tote boards was generally overestimated. They felt that it was much more important to provide individuals with only that information which they specifically needed; they further felt that for the most part this information could be passed out on sheets of paper (weather conditions, for example) or could be toted by individuals (on their own separate, small, plexiglass board, for example). The Cape Cod proposals have been reviewed with this in mind, and it does not appear that all of the tote boards which we had planned are actually needed. The particular situations for which such totes are still desirable are a) for visitors, (b) for quick briefing of the Sub-Sector Commander and c) for use in the Sector Command Post; totes will be used in the Cape Cod System for this purpose.

3. Group 21's experience indicates that the noise level which would result from the proposed layout of SC-53867-1 (M1857) might be too high. They suggested the use of acoustic partitions around groups of people engaged in frequent telephone or radio communication. This proposal seems pertinent, and in conjunction with Capt. Sullivan, Mr. Crow, and Mr. Gronhovd an attempt is being made to devise a better room layout -- one which is

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(D.R. Israel) (Continued)

satisfactory from operational and visitor considerations. The positions of the outer walls of the center have been decided upon: arrangements have been made with Fahnestock, Newitt, and Mercer so that the specification of the positions of the internal acoustic partitions need not be made for several weeks.

4. Group 21 questioned the advisability of our using new names for positions and personnel presently having satisfactory standard Air Force names. In the recent visit from ADC this matter was discussed; they are giving consideration to the matter and will discuss it with us in the near future. In the meantime, I have considered the matter with Sullivan, Crow, and Gronhovd. They have made out several tables showing existing jobs and names, as well as the current Group 61 proposals and a revised proposal.

5. I have prepared tentative schedules indicating the various non-TWS functions and programming activity which must be undertaken in preparation for September. Sufficient manpower and time is indicated. These schedules have been reviewed with Bob Wieser. Several decisions resulting from these schedules are discussed below.

6. Herb Benington will give his complete attention to the problem associated with the use of the display equipment. As a first task he is preparing a list of the various categories of information to be displayed and a list of the display categories which should be viewed at each operating position. Benington will coordinate between the authors of the non-TWS programs and Ben Morriss and Guy Young on matters concerning display lines.

7. A definite proposal for the assignment and use of track numbers and interceptor pair numbers has not been reached. An existing proposal has recently been shown to be inadequate and a new scheme involving permanent track numbers for interceptors is being considered. It is hoped that a definite scheme can be adopted by next week. If so, a memo describing it will be issued.

8. Mike Geraghty has been asked to devote a part of his time to assist in planning and coordinating in connection with the installation of intervention switches. He is currently compiling a list of the switch and binary digit requirements.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(D. R. Israel) (Continued)

9. Two of our present operating programs will be converted to operate with the data from N. Truro once the MITE is available, hopefully in the middle of April. These programs and the equipment (switches, etc.) to operate them will be used until at least August 1, 1953. The two programs are the Combined Intercept Program and the Four Pair Intercept Program. The Sixteen Aircraft Initiation and Tracking Program will not be converted. A new program tracking eight aircraft will be prepared to be used solely for AAA and height-finder tests.

10. With the cooperation of Captain Marks and Lt. Coble (of the 6520th), official Air Force assistance and personnel have been secured for taking pictures of our interceptions. Some test runs with A.F. photographers will be made during the week of March 16.

11. Discussions with members of Group 21 and 22 and with various Air Force personnel point to the following decisions:

a) Our interceptors should be based at Otis and Bedford.

b) The two short range radars should be placed so as to obtain satisfactory coverage on interceptors leaving Bedford. This coverage, supplementing that of the 6B, should extend north and east from Bedford to the coast.

c) One nodding-beam height finder should be sited at N. Truro to supplement the 6B at short ranges; another nodding-beam should be situated with one of the short-range radars.

12. Frequent meetings with Brand, Gaudette, Heart, and Zraket are being held in an attempt to settle overall questions relating to Cape Cod Program framework -- i.e., storage and timing. Walquist has frequently joined the meetings, and much progress has been made in reaching decisions satisfactory to all parties involved. The meetings will continue on a daily and twice-daily basis for two or three more weeks. Following this, it is hoped that the decisions can be issued in memo form.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(D. R. Israel) (Continued)

13. Dick Whelan (Group 22) has given me some literature regarding the present Navy picket ship activity which may tie in with our Cape Cod plans. This has been discussed with Commander Hilgedick (Lincoln Navy Liaison) and a possible visit to one of the picket ships is planned.

(M. Brand)

Identification Section- September Cape Cod System. I have designed a set of rules for use in establishing distance-time-velocity relationships for the pre-plot board. The drawings were sent out for estimate and were returned with ridiculously high price estimates from both external vendors and the lab itself. In lieu of this a simplified rule will be made up by ourselves with an estimated cost of a few cents.

I have written a flow diagram and program which form the basis of a proposed simulated test program. This program is essentially a timing control program which transfers control to external programs at one second intervals. It is cyclic with a 16 second period. If a simulated track program were written for those time intervals when TWS will normally be done in the Sept. system the remaining time intervals could be used for the actual non-TWS programs. Data tape or magnetic tape read-in could be used to simulate switch read-in.

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

(J.J. Cahill, Jr.)

During the past period, a visit was made to N. Truro to arrange for tests of the height-finding function of the CPS-6B. As a result of the visit, two flight tests have been run. On March 6, during a Combined Interception test, the first attempt was made to forward the range and azimuth of a tracked target with respect to N. Truro and thereby obtain an altitude estimate. Due to scope trouble at the site, no results were obtained. On March 10, a special Height-Finder Calobration test was performed, using the same program. The CPS-6B was off the air for twenty five minutes, but once it was operative, considerable success was experienced in obtaining estimates correct to within 1000-1500 feet at ranges from 30 - 60 miles. The time required was often under 30 seconds and never over 45. Further attempts will be made.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

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

On March 6, an AA Guidance exercise was run through the AAOC, twelve batteries cooperating. Three runs were made. On the first run, the target (Navy F3D, 280K) was acquired by the first battery at a range of 32 miles. On the second run, the target (F86D, 450K) closed too fast for acquisition. However, on the third run, acquisition was made by the first battery at 35 miles, the jet continuing to fly at 450 knots.

During this period, some thought was given to the writing of an 8-target AA-Guidance and Height-Finding program to use N. Truro radar data and to approach as nearly as possible the program that will be written for the Cape Cod System.

(P.O. Cioffi)

An estimate of some of the internal communications for the identification section within Information and Direction Center was made. This description is admittedly sketchy at this time for lack of actual experience with such a system.

I visited at Building B to discuss with R.N. Davis the new multiple corridor air entry system to be installed in this area. Actual details were not available at that time but are expected to be known soon.

(F.A. Webster)

A diagram entitled "Provisional Distribution of Person-to-Person Communication Lines in the 1953 Cape Cod System" has been distributed for revisions and suggestions. It is based on Conant's chart, the details of which were compiled by Israel, Brand, Cahill, Walquist and Zraket. A simplified functional diagram (SA-54167) was distributed along with it to illustrate the overall arrangement. Corrections should be made on the distributed copies for incorporation into a revised version.

A plot has been made to simulate the tracks of a small hostile attack (about 8 aircraft) from the East. This is to be used to study the sequence of messages that might have to be handled by the communication system in meeting such an attack.

(A.W. Curby)

A program for extrapolating flight plans has been written. Its first run on the computer was unsuccessful due to scale factoring errors. The program was rewritten to correct these mistakes and to

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(A.W. Curby) (Continued)

make it compatible with recent decisions on input of data. It is hoped that it will be checked out this week.

Thought is being given to a program for processing and storing data from Little Aircraft Movement Identification Section, GOC, and Brunswick. When these two programs are checked out, it should be possible to simulate much of the identification procedure.

(O. T. Conant)

The information desired concerning direct and conference phone lines in the 1953 Cape Cod System has now been received from most of the persons working on the various Defense Center functions. This information will be correlated as it is completed during the next biweekly period. A memo concerning the phone communication system will be published if it appears warranted.

A scope calibration and geography display program is being undertaken for the coverage of the N. Truro CPS-6B radar and the scope deflections proposed for the 1953 system. The coordinates from Truro of all important sites to be included in the system will also be published in memo form. Notification of any site which should appear in the display or memo will be appreciated.

(M. A. Geraghty)

During the past two weeks, further tests of J. Cahill's AA Guidance and Height-finder program were made, and I assisted at two of them. A test was held, using 3 jets and 2 B-17's, of the raid-size discrimination ability of the Rockport MPS-4 and the Scituate TPS-10 height-finders. The three jets made two runs on Rockport, the two bombers two runs on Scituate. First jet run was to be made in chain formation, second in line abreast, 1000' separation, but radio instructions to the flight leader were misunderstood, and the exact flight pattern is indeterminate. However, on both runs the MPS-4 counted three distinct craft at median ranges, and apparently could count fairly reliably on a one, few, many basis at such ranges. The two B-17's, stacked 1000 ft vertically, were counted successfully by Scituate TPS-10, but reports were varying and not too reliable. A comparatively new operator might explain the variations. Farthest accurate count was of four planes at 42 miles. This would seem exceptional.

Further tests are to be held, and encouraging results are anticipated. The modification of the AA guidance and HF program mentioned in the last report has been expanded to a logical programming of a

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(M. A. Geraghty) (Continued)

AA guidance and HF function to run with an eight A/C tracking program of S. Knapp's, using Truro data. This, together with a survey of data insertion register requirements for September, will occupy the majority of the coming two weeks.

(C. A. Zraket)

Conferences have been continued with members of the group as to the equipment and programming requirements for the 1953 Cape Cod System. Work has been concentrated on the switch input data and display line requirements for the non-TWS function. In addition, the allocation of storage in the form of tables for all the data of the non-TWS function is being considered. The data will be stored in such a manner that indexing from any one table to another can be easily programmed. The make-up of the blocks of data will be such that only a minimum of data need be read in for any program within the major program cycle.

(L. J. Murray)

During the past biweekly period work has continued in the standardization of subroutines for the September System. I have written check programs for the following proposed subroutines: arcsine, arctangent, sine-cosine, radius vector, and square root. When these programs are checked, and we are satisfied with the accuracy of the corresponding subroutines, the subroutines will be issued as an M-note.

In addition, I have been familiarizing myself with the Interception phase of the September System.

(C. H. Gaudette)

The first group of subroutines for the September System have been written and are now being duplicated for distribution. This group will include the following: arcsine, arctangent, square root, sine-cosine, radius vector, and two vector display subroutines. L. Murray has written programs which will check these subroutines.

F. Garth, W. Lemnios, C. Zraket, and I are planning to rewrite the Combined Interception Program. The new program will use the data from North Truro and will include the Final Turn Subprogram. No other major modifications are anticipated.

6.0 AIR DEFENSE CENTER OPERATIONS (CONTINUED)

(C.H. Gaudette) (Continued)

Some time has been spent in preparation for the demonstration held on March 13. Because of the preparation required for this demonstration, several scheduled Combined Interceptions had to be canceled.

(H.B. Benington)

During the period I started to familiarize myself with the display system to be used in September Cape Cod. This has entailed collating the scope display requirements of all the operators e.g. Weapons Director, in terms of a complete fundamental set of display categories e.g. positions of unassigned interceptors. I am preparing an interoffice memo which will give a temporary frozen allocation of output lines, since such perspective is preliminary to any further equipment, switch, or display program planning. This memo will be distributed to all interested persons for their comments.

7.0 ASSOCIATED STUDIES

(E.J. Craig)

The problem of determining the impulse response of a system from measured data has long been in need of a satisfactory solution. Using the superposition integral along with measured data, this problem can be shown to be one of "n" simultaneous non-linear equations in n-unknowns.

Generally n=6 will give a satisfactory representation, assuming the impulse-response is a function of three complex frequencies (3 poles, 3 residues).

I intend to use my iteration scheme on these equations, both to emphasize its value (if it has any) and to solve a heretofore unsolved problem.

(W.I. Wells)

A study is in progress to examine the results that can be obtained by a Wiener-Hopf approach to statistical filter design of discrete filters. It has been found possible to obtain the impulse response of these filters in closed form by a frequency domain approach rather than by the usual methods where simultaneous equations are solved to approximate the impulse response.

It is desired to see under what conditions these filters are equivalent to ones derived by a more sophisticated procedure. This procedure has been the result of work in previous months and I am attempting to compare it with the more well-known techniques.

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	3 hrs 25 min
Magnetic Tape	9 hrs 25 min
Data Screening	11 hrs 0 min
Multiple Radar Tracking & Control	9 hrs 0 min
Air Defense Center Operations	2 hrs 20 min
Library of Subroutines	1 hr 10 min
Indoctrination Programs	1 hr 0 min
Miscellaneous	1 hr 55 min
Calibration	40 min
Demonstration	7 hrs 0 min
Equipment	6 hrs 0 min
Total Time Used	51 hrs 55 min

8.0 COMPUTER OPERATIONS (CONTINUED)

(M. Brand) (Continued)

Time Lost to Computer (parities, etc.)	3 hrs 20 min
Time Given to Drum	12 hrs 45 min
Time Lost	2 hrs 0 min
Total Assigned Time	70 hrs 0 min
Percentage Assigned Time Used	74%
Percentage Available Time Used	96%

(C.A. Zraket)

Demonstrations:

1) A group of officers from the 6520th Wing visited the Laboratory on March 3 to witness a live two-aircraft combined interception.

2) The following programs were shown to the Kelly Committee on March 13:

   a) Two-Aircraft Interception with the use of the automatic ground-air data link. Ampex #238. (P-2466-1).

   b) Multiple Tracking and Initiation. Ampex #245. (T-2109-16).

9.0 FLIGHT TESTS

(F. Heart, M. Brand)

The following statistics apply to the last biweekly period:

1) Computer hours scheduled for flight tests	19
2) Computer hours used for flight tests	3 1/2
3) Computer hours returned due to flight test cancellations	12 3/4
4) Total Aircraft Hours Flown	18 1/2
5) Aircraft hours flown by 6520th Wing at Bedford	15
6) Aircraft hours flown by Navy (Quonset-based Squadron)	3 1/2
7) Aircraft hours flown by M.I.T. Instrumentation Laboratory	0

A flight test summary for the month of February was issued as M-1882.

DATE	TIME	SCHEDULED TEST A/C	SCHEDULED TEST Description	TEST ACTUALLY RUN A/C	TEST ACTUALLY RUN Description	REASONS FOR CHANGES OR COMMENTS
2/3	1000-1200	2	Two Aircraft Intercepts with Data Link	-	Cancelled	Aircraft not available
3/4	1000-1200	3	Two Aircraft Intercepts	-	Cancelled	Weather
	1400-1500	1	3 Radar Coverage	-	Cancelled	Weather
3/5	1400-1600	5	Aircraft Discrimination with Height Finder	5	As Scheduled	
3/6	1300-1500	2	Two Aircraft Intercepts	2	As Scheduled	
	1500-1600	1	Height Finder Test	1	As Scheduled	
3/10	1400-1600	4	2 Pair Intercepts	1	Ran Truro Height Finder Test	2 Pair Program not ready
3/11	1000-1200	2	Two Aircraft Intercepts	-	Cancelled	Unable to obtain aircraft
	1400-1500	1	Coverage with Foxboro Radar	1	As Scheduled	-
3/13	0900	4	Intercepts Demonstration	-	Cancelled	Weather

• Added to schedule during week of test

9.0 FLIGHT TESTS (CONTINUED)

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

March 5 1400-1600 Height Finder Discrimination, Geraghty
Three jets were used holding Portland at 15,000 ft. and vectoring toward Rockport. Two B-17's were also used, holding 15 miles east of York Beach at 12,000 ft. The jets made two runs on Pigeon Hill, the B-17's two runs on Scituate.

March 6 1300-1500 Two Aircraft Intercepts, Zraket & Gaudette
An F-94 #502 was used as fighter, holding on ground at Grenier for scramble.
An F-3D (Navy) was used as target, holding Nantucket at 12,000 ft. IAS 300 knots.
One run was made with the F-94, using runway #35, and climbing to 8.5, IAS 320 knots.
The F-94 was delayed in scramble and intercept took place east of Rockport, with the target passing one mile ahead of the fighter. Then, to study AAA, the F-3D made one run from Portland to Boston at 15,000 ft., IAS 380 knots.

1500-1600 Truro Height Finder, Geraghty
An F-86 made two runs from Portland to Boston at 15,000 ft., IAS 450 knots. Scope trouble at Truro was noted.

March 11 1400-1500 Foxboro Coverage, Mathiasen
One B-17 used for this test, flying over Foxboro area. Cloud clutter and general weather conditions were poor.

10.0 PUBLICATIONS

(M.R. Susskind)

LABORATORY REPORTS

1. "Programmed Generation of Marginal Checking Voltage," R.P. Mayer, K.H. Olsen, E-535, March 13, 1953.
   CONFIDENTIAL

2. "Flight Test Activity Report for February, 1953," F. Heart, P. Dolan, A. Hill, March 4, 1953.
   CONFIDENTIAL

3. "Air Defense Biweekly, February 27, 1953," M-1890, pp. 1-27.
   CONFIDENTIAL

4. "Summary of IBM-MIT Collaboration," February 1, 1953 to February 28, 1953 inclusive, A.P. Kromer, M-1891, March 9, 1953.
   CONFIDENTIAL

5. "Field of Work," A.P. Kromer, M-1892, March 9, 1953.
   CONFIDENTIAL

6. "Plans for Procurement of Video Filters," S.H. Dodd, E.S. Rich, M-1900, March 6, 1953.
   CONFIDENTIAL

7. "Block Diagrams: Control Registers," R.P. Mayer, M-1905, March 12, 1953.
   CONFIDENTIAL

8. "Block Diagrams: Command Generator," R.P. Mayer, M-1906, March 12, 1953.
   CONFIDENTIAL

9. "Block Diagrams: Functional Programs," R.P. Mayer, M-1907, March 12, 1953.
   CONFIDENTIAL

10. "Internal Storage and Computing Time Allocation," R.L. Walquist, M-1913, March 16, 1953, pp. 1-8.
    CONFIDENTIAL

TECHNICAL REPORTS

1. "Quarterly Progress Reports Sparrow III on the Development of the Sparrow III Missile," Report No. 4, April 1 thru June 30, 1952, Report No. 5, July 1 thru September 30, 1952, Raytheon Mfg. Co., Missile & Radar Division, (Abstracts), Lib. No. 2266R.
   RESTRICTED

2. "Description of a System for Transmission of Line Drawings with Bandwidth-Time Compression," M.A. Treuhaft, Rome Air Development Center, Polytechnic Institute of Brooklyn, November 25, 1952, Lib. No. 2283R.
   RESTRICTED

3. "Planning and Conducting Reliability Test Programs for Guided Missiles," Naval Air Missile Test Center, Pt., Mugu, Calif., June 20, 1953, Lib. No. 2300R.
   RESTRICTED

10.0 PUBLICATIONS (CONTINUED)

(M.R. Susskind) (Continued)

4. "Information Requirements and a Method of Estimating the Effect of Jamming on Short Range Missile Systems," A.C. Raymond, Haller, Raymond, & Brown,Inc., State College, Pa., Lib. No. 2167C.
CONFIDENTIAL

5. "Quarterly Progress Report, Division 2, Aircraft Control and Warning," Lincoln Laboratory, M.I.T., September 1, 1952, Lib. No. 2304C.
CONFIDENTIAL

6. "Quarterly Progress Report, Division 4, Weapons," Lincoln Laboratory, M.I.T., October 31, 1952, Lib. No. 300/S.
SECRET

7. Noise-Like Signals and Their Detection by Correlation," Basore, B.L., Research Laboratory of Electronics, and Lincoln Laboratory, M.I.T., Lib. No. 301/S.
SECRET

8. "Review of Scintillation Measurements," R.B. Muchmore, Hughes Aircraft Company, December 1, 1952, (Abstract), Lib. No. 302/S.
SECRET

9. "Development of a High-Temperature Resistant, Low-Density Foam Material for Sandwich-Type Radomes,"Quint,R.W., Kimmel, B.G., August 1, 1952, (Abstract,) Hughes, Lib. No. 303/S.
SECRET

10. "Non-Coherent Ground-Based Moving Target Indicator," Control Systems Laboratory, Univ. of Illinois, Urbana, January 1953, Lib. No. 304/S.
SECRET

11. "Airborne Moving Target Indicator Using Storage and Frequency Analysis," Control Systems Laboratory, Univ. of Illinois, January 10, 1953, Lib. No. 305/S.
SECRET

12. "A Proposed System for All Weather Attack on Moving Vehicles," Control Systems Laboratory, Univ. of Illinois, December 1952, Lib. No. 306/S.
SECRET

13. "Preliminary Report on the Observation of Snorkels and Sea Clutter Using Coherent Airborne Radar," Control Systems Lab., Univ. of Illinois, November 20, 1952, Lib. No. 307/S.
SECRET

14. "Progress Report for January 1953," Control Systems Lab., Univ. of Illinois, Lib. No. 308/S.
SECRET

WHIRLWIND II

(H. Boyd)

Basic Circuits: High-Speed (Gate-Tube-Driving) Flip-Flop. A triggering scheme has been developed, as requested by N. Daggett, so that positive triggers can be used for setting, clearing, and complementing the flip-flop. With this new triggering scheme the flip-flop's maximum prf is 4.5 megacycles (100 pf load, 12-30 triggers), and there is a constant 0.1-μsecond delay from the leading edge of the trigger to the point at which the upper output level starts to change (set and clear), and a delay of from 0.1 to 0.2 μsecond when complementing.

Recent plate dissipation re-ratings of the 5965 have allowed faster fall times with heavier loads.

Progress has been halted temporarily pending further comments from the WWI group.

Basic Circuits: (Low Input-Impedance) Diode-Driving Flip-Flop. Tests have been satisfactorily completed on the flip-flop recently designed for use in a low input-impedance and high input-impedance diode-driving flip-flop. This flip-flop is similar to the high-speed (gate-tube-driving) flip-flop, but possesses greater reliability. The increased reliability, however, was gotten by a sacrifice in speed, as a diode-driving flip-flop need only be operated at a maximum prf of 2 megacycles. Due to the tight limits set on the flip-flop's output levels, a doubly-clamped plate load was necessary. With respect to tubes, the doubly-clamped plate load and the permission of relatively large quantities of grid current allows the flip-flop to behave like a one-horse shay, i. e., no change in outputs until a tube ages to the point where its I_b has decreased to 40% of average.

(G. Briggs, H. Rising)

Although work is continuing on magnetic circuits, especially on developing a satisfactory single-advance pulse type counter and on reliability testing of the capacitor-coupled stepping-register circuit, we are developing proposals for the input phone line equipment which will use no more than the magnetic-core buffer storage and possibly the stepping register itself, elements which IBM also feels reasonably safe to propose in the time available.

For the SDV counters a time-shared counter is proposed, using a separate 1400-bit high-speed or stepping-register memory, rather than utilizing the input drum to store the count. IBM has a similar proposal. If this system were used, only three storages would be required at the end of each phone line, and these could be magnetic-core buffer storages.

WHIRLWIND II (CONTINUED)

For the radar-mapper scopes, a scheme using two 32-position telephone-type switches moving on alternate θ-change pulses appears attractive. It would produce an analogue x-y sweep with very little equipment per map per scope. It could be easily synchronized with north. Time-shared digital x-y deflection is also being reconsidered.

With the analogue schemes, a basic problem is still unsolved of how to get this type of display on the output scopes in case of computer failure.

(W. Clark)

Meetings with people from Project High have continued, and the WWII order code has been completely agreed upon, as expected. Pending the circulation of a more formal "operators' and programmers' manual" by IBM, copies of an ozalid listing of the order code are available from R. P. Mayer.

In order to study the code in practice, it has been decided to program a typical air defense problem. A single-radar multiple a/c tws program will be prepared both here and at Poughkeepsie, and it is expected that this will uncover some of the "tricks" which are made possible by the index registers.

(M. Epstein)

I spent the period acquainting myself with different methods of control circuitry in connection with WWII control.

(J. Gillette)

Basic Circuits: Level Inverter. A level inverter has been constructed. Preliminary tests indicate that the circuit will probably work properly.

(C. Grandy)

The study of display categories for the WWII coincidence display system has been continued during this bi-weekly period, and a number of conclusions have been made. The immediate objectives of the study were to evaluate the usefulness of various display categories and to select the best combination of categories for the coincidence display system. A display system has been outlined involving four categories upon which coincidence need be done at each console.

WHIRLWIND II (CONTINUED)

This system has an overall utility of 0.72, which compares favorably with the utility figure of 0.25 quoted in the last bi-weekly report for an eight-to-ten category system. Other displays are provided in the outlined system by the scope line technique with scope line information decoded partly by matrix or coincidence decoders near the drum and partly by computer programming. Using this method it is possible to save up to about 43% of the coincidence circuits and to achieve good utility without making any notable sacrifice in the display output. The method does restrict the generality of the display console so that all consoles at a computer center are not interchangeable; however, all of the consoles in one room, as the Track Supervision Room, would be interchangeable. Any scope in the room could be used for any function of track supervision, initiation, or monitoring, but scopes in the Identification Room could not be used for these functions. This appears to be a reasonable and perhaps even a desirable restriction.

Some information disclosed by this study has been discussed briefly with E. Goldman, IBM engineer working on In-Out equipment for WWII. During the next bi-weekly period I will write a more detailed outline of the system proposed and some notes explaining the study and its results and have them printed up for distribution to interested people. I am also keeping myself informed about the display system for the September Cape Cod system, and the development of that system will probably indicate revisions of the categories I have selected.

(J. Hayase)

A list of routines and sub-routines for the September Cape Cod system was made, and various members of the Cape Cod group were contacted to get a brief description of these routines.

In order to try out the new WWII order codes, a tracking program to track 16 aircraft using a single radar or 128-mile range (1 mile quantization) has been roughly block diagrammed. Initiation and cessation are done automatically, and the box correlation scheme is used for correlation. The data is stored on the buffer drum, and the block transfer order is used to introduce data into high-speed storage.

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

WWII Arithmetic Element and Control. At a meeting in Poughkeepsie on March 5-6 a specific logic and circuitry for the WWII arithmetic element was chosen. A block diagram has been prepared for distribution to the WWI and Air Defense groups. Comments and suggestions are invited. Details and possible modifications are being

WHIRLWIND II (CONTINUED)

worked out by Ross' group at IBM. Bill Klein is preparing a report (R-223) describing the dozen or so multipliers which were surveyed before the decision was reached.

We have begun a study of the timing of Memory, the Arithmetic Element and the In-Out equipment preparatory to designing Central Control and the In-Out interlock. As was the case with the Arithmetic Element, a number of methods will be surveyed before deciding on a specific logic and circuitry for control. We will be working with Marvin Epstein and with members of Jacobs' group in the control study.

(C. LaSpina)

Basic Circuits: Level Amplifier. A number of methods for amplifying and setting d-c levels, which are necessary for use with diode logic, are being evaluated.

Modifying a high-speed flip-flop (E-526) to trigger on d-c levels instead of 0.1-μsecond pulses and clamping only one-half of the flip-flop, so as to work as an amplifier, looks very good. Clamping both halves of the flip-flop (one-half acts as an amplifier and the other as an inverter) so as to eliminate a separate inverter, has too large a hysteresis (difference in trigger levels when triggering from different directions).

Driving a grounded grid amplifier with a cathode follower, which uses one tube less than the flip-flop method, is also being investigated.

(G. Rawling)

Master sheets suitable for ozalid reproduction have been completed for the following five chronological plan-sheets illustrating preliminary concepts in various subsystems of the Transition Phase of the Air Defense System:

1) Inputs
2) Outputs
3) Weapon assignment assistance from computer
4) Interception by manned interceptor
5) Interception by surface-to-air guided missile

Part of the past biweekly period was spent in discussions with IBM representatives concerning programming, coding and the code instructions for WWII.

WHIRLWIND II (CONTINUED)

A rough draft chronological flow sheet illustrating the roles of Computer Command Center and Anti-Aircraft Operations Center (AAOC) when coordinating in point defense has been prepared. This first draft includes such concepts as indexing defense sites as a function of hostile data; coordination with AAOC; correlation of hostile data with weapon class characteristics, to aid in optimum weapon selection; defense by guided missile, gun, and rocket, and low-altitude defense. Revisions and additions to this flow sheet are being made with the aid of several references.*

(D. Shansky)

Basic Circuits: X and Y Plane Driver. Attention is now being directed toward the utilization of a magnetic matrix switch to drive the WWII magnetic memory directly. A system involving feedback will be used to regulate the current pulse amplitude and shape. This system is presently being designed.

(J. Woolf)

Basic Circuits: Pulse Delay. The investigation of pulse delays of 0-2 μseconds using 400-ohm line has begun. At present the line is being driven from a buffer amplifier. Attempts will be made to drive the line from a gate tube.

The General Radio variable delay line will be investigated, and suggestions as to direction for performance improvements will be made.

---

* Anti-Aircraft Defense System AN/GSG-2, (Secret), ER 4982, Glenn L. Martin Co., 1952.

Defense of the Continental U. S. by Various Missile and Gun Systems for the Period 1953 to 1959, (Secret), RM-626, Rand, 1951.

Guidance, Control, and Accuracy of Defensive Guided Missiles, (Secret), RM-629, Rand, 1951.

Manpower, Equipment and Facility Requirements and Their Associated Costs for Guided Missile and Gun Defenses, (Secret), RM-630, Rand, 1951.

Low-Altitude Local Defenses: Part I, (Secret), RM-631, Rand, 1951.

Low-Altitude Local Defenses: Part II, (Secret), RM-633, Rand, 1951.

WHIRLWIND II (CONTINUED)

(J. Woolf, con'd.)

Basic Circuits: Pulse Standardizer. The pulse standardizer is a circuit which will provide standard pulses 0.1-µsecond half-sine-wave pulse whose amplitude and shape are independent of input amplitude and shape.

This investigation will be concerned with making the standardizer operate with a normally off tube.

(H. Zieman)

Terminal Equipment: Display 'Scope Deflection Amplifier. In the last bi-weekly report it was mentioned that some difficulty was experienced in the new amplifier with susceptibility to ground currents. Using a balanced feedback circuit and a balanced input circuit has corrected this situation. A common signal of six volts can now be completely balanced out, and this balance is independent of the setting of the gain on position controls.

A second unit has been built for a horizontal amplifier. It is planned to compare this prototype 'scope having the new amplifier with one of the old scopes to compare their relative susceptibility to induced signals on input leads, power supply variations, and internally induced 60-cycle interference.

The prototype 'scope has been revised to accept a standard 'scope power supply.