COMPANY CONFIDENTIAL

PROJECT STRETCH

FILE MEMO NO. 55

SUBJECT: A Program for Maintenance Development for Project STRETCH

BY: C. E. Stephens
W. R. Stringfellow
V. D. Winkler

DATE: December 18, 1956

Project Stretch File Memo #55

Project Stretch Maintenance
Development Memo #1

SUBJECT: A Program for Maintenance Development for Project STRETCH

BY: C. E. Stephens
W. R. Stringfellow
V. D. Winkler

DATE: December 18, 1956

The responsibilities of the Maintenance Development Group can be stated simply. The considerations of maintenance in the next generation of machines will have to involve the inevitable complexities associated with more sophisticated machines as well as the diminishing availability of the technical manpower required for maintaining these systems. The manifestations of such a program will allow the Customer Engineering organization to maintain these large systems at a lower expense-to-revenue than has ever been experienced in any DPM system to date. It is expected that the results of this program will lead to a decrease in scheduled maintenance time, to a reduction in man-hours required for analyzing troubles, a reduction in the over-all number of personnel required to maintain a system, and possibly to the use of less technically trained personnel.

The initial considerations of the Maintenance Development program is to define Unattended Operation and the type of Maintenance Periods anticipated for the Stretch System.

The Maintenance Periods will consist of routine System Performance Evaluations and Scheduled Preventive Maintenance Periods.

The System Performance Evaluations will be inspections of the automatic error recording equipment to determine the performance level of the machine. These indications will then be analyzed to establish the need for system repair during the next scheduled maintenance period. The frequency of these System Performance Evaluations is expected to decrease from once a day, during the initial stages of system installation, to customer call or as infrequently as the sales situation will permit approximately two years after machine installations.

The Scheduled Preventive Maintenance Periods will consist of making the necessary repairs as indicated by the results of the System Performance Evaluations, plus the regular necessary routines required to maintain the system in reliable operation. It is expected that the frequency of these Maintenance Periods will decrease from once a week to once a month. It is anticipated that the time involved in reaching this objective will be approximately two years after machine installation.

Unattended Operation, from the Customer Engineering point of view, is useful machine production without the attendance of the maintenance man. During the initial periods of System Production, it is felt that Unattended Operation

will consist of 8 to 16 hour periods. It is anticipated after approximately two years, that this period of Unattended Operation will be extended to one week.

The Maintenance Development program on STRETCH will fall into two main categories, system and component considerations. The following outline indicates the target objectives for this group's activity during the development of the STRETCH machine:

1. Systems Considerations

1.1 Rapid Fault Location

1.1.1 Error Detection

To facilitate Rapid Fault Location, the first step is detecting errors that will affect the problem being run on the machine. This includes the judicious location of error detecting equipment so that convenient checks might be made on information flow and the execution of various machine functions. This equipment will be located logically and chronologically so that the machine will be divided automatically into sections to localize the fault.

1.1.2 Automatic Error Recording

To aid in the analysis of errors and the cause of these errors, all error indications will be recorded. The data recorded will be such pertinent information as the location of error indicators, the character or word involved, the indicator set at the time of error detection, etc. This recording may take the form of information stored in a Maintenance Memory for later interrogation or recorded on some output media such as punch paper tape, printer or magnetic tape.

1.1.3 Auto-Correction of Errors

In the areas of the machine in which auto correction will be used, such information will be recorded concerning this operation as to indicate to the servicing personnel what faults might have caused the error.

1.1.4 Simplified Error Analysis

Error Analysis involves the recognition of errors, their frequency, and location, effects on normal machine operation,

and correlation with other errors in the machine. Error Analysis must be carried out with the aid of some recorded expression of the logic contained in the machine. This has normally been block diagrams which has involved many volumes of manuals, all interrelated. It is expected that the results of the STRETCH Automation Program will involve "machineable" expressions which may be used by Maintenance Personnel for analyzing errors and locating faults in the machine system. It also seems reasonable that a lesser machine, something in the order of Type 650 with RAM should be able to do a large portion of the error analysis and assist measurably in locating faults. This should result in a smaller maintenance crew with less technical abilities than as needed in the past. It is visualized that a small number of people assigned to the responsibility of servicing the STRETCH machine will need to be completely conversant with all the details of the system as we now experience in the 700 series machines. In the area of automatic error analysis it is felt that the 650 might be used to "shoot" trouble in the Link machine and the Link "service" the high speed system.

1.2 Rapid Fault Correction

1.2.1 Straight-Forward Logic

Rapid Fault Correction can be realized by simplifying the logic of any particular operation in the machine. This would minimize complex feedback circuits in which analysis of trouble is difficult, especially if the feedback involves many, many logical steps. If straight-forward logic blocks can be so organized in the machine, it can lead to improved packaging which will facilitate machine correction.

1.2.2 Packaging in Logical Blocks

The logical size of the packages which make up the STRETCH machine will be considered from many aspects. One of the foremost considerations will be the replacement problem necessary in Rapid Fault Correction. As logical blocks of circuitry are packaged as a unit, replaced easily, and substituted in various areas of the machine, Fault Location, as well as Fault Correction, can be facilitated. If within the logical blocks further break-down can be made to standard logical packages, the spare parts situation can be minimized, but yet give the maintenance personnel the facility to switch blocks for checking purposes. It is hoped that the fundamental package may be inexpensive enough so that they might be dispensable as in the case of the 604 pluggable unit.

Project Stretch Maintenance
Development Memo #1

1.3 Auto-Testing

1.3.1 Test Un-used Areas

In the past, un-used areas of the machine were able to deteriorate without being detected. It is expected that the STRETCH machine will utilize any idle time or scheduled time to test such areas of the machine.

1.3.2 Test Machine Fault Locators

Throughout the operation of the machine, various test cycles will be instigated to check the operation of the Rapid Fault Locators. This would be a technique of inverting the locator's logic or introducing invalid data and testing the locators to ascertain their proper function. Each of these test cycles could be recorded in the Maintenance Memory or on the maintenance output device so that a complete log of both successful and unsuccessful tests will be recorded. If machine Fault Locators are found inoperative, a sufficient signal will be given to the program and/or the operator so that the proper attention is given to this fact either through programming or through manual intervention.

1.4 Marginal Testing

As the technology of solid state circuits develop, attention will be given to the marginal characteristics of these circuits. These characteristics combined with whatever life data we have on the devices will be instrumental in designing the marginal testing facilities that will be incorporated in the machine. These facilities will probably be a compromise between the somewhat elaborate facility found on the AN-FSQ7, and the lesser facilities of the 704 and the 705. These marginal facilities will be made available to the Maintenance Personnel in such conveniences as determined by the frequency of their use, that is, if it is felt that marginal testing will be required only in the advent of an intermittent failure to aid in diagnosing fault location, it will probably be a minimum of equipment, however, if it is deemed necessary that the marginal equipment be used periodically, elaborate facilities will be included.

1.5 Diagnostic Considerations

1.5.1 Un-Checked Areas

Since a large amount of hardware will be checked with the facilities noted under Rapid Fault Location, it should not be necessary to provide detailed and extensive diagnostic programs to check these areas. However, the unchecked areas will need diagnostic programming attention. These areas will have to be laid out logically and physically such that diagnostic programming can be kept as simple as possible. This simplicity is necessary so that the diagnostic programming effort itself can be minimized, the running time of diagnostics minimized, and the understanding of these tests and their results increased for the Maintenance Personnel.

1.5.2 "Hard Core" Instructions

One of the greatest difficulties with diagnostic programming is that the "patient" is diagnosing "itself". By using extensive Fault Locators, it is felt that the analysis of errors is not being done by the equipment which is failing. To extend this philosophy to diagnostic programming, a "hard core" of checked instructions will be made available in the machine so that diagnostic programs can get started in an otherwise "sick" machine. These checked instructions, along with the large amount of Fault Locators in the machine should allow the diagnostic program to be simple, short, and effective.

2. Component Considerations

2.1 Component Control

Since the over-all reliability of a machine is a direct function of the reliability of the components, it is felt that STRETCH will need a Component Control Group to monitor all of the components that will be used in this machine. It has been evident in the past that initial specifications become relaxed after a short period of time, since the real value of these specifications seems to be dimmed as a machine gets into production. This is particularly true of a machine which will probably be the first to use some of the recently developed components. Careful consideration must be given to this work to see that the various testing and evaluation groups in engineering and manufacturing consider all components from a purchase and end-of-life specification.

2.2 Component Circuit Control

2.2.1 Iron-Clad Specifications

It has been noted in the past that component circuits have been used with little regard to the original specifications placed on them by the design group. As needs arise in the logical organization of a machine, variations in specifications for standard circuits seem necessary especially when the logical design groups are trying to minimize the component count. This leads to deviations from specifications and has resulted in some poor operating characteristics in the field.

2.2.2 Minimum Number of Circuit Types

To standardize on a small inexpensive package, a minimum number of different component circuits must be used in the logical design for most of the machine. If a set of applicable standard conditions can be met with regard to voltages, rise times and impedances, the number of different types can be small. Deviation from these standard types must be rigorously analyzed before they are permitted.

2.2.3 Marginal Testing

Early consideration must be made of marginal testing of component circuits so that the aggregate machine system may have sufficient margins. These margins must consider both purchase specifications and end-of-life specifications. Consideration of the most critical voltages must be given to the individual circuits so that when marginal equipment is designed into the over-all system, the proper voltages might be varied. It may be that additional components may have to be added to individual circuits for this testing.

There are many areas in the current DPM which should be modified if at all practical for the introduction to a new system such as STRETCH. The following are some of these areas that will have to be improved:

1. Design of a reliable device for replacing Card Machine Circuit Breakers. The problem of maintaining circuit breakers due to timing variations, bounce, dirty and burned points, wear, and electrical resistance are not new and have been under investigation for years.

2. The need for cleaning Tape Drive Units be reduced to an absolute minimum. By the end of 1956, cleaning of 727 tape drives will be costing I.B.M. between $180,000 and $360,000 depending upon shift usage. This cost plus the fact that it requires Stand-By Service should warrant considerable effort in this area.

Project Stretch Maintenance
Development Memo #1

3. Positive Fuse Failure indication. The failure of blown fuses to indicate has been responsible for several field trips by Engineering Personnel on 700 series machines plus considerable customer dissatisfaction.

4. Eliminate the need for moving cables after the machine system is installed. The removal of a 727 Tape Drive from System to Auxilary Operation requires the handling of from four to six cables. Machine down time and the necessity for Stand-By Service should warrant a selector network on future machine systems.

5. Minimize the wear on the tape read-write head due to tape motion. At present, the estimated life on a tape head is only 500 hours. This figure is very small and should be greatly increased on future machines.

6. The cover design be concurrent with good appearance and minimize the need for removal during servicing.

7. Caster design be such to permit easy unit movement without damage to the floor material.

8. Establish maximum margins on temperature and humidity exceeding those on our 700 series machines.

The Maintenance Development Group of STRETCH are cognizant of the effort being made to minimize maintenance in both commercial and military products. In the past, these considerations were not in the fore-front during the original design of the machine. Being able to incorporate the maintenance aspects of a machine at its concept will help eliminate the obvious contradictions in maintenance when this is considered after the machine system has been designed for optimum problem solving without regard to how it is to be corrected when a fault occurs.

It is expected that with a machine of 200 times the effectiveness of a 704, it will take less than one-half the manpower required to maintain a 704, and less technical ability on the part of most of these people. Efficiencies should also be realized in the education of these people in that the logical description of the machine will be simpler and may very well be presented to the Maintenance Personnel mechanically rather than using the persons analytical powers to find the proper expression for the part of the machine in question.

C. E. Stephens

CES:jdk

W. R. Stringfellow

V. D. Winkler