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Memorandum M-1498

Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: WHIRLWIND II MEETING OF MAY 9, 1952

To: Whirlwind II Planning Group

From: N. H. Taylor and R.P. Mayer

Date: May 23, 1952

Members Present:

P. Baltzer	W. Hosier	W. Ogden
G. Briggs	R. Jeffrey	R. Pacl
D. Brown	N. Jones	W. Papian
D. Eckl	A. Katz	R. Pfaff
R. Everett	W. Linvill	C. Schultz
W. Frank	R. Mayer	R. Sims
A. Guditz	J. McCusker	N. Taylor
H. Grosch	J. Mitchell	B. Widrowitz
R. Horn	R. Nelson	J. Woolf

It was felt that the group would like to know about at least one of the problems that has come up in the work with transistors. When a pulse is fed to a transistor, the output waveform shows a decay characteristic like that of a discharging capacitor. It is difficult to measure the internal capacity and the base resistance of a transistor. Both of these factors affect the speed of the discharging waveform and so affect the speed of the circuit in which the transistor is used. It has been suggested that the decay is not due to a capacitor discharge at all but that it may be due to something like the ionization of a gas tube or that it may have something to do with the storing of holes. Some initial measurements on the capacity that is known to exist indicate that it has a value of 40 m.m.f. Some later measurements indicate that it is less than 10 m.m.f., and some people claim that it is no more than 5 m.m.f. The problem of just what goes on in the transistor is not yet solved and provides material for thesis students at the present time. Since we do not know what goes on, we do not know how to define the required specifications. It is interesting to notice that the static characteristics predict the dynamic characteristics in only 30% of the cases.

Part of the transistor program is now devoted to building two adders, using logic like that of WWI. One of them uses static flip-flop and gate circuits like WWI. The other uses circulating flip-flops composed of delays and amplifiers. A single stage of the first type works well already and is expected to run in a four-bit adder at 500 kilocycles. The purpose is to compare both of these techniques and get objective, quantitative information on which is better at the moment. The circulating flip-flop presents a synchronizing problem only in the in-out equipment. A large part of the computer will be concerned with the in-out system, but perhaps the circulating flip-flop would be better than the static one if it required less critical transistor characteristics.

Separate meetings are being held on Wednesdays at 3:30 P.M. in N. Taylor's office at which D. Eckl is discussing the physics of transistors, for engineers, with a minimum of mathematics. It is hoped that this group can be kept small, so any interested persons should see N. Taylor if they would like to come.

Most of the rest of the meeting was concerned with a discussion of magnetic memory.

The 16 x 16 array of ferrite cores is now working at a low repetition rate with a read-write time of about 6 microseconds, and an access time of about 2 microseconds. Now it should be possible to write the required specifications for a final array.

However, in a large array which uses a number of digit columns, it is necessary to face the engineering problem of deciding how to drive the memory from the selection switch. Some possibilities were presented by W. Papian.

It is proposed that the memory should be composed of 32 digits, each made up of a square array, 64 cores by 64 cores. In order to read out of this array, it is necessary to have x and y selector drivers, each one driving 64 x 32 cores. In addition, a write-in digit driver capable of driving 64 x 64 cores might be necessary. There are two ways of arranging these drivers.

In the first system, the entire x,y selection switch is repeated for each digit column. All of these switches are driven by a single set of flip-flops. In this system, the flip-flops control driver tubes which drive the magnetic switch cores in each digit column. The switch cores, in turn, drive the memory cores in a coincident-current selection system. Two methods are available for writing into memory after the read-out has set up the selection switch cores and cleared the selected memory register: 1) The x and y selection switches in any column can be cleared at the same time to write a "1" in that column, or at different times to prevent writing a "1". 2) The switches can always be cleared at the same time, and a separate driver can be used in each digit column to prevent writing a "1" if the digit should be "0". Either of these methods can be used in the first system.

In the second system, a single x,y selection switch is used for the entire storage. In order to write in this system, it is necessary to use a separate driver for each digit. A small magnetic selection switch is used for controlling large driver tubes. (The reason for using tubes is discussed in the next paragraph.) These drivers must be capable of delivering about $1\frac{1}{2}$ amperes at about 250 volts, peak. It was pointed out that the duty factor is small and that the resultant average power required is about 40 watts. However, it may be necessary to use bigger tubes in order to provide the proper waveform at $1\frac{1}{2}$ amperes and also to prevent the large instantaneous currents from destroying the cathode. It is not desirable to use parallel tubes for providing the additional current.

Tubes are suggested for the following reasons: In driving a small array, high currents and low voltages are required. It is desirable to use a transformer for this application, and so the magnetic switch driver seems to be ideal. With a bigger array, the current remains the same, but the voltage required is much higher and so a high-impedance driver should be used. For this reason it may be desirable to use tubes, rather than the magnetic switch cores, as drivers for a large array.

The dilemma now appears: should we use many (200 more) big tubes in the single-switch system, or should we use many windings and soldered joints in the individual digit driver system?

G. Briggs suggested using a single 64 x 64 core array for driving only the 1 selected register of 32 cores in a linear system. This system improves the signal-to-noise ratio while reading, but does not aid in the problem of writing. It will be considered later.

J. Forrester is working on a chart showing the relative values of soldered joints, tubes, magnetic cores, etc. It was pointed out that perhaps we should not worry about winding cores and about soldered connections because the WWI replacement figures which are presented in Summary Report 28 show, in particular, that of 3,425 pulse transformers in WWI, only 11 have been replaced, and most of these because of broken lugs resulting from hanging video probes on them. It was pointed out that soldered joints are very good once they are made, but that the problem is that humans might forget them or missolder them on an assembly line. Printed circuits should be considered, but only for future mass production and not for the WWII prototype.

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