Memo 12

IBM CONFIDENTIAL

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SAN JOSE RESEARCH LABORATORY

June 29, 1961

Memorandum To: Mr. F. J. Cummiskey

Subject: STRETCH Evaluation Reports

I appreciate very much the opportunity to read reports by Mr. Adams and Dr. Meagher evaluating the STRETCH project and am happy to comply with your request for comments.

My general impression of the reports are that both are good and reasonably fair descriptions. (Quite frankly, they are both better than I expected them to be when I wrote my May 8 memo.)

Your discussion, dated June 6, 1961, of the reports is really all that needs be said. However, I will add a few comments of an historical nature to indicate how we faced the question of giving performance estimates three or four years ago.

The observation was made by both Adams and Meagher that one cannot give a single simple number to characterize STRETCH performance. STRETCH is not just a speeded up 704 or 7090, so that the performance improvement over the 704 or 7090 is bound to vary depending on the particular mix of instructions and I/O used in a particular program. The procedure one must use is to assume some sort of stable distribution of operations for "typical problems" and evaluation the performance ratio for these. The variances from such instruction mixes can be quite large in individual problems. For example, the matrix multiply loop used by Meagher has no divisions at all, yet I'm sure he would not suggest building a machine without a divide instruction.

The instruction mix we derived at Los Alamos five or six years ago as being typical of AEC problems was the so-called "6-6-3-1 mix" (6 housekeeping instructions, 6 adds, 3 multiplies, 1 divide). The average arithmetic times listed below and in the 1958 simulator memos used this mix. The "Gibson mix" which is based on a more recent analysis of many actual 704 and 7090 problems of different types can be characterized as a "36-10-3-1 mix" using the same notation. The ratios of divides to multiplies to adds are about the same, but significantly Gibson finds a much larger proportion of housekeeping instructions.

One can summarize the speeds as follows: The "standard" times are those quoted as the original (June 1956) STRETCH goals (ref. Cocke-Kolsky simulator memos, spring, 1958). "Sigma" represents engineers' best estimates as of January 1958. "Basic" represents the estimates in early 1958 of the Harvest computer's speeds. "Contract" are the times written into the AEC revised contract in July 1959. "Actual" are the times finally attained in STRETCH. "704" and "7090" are the corresponding times for these machines: "LARC" are the times for the Sperry-Rand LARC delivered to LRL-Livermore fall 1960.

| | 1956 Standard | 1958 Sigma | 1958 Basic | 1954 704 |
|---|---|---|---|---|
| Housekeeping | 0.2 μs | 0.4 μs | 0.4 μs | 24.0 μs |
| Fl Add | 0.6 | 1.0 | 1.0 | 84.0 |
| Fl Mpy | 1.2 | 2.5 | 7.5 | 204.0 |
| Fl Div. | 1.8 | 7.0 | 7.5 | 216.0 |
| 6-6-3-1 average | 0.64 | 1.43 | 2.40 | 92.25 |
| SPEED (Times 704) | 144.0 | 65.0 | 38.5 | 1.0 |

| | 1959 Contract | 1961 Actual | 1959 7090 | 1960 LARC |
|---|---|---|---|---|
| Housekeeping | 0.65 μs | 1.3 μs | 4.8 μs | 4.0 μs |
| Fl Add | 0.95 | 1.5 | 16.8 | 4.0 |
| Fl Mpy | 1.9 | 2.7 | 31.2 | 8.0 |
| Fl Div. | 7.0 | 13.0 | 43.2 | 28.0 |
| 6-6-3-1 average | 1.39 | 2.4 | 16.7 | 6.25 |
| SPEED (Times 704) | 66.5 | 39.0 | 5.5 | 14.8 |

As can be seen the biggest discrepancy between "standard" and "actual" occurs in the housekeeping instruction area.

I have included two curves from one of the Cocke-Kolsky simulator reports showing how the simulator showed speed would vary versus average arithmetic time and average indexing time. The dotted curves are free-hand extrapolations of the curves to our present range. Here again some number like 30 to 35 times the 704 or 5.5 to 6.0 times the 7090 seems to be indicated.

As a final remark I would like to point out that STRETCH is really in an extremely good position for a "Model II" development program: (1) the present design has a number of known weak points which can be redone easily, (2) new fast memories and new circuits could greatly simplify the internal structure of the machine while making it much faster, (3) the very costly--time-wise and manpower-wise--applied programming "software" effort is largely completed, (4) the present users are the recognized leaders of the computing profession who "set the fashions" for the rest of the community, and they are sold on the machine.

In other words, STRETCH is in a position where a "Model II" could be made for 60 percent of the cost, perform 90 percent better, and rent for 30 percent more--while having its programming package practically done.

N. G. Kolsky

HGKilc

bcc: A. G. Anderson
G. W. King

Figure 16

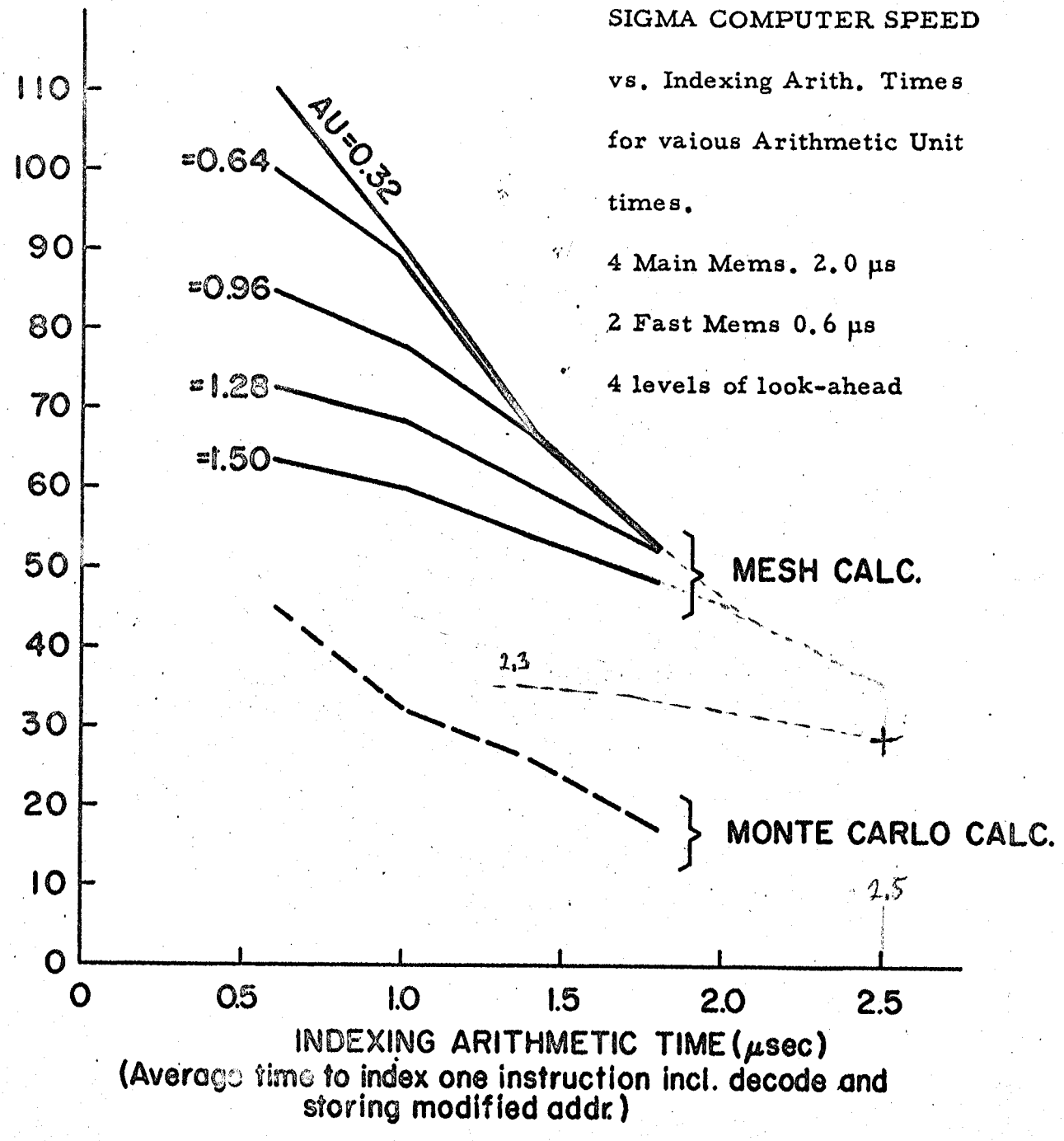
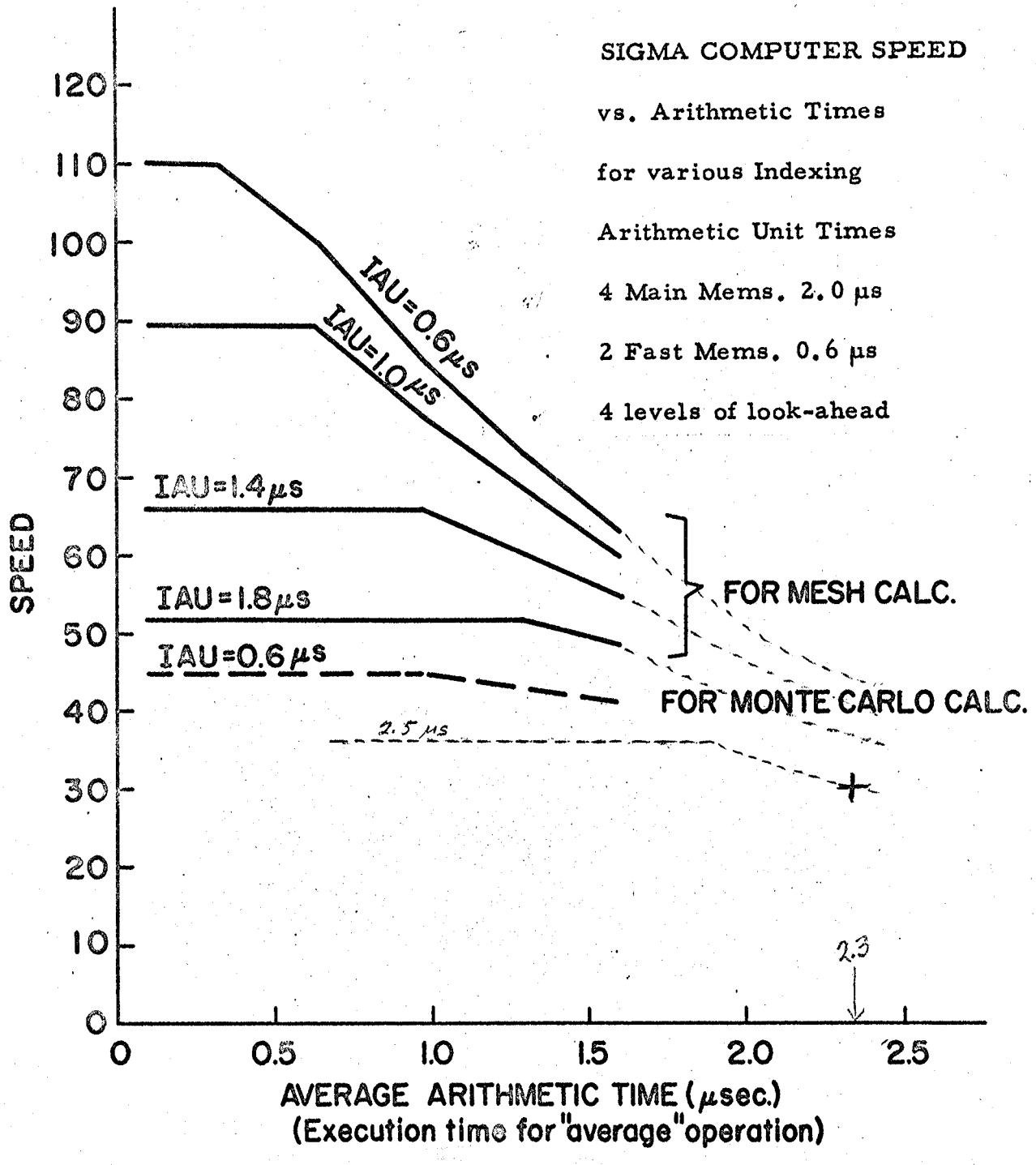

SIGMA COMPUTER SPEED
vs. Indexing Arith. Times
for vaious Arithmetic Unit
times.
4 Main Mems. 2.0 μs
2 Fast Mems 0.6 μs
4 levels of look-ahead
AU=0.32
=0.64
=0.96
=1.28
=1.50
MESH CALC.
2,3
MONTE CARLO CALC.
2,5
110
100
90
80
70
60
50
40
30
20
10
0
0
0.5
1.0
1.5
2.0
2.5
INDEXING ARITHMETIC TIME (μsec)
(Average time to index one instruction incl. decode and storing modified addr.)

Figure 17


SIGMA COMPUTER SPEED
vs. Arithmetic Times
for various Indexing
Arithmetic Unit Times
4 Main Mems. 2.0 μs
2 Fast Mems. 0.6 μs
4 levels of look-ahead
IAU=0.6μs
IAU=1.0μs
IAU=1.4μs
IAU=1.8μs
IAU=0.6μs
2.5 μs
FOR MESH CALC.
FOR MONTE CARLO CALC.
2.3
SPEED
120
110
100
90
80
70
60
50
40
30
20
10
0
0
0.5
1.0
1.5
2.0
2.5
AVERAGE ARITHMETIC TIME (μsec.)
(Execution time for "average" operation)