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Division 6 - Lincoln Laboratory  
Massachusetts Institute of Technology  
Cambridge 39, Massachusetts

SUBJECT: Group 62 Section Leaders Meeting, November 2, 1953  
AN/FSQ-7 Equipment Design Program

To: Division 6 Group Leaders; Group 62 Staff Members

From: A. P. Kromer

Abstract: Operation of the core memory in the WWI--Cape Cod System has resulted in several changes in the electronics to improve operating margins. Decision was reached to base drum system circuit design on a maximum memory cycle time of 8  $\mu$ sec. Additional storage capacity for radar input data has been achieved by reallocation of and use of previously unassigned drum fields. Primary power variations are to be studied. A proposal covering the amount of drum storage for output data, as well as kind and amount of data for each type of weapon has been prepared. A list of equipment for XD-1 and XD-2 systems is being issued.

1. Memory

The Whirlwind I engineers are finding that certain circuit changes are desirable in connection with the magnetic core memory which has now been added to the WWI computer. Indications to date are that these changes improve the margins on the memory operation. The application of the core memory to a large system has revealed certain marginal operating conditions which were not evident in the work as a memory alone itself, or in the MTC computer. In order to gain the maximum benefit of the experience of coupling the memory to a large system, the individual engineers and others concerned with the basic circuits and core memory for FSQ-7 should maintain close collaboration with the work being done at WWI.

2. MTC

Most of the circuitry being constructed by the MTC group will be ready and installed about the middle of November. The amplifier design has not yet been resolved, however. This is being worked on by Boyd and Anderson.

Ted Ogden is to make up a detailed schedule of the activities for MTC, including the installation and subsequent experimental testing in connection with the drum, work on drum circuit switching, tests of the drum and display system combination, and the addition of the new high speed memory to MTC.

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### 3. Drums

M-2494 will be issued by Ron Mayer to report on the estimated reduction in tube count through the various proposals for circuit switching and/or the use of larger size drums.

It was decided to have IBM complete their design of the drum system based on an 8  $\mu$ sec maximum memory cycle time. Papien indicated that if it should become necessary to have the memory cycle longer than 8  $\mu$ sec it could be effectively speeded up by the addition of more tubes to secure higher driving current.

A discussion regarding the stability of the input power as mentioned in (4) below raised the speculation concerning establishment of the master timing for the machine from the timing track of one of the drums. The use of suitable doubling circuits to count up to the main frequency at which the computer operates could be derived from this timing track, and thus power variations which affect the rotational speed of the drums would be reflected throughout the entire machine, simplifying the synchronizing or timing of the various parts of it.

It was generally agreed to proceed with the modification of the drum system addressing logic mentioned in last week's minutes. The additional flexibility seems to facilitate the programming to a considerable extent. The final decision for this point, however, will be made when the overall drum system is reviewed at the conclusion of the present study.

In order to increase the capacity for storage of raw, unprocessed radar input data, it was suggested that seven fields of 28 bits each on one of the drums be used for correlated and uncorrelated data. This would provide 14,000 registers of storage instead of 6,000 registers for this purpose. This can readily be done by using drum number V for this purpose, and reassigning the output data to drum number IV in the three fields initially allocated to storage of radar data.

The Systems Office, working with Jack Jacobs, is continuing the study of the use of a double diameter drum as an alternate means of reducing tube count. Results of this study will be compared with tube savings that are possible by means of circuit switching techniques. This comparison will provide a basis for a decision on whether or not a development program should be undertaken to design the larger physical drums.

Another study underway in the Systems Office is the combined use of the drum and display system. This is being studied with respect to the amount of storage available, ease and flexibility of use for both display and the computer, the amount of auxiliary memory storage, etc.

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4. Power

The Systems Offices at both MIT and IBM were asked to investigate the matter of input power frequency, and the degree to which this must be uniform. Exhibit AFCRC-1 indicates power frequency to be  $60 \pm 5$  cycles as one of the service conditions under which the system should operate. It is generally recognized that commercial electric power probably will not vary this much, but it is possible that with a system operating under emergency conditions on diesel generated power, variations approaching this might be encountered. The study is to determine the maximum probable amount of variation in frequency that the system might be expected to encounter, and the effect of such variation upon the actual circuits and design of the system.

5. Central Computer

Ron Mayer indicated that he is reviewing the timing diagrams for the central machine in preparation for advising IBM regarding their suitability and making them available for release and continuation of design work.

Mayer also said that he is checking with the programmers regarding the ab instruction. As it is presently planned, the ab instruction in XD-1 will be considerably different from the same instruction in WWI's. This might result in confusion from a programming standpoint.

6. Basic Circuits

Work on the sense amplifier for memory is continuing, based on the use of the type 7072 tube in the first stage instead of the 5965 tube which has proven to be microphonic when used in this manner.

Further study of the application of a high powered cathode follower (using the 5998 tube) to the control section of the machine, with the addition of feedback to the circuit, not only reduced the tube count but permits this part of the machine to become considerably smaller in size through the elimination of a number of level setting circuits.

Substitution of a cathode follower circuit using the 7AK7 tubes in place of 5965's in the various registers in the central machine seems to offer savings of something over 100 tubes, and is therefore being pursued.

The use of diodes in a high speed OR circuit under pulse conditions has been questioned by IBM. It seems quite possible that due to overshoot on one input, a second input pulse on another line to the same diode within a half  $\mu$ sec might not function properly. Dick Best is making a lab bench setup of this condition in order to study it further. Diodes are used in this manner in the accumulator of XD-1.

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### 7. Outputs

The meeting last week covering the study being done on outputs provided a decision to assign 4000 registers (2 fields) on the output buffer drum as available capacity for all weapons direction information. The amount and kind of information to constitute the output data for each type of weapon was also determined. Complete notes regarding this information are being prepared by D. C. Ross of IBM who attended the meeting, and copies will be secured for wide distribution throughout Lincoln in order to secure comments from all concerned.

The next two weeks will be devoted to the preparation of specifications for the output buffer drum. This work will be done largely by Housman of IBM and Jeffrey of MIT, with collaboration by Arnow or someone else from Group 61.

A study has been started by Rising to determine the effects of transmission of output data along phone lines low frequency rates (100 cycles).

### 8. Parts Lists

Study of the functional use of FSQ-7 (XD-1 and XD-2) has resulted in the preparation of M-2495 which will be issued shortly to list the full complement of equipment to make up each of these two systems.

### 9. Display

Corderman has conducted demonstrations of the Charactron tube to various persons in Lincoln Laboratory and representatives of IBM. A demonstration is scheduled for Thursday, November 5, at Poughkeepsie, when IBM will present the character generating system which they have had under development. After this demonstration, consideration of the two alternatives will lead to a selection of one or the other for use in the FSQ-7.

The Charactron tubes now at MIT will be placed into consoles to make one permanently available to MTC, and to have the second available at the Barta Building for study and demonstration in connection with WWI---Cape Cod System.

Corderman advised that he plans to prepare a proposal and evaluate the matter of digital expansion during the next week.

Signed: 

A. P. Kromer

APK/mmt

CC: J. W. Forrester, R. R. Everett

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