June 6, 1961

Memorandum to: Mr. W. B. McWhirter

Subject: STRETCH Project Evaluation -- Review of Reports by Dr. R. E. Meagher and C. W. Adams

The evaluation of the STRETCH system and its development was completed on June 3rd with the submission of the report by C. W. Adams. Dr. R. E. Meagher submitted the final appendix to his original report of May 9 on May [illegible]. The evaluations were done independently with no consultation between Meagher and Adams.

The reports are well done. Dr. Meagher's treatment of the subject is more technical and treats the development program from an engineering viewpoint. On the other hand, Mr. Adams' report is more reflective of how a user would view STRETCH. They were selected to represent these two different orientations.

They have divided their reports into two general sections:

1. Evaluation of STRETCH Performance
2. Evaluation of STRETCH Development

This review will treat them in the same order.

Both consultants state there is no satisfactory means of establishing a precise "speed ratio" that will hold true in all problem solutions. They do, however, believe an average, relative number can be established for STRETCH on scientific work and have done so. Their average speed ratio relative to a 704 follows:

	STRETCH	7090	704
I. Adams -	35	6	1
R. E. Meagher -	40	6.5	1

Note: Jack Gibson's applications of our instruction mix produces a number comparable to Meagher's.

Adams choose to construct an average based on actual running times of five problems performed on STRETCH. Meagher constructed a simple loop of four instructions and adjusted for the longer word length of STRETCH (i. e. 36 bit of 704/60 bit of STRETCH).

It should be noted that neither gentleman feels the single number satisfactory and prefer to state their findings as a range:

I. Adams - 5 to 60 X 704
.8 to 10 X 7090

II. Meagher - 5 to 53 X 704
.8 to 8 X 7090

In both instances the low performance number reflects the disappointing performance of STRETCH on logical type problems that utilize a great number of Branch instructions. It is recognized this type of instruction can be avoided to a large extent but this avoidance demands re-education of programmers to avoid instructions that implement one of the basic concepts of computers, the conditional transfer or branch instruction.

The high performance number reflects the high regard that Dr. Meagher and Mr. Adams have for the arithmetic unit. Dr. Meagher's report opens with the statement: "The STRETCH system has the fastest operating arithmetic unit." Hence, on problems mostly arithmetic in nature, it is an outstanding computer.

Both consultants list and comment on various features of STRETCH that are not precisely evaluated but in certain problems they are of extreme value and necessity. These features are:

1. Large memory capacity
2. Long Word Length
3. Checking, Error Detection and Correction
4. Extensive Instruction Repetoire

There are certain problems that are not feasible on machines of less capacity than STRETCH. Without question, very few such problems can be identified, but Adams feels "this is due to the fact that until STRETCH became available there was little point for anyone in studying problems which would fall into this class".

To summarize the evaluation sections:

Mr. Adams and Dr. Meagher feel STRETCH to be an outstanding large scale computer. Although it did not achieve its original goal of 100 times 704, it suffers most, in comparison, from the excellent performance of the 7090. Dr. Meagher states "All of the developments in speed which are in the 7090 were started and sponsored for STRETCH." Hence, on certain instructions, it is impossible to show much improvement over 7090 performance. Mr. Adams believes the 7090 provides such strong competition that a price reduction was necessary to keep the two systems in proper perspective. He states, "It seems likely, however, that the price reduction actually established was unnecessarily great and that STRETCH at its new price is a considerable bargain for many types of problems."

Part II -- Evaluation of STRETCH Development

The original goals set for the STRETCH systems in 1955 or 1956 approached what then must have been the ultimate or near ultimate for all of the essential elements of a computer design program. For example:

1. Development of devices to permit construction of circuits of 10 nanosecond delay.

2. Development of a half microsecond memory.

3. Instantaneous interrupt.

4. Development of a complex and powerful instruction repertoire to relieve the programmer of heeding special rules in use of the instruction.

5. Development of a fully checked system to provide error detection and correction.

These goals coupled with the requirement to provide a large scale scientific computer (Los Alamos system) to solve extremely complex problems and in addition have the same system perform an extremely complex data processing task (HARVEST) put the STRETCH program in the class of a best effort development program rather than a product development.

The very nature of the STRETCH project bespoke a research project and yet we wrote a contract with Los Alamos in November 1956 which in many ways is more precise than contracts for our normal products. Dr. Meagher remarks "It is a puzzle to understand why IBM, which has traditionally been conservative in its approaches to proposals and commitments, should enter into an agreement with Los Alamos for the delivery of a definite machine with fairly definite specifications as far as speed is concerned when the engineers, although enthusiastic, were not at all certain just how they would carry out this work."

This contract specified instruction speeds yet to be achieved in any computer available today. We continued to amplify the identification of STRETCH as a product by publishing papers and advertisements rating its speed. This reflects poor marketing decisions and control.

The STRETCH development was complicated by the "three in one concept" or the decision to provide 705, 704 successor from the same machine developed to satisfy the two contracts.

In 1958 when the "three in one concept" was abandoned, IBM resolved to direct all STRETCH effort to meeting the requirements of the two contracts. This in effect "froze" the design of the machine even though planning and simulation work indicated the system would not achieve its original goals. Both Adams and Meagher comment on the normal necessity of a second design iteration in any development program. A second design iteration with the system planners aware of technological barriers (i. e. slower circuits, etc.) and the limiting of requirements to produce the two contract machines might well have resulted in the development of two separate systems, one scientific (Los Alamos), one data processing (HARVEST). Both Meagher and Adams believe the system planners should have remained with the program through the second design iteration. If they had a natural product of their work would have been more sample programming and greater effort in simulation. This work would have highlighted deficiencies earlier in the program.

Dr. Meagher feels strongly that any development as complex as STRETCH must have design decisions made by a small group completely conversant with the system. This insists on continuity of personnel who have the same relationship to the project that an architect has to a construction development. The withdrawal of the system planners left project management in the position of making decisions on individual problems without the ability to assess their effect on the whole. He states Mr. S. E. Dunwell did a superior job in managing the project but was hampered by organizational changes disrupting the continuity in systems and engineering planning. He states "Mr. Dunwell did not have constant and expert engineering help in the early period of the program and really did not have proper engineering help until about the early part of 1959."

In total, Meagher and Adams feel the STRETCH effort has produced the following considerable benefits to IBM.

1. Two microsecond memory and circuits and some logical concepts which permitted the rapid development and introduction of the 7080 and 7090.

2. The development and installation of the largest, fastest computer in operation today.

3. The development and testing of logical design concepts such as "look ahead", "exchange memory", and "standard interface".

The STRETCH system suffered mainly from:

1. Attempts to impress it into our normal product development procedure, exposing the "best effort" development program to standards consideration, budget consideration and organization problems among others.

2. Lack of consistency in establishing end objectives (i. e. normal product or special contract fulfillment).

3. Failure to recognize that a research effort such as STRETCH is worthwhile in itself.

It should not be concluded that the lessons learned have been ignored. The current effort in the DS Division will provide us with a general purpose simulator in January of 1962. This will be of great assistance in measuring future products. Data Systems now maintains close contact between planning, engineering and applied programming. It is presumed this liaison will strengthen with time.

Nor should it be concluded that the systems innovations in the logical design of STRETCH are necessarily mistakes. Many of them appear in our most successful competitors' equipment. We are in a better position today to produce a multipurpose machine from the lessons learned on STRETCH.

The efforts of Dr. Meagher and Mr. Adams have been worthwhile. They provide us with two evaluations of a project that has been difficult for competent IBM personnel to view without prejudice. Their conclusions are not necessarily new or startlingly different from the conclusions of other review groups with the possible exception that both highlight the problems presented in establishing a product goal for what was obviously a "best effort" development project.

Dr. Harwood Kolsky of Research has written an excellent review and evaluation of STRETCH. His relationship and long association with the project both as a Los Alamos and IBM employee provides him with a unique insight. His is an excellent report and should be a part of this evaluation file.

F. J. Cummiskey

FJC:dm

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