Digital Computer Laboratory
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SUBJECT: WWII BLOCK DIAGRAMS GROUP MEETINGS OF MAY 20 & 22, 1952

To: WWII Planning Group

From: W. A. Hosier

Date: May 29, 1952

Abstract: This note summarizes the discussion at the above meetings for the benefit of those who may wish to trace the course of thought on the subject.

Present: May 20: G. R. Briggs, D. R. Brown, R. C. Jeffrey, W. A. Hosier, R. P. Mayer, K. H. Olsen, I. S. Reed, N. H. Taylor, R. von Buelow

May 22: D. R. Brown, J. W. Forrester, H.R.J. Grosch, R. C. Jeffrey, W. A. Hosier, R. P. Mayer, W. N. Papian, E. S. Rich, N. H. Taylor, R. von Buelow

The May 20 meeting was for the most part devoted to continuing discussion begun Friday, May 16 at the WWII meeting in which WWIA was "resurrected". It was agreed that WWIA should be primarily a device to test components, but the question arises whether it should also be useful as a computer. For example, should it have 16 bits, be able to handle radar input data, or perhaps to act as an input to WWI? The general problem of running two computers in tandem would be interesting to investigate but probably impractical, since we cannot make the Cape Cod system depend in any way on WWIA. A further motive for building WWIA is to provide a means of training new staff where mistakes would be less costly than on the WWII prototype. WWIA should also be a stimulus to group effort by supplying a goal more immediate than the rather distant WWII. In about 18 months, experience with the Cape Cod system should have the air defense problem better defined; then with WWIA experience of components we should be able to design WWII with more confidence and purpose.

I. S. Reed felt that the proposed time schedule does not allow time for adequate engineering to make WWII a satisfactory production prototype and that the effort put into WWIA would be better spent on WWII itself.

As part of its purpose WWIA should presumably incorporate as many new components as possible. The memory has been referred to previously: probably two memories will be wanted, one for orders, one for numbers, perhaps a buffer memory besides. D. Brown thought these memories ought to be of at least 256 registers. This means an 8-bit address, plus another bit to designate which of two memories, plus three bits for the order, making at least a 12-bit instruction. This might be stored as two 6-digit numbers. Brown suggested that WWIA use for its memory part of the large 64 x 64 WWII memory which has to be built anyhow; say, a 4 x 64 section, for example; or WWIA might be made to cycle through the large memory in sections (see discussion of this in minutes of the WWII meeting of Friday, May 23).

For terminal equipment N. Taylor suggested that probably a tape input, typewriter output and display scope would be sufficient; however, the machine ought to be flexible enough to handle new proposals for terminal equipment such as buffer stepping registers. It will be desirable to have all components "pluggable" - that is to say, with interchangeable connections as far as possible.

It seems that 8 orders ought to be adequate. R. Mayer thinks that <u>sp</u> and <u>ca</u> or <u>ts</u> are the only necessary basic orders. In addition to these, special orders and facilities for checking must be included, since test runs are a primary purpose of the machine. If extreme economy of orders were desired, programs could be set into the machine by hand, but N. Taylor favors having enough orders and kindred facilities to read programs in from tape. A temporary control system, it was pointed out, can be put together out of Burroughs test equipment if need be. N. Taylor felt that it will facilitate the work of the Block Diagrams group if its members are each attached to separate components engineering groups - that is, to memory, control, arithmetic element, terminal equipment, etc.

It was again suggested that we consult with Hugo Logemann of Project Lincoln who is working on terminal equipment for Lincoln's CADAC (Logemann's name was mistakenly given in the report of May 8 as Lodermann).

E. Rich began the May 22 meeting by commenting that real-time problems, as one might expect, are the ones which give most of the difficulties with the WWI in-out system; further, that the magnetic drum is harder to integrate into the WWI system than most other pieces of terminal equipment. This, conceivably, is due to its intermediate random access time (about 8 ms): too long to be treated as "instantaneous", yet short enough to hold out a tantalizing promise of not seriously interrupting computer routine or requiring the special treatment that is obviously necessary, say, with long reels of tape.

For example: one problem that seems easy but has so far proved obdurate is to have the computer go on working after initiating a drum transfer order, letting the drum issue a warning and stop the computer when it is about to perform the transfer.

Present thinking envisages such a transfer (block read) as follows:

1. si selects drum from among other terminal equipment and gives starting drum address (from accumulator) to drum address register,

2. ca puts starting ES address into accumulator.

3. bi gives number of words in block, initiates actual transfer. Computer waits 0-16 ms to receive first word.

The desired sequence of events would be more like this:

si selects drum, transfers drum address from accumulator to drum address register, puts ES address and block length into special registers where they are held until drum address comes up; initiates transfer.

ca, ad, etc.; computer goes on with intervening program.

warning from drum stops computer, sets up ES switch to first address.

The trouble with the second method is: (a) it requires at least one extra register to hold the starting ES address, perhaps another for the block length. These could be provided. However, (b) a more serious objection, which may be fundamental to all proposals for operating the computer while data is being read into or out of the memory, is that it can be difficult or impossible to synchronize computer and transfer sufficiently so that the contents of a given memory address are predictable at the step in the program when that address is read out. (Gratuitous comment by W.A.H.: if it is possible to "compartmentize" the memory, couldn't the part to be read into or out of be "quarantined" at the start of this operation so that the program couldn't refer to it? Or would this mean redundancy of data and waste of space in the memory?)

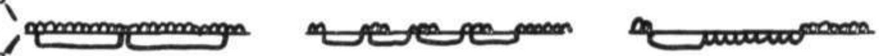
Rather than do the hair-splitting which may be necessary to jibe program and data transfer, the programmer probably will prefer to play it safe and let the computer wait until the transfer is completed. Thus the time saved by operation in this manner would be illusory, unless objection (b) can be overcome.

Of course a fast random access memory in place of the drum would not present such obstacles. N. Taylor suggested that it might help to have a small one interposed between drum and computer. D. Brown suggested a circulating register on the drum, or perhaps a magnetic shifting register.

Mr. Rich showed graphically the differences between several types of terminal equipment operation, using the sort of diagram which has become customary in his group:

Computer internal* cycles

Terminal Equipment cycles



Typewriter Drum, line-by-line Drum, block

*Excluding storage transfers of data to or from terminal equipment.

He thought that effort should be made to investigate possibilities for computer operation between in-out operations such as the reading operations of a typical sequence si, rd, rd, rd, ... including the question of whether the sequence can be programmed together as a unit letting the intermediate operations follow.

Other general questions were raised as follows:

Elevation data is unquestionably needed for interception. Is it also needed for acquisition of target?

Since central control is obliged essentially to do two things at once in order to permit computer and terminal equipment to operate concurrently, does this mean that one ought to have two or more separate controls? It was suggested by R. Jeffrey that an operation counter of the sort proposed in the memo E-462 on the 4-register computer could be built to combine the three functions of central control, in-out control, and interlock between these two.

Should each piece of terminal equipment have its own buffer storage? How large such storage should be is difficult to say, but will depend on how frequently data is to be extracted from it, what its random access time is, etc.

Would it be better to connect display scopes internally and not treat them as items of terminal equipment at all?

Is it possible to state a minimum set of conditions which a computer must meet to function with any and all terminal equipment regardless of the type of such equipment?

The meeting concluded with a brief review of the work done so far on magnetic stepping registers. R. Mayer said that he had had some success in devising orders which would require less mixing than those previously outlined. He also sketched a scheme for reading out any "line" of a partly filled buffer stepping register at one pulse rather than delay the reading by stepping it all the way along to the end of the register.

W. Papian pointed out that two stepping register chains can run simultaneously, one issuing commands to operate internal computer functions, and the other to operate terminal equipment. H. Grosch felt that stepping registers are inherently too specialized and that we will do better with operation counter type of control or even with a matrix of the sort used in WWI.

SIGNED W. A. Hosier
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APPROVED NHT
N. H. Taylor

WAH/cp