Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: GROUP 61, BI-WEEKLY REPORT, July 3, 1952

1.0 GENERAL

(D. R. Israel)

Plans have been made to move the MEW at the Bedford Airport. This move, to a site as yet unchosen, will be made during the month of August, and it is hoped that it will be completed and the radar will be back into operation by the time the installation of the Whirlwind In-Out system is completed.

At a meeting of the interested parties, changes in the assignment of computer operation time to Group 61 were effected. These changes do not materially increase the amount of computer time that the group gets, but rather provide a two-hour period from 10 AM to noon on Mondays, Wednesdays, Thursdays, and Fridays for flight tests as well as giving the group approximately six hours per week of computer time in the late afternoon and early evening.

The filing and numbering scheme mentioned on the first page of the previous bi-weekly report will not be used. Every attempt should be made to conform strictly to the standard Whirlwind numbering system.

2.0 EQUIPMENT ENGINEERING

(E. S. Rich)

A draft of a report on the detailed logical operation of the In-Out element and of the new IO orders has been completed. After correction and completion of some drawings it will be ready for publication. This is the first of a series of reports which are planned to comprise a complete description of the new In-Out system. Jim Forgie has been assigned to assist in this report writing.

F. Heart has drafted a memo intended to provide programmers with preliminary information as to what will be contained in the Terminal Equipment system after installation of the new IO element. It enumerates the units which will be tied in through the IOS and IOC and describes how these will be controlled with the new IO orders. An informal conference was held last week with members of Adams' group to pass on similar information.

2.0 EQUIPMENT ENGINEERING (Continued)

(J. H. Newitt)

During the past bi-weekly period decisions have been reached that allow an air-conditioning installation specification to be written for the purpose of obtaining outside bids. The air conditioning companies have not yet submitted their proposals but I now feel sufficiently conversant with the overall problem to write the specification without their help. The specification is now in preparation and will be circulated to interested parties in our group for general criticism before it is released.

Miscellaneous installation problems absorbed a portion of the past bi-weekly period. Consultation with J. Gano with regard to methods for cooling the new power supply equipment has resulted in a definite plan of attack. A method of taking care of C. Corderman's cooling requirement in Room 026 has been worked out although a little more investigation is necessary before detail decisions can be made. The general plan involves filling the Room 026 requirement with the present 10 - ton compressor in the basement and by using a suspended weather-maker unit in the room directly above 026. In this manner, Room 026 will be completely independent of the system for WWI, Room 224 and Room 156.

I spoke to a representative of the city fire department about the sprinkler system of WWI and the proposed sprinkler system of Room 156. This resulted in a lot of confusion which was straightened out by a subsequent visit from a representative from the sprinkler company. To clarify possible misconceptions that may exist it might be well to make the fire protection system of WWI more generally known. The system works as follows:

The present sprinkler system of WWI is a "dry system", i.e. there is no water in the sprinkler pipes. Air pressure in the pipes holds a water valve normally closed. The system can be actuated either by a rate-of-rise control which ties into the water valve or it can be actuated by an absolute rise which would cause a sprinkler nozzle to release the air in the sprinkler pipes and consequently operate the water valve. The rate-of-rise system is more sensitive than the absolute system and would normally be the first to act. This system would actuate an alarm and open the water valve, thereby converting the "dry" system to a normal type of "wet" system. The water however, would not be released into WWI equipment until the absolute temperature fuse of a sprinkler nozzle was effected. In this manner, time is available to appraise the fire hazard and to prevent water damage in WWI where the fire threat is not serious. Whenever the rate-of-rise system is set into operation it should be remembered that the sprinkler system becomes "wet" and should be drained and restored to a "dry" condition at the earliest opportunity.

It is planned that the above-described "dry" system be employed in Room 156. An estimate on installation will be forthcoming soon from the sprinkler company.

2.0 EQUIPMENT ENGINEERING (Continued)

(H. J. Kirshner)

Fidelity of reproduction of SDV data, when using the Ampex twin track recorder, has been considerably improved by the use of "Scotch" Telemetering Tape. Several reels of tape have been recorded, and as far as can be determined, recorded data is as good as live data.

Two pre-amplifiers, now under construction for the Ampex unit, will facilitate recording and playback and should provide ease of operation of the Ampex unit comparable to that of the Magnecorder.

A phone line repeater amplifier has been constructed and installed for the purpose of boosting SDV re-transmission to the Lincoln Laboratory.

Field experiments were made to determine the feasibility of using a VHF communication link between Whirlwind and AAA sites. It appears that communication can be established provided that the antenna at the AAA site is sufficiently high. Communication reliability will probably be improved when the present VHF facility at Bedford Airport, which we use, is replaced by new equipment at the Lexington Field Station. This change will probably take place in a month.

Some down time of the Bedford Terminal equipment developed on July 3 due to an open pulse transformer winding and an open filament in a 12AX7.

(F. Sandy)

A meeting was held June 27, at which time the details for the painting, lighting and air distribution to be installed in Room 156 were decided upon. For further details, see memo M-1545.

(A. V. Shortell, Jr.)

Pictures of Scituate data recorded during the previous bi-weekly period, were made into a mask for use with the video mapper. This mask was used by Bob Walquist with fair success, but drift in the vertical amplifier of the mapper scope proved to be quite troublesome.

Rather than design a deflection amplifier with low drift, it was decided to install the present mapper setup temporarily and incorporate a simple scheme for checking the mask alignment quickly. The alignment scheme has taken a fairly definite form and should be installed during the next bi-weekly period.

2.0 EQUIPMENT ENGINEERING (Continued)

(P. W. Stephan)

A line diagram of paper tape recorders and printers is in the drafting room and will be issued shortly. I am now doing a line diagram of paper tape readers.

The block diagrams of all units in the new in-out system except the in-out switch are ready or in drafting, and a list will be put in the next bi-weekly report.

(C. Watt)

A vendor to assemble the production quantities of plug-in units is now being selected. It is hoped that by July 15 all bids will be in our hands.

3.0 BEDFORD EXPERIMENT

(D. R. Israel)

The new schedule of computer time will permit the Bedford Experiment Group to use the computer three times a week -- Monday, Wednesday, and Friday -- for flight tests from 10AM to noon. A flight test schedule has been drawn up and all of the flight test periods from June 30 through September 25 have already been filled; no tests are scheduled for the last three weeks in August. In addition, roughly four hours a week of flight tests are scheduled during which time the computer will not be used.

Fligh tests during the past two weeks have not been particularly satisfactory. This situation can be attributed to several causes; among them have been the difficulties involved in coordinating with the new flight test group and in indoctrinating new personnel here. We have been particularly bothered during our flight tests by the very noticeable vertical drift of the 5 inch scopes; this drift is sufficient to render these scopes unusable. It has also been very evident that the present setup of equipment in Room 224 is inadequate and must be changed; we have reached the point where it is no longer possible for one person to run the whole flight test. Rather, our present flight tests involve the coordinated efforts of anywhere from two to five people.

It became apparent during the past two weeks that efforts must be made to formalize the operation and availability of the MPS-4 Height Finder at Rockport; H. Boehmer of Group 22 is undertaking to do this.

On a flight test on July 2 an F-80 jet interceptor was matched against a B-17 with unsatisfactory results. The lack of solid radar echoes was a contributing factor but we also seemed to have difficulty in tracking the very high speed jet during turns. A jet interception is of such short duration that unless proper initiation and tracking is established immediately, the results are likely to be poor. Unfortunately we neglected to record two of the three tests on July 2 and the opportunity for further study of the difficulties does not exist.

3.0 BEDFORD EXPERIMENT (Continued)

(D. R. Israel) (Continued)

We have attempted on several occasions to hold tests in which aircraft were "scrambled" from Grenier (N.H.) Air Force Base. We have not as yet been able to establish proper communications with Grenier so that we can be immediately notified when the aircraft takeoff. Further tests will be attempted.

(A. Hill)

In the period from June 23rd, through July 3rd, a total of seventeen aircraft flying hours were devoted to our test program. Four hours were cancelled; two hours due to the weather, and two hours due to aircraft mechanical trouble.

Breakdown of flying time as follows:

June 23 — One hour, automatic initiation after takeoff from Grenier. One hour, final phase guidance, a B-26 was used.

June 26 — Two hour coverage test for both Bedford (MEW) and Rockport using a H-12 (Helicopter)

June 30 — One hour final phase guidance, using a B-17
One hour -- testing the height finder at Rockport.

July 2 — Five hours -- "Jet on Piston" interception, using a B-17 as the target, and an F-80 as the interceptor. In addition to the interceptions, Radar coverage on the F-80 at 19,000' at an I.A.S. of 260 was measured -- results were poor. Also the time for turns at one needle width and two needle widths on the B-17 were measured and recorded.

Three runs were attempted, for all three runs the interceptor started at Concord, N.H., with the target at a position approximately 20 miles east of Sanford, altitudes used were 10,500' for the interceptor and 10,000' for the target. Results were as follows:

Run #1 Initially, the wrong target was tracked. After reinitiation, correct target picked up. The F-80 was tracked during the first stages of the interception. However, after a short time, tracking of the F-80 ceased and another a/c in the vicinity was picked up. Difficulty seemed to be in maintaining a track on the high-speed F-80. Closest separation was five miles.

3.0 BEDFORD EXPERIMENT (Continued)

(A. Hill) (Continued)

Run #2 Tracking of the F-80 was poor. Continuous re-initiation had to be made in order to maintain tracking. Closest separation was 1/2 mile.

Run #3 Tracking of the F-80 was poor. Same troubles occurred during this run, as in run #2. Pilot reported that the closest separation 2 miles, occurred two minutes before indication of the interception by the computer. This was probably caused by tracking the wrong target.

July 3 Two hours -- Automatic takeoff initiation from Grenier.

(J. J. Cahill, Jr.)

A program for displaying AA Guidance information in the form of the position of a tracked target with respect to the georef grid has been prepared and run successfully during the past two-week period. It was successfully combined with T-1000, M-5 (Interception Display Program), and a new tape, T-1382, will soon be available which will present this combination on a single tape. The same program has also been prepared in the form of a parameter for use with T-1298, M-2 (Basic 2 A/C Tracking Program), but has not been checked out to date.

A study was initiated during the past two weeks, having for its purpose the possible preparation of a program which will evaluate targets and assign AAA batteries.

The various programs used during flight tests were studied, having in mind the requirement that all members of that section concerned with the Bedford Experiments be familiar enough with all the programs to handle the computer during a flight test, should the need arise. This study involved assisting at all tests run during the past week.

(P. O. Cioffi)

I have been engaged primarily in clearing up work already underway in order that I might give more time to matters brought under the consideration of a committee recently named by D. Israel of which I am a member. This received brief mention in my last report.

I am also giving more time to flight test activities.

3.0 BEDFORD EXPERIMENT (Continued)

(S. Knapp)

The Multiple Aircraft Tracking Program is still rather erratic in its behavior. Sometimes it will track for a considerable number of scans and then start missing, sometimes it misses on every other scan, etc. Work is continuing on de-bugging this program.

The Automatic Initiation Program is written, but until the tracking section, MACT-16, has been checked out, nothing further can be done on this.

It is planned to use the Three Aircraft Interception Program in a flight test for a "two on one" interception. NLS-2c, and provisions for wind data, are being put into this program.

(C. A. Zraket)

1. Explicit Solutions and Programs for Interception Equations: The shorter version of the "lead angle" solution has been checked on the computer against the longer version which employs scale factoring techniques. For separations, in both Δx and Δy, of 2 miles or greater, both programs give accurate answers. For separations less than 2 miles (both 1 mile and 1/2 mile were tried), the shorter version generates a considerable error. These results indicate that scale factoring will probably have to be employed.

The anomalies in the "time" solution where $V_i \cong V_t$ have been discovered. The program was run successfully after the corrections were made. Although this solution is more wasteful in storage space than the "lead angle" solution, more information, such as time to interception, is derived from the final results. P. Cioffi is now incorporating the above results in M-1489, "Solution of Interception Equations".

2. The program which automatically initiates on an interceptor when time of take-off is known has been run successfully on the computer. More tests will be conducted along this line.

3. Program errors were discovered in the basic 2 A/C Interception Program. P. Cioffi and mayself are currently "trouble-shooting" the program.

4. Successful flight tests were held with the Final-Phase Guidance Program. As soon as C. Gaudette becomes familiar with the program, we will work together on the Final-Phase Interception Program.

4.0 DATA SCREENING

(W. S. Attridge, Jr.)

Investigation of data taken from MT-140 and processed by T-1288 (Muldar Tracking Program #1) shows that many noise returns come from the MEW and occupy a significant percentage of the tracking space available in T-1288. The present tracking and automatic initiation scheme allows one noise return to occupy a tracking channel for three scans. The necessity for a scheme for using two types of tracking methods simultaneously is indicated. A velocity tracking method such as the one now used requires ten storage registers per track channel. A positional tracking method requiring five storage registers per track is contemplated. Thus for each velocity track two positional tracks could be substituted.

Data from MT-129 was recorded on magnetic tape with R. Walquist's T-1290 M3, Block Record of MEW Data. There is much more data per radar scan than it is possible to handle with the 25 tracking channels of T-1288. The data at the beginning of each scan has a much better chance for initiation than data at the end of the scan because of the extremely high ratio of uncorrelated data to track channels available. T-1290 M3 starts each scan at the same azimuth, thus giving data in one small area the best chance for initiation.

A modification to T-1290 M3 enables the program to record in blocks of twelve seconds each. This rotates the azimuth at which the recording is done, consequently giving tracks in all directions from the radar set a more even chance for initiation.

(P. R. Bagley)

Muldar Tracking Program. Studied in detail Attridge's section of the Muldar Tracking Program No. 1 (T-1288).

Clutter Rejection. The modification of T-1255 outlined in the last bi-weekly has been made and a new set of photographs taken but not yet printed.

A new clutter rejection program (T-1334) to replace Clutter Table Construction for Three Radars (T-908) has been coded and is nearly ready for the tape room. This program utilizes the principles of T-1255. It will punch out a clutter table for each of the three radars. Each radar is dealt with in turn, the construction and punching of the table taking about 10 minutes for each radar.

4.0 DATA SCREENING (CONTINUED)

(W. A. Clark)

The program for the evaluation of the distribution of radar coverage in the Muldar system is now operating successfully. As new sites are proposed and new data on the characteristics of the radars become available, it will be possible to calculate the effects of these changes on the coverage performance of the system as a whole.

During the course of "checking out" this program (Tape 1325 mod 3), it was discovered that parity discrepancies occurred quite often in digit 6 of register 1320 and vicinity. The systems people attribute this to low holding-gun current density at the fringes of the storage pattern (where this register is located) in conjunction with the fact that reference to the register was made with great frequency for prolonged periods throughout the calculation. It would, therefore, seem valuable to avoid allotting fringe storage positions to those registers, e.g. counters, which see heavy traffic during operation. A map of the present storage positions is available in the print room files (# C-50746 - 1).

(J. Ishihara)

Data obtained from Muldar Tracking Program #1 (T 1288) has pointed out the necessity of a more elaborate track sorting scheme. Under consideration are methods which will track slow moving clutter, when tracking channels are available, and which incorporate schemes of automatic initiation. It is hoped that such a program would also reduce operating time.

Work on the problem of inclusion of information from a long range set, which would cover the entire Muldar System plus a large "outside" area, has been started. Contemplations on this situation have been fruitful in ideas for track sorting. These conjectures will have to be studied further for their relative merits.

A proposal by Bob Walquist for screening with a fixed area before using any "search area" in correlation is being evaluated.

(D. Goldenberg)

The completed flow diagrams and programs of the five most promising methods of sorting of data have been submitted to W. S. Attridge for checking, preliminary to undertaking a time versus pieces of data analysis.

4.0 DATA SCREENING (CONTINUED)

(D. Goldenberg) (continued)

Work has been started on determining the best shape, size and the center of the correlation area used for tracking an aircraft.

Solutions to the indoctrination problems for the June-July 1952 group and a data tape for one of the problems are being completed.

5.0 TRACKING AND CONTROL

(J. Arnow)

Word has been received as to the range calibration factors in the Rockport and Scituate data transmission systems. The range as read in to the computer from Rockport is biased by a factor of minus one-quarter of a mile. That is, 25 miles as inserted into WWI is actually 24.75 miles. As for Scituate, the quantization is actually 46 miles and the initial error amounts to one mile. At present, this means that the range from Scituate must be multiplied by .92 and one mile added. The quantization will be changed to .5 miles as soon as possible.

A flight test was held with a B-17 and the Scituate 584. The results were very encouraging. The coverage was spotty at 13 and 15 thousand feet, but solid at 1, 3, 5, 7 and 9. There were no noticeable errors due to loss of north markers or azimuth change pulses during approximately two hours of recording. It is felt that Scituate is in very good operational condition.

A flight test designed for azimuth calibration of Rockport and Scituate was cancelled due to the unavailability of the required aircraft and will probably be held during the coming bi-weekly period.

An attempt is being made to complete work on all existing two radar programs using synthetic data before the computer shutdown. Work with programs using live data will proceed after the results of these programs have been analyzed sufficiently.

(M. Frazier)

A tape has been prepared for the indoctrination problem, but it has not yet been run.

The error troubling Polysmooth for the past month turned out to be due to the fact that the cycle left order does not clear special add memory. This was finally determined after inspection of the computer by R. Mayer.

5.0 TRACKING AND CONTROL (CONTINUED)

(M. Frazier) (Continued)

In a discussion with Arnow, it was decided to discontinue general two radar smoothing study programs (Polysmooth especially) in favor of a series of special programs to be written by Lone, Mathiasen, Stahl and myself. Discussion revealed that several of these programs were already written or needed small modification to produce the desired results. An attempt is being made to complete this smoothing study by the end of the month.

(W. Lone)

TRASACT with times and positions averaged appears to work successfully when tried with one of the data tapes. I plan to try it with others during the coming period.

A tape preparation error has prevented use of the non-linear smoothing parameter in the TRASACT first fit program. This is being corrected.

I am writing a program which accepts data to be used in the smoothing equations only from the radar closest to the aircraft.

(A. Mathiasen)

A trial of TRASACT I with data from one radar fed into FF1 and FF2 simultaneously was successful as far as could be told under such a condition. However, amendments will have to be made to the program to take care of varying scan rates and the range error in the data.

A new tracking program for a single radar has almost been completed. Its features include control of type of information to be printed, choice of smoothing method, computation of scan time, and choice of live or simulated data input.

An "economized" two-radar tracking program has been written by Jack Arnow and myself. A preliminary estimate gives 129 orders and 26 storage registers.

As noted in M. Frazier's section, priority will be given to one or two basic two-radar tracking programs for comparison studies.

5.0 TRACKING AND CONTROL

(B. R. Stahl)

A program has been written to determine the time in seconds per scan of the Bedford radar. This is T-1364 and is working satisfactorily.

The three-radar display requires slight modification in order to be completely successful. The display does not take up the full area of the scope when only one of the two SCR-584's is being displayed. Under all other conditions, however, (e.g., Bedford and Rockport together, Rockport and Scituate, etc.) the display is made large or small enough to use the entire scope.

The Rockport north-marker indicator program has not been tested.

6.0 AIR DEFENSE CENTER OPERATIONS

(D. R. Israel)

A good deal of thought and study is being devoted to the problems of organizing an adequate air defense center for use in the Cape Cod System. Of prime importance are questions of suitable displays and control facilities. It is expected that this study will result in a proposal in the form of a memorandum for the renovation of Rm. 222 and the installation and organization of certain equipment. Preliminary to the work in Rm. 222 — which it is hoped can get underway immediately and result in the use of the room by sometime in September — it is expected that a reorganization of equipment will be made in Rm. 224. Three primary reasons behind all this activity are:

a) the necessity to ease the operation and control of our present flight tests (see section 3.0).

b) to improve the facilities for the demonstration of our programs, these demonstrations to become bigger and more complex in the near future.

c) provide the necessary laboratory for obtaining experience in air defense center operation, a problem which will become greater and greater as time passes, particularly after the installation of the magnetic drums.

The original plans for the installation of a monitoring telephone connection to the Manchester GOC Filter Center will not be carried out in the near future in view of the fact that the telephone company has uncovered a technical (engineering) problem which they cannot handle immediately. A private line connection to a telephone instrument in the Manchester Filter Center will be installed by July 15, on which date our first combined GOC-MEW experiment will be held.

On Friday, June 27, Messrs. Jackson and Gross of the CAA Technical Development Center at Indianapolis visited the Laboratory. They are developing a system for storing flight plan data on a magnetic drum. There does not appear to be any immediate opportunity for any cooperation between our work and theirs, but we did receive from them some interesting information regarding display indicators, of a type similar to those manufactured by Teleregister Corporation, which have been designed by the Union Switch and Signal Company and the General Railway Signal Company. Further information is being requested directly from those concerns.

Group 21 has made arrangements for the installation of a phone line between the Boston Air Route Traffic Control Center and their Truro installation. They will station a man at the Traffic Control Center to forward flight plan information to them and they have agreed to permit us to monitor this telephone line.

6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(D. R. Israel) (Continued)

On July 1, a demonstration of the new Eidophor system in New York City was attended. The Eidophor is a TV projection system which has been developed in Switzerland and has been bought by Twentieth-Century Fox as a means of obtaining a large-screen theater TV in color. The system, which is being further developed by the General Electric Company, provides a very bright picture due to the fact that an arc light source is used. There does not appear to be an immediate application of the device in our work, nor does it appear that the device itself will be available in the near future.

Initial tests have been made of the feasibility of radio communication between the Barta Building and local AAA sites surrounding Boston. The results of the first test (see Section 2.0) gave some hope that this means of communication might be usable. The first tests, involving the direction of one of the gun batteries, are scheduled for July 11.

(M. Brand)

Some time has been spent trouble shooting the GOC data analysis and scoring program. As of June 27 the program satisfactorily processed data and scored incoming reports of number, type and altitude of aircraft correctly. There remains some trouble in the conversion of Georef coordinates to x,y coordinates. This gives rise to some trouble in the evaluation of heading score and velocity score. As soon as this is ironed out the program will presumably be running fine. The present plan is to utilize large portions of this program in the proposed GOC single aircraft tracking program.

A memo has been written proposing a method of automatic initiation of a GOC track which can use any one of 5 methods of satisfying initiation requirements:

1) Initiation from a given GOC post
2) " " " " Georef box
3) " " " " row of Georef boxes
4) " " " " large general area
5) " " " " column of Georef boxes

A program has been written to accomplish this.

The last week of this period was spent on vacation.

(C. H. Gaudette)

The error in converting Georef coordinates to (x,y) coordinates in M. Brand's GOC Data Analysis Program has been uncovered. The program is now ready for another trial run.

6.0 AIR DEFENSE CENTER OPERATIONS (Continued)

(C. H. Gaudette) (Continued)

The memorandum, "Decoding GOC Posts Locations", is now ready for publication and will be issued as M-1542.

The first week of this period was spent on vacation.

(F. A. Webster)

Most of this period has been spent on the analysis of samples of GOC (Ground Observer Corps) data to be used in the report on manual tracking with GOC data. ("Manual tracking", or "tracking by eye", refers to tracking carried out with the aid of physical manipulation of arrows, etc, on a board or table. In a filter center, the process is called "filtering".) A flow diagram is being drawn up to cover all the decisions that might be made while performing multiple manual tracking. To systematize the data-categories and the weightings used in complete manual tracking, rough graphs and tables are being made up.

From the point of view of programming, the outstanding fact that characterizes such tracking is the large number of unstated (and almost simultaneous) decisions which rapidly narrow down both the data and the methods that have to be considered at a given moment. It is likely that any mechanized process which scanned and eliminated so many possibilities would be sufficiently complex as to be impracticable with present equipment. Definitive specification of the nature of the processes, however, may serve as a useful guide to the planning of abbreviated methods for handling this type of data.

7.0 ASSOCIATED STUDIES

(P. R. Bagley)

Indoctrination Course. Most of the time during this period has been spent jointly with Lone and Cioffi in carrying on the indoctrination course for new members of the group.

(G. Cooper)

The alternate viewpoint mentioned in the previous bi-weekly has proven to be a very potent tool. It leads to much more direct and satisfying derivations of the recursion formulae in the cases of pure filtering, filtering with prediction, and filtering with delay. In all cases, the results obtained agree with those previously obtained by more cumbersome and dubious methods.

(D. R. Israel)

At a meeting of the programmers of Group 61 on July 2, the proposed scheme of block assembly was discussed. The decision of the

7.0 ASSOCIATED STUDIES (Continued)

(D. R. Israel) (Continued)

meeting was not to implement immediately the conversion program necessary to handle the block assembly, but rather to prepare the necessary programming forms in order to give members of the group an opportunity to become familiar with block programming.

(W. Lone)

A revision of the form for requesting computer time has been made which incorporates the operating instructions with the computer time request. These are being printed and will be available immediately.

A memorandum indicating the procedures to follow in requesting computer time has been written and distributed.

Some time was spent with routine details in connection with the indoctrination program.

(R. W. Sittler)

The past weeks, in collaboration with Walter I. Wells, have been devoted to the study of the operation of the interception system under the disturbing influence of quantization error. Four problems have been investigated.

1. The statistical distribution of the distance of minimum separation of target and interceptor.

2. The effect on this distribution of release of the interceptor some time before final contact.

3. The smoothing of interceptor heading angle instructions.

4. The accumulated extra penetration of the target into the defense area due to errors in the interceptor instructions.

A brief summary of the chief results of the above investigations follows.

The minimum miss distance is a random variable approximately normally distributed. For straight line paths, of target and interceptor, an optimum system based on the information in ten consecutive scans would lead to a standard deviation of about 350 yds. (That is, 68% of the interceptions would result in a miss distance less than 350 yds., and 95% of them would result in misses of less than 700 yds.)

The early release of the interceptor control leads to rather rapid loss in accuracy. As a very rough rule the standard deviation of miss distances doubles if the release is at a distance from the interception, equivalent to the effective number of scans on which the data

7.0 ASSOCIATED STUDIES (Continued)

(R. W. Sittler) (Continued)

smoothing is based. If the target does not follow a straight path the resulting error is still worse.

There seems to be no apparent reason why interceptor heading angles cannot be rounded off for convenience provided the final approach is made without such approximations. It seems feasible to quantize the heading angles instructions, say in steps of 10 degrees at long distances from interception. This quantization must be reduced down to 0 degrees as the moment of interception approaches. This quantization is accomplished by only transmitting heading angles when the accumulated changes reach the prescribed values.

The above process has the effect of delaying the interception. Preliminary work on this problem indicated that this delay may result in increasing the time interval from first contact of the target to the interception by about 10%. Interceptor heading angle errors which cause the interceptor to lag the target are more serious in delaying interception than those which produce a lead. Delay considerations appear of outstanding importance when the ratio of target to interceptor speed is .8 or greater.

These results will be presented in more detail in a forthcoming memorandum.

(W. I. Wells)

The memorandum on quantization has been completed and is ready to be printed. The results of this study are now being applied to the problem of interception. I have been assisting Robert Sittler in the development of the interception equations; that is, in the derivation of their statistical properties in terms of the probability distributions of the measured variables. Some thought has been given to the problem of erratic heading instructions being given to the interceptor. A tentative limit has been placed upon the size of these variations that are caused by quantization effects.

8.0 COMPUTER OPERATIONS

(J. Arnow)

The following is an indication of how the computer time was distributed during the last bi-weekly period. The amount of time used under the miscellaneous category suggests that a redesign of the subject index is still overdue.

8.0 COMPUTER OPERATIONS (Continued)

(J. Arnow) (Continued)

Radar and relay link	2.75 hours
Data Screening	7.5
Tracking and Smoothing	11.0
Aircraft Control	2.75
Miscellaneous	14.25
Sub Total	38.25
Flight tests	5.50
Calibration	2.5
Lost	6.5
Not Used	7.75
Total	60.50 hours

9.0 PUBLICATIONS

(M.R. Susskind)

The following material has been received in the Library, Rm. 217, and is available for Laboratory personnel:

LABORATORY REPORTS

1. "Group 61 Bi-Weekly Report June 6, 1952," M-1528, pp. 1-15.
CONFIDENTIAL

2. "Group 61 Bi-Weekly Report June 20, 1952," M-1539, pp. 1-17.
CONFIDENTIAL

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