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Department 539
South Road Laboratory
October 13, 1958

FILE MEMO

SUBJECT: Proposal for an Interlock Signal

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The input units so far selected for attachment to the Exchange provide well-defined stopping points which permit data flow to be synchronized to the computing process. At the end of each block, a gap is left to provide time for the computer to exercise the option of continuing operation by issuing the next instruction or, by failing to do so, causing the unit to stop. Thus the computing process may be synchronized to keep the input unit running at full speed, but the process is fail-safe since the unit is prepared to come to a clean stop and wait when the program is not ready.

This synchronizing technique cannot be applied when the data come from a source which cannot be stopped immediately without losing some of the data. An example occurs in long-distance data transmission where the transmission line acts as a delay-line storage device. Even assuming that the transmitter can stop transmitting immediately on a signal, there are still several bits in transit to the receiving end before the receiver can stop accepting data. If the delay from one end of the line to the other is d seconds and data are transmitted at a rate of r bits per second, a total of at least $2rd$ bits must be expected to arrive between the time the receiving station issues a request to stop and the last bit of data actually arrives. This effect becomes more pronounced as the transmission speed r is increased over a given distance.

A more immediate example is the Small Document Reader which, like the punched-card sorters, cannot be stopped except by interrupting the feeding right at the hopper. When feeding is interrupted, there may be one or more documents in the continuously running part of the feed ahead of the reading stations and these cannot be stopped until they have reached the stacker. Clutching the feed at the reading station would be difficult because the documents are paper of different sizes. Other examples will occur when higher-speed card and paper tape readers are developed. As the speed goes up, clutching becomes increasingly difficult and costly.

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With such input devices it is not possible for the computer to say "stop" when the program is not ready to continue. It must either be prepared to follow the input device at full speed until the device decides to stop on its own, or it must give enough advance warning to the device to allow it to come to a stop gradually without requiring data transfer to cease immediately.

Requiring the computer program to follow the input device unconditionally places severe restrictions on the programmer. Speed is difficult to predict in an asynchronous computer, and large margins of safety must be allowed to complete the program in time without conflict. Thus a subsidiary process using a device which cannot wait may have to assume top priority. The situation is even more difficult when more than one such time-urgent process must be kept running.

It is proposed, therefore, to incorporate an Interlock signal in the Exchange. Specifically, when the multiple and chain flags in the Control Word are both one and the count has gone to zero, a special signal is sent to the unit. The Exchange also fetches a new Control Word in the usual manner.

Different units may interpret the signal in different ways. It may do nothing, it may cause a restart (which is a function presently provided by the Exchange under these conditions but which has no meaning for the type of unit being considered here), or it may initiate a stop. If a stop is initiated, reading may continue for a while and the Exchange is prepared for more information because it will have a new Control Word ready to receive the "run-out".

Two alternatives to such a "slow-down" signal have been considered:

1. Allow the Read operation to end without stopping the unit, thus interrupting the program which may then give a Control instruction to initiate a stop and another Read instruction to catch the run-out. (The Control instruction could be omitted if the second Read were interpreted as a notice to stop.) This technique places too much reliance on the computer responding quickly to an interrupt. It is not fail-safe and is limited to relatively low speeds.

2. Define an amount of information or a length of time after which the unit automatically comes to a stop. Reading continues until the stopping point is reached. This situation differs from that in a conventionally clutched input device in that no option to continue at full speed exists at the end of the Read operation. The unit has already run out, so that a considerable delay ensues on the next Read instruction before operation continues. This delay is similar to the gap time in a magnetic tape unit. By choosing a large enough block of information ("grouping") the delay may be minimized, but only at the expense of providing larger amounts of buffer storage.

The Interlock signal seems superior to these alternatives in that it gives the programmer the option of continuous operation, even at high speed, while retaining the start-stop mode as another choice.

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10-13-58

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