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The Concept of a Virtual Memory

In designing a high speed computer one is confronted with the fact that it may be easier to build high speed arithmetic units than it is large high speed memories, and the speed of the machine can then be shown to be limited to memory speed.

Various devices known under the titles of Look-Ahead, Non-Sequential Asynchronous-Decoder, etc., have been proposed to multiplex the memories and circumvent this problem. In the design of these devices, various logical problems arise due to the fact that it is necessary to begin executing instructions before the prior instructions have been completed. Since the number of instructions involved is variable depending on data as well as the instruction set, difficulties arise when an instruction beginning to be executed needs the results of an uncompleted instruction. This problem is further complicated by the fact that the normal operation of the machine may be interrupted by such things as exponent overflow, etc. If this type of thing occurs, it is necessary to restore any changes which have been made that would affect the program subsequent to the operation which caused the interruption.

These logical problems would cause serious program restrictions and multiply the programmer's problems many times if the machine did not automatically eliminate them. Following the simple concept of a virtual memory leads easily to the design of a device which solves all of these logical problems in an automatic fashion. The major part of the discussion will consist of the application of these principles to the Stretch Look-Ahead system, and the use of simulation on the 704 to determine the amount of hardware that should be devoted to the virtual memory in terms of increased machine performance.

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