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Memorandum M-1753

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By: R. R. Everett
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Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

Subject: DESIGN AND CONSTRUCTION SCHEDULE, WWII PROTOTYPE

To: Whirlwind II Planning Group

From: A. P. Kromer, R. P. Mayer and N. H. Taylor

Date: December 11, 1952

Abstract: The present schedule for the development of the first prototype model of WWII calls for the urgent decisions concerning specifications and block diagrams to be made early in 1953 so that time will be available to procure, construct, and thoroughly test the machine by January 1, 1955.

Present:
Anderson, H.
Aronson, I.
*Astrahan, M.
Briggs, G.
Brown, D.
*Butler, L.
Callahan, R.
Canty, W.
Cohler, E.
*Coombs, J.
Crane, J.
*Crawford, D.
Eckl, D.
*Edwards, N.
Epstein, M.
Everett, R.
Fahnestock, H.
Forrester, J.
Gerhardt, R.
*Goldman, E.
Goodenough, J.
Guditz, A.
Heineck, A.
Henegar, H.
*Heywood, J.
Hosier, W.
*Housman, B.
Hughes, A.
Hughes, R.
Jacobs, J.
Jeffrey, R.
Katz, A.
Kromer, A
LaSpina, C.
Mayer, R.
McCann, D.
Menyuk, N.
Mitchell, J.
Ogden, W.
Olsen, K.
Papian, W.
Pfaff, R.
Platt, H.
Remus, B.
*Ross, H.
*Sarahan, L.
Schultz, C.
Shansky, D.
Smead, H.
Taylor, N.
*Thomas, W.
Thompson, S.
von Buelow, R.
Widrowitz, B.
Woolf, J.
Zieman, H.

*IBM personnel.

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SECURITY INFORMATION

On December 5, 1952, a meeting was held of MIT and IBM people concerned with the development of the WWII computer and associated equipment for an air defense application. The purpose of the meeting was to review for all parties concerned the projected future program and time schedule under which the development is to be done. N. H. Taylor led the presentation and discussion.

An original schedule for the development of WWII was made on April 3, 1952, under which a number of decisions have already been made. The following schedule* simply emphasizes the deadlines for the work remaining to be done.

It may be helpful to review a few of the decisions already reached. By June, 1952, it was decided that the arithmetic element should probably use vacuum tubes rather than cores or transistors, and so work was started on vacuum tube circuits. Only a small group has been retained for continuing basic work with transistors, which may become important in future designs. In April, 1952, there seemed to be no doubt that the magnetic memory program would meet the required deadlines, and this program is still progressing satisfactorily.

The schedule to be discussed shows the target dates, that is, the latest dates beyond which we should not make a major change in the related decisions. The target date for the overall project is January 1, 1955, by which time the computer and associated equipment must be running well. That is, it must be running better than WWI is running now: it must maintain a schedule of uninterrupted computing runs of $23\frac{1}{2}$ hours a day and a scheduled down time of $\frac{1}{2}$-hour a day. Although the aim is to have no intermittent failures during the $23\frac{1}{2}$-hour period, we should not feel too discouraged if there happen to be one or two. In addition to running well, it must be ready for integration into an air defense network such as Cape Cod, or an expansion of Cape Cod. Inserted in such a network, WWII is an important step in the transition of the air defense system from its state in 1952 to its state in 1958.

Figure 1 shows the time schedule, which is explained below. It is important to feel that the urgency in this schedule is <u>now</u>, because if we are late in some of the early decisions, then there will be no leeway for the delays that are bound to be encountered in the later stages of procurement, construction, and testing. The schedule, therefore, was originally planned by beginning with the 1955 deadline and working backward to 1953. This program probably represents a tighter schedule than has ever been contemplated for any electronic equipment as large in size as WWII and therefore presents a real engineering challenge to everyone. Prompt decisions, based on carefully considered work, and complete cooperation between all parties concerned are the key to successful accomplishment of the task. Although the schedule is tight, it is not an impossible or impractical one, ~~however.~~

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* In general, components are unclassified, but anything that approaches the overall air defense situation (including time schedules) is confidential.

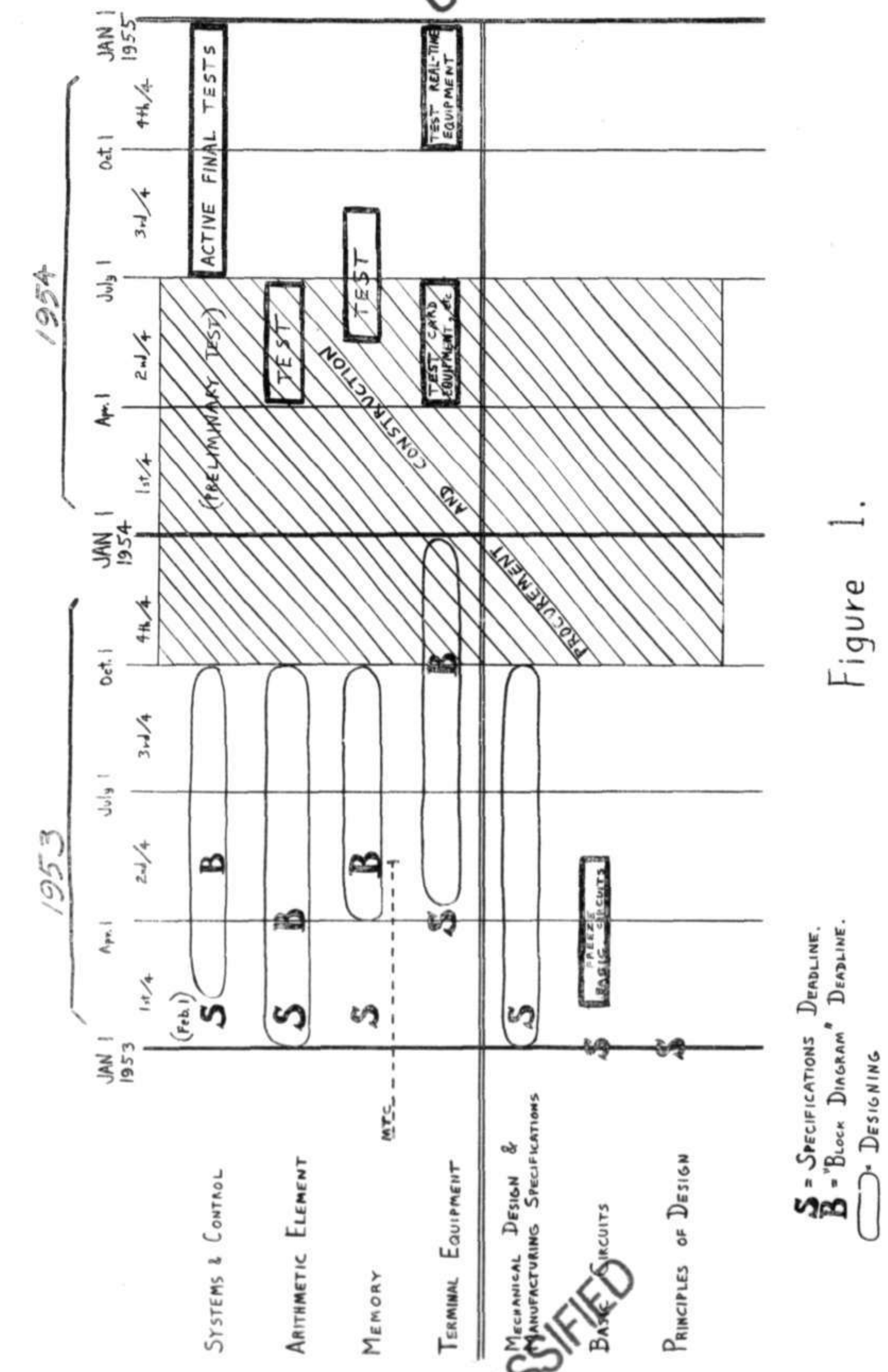
1953
1954
JAN 1 1953
1st/4
Apr. 1
2nd/4
July 1
3rd/4
Oct. 1
4th/4
JAN 1 1954
1st/4
Apr. 1
2nd/4
July 1
3rd/4
Oct. 1
4th/4
JAN 1 1955
SYSTEMS & CONTROL
ARITHMETIC ELEMENT
MEMORY
TERMINAL EQUIPMENT
MECHANICAL DESIGN & MANUFACTURING SPECIFICATIONS
BASIC CIRCUITS
PRINCIPLES OF DESIGN
(Feb. 1)
S
B
MTC
FREEZE BASIC CIRCUITS
(PRELIMINARY TEST)
CONSTRUCTION AND PROCUREMENT
TEST
TEST
TEST CARD EQUIPMENT, ETC.
ACTIVE FINAL TESTS
TEST REAL-TIME EQUIPMENT
S = SPECIFICATIONS DEADLINE.
B = "BLOCK DIAGRAM" DEADLINE.
◯ = DESIGNING

Figure 1.

The phases of the development can be divided into sections related to the sections of the computer. The system-and-control section includes the generation of command pulses (including those for the terminal equipment) and also the power control and distribution system. The arithmetic element and memory sections should be self-explanatory. Almost everything else is included in terminal equipment. The phases of the development can also be broken down into the various engineering activities which apply to all sections of the system; e. g., mechanical design and manufacturing specifications, basic circuits, and principles of design, etc.

The time allotted for procurement and construction (¾ of a year) is necessarily short. Some testing using temporary circuits can be done during the second quarter of 1954, but by July 1, 1954, the computer should be sufficiently completed to allow the final testing of the overall machine to start. The real-time terminal equipment (input, output, display, etc.) presents a rather special problem, and it can be tested in the fourth quarter of 1954. Other terminal equipment, such as card readers and punch, can be tested as early as the second quarter.

Before October 1, 1953, nearly all of the design work must be completed. Referring to Figure 1, the letter "S" stands for the latest date for freezing specifications. "B" stands for the latest date for freezing detailed block diagrams, and the balloons indicate the period during which the design will be finished.

This process of arriving at the design can be clarified as follows: First, systems studies must be completed showing what the system has to do and how it can be arranged to go about doing it. Second, specifications must be completed; these specifications must be based on systems studies and will provide the broad numbers indicating the speed, memory size, desirable order code, etc. Specifications for basic circuits involve the establishment of a set of criteria for use in deciding whether or not a circuit has inherent characteristics of stability, reliability, etc., which entitle it to be considered as a basic building block. Basic circuits should be investigated and frozen during the first and second quarters of 1953. Third, "block diagrams" (for want of a better name) must be based on the specifications and will show in more detail how the parts of the computer must be interconnected. Fourth, the "design" starts with the block diagrams and ends up with a number of drawings including circuit schematics, wiring diagrams, mechanical assembly drawings, bills of materials, and the methods of interconnecting various parts. The people associated with the systems group should keep a watchful eye on the interconnections, timing sequences, starting and stopping of pulses, etc.

The design in most cases can begin before the block diagrams are completed. In the case of the terminal equipment, a number of block diagram decisions cannot be made until more is known about the Cape Cod system, so that some of the design work must be carried out before the block diagrams are frozen on October 1, 1953.

Next summer is a critical time because during the third quarter of 1953 we need to know whether we are making the correct decisions as far as equipment is concerned and as far as the Cape Cod system is concerned.

It should be emphasized that, although these times are deadlines, it is desirable to make the decisions ahead of schedule, if possible. As pointed out previously, we should feel that the urgency is <u>now</u>, but at the same time, we should continually bear in mind that <u>RELIABILITY</u> is perhaps even more important than the schedule. The air defense network is urgently needed, but an unreliable one on time would probably be worse in the long run than a reliable one a little late.

Because of these requirements, it is necessary for us to rely on known techniques and to avoid the use of untried but promising ideas. The overall problem is one of following an engineering program which is on a strict time schedule and which must be based on certainties and not on hopes, if at all possible. "Memory" is an exception to this rule, because, for one thing, we do not know about anyone who has to date built a very reliable memory system. We must, therefore, make every effort to test the magnetic memory so that we can gain experience and come to know the techniques. For this reason, MTC must provide us with the answers concerning the memory system by the middle of the second quarter of 1953, regardless of anything else that the MTC group may eventually want to build into their computer.

The following chart indicates the people who will be working on the various phases of the project. No rigidity should be attached to this list, as it may change from time to time, and in any case, indicates only the primary responsibilities of the various people. The people indicated are heads of, or representatives from, the groups of people who will be associated with each phase. Some of these assignments are temporary, and the vacant spots will be filled later.

	MIT	IBM
System-and-Control:	Olsen, von Buelow, Mayer	Ross, Crawford
Arithmetic Element:	Jacobs	Ross, Crawford
Memory:	Papian	Edwards
Terminal Equipment:	McCann, Mayer, Morriss, Walquist	Heywood
Mechanical Design and Manufacturing Specifications:	Kromer	....