AN OUTLINE OF PROJECT STRETCH

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1. Introduction

We are being given the opportunity this morning to report to you on Project STRETCH. Several of us will speak, and each will cover a different aspect of the program. It is my previlege to give you a general outline of the objectives of Project STRETCH and of the steps being taken to fulfill them.

2. Basic Objective

Project STRETCH has as its objective to put together the most advanced computer which can be developed within the next three and one-half years, and to have the first model of this machine in operation in the field at the end of that time, which will be January, 1960.

Project STRETCH is now a part of the research organization, and will continue to remain in research for the next year or year and one-half. This provides us with the maximum opportunity to collect and apply to STRETCH the new ideas which are developing within the research organization. Similarly, it gives us a maximum opportunity to influence further research in the direction of solving the remaining problems which we encounter in laying out the machine.

3. Form of the Machine (Figure 1)

The STRETCH machine is being designed to include a general purpose input-output system which will permit the attachment of virtually all kinds of digital input-output mechanisms known to us today, or which we are able to anticipate for the future. Included within its scope will be character recognition, various forms of electronic printers, high performance magnetic tapes up to speeds at least one hundred times as high as that of present tapes, and magnetic disk storage units of several varieties. Over wire communication with control devices at remote points for on line operation will be a standard feature of the machine. We are confident that future devices, such as speech recognition mechanisms will, when developed, prove directly adaptable to the machine.

The machine is to be capable of operating a number of input-output devices simultaneously. The main memory of the computer will be used for all buffering beyond single words. The input-output exchange, which handles this multiplex communication, has the form of an electronic telephone exchange. As Mr. Wild will indicate later, the device

has all of the basic telephone switching problems, including the use of trunk lines, their assignment to active units, ringing circuits, busy signals, etc.

An input-output computer is provided whose function is to edit data as it flows in and out of the machine. The computer is able to convert from one machine code to another, to make radix conversions, such as binary to decimal and decimal to binary, rearrange data for printing, etc. In order to perform these functions, the input-output computer must be equipped with all the logical and arithmetic facilities which we recognize as being required in a conventional stored program machine.

The machine will be equipped with multiple memory boxes, each capable of operating simultaneously with the others. One class of memory will be provided in units of 8,192 words, and will have a full read-write cycle time of 2 microseconds. A second class of memory will be assembled in units of 512 words, and will have a full cycle of 1/2 microsecond. In addition a number of registers with a 0.2 microsecond cycle will be provided. The customer will be able to obtain any desired number of memory units in each class. The memory addressing system used in the machine permits the programmer to,for the most part, ignore the divisions of the memory into classes and units. In anticipation of the future use of very large memories, the memory addressing system for the machine will allow for up to one million words of directly addressable core memory.

The fast arithmetic system which performs arithmetic upon the problem proper is a 10 megapulse parallel device capable of performing a complete fixed point addition in 0.2 microsecond, floating point addition in 0.6 microsecond and of multiplying fixed or floating point in 1.2 microseconds. The decoding of instructions and address modification of the program on which the fast arithmetic unit operates is performed by the high-speed control device. All classes of control instructions, such as logical transfers, together with address modification and the control of index registers are handled by this mechanism.

4. New Components

A number of new components are being developed for the STRETCH machine. Among these are a drift transistor capable of operating effectively at a 10 megapulse rate. In addition, it is necessary to develop a high current transistor capable of operating at approximately the same speeds to drive the core memories and magnetic logical elements.

New types of magnetic cores are being developed for use in the 2 microsecond and 1/2 microsecond core memories.

Quite recently, a magnetic device has been developed for use in switching operations similar to those for which crossbar relays are used in present telephone systems. We look forward during the course of the STRETCH development to the discovery of new semi-conductor and magnetic devices which can play an important part in the design of the machine. An element capable of performing the exclusive-OR function is, for example, known to be very desirable.

5. New Ideas

In addition to the new components to be used in the system, a number of new ideas regarding computer organization had already been contributed to the STRETCH machine. Among these is the means by which the various parts of the computer can be effectively multiplexed. This concept, which is included in no other computer, raises the general level of performance several fold. (Slide, explain)

There is also a new selector concept, under which each of a large number of machine triggers or similar control devices can be set and sampled by the computer program to direct its course of action.

In the area of logic, new and powerful instructions have been added which increase possibly one hundred fold the facility with which a stored program machine can handle problems of a logical nature.

6. Performance

The problem testing which we have done to date leads us to believe that the STRETCH machine will be approximately 200 times as fast as the Type 704, and about 170 times as fast as the NORC. One of our greatest problems in the development of the machine is the fact that so large a step is being taken beyond our present computer experience. It is quite apparent, for example, that the mathematical techniques for problem solution in a machine with the capacity and speed of STRETCH will be quite different from those which have been used in earlier machines. An important part of our program is to review the mathematical methods of problem solution with some of our country's best mathematicians to determine how these techniques will change and what effect these changes should have upon the design of computers.

The input-output section of the STRETCH system including the input-output units, the input-output exchange, the input-output computer and the memories has been given the name LINK, to signify that it provides the link between the outside world and the high-speed section of the machine. This portion of the machine is a complete

computer with all of the capabilities of our present Type 704 and Type 705 machines. It is capable of operating upon technical problems at approximately ten times the speed of the Type 704 machine, and upon commercial problems at speeds up to possibly 20 times that of the 705. The LINK system is being designed as an eventual replacement for both the Type 704 and Type 705 EDPM systems. In addition, it would appear to have all of the central computer requirements necessary for the guidance and interception of aircraft and missiles. We think it quite possible that the systems produced by Military Products will use the LINK input-output computer and exchange sections coupled to input-output units of their own design.

7. Customer Engineering

A great deal of emphasis is being placed upon the various aspects of repair and customer engineering. Primarily for this purpose, the machine is being equipped with automatic checking throughout. In addition, large sections of the machine will be provided with automatic error correction systems permitting the machine to continue to operate accurately despite intermittent and in some cases complete failure of individual parts. Special emphasis is being placed on arranging the error detecting mechanism to indicate as fully as possible the location and nature of the faulty part when errors do occur. Emphasis also is being placed on modular design to permit the rapid substitution of new pluggable units for faulty units, thereby reducing the proportion of customer engineering time which must be spent on the machine, rather than on bench testing of removed units.

8. Automation of Design

Approximately 1/3 of the total personnel on the STRETCH project will be devoting its effort to one or another aspect of automation of design. Mr. Snyder will tell you in more detail about our program. At this point I will only enumerate its major objectives. One of these objectives is to reduce the manpower required in the design of the machine and to develop techniques which can be applied not only to STRETCH but to the machines which will follow it. Less apparent, but equally important is that automation will allow us to make changes in the machine design to accommodate new inventions and new ideas from research at a much later date in the machine development program than would be possible if all the detailed design work were to be done by hand, as it has in the past. Thirdly, the use of computers to design the STRETCH machine will allow us to produce variations on the design which will permit it to be adapted to special applications to a degree which would not otherwise be possible.

9. Schedule

The schedule for the STRETCH machine is primarily dependent upon the availability of components in the quantities necessary to fabricate the model. Before the end of this year, we intend to undertake the design of a single input-output unit, as a basic experiment in the application of new checking and autocorrection techniques, new techniques for machine maintenance, and computer programs for automation of design. By January, 1957 at the latest, we intend to commence the detailed design of the input-output exchange unit. Specifications on the input-output computer are to be complete and final by July, 1957, so that the detailing of this portion of the machine can commence at that time. We intend that the first model of the LINK system be complete and operating by March, 1959. The detailing of the high-speed arithmetic and high-speed control mechanisms will be undertaken last, since this portion of the machine places the most rigorous demands upon the components and requires them in the largest numbers.

The individual sections of the system will be turned over individually to Product Development. In each case, this will be done as soon as the development of that portion of the machine has reached the point where the new principles used in it are sufficiently checked out and proven to establish beyond reasonable doubt that it will not later require appreciable revision.

Those of us in the STRETCH program look forward to a very close association with the members of Product Development during the coming months. It is our hope that we will be in a position to work together toward the development of a computer which in later years we can all look upon as one of the proudest developments of our engineering laboratories.

MAJOR UNITS IN THE STRETCH SYSTEM