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BASIC COMPUTER MEMO # 1

SUBJECT: Memory Accessing and the Basic Computer

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A preliminary study was made, the results of which were analyzed and provided the basis for concluding that the basic computer of the Stretch System should have the ability to provide and control at least two concurrent memory accesses.

It is also concluded that if no great cost is incurred and that if Sigma or Harvest find it a necessity the ability to provide and control more than two concurrent memory accesses will be provided in the Basic computer and not as adjuncts to the respective H or S box. If it is found that conversion to a N concurrent memory accessing system is costly and is a necessity to H or S then H or S will be burdened with the costly adjuncts.

A sample program was generated and plotted on a time axis for three modes of Basic computer overlap. The three methods of operation were:

1. Single sequential memory references with the instruction portion of the basic computer controlling the initial data word access.

2. Single sequential memory references with the execution portion of the basic computer controlling all data word accesses.

3. Double, concurrent (although offset in time) memory references with the execution portion of the basic computer controlling all data word accesses.

It was possible to calculate several parameters for each method which are indicative of performance qualities. The calculated parameters are listed

ITEM	METHOD #1	METHOD #2	METHOD #3
Avg. time/instruction	8.16 us	8.2 us	7.55 us
% time E busy	62.4 %	78.0 %	78 %
% time I busy	72.0 %	43.0 %	66 %
% H1 time in Mem. Access	72.5 %	72.5 %	60%
OVERLAP rate *	1.32	1.32	1.42
Efficiency of overlap	66.0 %	66.0 %	72.0 %

* 2.0 is maximum and optimum

It is recognized that the sample was limited and perhaps not representative of a typical case. The conclusions reached are based on the sample case and will be modified if a proven more typical case is charted or if statistics representing a larger sampling become available.

From the calculated performance parameters and from the graphic charts, the following conclusions were drawn:

1. With double, concurrent (offset in time) memory accessing the E portion of the basic computer is more continuously being used.

2. With double, concurrent memory accessing there is a small (6%) but definite improvement in the basic computer's performance.

3. With double, concurrent memory accessing there appears to be more likelihood that a delay in accessing (mem. busy) can more readily be absorbed with greater probability of not increasing the time to complete a given job.

4. There is no apparent difference in a single sequential access system whether the first data word access is controlled by the I or E portion of the computer. For simplified control logic within the basic computer, it is concluded that all data word accesses (for execution in the E portion) be controlled by the E portion of the machine.

5. If a single sequential accessing system is provided for the basic computer, a second single accessing system (as a minimum) is necessary when a Harvest or Sigma addition is made to the basic computer and

    a.) S and H individually have to carry the burden of cost.

    b.) Additional cost and complexity may be encountered to make the two independent single access systems work together.

    c.) Some extravagance (equipment duplication) may be found in two single access systems in combination, (ie: Two Hamming checkers where one might suffice, number of buffer registers on in/out line, etc.

6. The need for multiple accessing to satisfy the requirements of the I portion of the machine is non existant. (An exception might be where geometric indexing is provided which refers to memory locations instead of high speed registers).

7. The only outstanding reason for not providing a multiple access mechanism in the basic computer is cost. If it is desired to reduce the cost of the basic computer, then some cost can be saved by reverting to a single access system at some penalty in performance.

8. There is no benefit from having anything more than a single sequential access system if the memory provided with the computer system consists only of a single unit.

Some areas remain to be investigated and evaluated, these include:

1. Will a two access, concurrent system satisfy the requirements of Sigma (also Harvest)? If no, will a 3 access system suffice?

2. The cost difference between providing a single, double or n concurrent memory accessing system.

3. The relative ease or difficulty of combining an H (or S) unit to a basic computer under several of the above suggested combinations.

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APPENDIX

1. Average time per instruction =
   Total time to execute the program divided by number of instruction in the program.

2. Percent time that E portion is busy =
   (Time that E is productively engaged divided by total time to complete the program) multiplied by 100.

3. Percent time that I portion is busy =
   (Time that I is productively engaged divided by total time to complete the program) multiplied by 100.

4. Percent total time in Memory Accessing =
   (Total linear time spent in memory accessing divided by total time to complete the program) multiplied by 100.

5. Overlap rate =
   (The sum of productive E time and productive I time) divided by total time to complete the program. If E and I both were fully productive 100 + 100 = 200, and the total time to complete the job would equal 100, therefore, 200 divided by 100 would=2.0 which is maximum.

6. Efficiency of overlap =
   (The overlap rate divided by 2.0) multiplied by 100.