Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: OPERATIONAL PROCEDURE ON THE WHIRLWIND COMPUTER

To: The Mathematics Group

From: J. T. Gilmore

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Abstract: Because of the ever-increasing number of programs being operated, it has been necessary to change the procedure of operating programs on the computer. This is the second in a series of three memorandums which explain the general procedure for putting programs on the computer.

In the past year of computer operation a great deal of experience has been gained with regard to the method of operating and trouble-shooting programs. One of the first things a programmer should realize is that the probability of a program performing correctly during its first operation is very small. The reason for this is usually due to the negligence of the programmer. In his attempt to check the whole program, his attention will mainly be directed toward his logic and his numerical method. If and when he checks for the possibility of a mistake arising from various little oversights, from the copying from the work sheet or from a misunderstanding of the exact function of a computer operation, the program will have become so subjective to him that any such mistakes will usually be undetected. In addition to this obstacle the occurrence of a mistake in typing or of a tape equipment malfunction is possible, and last (but not least from some programmer's point of view) there is the slight possibility of a transient malfunction occurring during computer operation. Because of the latter it is fortunate that Whirlwind lacks the human property of being sensitive to insults. Suspecting the computer of malfunctions is in itself not to be frowned upon. But to accuse it of incorrectly performing without sufficient evidence is analogous to accusing a mirror of reflecting a false image. It is now the confirmed opinion of those experienced with computer operation that a successful programmer is one who quietly accepts notice of an alarm and methodically investigates the information produced by the alarm. Then, should he discover a blunder, he is saved the humility of advertising it throughout the laboratory and should he eliminate all possibilities of a personal mistake and produce conclusive evidence of where the machine malfunction did occur, he is not only an efficient programmer but a capable trouble-shooter of whom there cannot be too many.

Although it would seem that a programmer should double his efforts in checking his program before its initial operation, this is not the case. True, he should be reasonably confident of its working; but to waste time

checking and rechecking is nonsense when one considers the purpose of the computer. It was built to serve, not to be served. With this in mind and with a fair amount of patience, one can give the computer not only the task of solving his numerical problem but also the chore of trouble-shooting the errors in his program. However, like the former, the latter should be systematic and organized. One should decide what error diagnostic data is necessary only after a sufficient amount of intelligent investigation has been made.

When the computer was first made available to the applications group, each programmer operated his own program. When alarms occurred it was common to see the computer sit idle for large periods of time while the programmer desperately tried to guess what the trouble was. Usually he would randomly examine the contents of some storage registers or operate the computer in an "order-by-order" fashion to trace the path of control. Not infrequently a wrong button pressed or a switch forgotten, under the pressure of the moment, resulted in destruction of the symptoms he was trying to diagnose. The majority of these situations ended with the next programmer, his patience at an end, demanding his turn and the woeful programmer, still puzzled, returning to his office. Surprisingly enough, however, he was not puzzled too long after a systematic study of the alarm information. In some cases when three or four successive hours of computer time were available, the programmer was able to reoperate the program, examine a few specific registers, make the necessary modifications, and successfully operate his program. However, all these manual examinations and modifications took valuable time and caused much unnecessary strain on the part of the programmer.

Today, by means of special programs (post mortems), it is possible to obtain printed records of the contents of any section of storage registers in one of the five different forms in which a word is normally written. It is also possible to obtain automatically printed or punched information associated with each operation or with certain selected operations as they are executed by the program. Also, our input equipment is fast enough for a large number of parameters to be inserted in a program in a very short length of time. This can be especially valuable to a programmer who has limiting range troubles and finds it necessary to try a large number of different values before a successful operation is obtained. With all these facilities it should not be too difficult to acquire the necessary error diagnostic information.

However, inasmuch as all this potential information takes computer time in being procured, no requests for such data should be made until the program has failed to operate and sufficient time spent deciding what information will be needed. In order for the programmer to comply with such a demand, the computer schedule must be such that he will not be kept waiting for the results of the error diagnostic test. To accomplish this and to avoid tie-ups, at least three hourly computer periods, separated by at least two hours, should be scheduled each day. This would provide the ability to operate or test a program at least four times during a week and yet not consume more than a half hour of computer time.

Since very little time will be spent in each operation of a program, the presence of the programmer should not be necessary. A regular operator should be able to run the program by merely following a simple set of instructions. It has been found that more programs can be operated during a computer period if it is the responsibility of one or two men to operate all of the programs, rather than if each programmer operates his own. To increase efficiency further, it has been requested that no manual control of the program be necessary in order for it to be operated (i.e. flip-flop registers containing parameters, manual photography, etc.). Should the programmer feel the absolute need to operate his own program, he will be allowed, on request, one fifteen minute period a week. If more time is needed it will be granted through the head of the mathematics group. For programs that have been tested and require long periods of operation to produce sufficient data, an evening schedule, which can be varied depending on the number of programs and the amount of data, will be available.

The actual mechanics of operating a program on the computer requires two requisition forms. The first requests the preparation of the Flexowriter tape and the second, the actual operation. Should an alarm occur in the operation of the program there is a third requisition which requests an error diagnostic test of the operation. (See M-1351)

The tapes of main programs will be numbered using a capital T as the prefix and any modifications will be indicated by its file number preceded by a dash (-). For example, tape number six hundred and fifteen modification six would be written as T 615 - 6. All parameter tape numbers will have a capital P as a prefix. The file number will correspond to the main program's file number and the actual parameter number will follow a dash. For example, the second set of parameters in file number 615 would be P 615 - 2 . Therefore if one wished to operate tape six hundred and fifteen modification six together with the second set or parameters, the assembled tape would consist of T 615 - 6 and P 615 - 2. Note that a parameter number distinguishes between sets of parameters in a given file, not sets of parameters associated with a single modification.

A "parameter" is defined as a set or "clutch" of values. The term clutch is used to emphasize the fact that all the values of one parameter are read in on one movement of the photoelectric reader's clutch. This procedure was decided on in order to aid the operator in distinguishing parameters as they are read in. Also, it has been decided to request programmers not to read in new sets of parameters by transferring control to

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* Parameter tapes will be filed separately, and in 5-5-6 form will be distinguished from regular tape numbers by a double slash between the main number and parameter number.
i.e. p6, p1, p3, p31, p6 = T615 - 6
p3, p1, p3, p2015, p2 = P615 - 2
p31 will cause a single slash in the 5-5-6 tape number.
p2015 will cause a double slash in the 5-5-6 tape number.

P1023

the input program. At the present time this practice is susceptible to transient errors in the read operation. Therefore, when a program is ready for its next set of parameters the program should stop and allow the operator to read in the parameter. This practice will not only assure the programmer of getting his parameter into storage correctly but will avoid confusing the operator regarding which parameters have been read in. This is a very temporary situation and programmers will be informed when it has been corrected.

The performance request form (DL - 324) is to be used each time there has been a change in the main program or the parameters. The form is divided into two sections, the first being the requisition itself and the second the indication of what happened. In filling out the requisition section, one must indicate the following:

a) The kind of tape to be used.
Because of the increase in storage capacity and the addition of magnetic tape it soon will be possible to read in Flexowriter standard tape, convert it, and operate the program immediately. Hence the necessity of knowing whether the tape is in 5-5-6 or Flexowriter form.

b) The kind of output equipment and whether it is automatically or manually controlled.
There are instructions which will print $\begin{pmatrix} \text{qp } 200 & (o) \\ \text{qp } 128 & (d) \end{pmatrix}$, punch $\begin{pmatrix} \text{qp } 100 & (o) \\ \text{qp } 64 & (d) \end{pmatrix}$, and photograph (qs o) automatically. If the output is automatic the other equipment can be left on with no effect. With manual control the other equipment has to be turned off.

c) The time consumed by the program before any of the output equipment responds.
In order for the operator to avoid confusing a lengthy computation with a closed loop, he needs to know approximately how long the computation should last.

d) The total time consumed by the program from the moment it is read in until it is automatically or manually stopped.
This information is needed in order for the operator to calculate approximately how many programs he will be able to operate, and also to determine if something is wrong with the program should it continue to run over the estimated time by a fair margin.

e) The amount of output.
The operator must know how much data is to be obtained. Programs have been known to err in such a way that the output equipment is constantly being sent nonsense. Also, the program may be set to turn out a great amount of data but the programmer

may desire only a fraction of this to determine whether the program is operating correctly. If the program exceeds the amount of data predicted, the program will be stopped manually. If the program did perform correctly, then the program may be operated in an evening period for as long a time as is needed. In this way the handling of programs under test can be expedited.

f) The type of storage to be used.
There are three available sets of storage. The first has a capacity of two hundred and fifty-six registers(40 - 437(o), 32 - 237 (d)) and is referred to as Bank A, regular. This is not to be used in any new programs. The second has a capacity of 320 registers (140 - 637 (o), 96 - 415 (d)) and is referred to as Bank A, extra. This is to be used in all cases where 320 registers are sufficient. The third has a capacity of one thousand twenty-four registers (40 - 2037(o), 32 - 1056(d)), and is referred to as Bank B. This is available only unofficially but may be used whenever more than 320 registers are necessary. Bank B is quite reliable and will be officially a part of Whirlwind by the first of the year (1952). Programs written for Bank A can and will be operated in Bank B when available, but those designated as Bank B will only be performed when the full Bank B is available.

g) The parameters which are to be used listed in the indicated place with the appropriate one of the four possible instructions circled next to each. The four possibilities are:

1) To be read in before operating the main program. (i.e. stop after read-in of main program and read-in the parameter before operating - or stop after read-in of the preceding parameter and read this parameter in before operating.)

2) To be read in only if no alarm occurs in preceding operation. (i.e. skip this parameter should an alarm occur before it is read in.)

3) To be read in only if alarm occurs in preceding operation. (i.e. skip this parameter unless an alarm occurs in preceding operations.)

4) To be read in whether or not alarm occurred in preceding operation. (i.e. try this parameter no matter what happens in preceding operations.)

Let us assume that my program's type number is T464-5 and I have seven parameters to be tried. Let us further assume that the first two are to be read in before operating the main program, the fifth and sixth to be tried (separately) only if no alarm occurs in the preceding operations, that the third is a parameter which provides useful information via some output

on what might have occurred to a few registers in the event of an alarm, that the fourth is a parameter which resets any possible changes in the program and that the seventh is a parameter which tries a final set of values, which are used to test the range limits of the program. The parameter setup would appear as:

P 464 - 1 (1) 2 3 4
P 464 - 2 (1) 2 3 4
P 464 - 3 1 (2) 3 4
P 464 - 6 1 (2) 3 4
P 464 - 3 1 2 (3) 4
P 464 - 4 1 2 3 (4)
P 464 - 7 (1) 2 3 4

When the operator receives the performance requisition, he will check the form for completeness and then assemble the main tape and its parameters. If there are any questions, the programmer will be called upon to answer them before the program is operated. After the operation of the program, a copy of the completed form and any results will be returned to the programmer along with the assembled tape. Should the programmer be doubtful about what was read in, he will have the opportunity to check the tape without going to the tape files. If the assembled tape is no longer needed, the programmer may destroy it. However, if he wishes it filed in the tape room, it must be assigned a new tape number. This situation may arise if a program and a certain set of parameters are to be used very often. If any assembled tape is to be modified in the least way, the whole tape must be reassembled by the operators. Although this may seem wasteful, it will avoid confusion. If the assembly is to be reoperated again, the programmer may return the assembly with a new requisition form in order to save unnecessary duplication time. If a programmer decides that his sample data is correct and wants to obtain a complete set of data, he will indicate this in the "Comments" section of his new requisition form and include, if possible, a copy of the sample data.

Program Performance Summary

I. A) For the first run of a new program, a modified program or a program with new parameters, fill out in duplicate a Program Performance Request, DL-324, writing the file, or tape, number in the upper left, your name, problem number, (request number will be filled in by operator), the type of tape to be used, the type of output which will be automatically called into play by the program, the amount of each output expected or desired, the storage registers used (Bank A if no more than registers 96 to 415 decimal = 140 to 637 octal, Bank B otherwise), and lastly, list in proper order the numbers of the various sets of parameters, if any, to be used and circle for each the appropriate one of the four indicated possibilities.

If a programmer wishes, he may operate his own program but must accept the time assigned and must not take longer than 15 minutes without special arrangement.

Performance Requests may be submitted before the needed tapes have been completely prepared. The program will generally be performed, if possible, in the first or second assigned computer period following receipt of request and completion of tape.

B) For error diagnosis data (post mortem or otherwise) on programs which have failed, fill out the ERROR DIAGNOSIS TEST REQUEST form DL-329, to be available and described soon.

C) For result runs of a tested program, fill out the Program Performance Request form DL-324 as in A) but indicate under COMMENTS what results are expected so that the program can be scheduled for a night run if desired by the operator. Results should be available within a day in any case.

II. The original copy of the Program Performance Request will be returned to you as soon as the program has been performed, together with any printed or punched results. Indication of any failure in the program, with each parameter listed separately, is given on the form. Any photographs will be delivered to you in the form of strips of 35 mm negatives on the day following the program's performance and any prints may be requested then. (See M-1333).

Signed J. T. Gilmore
J. T. Gilmore

Approved C. W. Adams
C. W. Adams

JTG:as

Attached: DL-143-3
DL-324

TAPE PREPARATION REQUISITION

Rec'd at _____ hour _____ date

Needed by _____ hour _____ date

File # _____

_____ Problem #
Title

1. Program # _____

_____ Project #
Author

Parameter # _____

Fill in Title, Author, and File #; indicate when the tape must be ready for use; fill out a separate requisition for each modification of the program and for each new parameter; check the applicable line in items 1, 2, 3, and 4; fill in items 5 and/or 6 if desired; fill in the desired program or parameters on this sheet or on a suitable form (s) securely attached to this requisition.

2. This is a complete program (or parameter).

Attach to _____

Control transferred to reg. _____ after read in.

3. Octal addresses are used throughout.

Decimal addresses are used throughout.

4. Type and have converted to conventional 5-5-6 form.

Type in conventional form but do not convert to 5-5-6 form

Prepare directly in 5-5-6 form (no more than 4 registers may be involved).

Type in SUBROUTINE form.

File in SUBROUTINE Library. LSR # _____

v _____ address of zero temporary register

vx _____ address of 1st order of interpretive routine

vx2 _____ separation constant

revx1 _____ address of 1st multiple length constant of multilength print routine.

Type exactly as indicated, do not convert or add convention characters.

5. Make obsolete all previous programs (or parameters, as the case may be) in this file except those circled: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

6. Make obsolete File #(s) _____

address	contents	address	contents	address	contents

FORM DL-43-6

WW1 PROGRAM PERFORMANCE REQUEST

Room 221_____
Rec'd_____

File # Submitted by Problem # Performance Request #

☐ Short Run
☐ Long Run

If the expected total time for the operation of the main program and all Parameters is more than ten minutes, the program should be listed as a long run.

The program is to be operated by ☐ The regular operator
☐ _____ at _____ approved by _____

Number system
☐ 15,0,0
☐ 24,6,0
☐ _,_,_

The programmer and _____ ☐ Need not ☐ Must be present during the operation.
Should there be any questions...MIT phone #_____ home_____

Input
☐ 6-5-6 tape only
☐ flexo tape only
☐ 6-5-6 and flexo

Output
☐ printer
☐ punch
☐ scope & camera
☐ magnetic tape
☐ _____

The output equipment is expected to start operating within _____ seconds after the start of the program.
The program is expected to run for _____ min. total and print _____ lines, punch _____ inches, photograph _____ frames record _____ blocks on magnetic tape, read _____ blocks on magnetic tape.
The program should ☐ stop automatically by _____
☐ be stopped manually.
If the program runs for more than _____ minutes or _____ it should be stopped manually.

The following is the list and sequence of tapes to be operated.
Each line is to be a separate operation of main program, parameters and interpretive routine.

	SEQUENCE					COMMENT
1.						
2.						
3.						
4.						
5.						
6.						

SPECIAL INSTRUCTIONS:

DL-324-3