An HP-75/HP-86 Computer Data Collection System for Recording and Displaying Logging Equipment Time Studies

by

Thomas M. Campbell

A PAPER

Submitted to

Forest Engineering Department

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Forestry

June 1984

APPROVED:

John E. O'Leary

Professor of Forest Engineering in charge of major

George W. Brown

Head of the Department of Forest Engineering

Date paper is presented: May 25, 1984

Typed by Mary Ann (Sadie) Airth for Thomas M. Campbell

ACKNOWLEDGEMENT

It is with heart felt thanks that the author remembers Dr. Eldon Olsen for his inspiration, optimism and help in organizing the project, Dr. Marvin Pyles for timely assistance in providing HP-IL interface loop information and John Balcom for long hours spent helping to unravel the HP-IL system commands and writing program steps to make the electronic data transfer a reality.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

An HP-75/HP-86 Computer Data Collection System for Recording and Displaying Logging Equipment Time Studies

INTRODUCTION

Time studies of logging equipment are important to determine production rates, calculate logging costs and locate operating inefficiencies. However, using present time study techniques, they are also costly and time consuming to complete. This project will develop a new data gathering and storage technique using the HP-75 portable computer to make time measurements and directly store field data.

Normally one or more analysts are assigned to observe an operating machine for two or more weeks. During this time they divide the machine cycle into a series of easily definable operations called elements and record the start and stop time for each of these elements. Various techniques are used, however, usually one person will observe the machine and call out the start of each new element in the operating cycle. The second person, using a stop watch, will note the times of these calls and record them on a data sheet. These jobs can be both hectic, and tedious as element times are often numerous and fast paced while being repetitious and uneventful.

These job characteristics can lead to data errors as calls are late or missed, stop watches are misread, data sheet columns are confused and delays are omitted. Further expense, time and possible errors occur as the field data is transcribed and processed.

The HP-75 is a small portable hand-held computer having a 24K bytes random access memory and an internal clock. This project will program this computer to accept time study information keyed directly into memory during field observations. By assigning time, delay and mensuration functions to different computer keys one person can view an operation and punch the appropriate key to record necessary time study information. Stop watch readings will be unnecessary as the computer program will automatically record the start and stop times from the constantly running internal clock.

Once data is internally recorded in the HP-75 memory data transcription for processing will be unnecessary. The HP-75 can be interfaced with the larger HP-80 series desk top computers, such as the HP-86, for data processing. All recorded information is electronically transferred directly to the desk top unit saving time and money while eliminating possible errors.

Using this approach this project will have three objectives:

1) Program the HP-75 to directly measure and store time study data. The program must:
    a. Be fast enough to record the type of elements that occur in typical harvesting operations, i.e. elements lasting less than one minute,
    b. be designed to help the user from making observational or recording errors,
    c. have adequate memory to record a full day's data,

d. take less user training than traditional stop watch methods,

e. be easier mentally and physically to use as well as less stressful than stop watch studies.

2) Program the HP-75 to interface with and transmit data directly to the HP-86.

3) Program the HP-86 to accept, store, recall and print out data.

This project will also test the finished programs for compliance with the above objectives and will document instructions on using the system.

LITERATURE REVIEW

A variety of techniques are available to record time study data. Which technique is selected depends upon cost and desired accuracy. Haarlaa (1981) reports that tachographs, a machine mounted instrument that automatically records machine use on a cardboard disc, is suitable for long term studies on many machines. Stopwatches, both conventional and digital, are popular for more detailed time study applications.

Efforts to automate data collection have brought tape recorders into use. Verbal words and codes describing work phases are field recorded for future office transcription. Again Haarlaa (1981) reports tape recorders have been used to a large extent in Nordic countries.

de Souya, Cottell and Lawrence (1981) of the University of British Columbia combined a Data Logger with a cassette tape storage device and mounted both directly in a machine. The Data Logger, a microprocessor-based module, can monitor 16 analog and 16 digital input channels. Data events including channel identification, data value and time are recorded on tape for analysis by an HP-9845 computer. Although primarily geared to ergonomic factors such as noise and vibration instrumentation the Data Logger can record machine control level positions which are subsequently interpreted by computer into machine work cycles.

Finally, Nickerson (1979) programmed the HP-67 calculator to record up to four elements per cycle by assigning keys to the four functions. Output included number of observations, mean time and standard deviation of each elements. Similar programs have also been completed for the HP-41.

This project will improve upon these previous approaches. The stopwatch and tape recorder techniques require substantial data transcription and manipulation for acceptable output. This system will have a direct computer interface to eliminate data transcription. Whereas the tachograph and Data Logger are machine data oriented and require individual machine installation the HP-75 is time study oriented and is highly mobile. Finally, similar HP-67/HP-41 programs have insufficient data storage capacity and insufficient visual cues and feedback.

EQUIPMENT

The computer equipment used for this study includes the HP-75 Portable Computer; the HP-86 Personal Computer complete with disc drives, monitor and printer and an HP-IL (Interface Loop).

The HP-75 is a small portable BASIC language computer measuring approximately 10" x 5" x 1 1/4". It weighs 26 ounces, is battery powered, has continuous memory, a built in card reader and a 16 K bytes random access memory (RAM). For this project the RAM was expanded to maximum capacity 24 K using an 8 K memory module.

In 1983 the HP-86 was Hewlett-Packard's standard personal computer. The model used for this project had expanded RAM memory from the standard 64 K to 128 K. Although not necessary for short time studies the additional memory is required for larger data collections. Necessary supplementary hardware included an Advanced Programming ROM (Read Only Memory) which expanded the BASIC language commands. Peripheral devices were standard.

The HP-IL is a small module that plugs into the HP-86 permitting a two wire serial HP-75 interface. One wire carries data from the HP-75 to the HP-86 while the other works in the opposite direction thus completing the "loop". Interface loop functions have been designed into both machines.

Also of interest is the new HP-71. It is a smaller, lighter, less expensive BASIC language portable computer. This model has a RAM expandable to 33.5 K bytes. While not available when this project was begun it promises to be compatable with these programs and have the same interface loop capabilities.

INPUT FORMAT

Early in the design of the HP-75 program named ELEMENT, it was decided to make the program as flexible and general as possible to handle a wide range of time study applications. At the same time the program had to be user friendly to allow easy setup for each application. To accomplish this numerous prompts have been built into the program that guide the user step by step. By entering the appropriate information the user can customize the program for each application.

The program (ELEMENT) has four main parts. They are:

1. Operations Data
2. Element Selection
3. Delay Code Selection
4. Time study

Parts 1 through 3 customize the program and are completed before the time study begins. Part 4 does the actual time study.

Part 1 - Operations Data

Part 1 helps the user record general information pertaining to the time study. Altogether 10 categories are recorded. They are:

1. Date
2. Time
3. Equipment
4. Layout
5. Landing
6. Corridor
7. Observers
8. Crew Size
9. Slope
10. Weather

Date and time are automatically recorded from the computer clock. The program informs the user of this and then prompts individually for the remaining eight categories. All categories do not have to be used as nonapplicable ones can be left blank. A maximum of 20 characters can be recorded per category.

Once all categores are completed the program reviews all 10 entries and asks for any corrections. If the user indicates there are none the program advances to Part 2. If corrections are necessary the user can option to edit any or all categories as many times as necessary before continuing with Part 2.

Note that any of the 10 prompts can be changed should the user repeatedly wish to record different information. However, this is not a user friendly operation. Prompts must be changed within both the HP-75 and HP-86 programs.

Part 2 - Element Selection

Upon entering Part 2 the program prompts for the number of elements desired, from 1 to 9. Once this number is entered the program prompts for the name of each element, 7 characters maximum. For example, the feller buncher time study used to test this program used four elements which were entered as follows:

Element	Program Entry
Travel Empty	TRAV E
Cut	CUT
Travel Loaded	TRAV L
Pile	PILE

As before, when all elements have been entered the program reviews the entires and asks for corrections. The user can then edit as necessary or advance to Part 3.

Part 3 - Delay Code Selection

Six possible delay codes have been included in the program. Four have been pre-assigned and are available without further input as they are usually universal to most time studies. They are assigned to keys 1-4 as follows:

1. Reset
2. Rigging
3. Personal
4. Mechanical

After reviewing these codes the programs prompts for whether the two additional codes are required and if so, how many. These two codes can be given any name up to 10 characters and are assigned to keys 5 and 6. As before the user is given opportunity to edit the additional codes.

Note that the four pre-assigned codes can be easily changed by changing lines 110, 120, 130 and 140 in the HP-75 program. However, this is not a user friendly operation.

One final feature of the Delay Code Section is that the zero key has been assigned to ERROR. Should a timing error occur during any element, assigning a zero delay code will delete the erroneous time and replace it with zero.

Part 4 - Time Study

This program part conducts the actual time study. A brief operations summary is given below. More detailed instructions can be found in Appendix B.

After delay code input the HP-75 will display the beginning turn number, element and the word "READY" as follows.

TURN 1	TRAV E	READY

Keying the space bar begins the time study and changes "READY" to "RECORDING". Each time the space bar is keyed the display changes to the next element in sequence while recording the time for the previous element. All timing is done internally and is not displayed.

Delays are timed by keying [Z]. This beings delay timing and prompts for a delay code for which 0-6 is entered. Keying [Z] again completes the delay cycle, records delay time, turn number and element and returns the display to the element timing format.

Mensuration functions and distance measurements are found on the [M] , [,], [.] and [/] keys found on the lower right keyboard row. Keying these keys provides the following prompts for recording information.

Key	Prompt	
[M]	Slope yarding distance?	
[,]	Lateral yarding distance?	
[.]	Logs/Turn (6 max.)?	
[/]	Diameter Log 1?	prompts for all
	Length Log 1?	logs up to 6.

These keys can be accessed while timing any element or delay. If desired, log tag numbers can be recorded using [/] in lieu of diameter and length.

All information is stored intact, turn by turn, in four data files for future recall and analysis.

OUTPUT FORMAT

Once the time study is complete the data must be transmitted to the HP-86. This is done by a small program named TRANSMIT, listed in Appendix A. it is an uncomplicated program and will not be discussed further. A third program named HPILCMDS for Hewlett-Packard Interface Loop Commands is also needed. This program is copywrited by Hewlett-Packard. TRANSMIT and HPILCMDS need not be in the HP-75 during the time study. Likewise ELEMENT does not have to be in the HP-75 to transmit data. For long time studies memory can be conserved by not entering the two transmission programs until needed. ELEMENT can be purged to provide room. However, with all three programs in memory the HP-75 can still record over 150 turns using a 6 element format.

To receive transmitted data the HP-86 must run the program HP-75 TALK. A subroutine of this program interacts with TRANSMIT to effect the transmission. To transmit data:

1) Connect the hardware as described under Equipment
2) run the HP-86 program HP-75 TALK and choose the 75 INPUT option by pressing the appropriately assigned key.
3) simultaneously run the HP-75 program TRANSMIT, calling up the appropriate file name.
4) when data transmission is complete the HP-75 can be turned off.

Once the data files have been transmitted they should be stored. Thus, they can be recalled for future analysis. HP-75 TALK is user friendly so that the user need only follow the program prompts to exercise these options.

The PRINT OUT option for HP-75 TALK consists of six subroutines. These subroutines are:

TITLE	-	prints out the general operations data
UNCOR TIME	-	prints out element times and scale data, times are uncorrected for delays
DELAY ONLY	-	prints out only the delays
UNCOR ALL	-	prints out a full data table, however element times are uncorrected for delays
COR TIME	-	prints out element times and scale data, delays have been removed from element times to give productive time
COR ALL	-	prints out a full data table showing corrected productive times.

Subroutines can be used in any order. Figure 1 shows a sample data printout using the TITLE and UNCOR ALL options. Delays are listed directly below the turn in which they occurred. Element times are corrected for delays.

TIME STUDY: DSRV

DATE 84/04/10
TIME 15:02:11
EQUIPMENT VIDEO MONITOR
LAYOUT
LANDING
CORRIDOR
OBSERVERS DREW ROSLUND
CREW SIZE
SLOPE
WEATHER

CORRECTED TIME STUDY DATA FOR: DSRV

NOTE: DELAYS HAVE BEEN SUBTRACTED FROM ELEMENT TIMES.
TIMES SHOWN ARE DELAY FREE TIMES.

DIAMETER/LENGTH OF LOGS (6 LOGS MAXIMUM) DIAMETERS ARE IN INCHES LENGTHS ARE IN FEET

TURN	TRAV E	CUT	TRAV L	PILE	SLYD DIST	LAYD DIST	LOGS/TURN	1	2	3	4	5	6
1	5.54	23.50	17.54	1.14	0	0	2	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0

TURN #	ELEMENT	DELAY TIME	DELAY TYPE
1	TRAV L	16.97	HANG UP

TURN	TRAV E	CUT	TRAV L	PILE	SLYD DIST	LAYD DIST	LOGS/TURN	1	2	3	4	5	6
2	5.55	19.94	8.04	2.08	0	0	0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0
3	13.93	20.38	5.55	9.35	0	0	0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0
4	12.97	30.66	8.78	8.81	0	0	2	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0

TURN #	ELEMENT	DELAY TIME	DELAY TYPE
4	PILE	4.39	HANG UP

TURN	TRAV E	CUT	TRAV L	PILE	SLYD DIST	LAYD DIST	LOGS/TURN	1	2	3	4	5	6
5	6.64	23.14	11.96	5.01	0	0	2	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0
6	8.40	21.24	11.44	4.13	0	0	2	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0
7	17.66	22.56	11.16	6.43	0	0	0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0	0/ 0

TURN #	ELEMENT	DELAY TIME	DELAY TYPE
7	CUT	11.58	MONITOR

Figure 1
Sample Data Print Out.

PROGRAM FLOW CHARTS

The following flow charts show program logic for the HP-75 program ELEMENT.

A separate much simplified chart shows the major branches for the HP-86 program HP-75 TALK. Although this program is longer it is more straight forward than ELEMENT and need not be charted in detail.

GENERAL INFORMATION INPUT

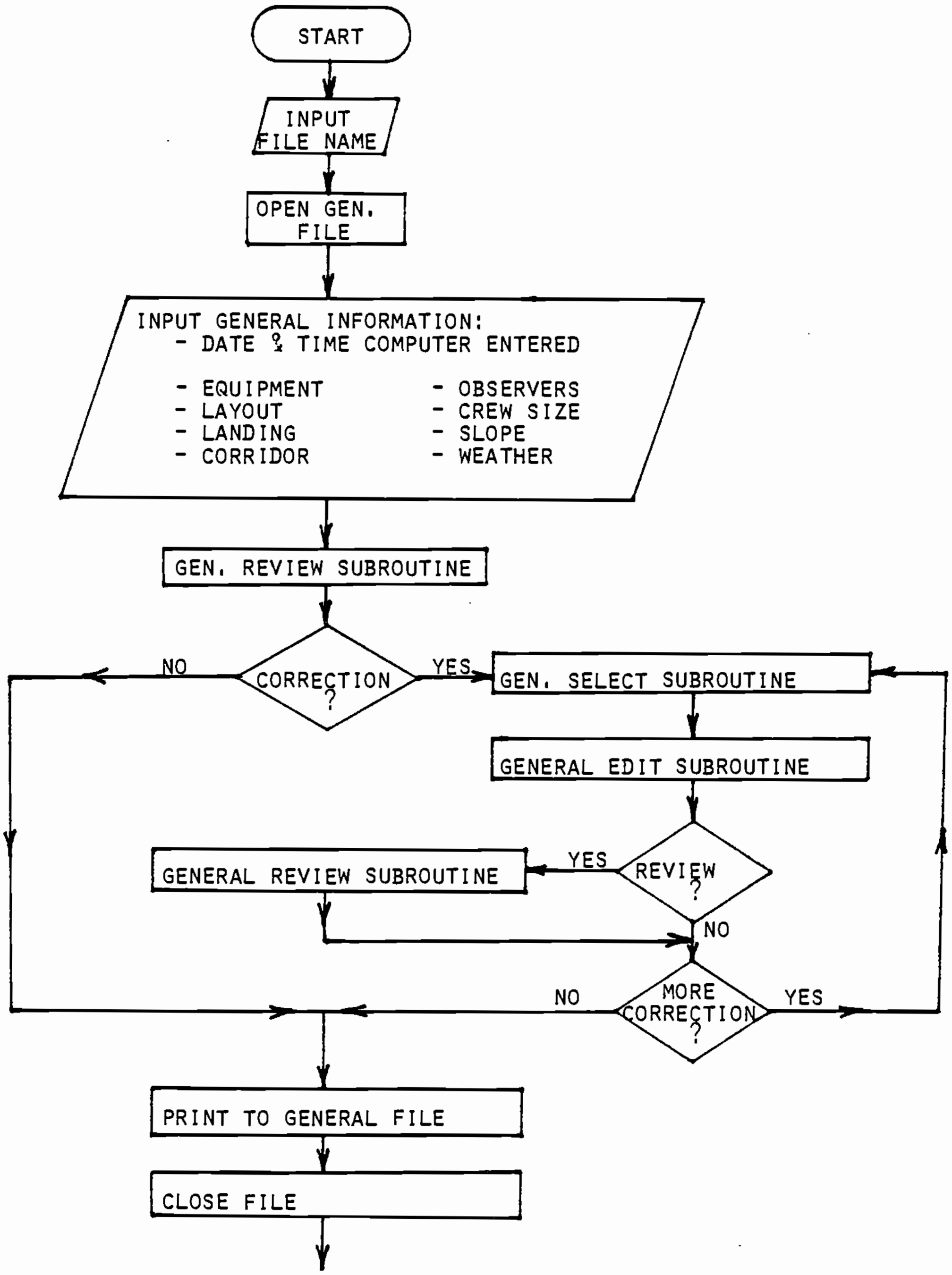
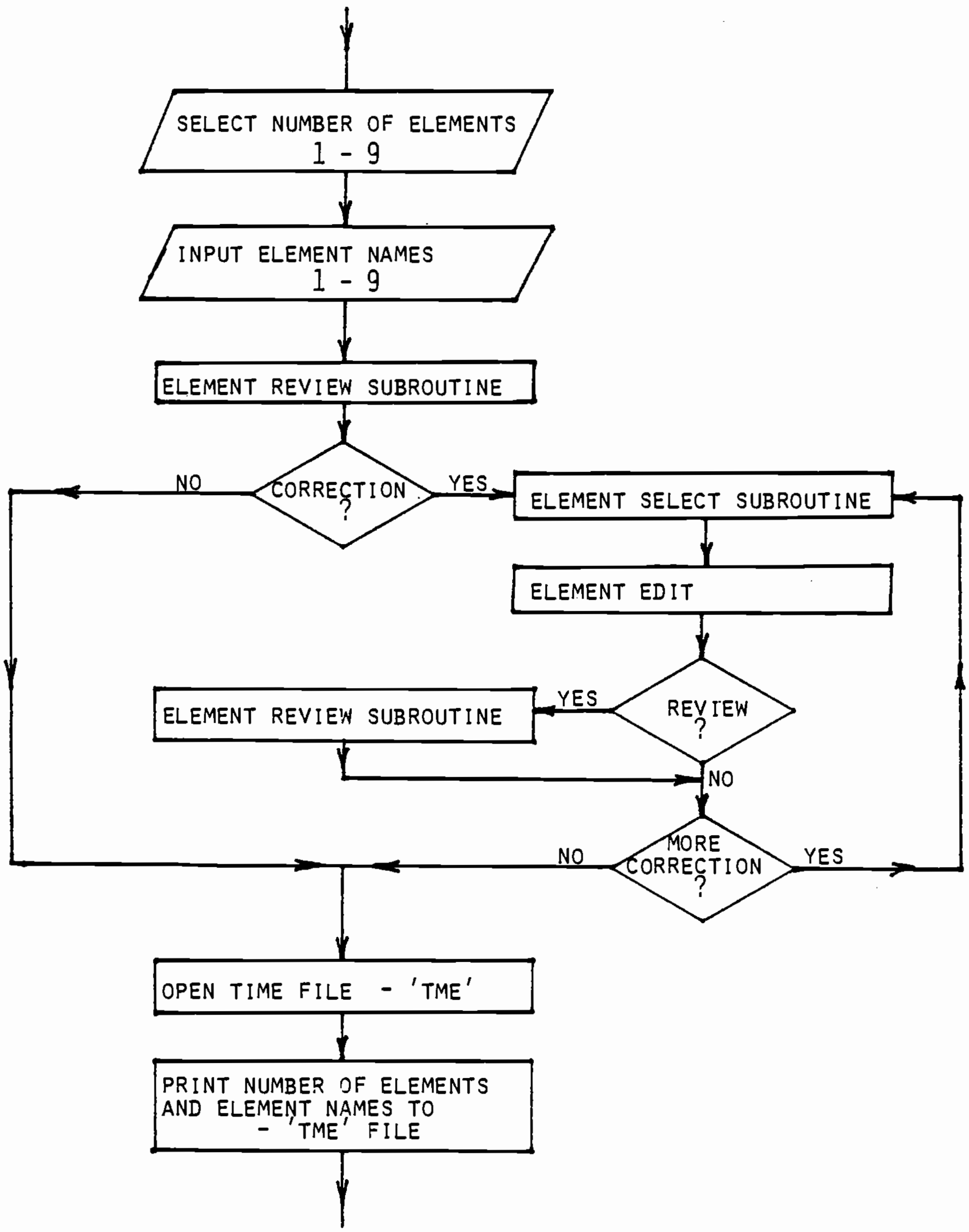
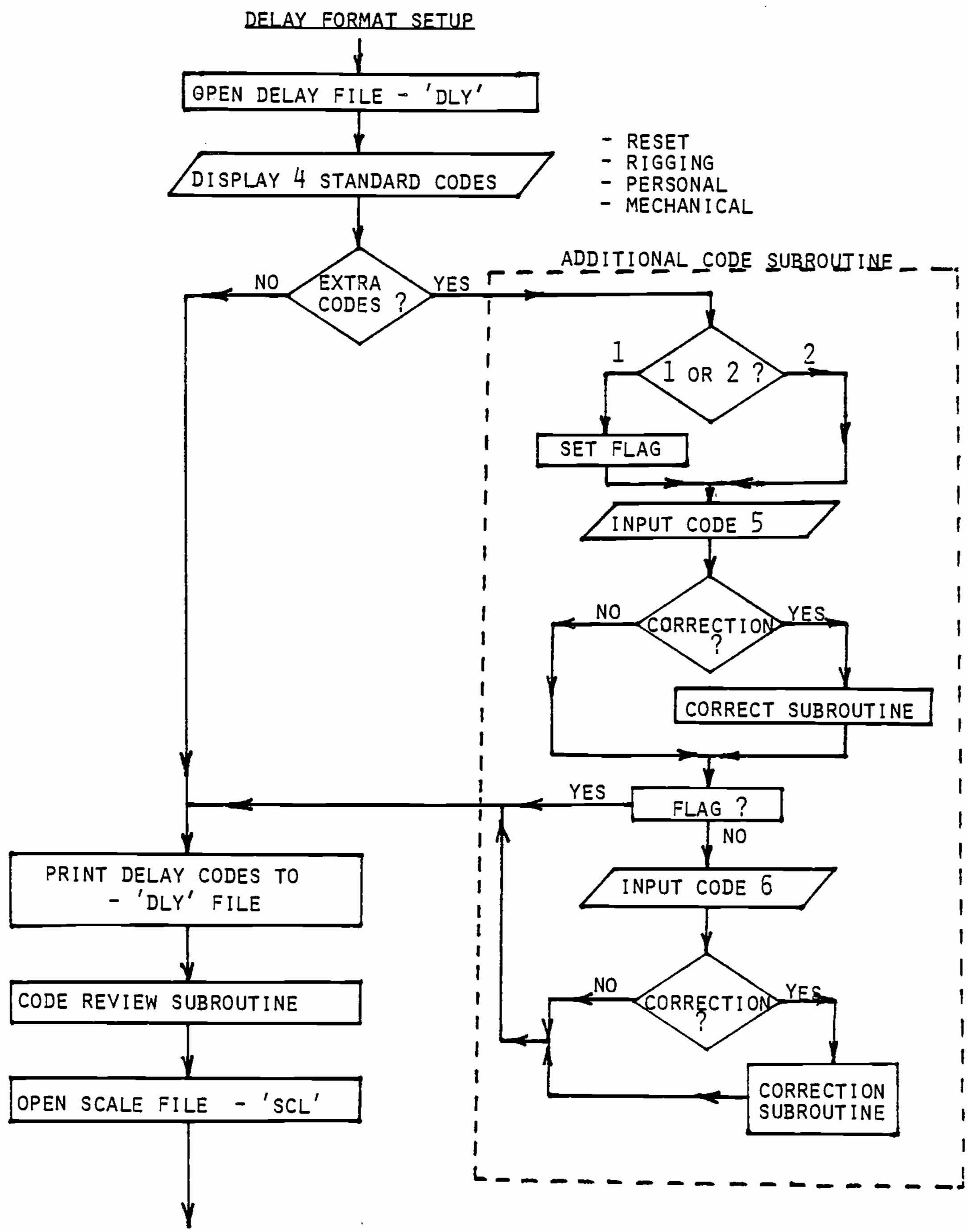


Figure 2

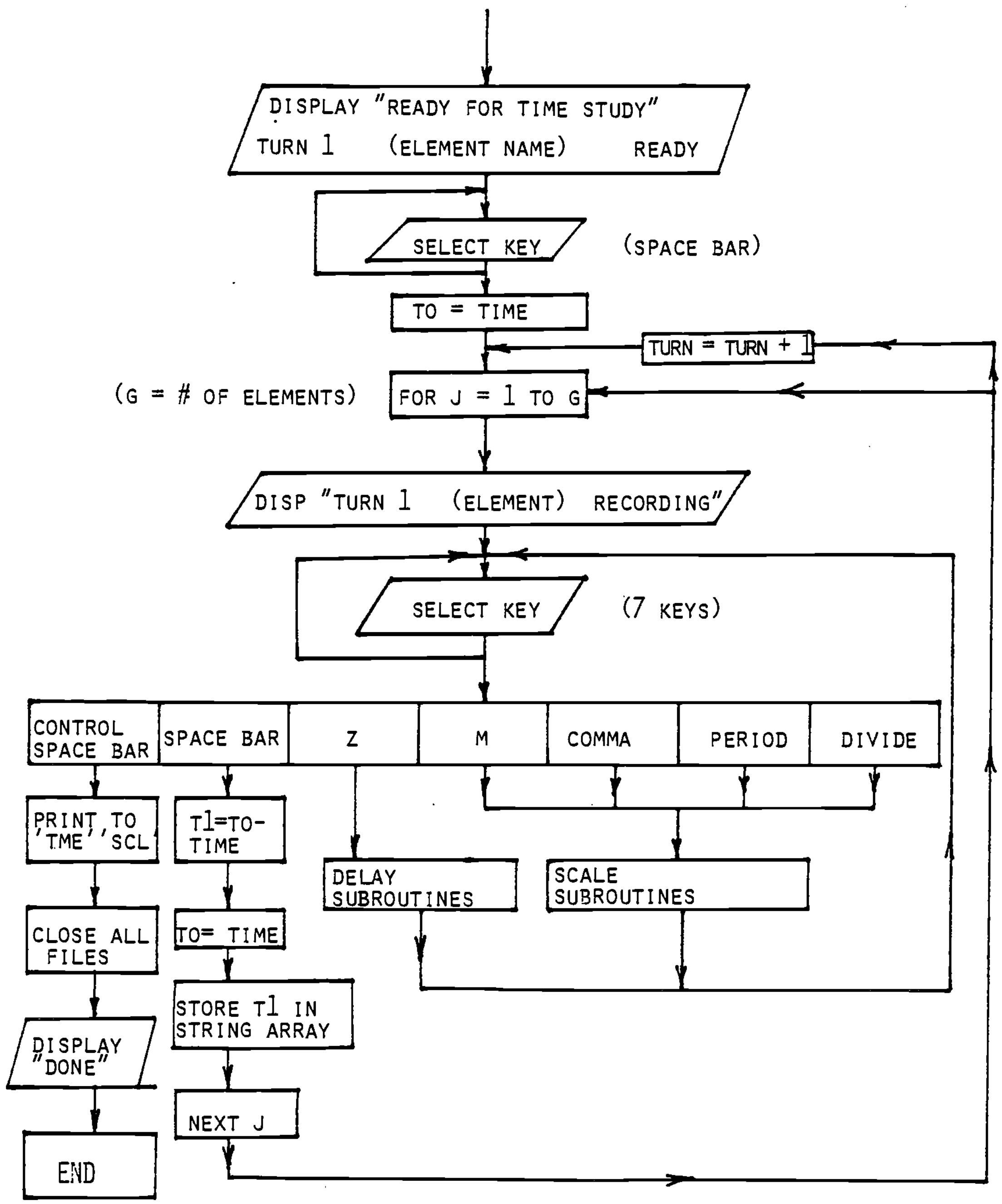
FLOW CHART OF PROGRAM "ELEMENT"

ELEMENT FORMAT SETUP

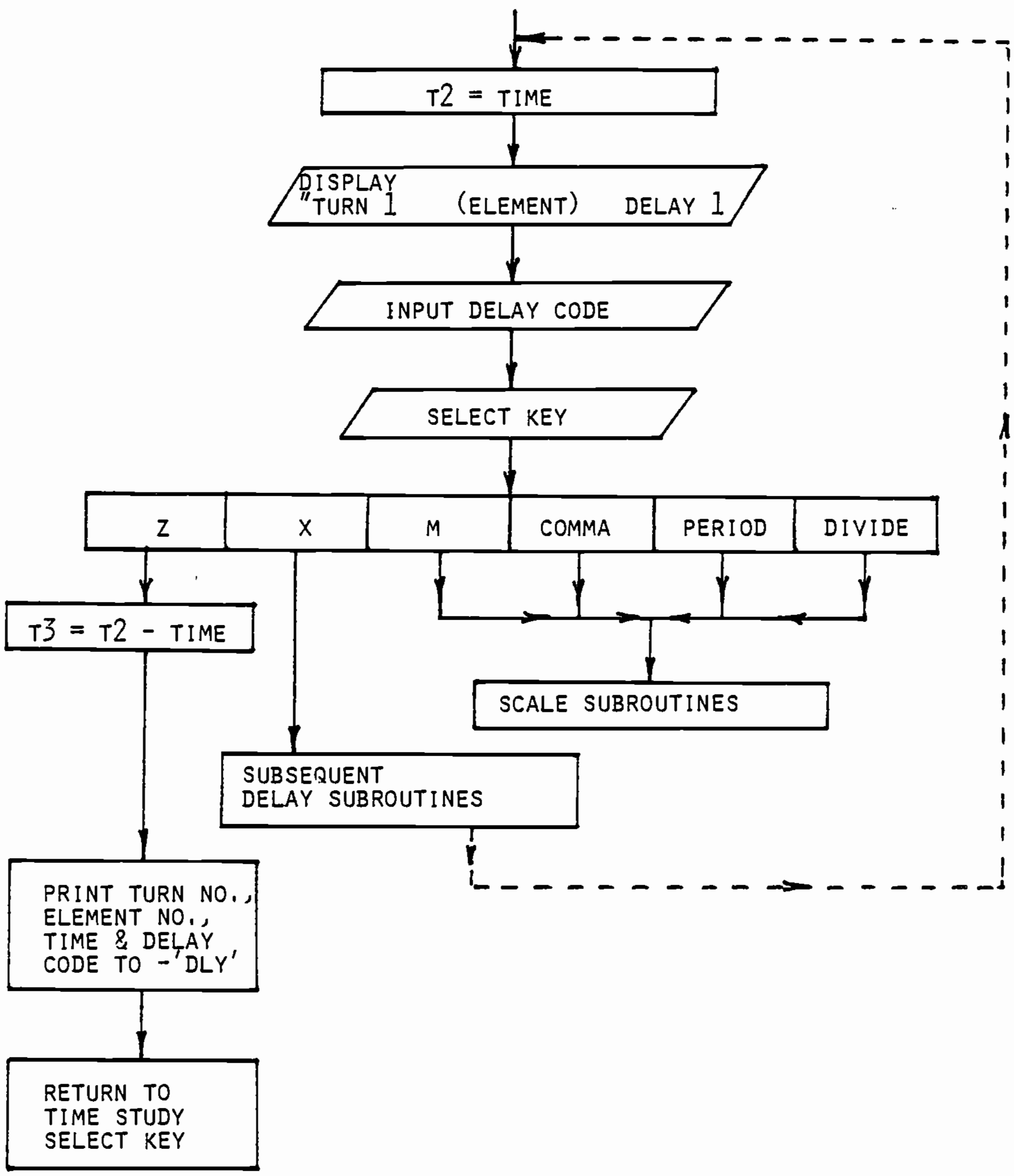



DELAY FORMAT SETUP
OPEN DELAY FILE - 'DLY'
DISPLAY 4 STANDARD CODES
- RESET
- RIGGING
- PERSONAL
- MECHANICAL
EXTRA CODES ?
NO
YES
ADDITIONAL CODE SUBROUTINE
1 OR 2 ?
1
2
SET FLAG
INPUT CODE 5
CORRECTION ?
NO
YES
CORRECT SUBROUTINE
FLAG ?
YES
NO
INPUT CODE 6
CORRECTION ?
NO
YES
CORRECTION SUBROUTINE
PRINT DELAY CODES TO - 'DLY' FILE
CODE REVIEW SUBROUTINE
OPEN SCALE FILE - 'SCL'

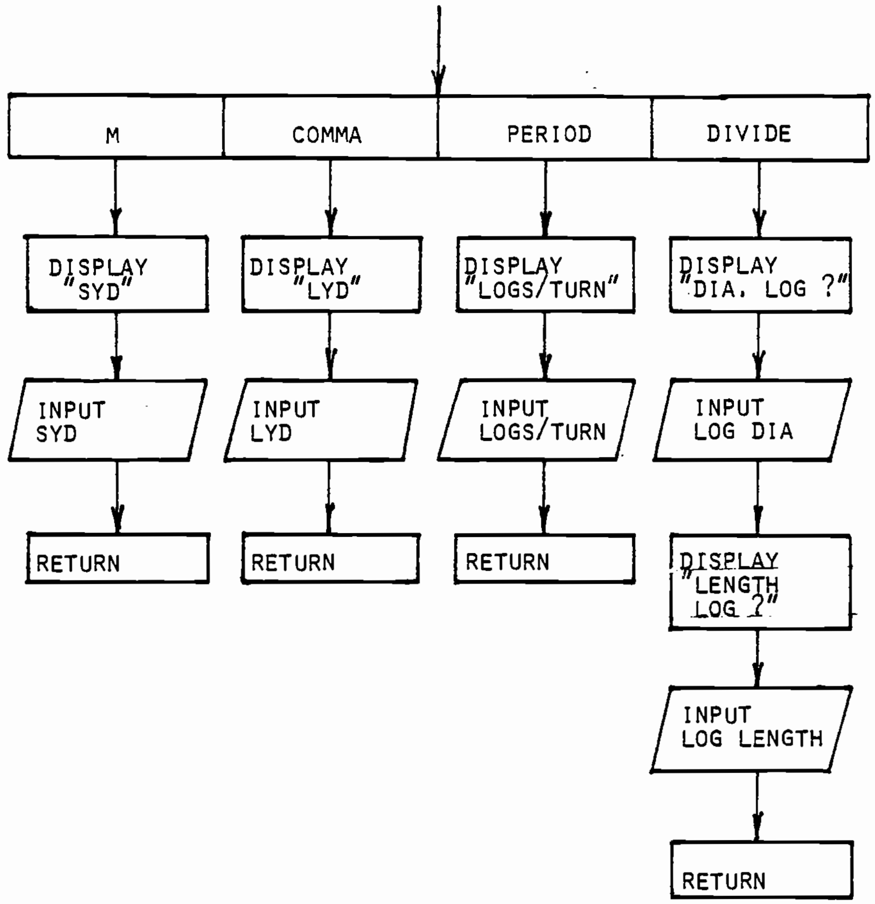
TIME STUDY LOOPS



DELAY SUBROUTINES



SCALE SUBROUTINES



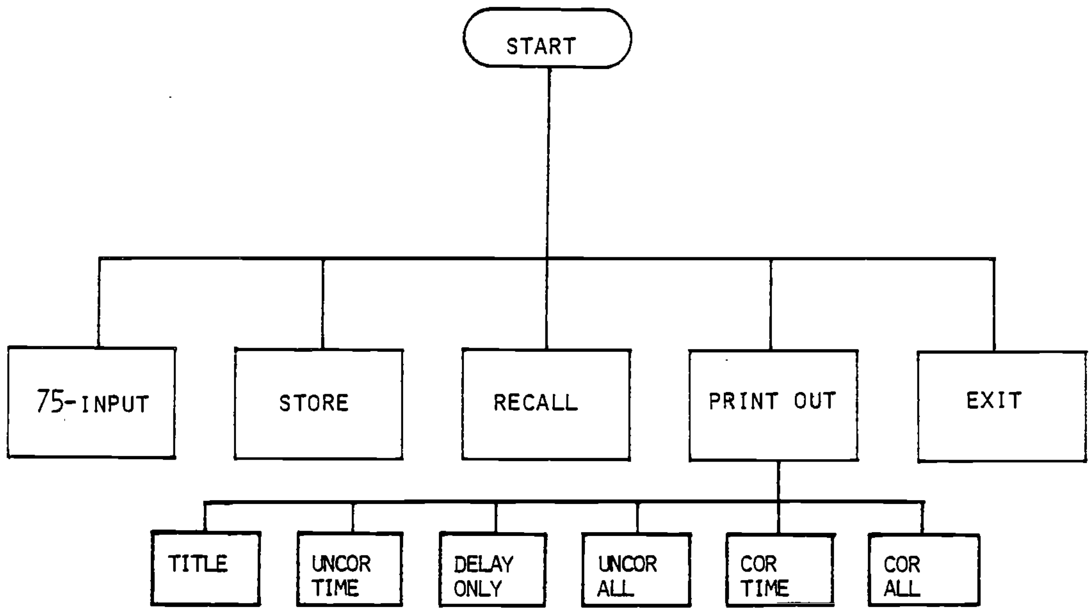


Figure 3

FLOW CHART OF PROGRAM "HP-75 TALK".

EXPERIMENTAL TESTING

The ELEMENT program was tested against the stopwatch technique for timing accuracy, number of missed element time readings and number of missed delays. Two tests were used; one using the HP-86 to generate random tones and one using a video tape of a feller buncher operation.

Twelve persons were selected to conduct the tests. Eleven had limited time study experience using stopwatches while one had conducted studies over a 3 month period. None had previously used an HP-75. Each person did both tests, however the order in which the tests were conducted was randomized. All instructions concerning conducting the tests and using the equipment were written to standardize the tests, however questions could be asked after reading the instructions. Tests were conducted for two people at a time. Electronic digital stop watches were used.

Random Tone Test

This test was conducted to compare accuracy of the two methods. The HP-86 was programmed to randomly generate a 15 minutes series of tones at intervals between 5 and 30 seconds and to record in a data file the exact times between tones. Two sequences were generated; one to test the HP-75 method, the other to test the stopwatch method. Both sequences were random with the HP-86 randomly deciding order of sequence. A visual display was provided with each tone to enforce the time sequence.

Each person timed both sequences using the HP-75 and the stopwatch. Each test contained approximately 50 time signals giving just over 600 observations total per technique. The test recorded times were then compared against the HP-86 recorded standard times. Two samples were formed from the absolute value of the difference between the standard time and the test time. These samples were then compared using a two tailed Student's "t" test of significance for grouped data to determine if there was any statistically significant difference between the accuracy of the HP-75 data versus the stopwatch data.

Video Tape Test

This test was used to compare the number of missed elements and delays. A 15 minute segment of a video tape showing a feller buncher operation was shown twice to test both the HP-75 and the stopwatch method. A video tape was chosen over a field test to control the delays and element sequence shown each person.

Each cycle consisted of four elements. Element times were fast paced with 18 cycles in the 15 minute showings. Four delays were also included. The only scaling information required was number of trees per cycle. As 12 persons were tested each method amassed 216 cycles of data containing 4 elements each. Fourty-eight delays were also recorded for each method.

TEST RESULTS

Random Tone Test for Accuracy

Preliminary data scans showed that the HP-75 method missed 20 element times while the stopwatch missed 9 times. This is very similar considering the HP-75 program automatically misses two times when the space bar is wrongly depressed whereas the stopwatch can usually recover after one missed time. Missed times were deleted from the sample.

The statistical analysis revealed the following information. The table shows the magnitude of the errors.

Table 1

Statistical Results

	HP-75	Stopwatch
$\overline{x}$ (seconds)	0.125	0.123
s	0.149	0.088

The HP-75 system had an average difference of .125 seconds between the actual internally recorded time interval (HP-86) and the interval recorded by the observer on the HP-75. The stopwatch system had .123 seconds. The null hypothesis that the accuracy of the two samples is the same ($\mu 1 = \mu 2$) was overwhelmingly upheld with a P-value of 0.78. This is not unexpected as the sample means were virtually the same. An F test showed the variances unequal. However, correcting for this fact still gave a t' test statistic of 0.2773 with 977 degrees of freedom. Thus the HP-75 is as accurate as the stopwatch method.

Of equal interest is the standard deviations of the two samples. Although the means are equal the HP-75 data had a much larger standard deviation. Checking the original data showed that the HP-75 usually had much smaller absolute value deviations from the standard than the stopwatch except for a substantial scattering of much larger numbers. Talking with the people who did the tests revealed that using the HP-75 was much easier than the stopwatch to the point that people became somewhat inattentive. They would thus have slower reflexes listening to the random tones as their attention wandered. This was not a problem with the stopwatch as people had to remain attentive just to record the data.

A more challenging or intensive test that would have better held the participant's interest may have yielded different results.

<u>Video Tape Test for Missing Data</u>

Table 2 shows the results of this test.

The HP-75 did substantially better recording delays than the stopwatch. 89.6% were correctly recorded with 2 completely missed compared to the stopwatch which recorded 50% accurately with 6 complete misses. Element records show the same trend. The HP-75 missed none of the 864 readings, perhaps indicating that inattention was not a problem during the more realistic video test. Stopwatch data had

30 missed readings. The fast paced element times of this particular study probably caused the reduced stopwatch method accuracy. More typical time studies should yield stopwatch accuracies closer to 90%.

Table 2

Missing Data

		HP-75			Stopwatch		
Test Item	Total No.	Recorded Correctly Number	Recorded Correctly Percent	Completely Missed	Recorded Correctly Number	Recorded Correctly Percent	Com-plete-ly Missed
Delays	48	43	89.6	2	24	50.0	6
Ele-ments	864	864	100	0	834	96.5	30
Scale Data	216	203	94.0	13	212	98.2	4

In contrast, scaling data is less accurate for the HP-75. Talking with the persons who did the tests revealed that they sometimes forgot to record this data. There was no blank data sheet column to prompt for input.

Qualitative Comments

All 12 test participants recommended the HP-75 system over the stopwatch. Most found the HP-75 easy to learn how to use and easy to use. The test pace was less hectic. Towards the end of the testing all could press the appropriate keys without constantly watching the keyboard, thus giving more time to watch the fast paced activity. However, fast, formatted data printouts without tedious data transcriptions was the most often cited HP-75 benefit.

In comparison, the digital stopwatch required visual attention to read and record data. This lead to missed elements and delays as attention was drawn away from the feller buncher. One person found himself transposing numbers when recording. Data transcription required at least 20 minutes for each 15 minute test just to change elapsed time into individual element times. Removing delays would have taken longer.

FUTURE PROGRAM MODIFICATIONS

The program can conceivably run on any portable BASIC language calcutor on which functions can be assigned to keys. However, program syntax must be modified as required. The same restrictions apply to the desk top computer.

Thought was given to interfacing the HP-75 with the HP-9000, a larger capacity faster desk top computer, in order to increase analysis speed. However, the HP-9000 does not have HP-IL capability and would require a different, expensive interface module.

Although the present system gives organized data printouts in either recorded time or delay free production time it does not do statistical analysis such as mean time by element. This can be accomplished by additional data manipulation subroutines within the printout portion of HP-75 TALK. A matrix ROM may speed these calculations, however, summation FOR-NEXT loops would do the same task. The location of these improvements is commented within the HP-75 TALK program.

BIBLIOGRAPHY

Haarlaa, Rihko. Productivity Measurement in Logging Operations Recommendations Based On International Practice. Harvesting Research Group. Division of Forest Research. CSIRO. PO Box 4008, Camberra A.C.T. 2600 Australia. 1981. p. 29.

Nickerson, Devon. Quickie Time Study. Logging System. Region 6. U.S. Forest Service. Portland, Oregon. 1979. p. 7.

de Souya, A. P., Cottell, P. L., Lawrence, P. D. Electronic Data Logger for Ergonomic Studies in Mechanized Logging Op erations. FAO/ECE/ILO International Service on "Occupational Safety and Health and Applied Ergonomics on Highly Mechanized Logging Operations", Seoptember 21-25, 1981. Ottawa, Canada. p. 11.

APPENDICES

APPENDIX A

Instructions for Running Time Study Program

ELEMENT

on the HP-75

Instructions for Running Time Study Program ELEMENT on the HP-75

Introduction

These instructions will help the first time user of the HP-75 to use the ELEMENT program to conduct a time study. It is assumed that the user has some familiarity with hand held calculators or computers and has access to the HP-75 Owner's Manual. While the program is user friendly and prompts for necessary input it may be necessary to consult the HP-75 Owner's Manual to set the clock and similar special procedures.

Turning on the HP-75

The HP-75 is turned on by pressing the [ATTN] (attention) key in the upper left hand corner of the keyboard. The BASIC language prompt symbol, , will appear in the display followed by the cursor.

There are three operating modes in the HP-75; time ([TIME]), appointment ([APPT]) and edit ([EDIT]). Keys to call these modes are found next to the [ATTN] key. The computer is always in EDIT mode when first turned on.

EDIT is the main operations mode. All programming, arithemetic operations and program runs are done in this mode. APPT (appointment) mode allows the user to schedule appointments for future recall. This mode is not used in this program application. TIME mode allows the user to view HP-75 date and time display, set the clock as necessary and adjust clock speed.

Once the computer clock has been set and adjusted it should not be necessary to make corrections unless the battery pack has been completely discharged or removed. When the HP-75 is first turned on key the TIME mode to check the display. If the display is accurate key EDIT to return to EDIT mode. If corrections are necessary refer to the HP-75 Owner's Manual for reset and adjustment instructions. The clock must be properly adjusted before proceeding with the time study.

Loading the Program

The standard HP-75 has 16 K of random access memory (RAM) which has been extended to 24 K using an Enhancement Memory Module. While the module is not necessary it greatly increases field data storage capacity as the program ELEMENT uses 8 K of memory.

To increase available memory all unnecessary programs and files should be purged from the computer. After making copies of desired information use the PURGE command to erase files one by one. The CATALL command will display files currently in memory. Refer to the HP-75 Owner's Manual to use these commands.

Time study program ELEMENT can be loaded into the HP-75 using the keyboard or the card reader. The owner's manual again references these procedures. Once loaded keying RUN will begin execution.

Program Overview

The program has four separate parts which follow in succession.

They are:

Part 1: Input operations data

Part 2: Set up study elements

Part 3: Set up delay codes

Part 4: Record time study data

Part 1 allows the user to store operations data. Ten categories such as date, time, equipment model and weather can be stored to document each study. Parts 2 and 3 allow the user to customize the program to fit each particular time study. Both the number of time study elements and delay categories can be selected and appropriate names assigned. Part 4 records time by element and delay as well as scaling data.

Collected data is stored in four computer files; one for equipment, one for element time, one for scale, and one for delays.

Edit Commands

Input can be corrected using the following top row keys.

[←] - Back arrow, backspaces the cursor one character at a time, holding the key down gives continuous motion, characters are not erased.

[→] - Forward arrow, same as the back arrow only in the opposite direction.

[I/R] - Insert/Replace Key, activates the insert cursor to make a space and insert characters between existing characters.

[DEL] - Delete key, deletes a character and closes the space, holding the key down gives continuous motion to the right.

[SHIFT] [DEL] - deletes all characters under and to the right of the cursor.

[BACK] - Back key, backspaces the cursor erasing characters one at a time.

Any of these keys can be used to correct input in the display. Use [RTN] (return) to return control to the program.

File Name

Program execution begins by keying [RUN] . The program label will be displayed while the HP-75 initializes the program. Once initialized the program will prompt for a file name under which to store data. Key in any name using five characters maximum. A good idea is to use the name of the machine being studied such as 'TMY45' for a Thunderbird model 45 yarder. Four files are created by the program. The first is labeled by the five character input name and records operations data. A second file is labeled by adding the suffix 'TME' to the original name. This file records element times. A third file, labeled by adding 'SCL' to the original name, records scaling data. A fourth file, using a 'DLY' suffix, records delays.

Operations Data Section

The first program section records operations data for ten different categories. Date and time, the first two categories, are automatically entered by the HP-75. The user must key in data for the next eight, 20 characters maximum per category. Do not use commas! They will not be accepted by the program and will produce an error message that must be corrected before proceeding. Key [RTN] when finished to advance to the next category.

The eight categories are:

Equipment	Observers
Layout	Crew Size
Landing	Slope
Corridor	Weather

The program will review all entries once input is completed and then prompt for any corrections. Program prompts will guide the user through any corrections. Answer all prompts by typing from the keyboard.

Note: As the HP-75 is battery powered it will turn itself off after five minutes of idleness to conserve power. Keying [ATTN] will return power but the program will have to be executed again from the beginning.

Study Elements and Delays Section

Program ELEMENT will accept from 1 to 9 time study elements. An element is a portion of the machine cycle that is being isolated for study.

Example: One cycle of a skyline yarding operation could consist of six elements. These elements in order are:

Outhaul

Lateral Outhaul

Hook

Lateral Inhaul

Inhaul

Unhook

When prompted, key in the number of desired elements and [RTN]. The display will respond by prompting for the names of each requested element. Key in each name, 7 characters maximum per name, and [RTN].

Example: One way to key in the above elements would be:

OUTHAUL

LAT-OUT

HOOK

LAT-IN

INHAUL

UNHOOK

As with the operations data section once all names have been entered they are reviewed and opportunity given for corrections. Follow program prompts to use correction options.

Six delay categories are available. The first four are coded 1 through 4 and are already assigned. They are:

1 - Reset	3 - Personal
2 - Rigging	4 - Mechanical

Two additional categories, coded 5 and 6, can be assigned from the keyboard. After reviewing the first four categories the program offers this option. Follow the display prompts to input one or two additional categories or make corrections. Codes are activated using keys 1-6.

Note: An error code is assigned to the zero key. Use this code to designate timing errors. If a non-recoverable keying mistake is made key the 'ERROR' delay code to mark the inaccurate element.

Time Study Section

The HP-75 is now ready to record the time study. Keying SPACE BAR begins the stop watch. Turn number, element name, and the word RECORDING are displayed. Elapsed time is not shown. It is recorded internally and automatically.

Keying SPACE BAR again stops time on the element being recorded, calculates and records the time for that elements by subtracting start time from stop time, and begins timing the next element. The display will show the next element name. Once all elements in the cycle have been timed, turn number is increased by 1 and the elements repeat. Each keying of the space bar advances timing to the next element.

Delays can be entered by keying [Z] found on the left bottom row. Element time continues as delay time begins. The display will change from RECORDING to DELAY and flash a prompt for delay code. Key the proper code 1-6.

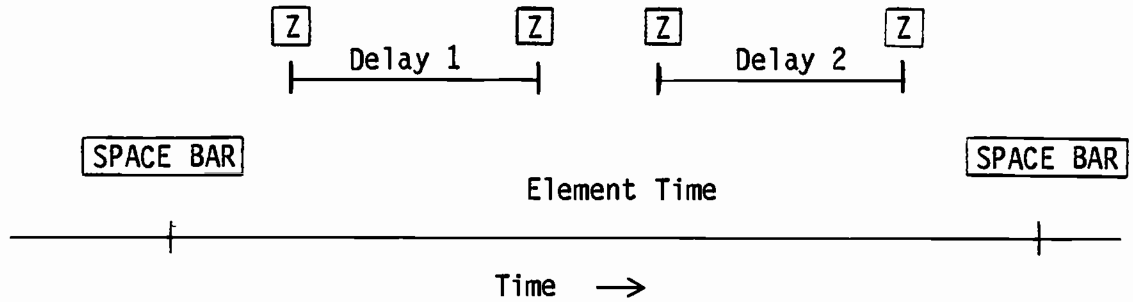
Keying [Z] again will stop delay time, calculate and record time for that delay by subtracting start time from stop time and return control to the element originally being timed. The user can repeatedly enter and exit the delay subroutine as often as necessary. If a delay happens at the end of an element key [Z] to finish the delay and then key [SPACE BAR] to quickly change elements.

Sometimes delays in time studies will run in sequence. For example, during a RESET delay on a yarder a choker is broken changing the delay to a RIGGING delay. Keying [X] will terminate and record time for the RESET delay and begin to keep time for the new delay. The HP-75 will prompt for the new delay code. When the choker problem is corrected and a reset delay again beings keying [X] again allows the user to switch and record this subsequent delay.

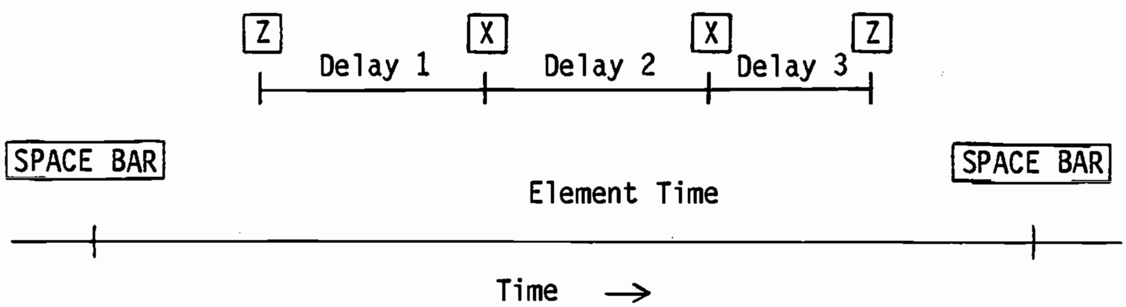
Subsequent delays can be recorded as often as necessary using [X]. The HP-75 must already be in the delay subroutine to usethis feature. To return to element time from [X] key [Z].

[SPACE BAR] ,[Z] and [X] are inactive while the HP-75 prompts for delay codes. Enter the proper code quickly to avoid error. The automatic turn off feature is not operative during long delays or element timings.

Example: Individual Delays



Example: Subsequent Delays



Four keys in the lower right row; [M], [,] , [.] and [/] , control the scaling data subroutines. These keys can be used to access the scaling subroutines at any time; either from normal element, delay or subsequent delay timings. Time functions will continue without interruption. Once scaling data is entered and RTN keyed program control is returned to the point where the scaling subroutine was activated.

Keying each of the four keys will cause the HP-75 to prompt for the following information.

[M] - Slope yarding distance?

[,] - Lateral yarding distance?

[.] - Logs per turn?

[/] - Diameter Log 1-6?
Length Log 1-6?

Input the requested information and [RTN]. All four keys need not be used in any particular time study and can be accessed in any order. If a mistake is made during data entry by [RTN] then recall that function and reenter data.

When [/] is first keyed it will prompt for the diameter than length of log 1. Subsequent keyings will prompt for logs 2 through 6 maximum. All six entries need not be used. Keying [/] after the sixth log will return the sequence to log 1 and write over previously entered data.

Although timing functions continue while scaling data is being entered [SPACE BAR], [Z] and [X] are inactive. Only call the scaling subroutines when there is high probability that these keys will not be used. Enter scaling data and quickly return to element or delay timing mode.

Concluding The Time Study

To stop the time study key [CTL] [SPACE BAR] simultaneously. This makes a final time entry, closes all files and flahses 'DONE' on the display. All recorded data is now found in one of the four previously named files. Clearing the display and executing CATALL will show that these files exist. Use [↓] to view all files. Time Study

Program ELEMENT can be executed again and again using different file names as long as these is enough memory.

Turning Off The HP-75

Key [SHIFT] [ATTN] simultaneously to turn off the HP-75. Memory is not lost when the HP-75 is turned off. All files are retained.

APPENDIX B

Program Listings for

HP-75 Program	TRANSMIT
HP-86 Program	HP-75 TALK

HP-75 Time Study Program ELEMENT

HP-75 Program TRANSMIT

```
10 ! Program 'TRANSMIT'
20 ! HP-75 Program to transmit 'ELEMENT' files to HP-86
30 DELAY 1.5
40 DIM A1$[180],A3$[63],A4$[60],D$[5],E$[24],G$[3],S$[60],
   T$[60],T1$[3]
50 A1$,A3$,A4$,D$,E$,G$,S$,T$,T1$=' '
60 INTEGER I
70 ASSIGN IO ':H6'
80 DISP 'This program transmits ELEMENT'
90 DISP 'files to the HP-86.'
100 INPUT 'Enter data file name:  ';D$
110 ASSIGN # 1 TO D$
120 DISP 'General data being transmitted.'
130 SENDIO ':H6','LAD#',D$&CHR$(10)
140 READ # 1 ; A1$[1,80]
150 READ # 1 ; A1$[81,160]
160 READ # 1 ; A1$[161,180]
170 SENDIO ':H6','LAD#',A1$&CHR$(10)
180 ASSIGN # 1 TO *
190 ASSIGN # 2 TO D$&'TME'
200 DISP 'Time data being transmitted.'
210 READ # 2 ; G$
220 READ # 2 ; A3$
230 READ # 2 ; T1$
240 SENDIO ':H6','LAD#',G$&CHR$(10)
250 SENDIO ':H6','LAD#',A3$&CHR$(10)
260 SENDIO ':H6','LAD#',T1$&CHR$(10)
270 FOR I=1 TO VAL(T1$)
280 READ # 2 ; T$
290 SENDIO ':H6','LAD#',T$&CHR$(10)
300 T$=' '
310 NEXT I
320 ASSIGN # 2 TO *
330 ASSIGN # 3 TO D$&'DLY'
340 DISP 'Delay data being transmitted.'
350 READ # 3 ; A4$
360 SENDIO ':H6','LAD#',A4$&CHR$(10)
370 ON ERROR GOTO 420
380 READ # 3 ; E$
390 SENDIO ':H6','LAD#',E$&CHR$(10)
400 E$=' '
410 GOTO 380
420 OFF ERROR
430 SENDIO ':H6','LAD#','END'&CHR$(10)
440 ASSIGN # 3 TO *
450 ASSIGN # 4 TO D$&'SCL'
460 DISP 'Scale data being transmitted.'
```

```
470 FOR I=1 TO VAL(T1$)
480 READ # 4 ; S$
490 SENDIO ':H6','LAD#',S$&CHR$(10)
500 S$=' '
510 NEXT I
520 ASSIGN # 4 TO *
530 DISP 'Data Transmission Completed'
540 END
```

HP-86 Program HP-75 TALK

```
10 !
20 !
30 ! PROGRAM HP-75 TALK REVISED EDITION   LISTED AS TRIAL_OUT
11 !        -  THIS VERSION CAN COMPUTE DELAY FREE TIME
40 !        -  TO MODIFY FOR STATISTICAL ANALYSIS INSERT SUMMATION SUBROUTINES
50 !           BETWEEN LINES 4990 AND 5000.  THIS WILL DO COMPUTATIONS FOR
60 !           DELAY FREE TIMES ONLY.
70 !
80 !
90 CLEAR @ CFLAG 5
100 PAGESIZE 24
110 OPTION BASE 1
120 SHORT E(200,4)
130 DIM D$[5],A1$[180],A3$[63],A4$[60],E$[24],S$[60],T$[60],TYPE$[10],ELEM$[7]
140 DIM B1$[132],B2$[132],B3$[132],B4$[132],B5$[132],B6$[132],B7$[132],B8$[132],
B9$[132],B0$[132]
150 DIM PART_TURN$[70],PART_SCALE$[100]
160  MAIN_MENU: ! **************************************************
170  CLEAR @ CFLAG 1 @ CFLAG 2 @ CFLAG 3 @ CFLAG 4
180  OFF KEY#
190 !
200 !
210 !  THE MAIN MENU FUNCTIONS ARE AS FOLLOWS:
220 !
230 !    KEY# 5 (75 INPUT)     -  THIS SUBROUTINE RECEIVES DATA BEING
240 !                            TRANSMITTED FROM THE HP-75 AND STORES IT
250 !                            WITHIN PROGRAM VARIABLES
260 !    KEY# 1 (STORE)        -  THIS SUBROUTINE STORES THE PROGRAM VARIABLES
270 !                            RECEIVED FROM THE HP-75 ONTO DISC DATA FILES
280 !                            FOR FUTURE RECALL
290 !    KEY# 2 (RECALL_DATA)  -  THIS SUBROUTINE RECALLS STORED FILES FOR
300 !                            PRINT OUT
310 !    KEY# 3 (PRINT_OUT)    -  THIS SUBROUTINE PRINTS OUT TIME STUDY DATA IN
320 !                            TABULAR FORM
330 !    KEY# 7 (EXIT)         -  THIS SUBROUTINE ENDS THE PROGRAM
340 !
350 !
360  DISP USING "10/,K" ; "USE THE APPROPRIATE SPECIAL FUNCTION KEY TO MAKE YOUR
 SELECTION"
370  ON KEY# 1," STORE" GOTO STORE_DATA
380  ON KEY# 2," RECALL" GOTO RECALL_DATA
390  ON KEY# 3,"PRINT OUT" GOTO PRINT_OUT
400  ON KEY# 5,"75 INPUT" GOTO INPUT_DATA
410  ON KEY# 7,"  EXIT" GOTO EXIT
420  KEY LABEL
430  GOTO 430
440 !
450 !
460 INPUT_DATA: ! ************************************************************
320 KEY LABEL
470 CLEAR
480 DISP USING "4/,K" ; "READY TO RECEIVE DATA..."
490 !
500 ! READ IN DATA
510 !
520 ! GENERAL FILE:
530 !
540 !          D$             - NAME OF FILE
550 !          A1$            _ GENERAL INFORMATION
560 !          A1$[1,8]       - DATE
570 !          A1$[11,18]     _ TIME
```

```
580 !            A1$[21,40]     _ EQUIPMENT
590 !            A1$[41,60]     - LAYOUT
600 !            A1$[61,80]     - LANDING
610 !            A1$[81,100]    - CORRIDOR
620 !            A1$[101,120]   - OBSERVERS
630 !            A1$[121,140]   - CREW SIZE
640 !            A1$[141,160]   _ SLOPE
650 !            A1$[161,180]   - WEATHER
660 !
670 ENTER 9 ; D$,A1$
680 DISP USING "2/,K" ; "     GENERAL FILE BEING RECEIVED..."
690 !
700 ! TIME STUDY DATA FILE:
710 !
720 !             G$            - NUMBER OF ELEMENTS (CYCLE ELEMENTS)
730 !            A3$            - STRING WHICH CONTAINS THE ELEMENT NAMES (7 CHAR'S
                                  PER NAME)
740 !            T1$            - NUMBER OF OBSERVATIONS (ie ROWS)
750 !             T$            - ACTUAL TIME STUDY DATA (ROW BY ROW)
760 !
770 ENTER 9 ; G$,A3$,T1$
780 DISP USING "2/,K" ; "     TIME FILE BEING RECEIVED..."
790 !
800 !                             THIS PART DIMENSIONS THE TIME STUDY ARRAY
810 !                             DEPENDENT UPON INCOMING DATA
820 !
830 G=VAL (G$)
840 ON G GOSUB 860,880,900,920,940,960,980,1000,1020
850 IF FLAG (1) THEN RETURN ELSE GOTO 1040
860 SHORT D(300,17)
870 RETURN
880 SHORT D(300,18)
890 RETURN
900 SHORT D(300,19)
910 RETURN
920 SHORT D(300,20)
930 RETURN
940 SHORT D(300,21)
950 RETURN
960 SHORT D(300,22)
970 RETURN
980 SHORT D(300,23)
990 RETURN
1000 SHORT D(300,24)
1010 RETURN
1020 SHORT D(300,25)
1030 RETURN
1040 FOR I=1 TO VAL (T1$)-1
1050    ENTER 9 ; T$
1060    FOR C=1 TO G+1
1070       D(I,C)=VAL (T$[C*6-5,C*6])
1080    NEXT C
1090 NEXT I
1100 !
1110 !          THE NEXT ENTER STATEMENT STORES ANY PARTIAL TURN DATA LEFT
1120 !          AT THE END OF THE DATA FILE.  IT IS NOT USED IN ANY
1130 !          COMPUTATIONS.
1140 !
1150 ENTER 9 ; PART_TURN$
1160 !
1170 !
1180 ! DELAY TIME FILE:             FILE NAME = D$&"DLY"
```

```
1190 !
1200 !           A4$           - STRING WHICH CONTAINS THE 4-6 DELAY CODE NAMES
1210 !                           (ie A4$[1,10]=DELAY CODE #1)
1220 !           E$            - ARRAY WHICH CONTAINS THE DELAY INFORMATION
1230 !               E$[1,6]  - TURN #
1240 !               E$[7,12] - ELEMENT #
1250 !               E$[13,18]- DELAY TIME
1260 !               E$[19,24]- DELAY CODE (1-6)
1270 !
1280 ENTER 9 ; A4$
1290 DISP USING "2/,K" ; "     DELAY FILE BEING RECEIVED..."
1300 I=0
1310 I=I+1
1320 ENTER 9 ; E$
1330 IF E$="END" THEN 1380
1340 FOR C=1 TO 4
1350    E(I,C)=VAL (E$[C*6-5,C*6])
1360 NEXT C
1370 GOTO 1310
1380 IDELAY=I
1390 !        S$  - 15 COLUMNS OF 4 SPACES, CONTAINS THE ADDITIONAL INFORMATION
1400 !              FOR EACH TURN (ie SLOPE,DIST,ETC)
1410 DISP USING "2/,K" ; "     SCALING FILE BEING RECEIVED..."
1420 FOR I=1 TO VAL (T1$)-1
1430    ENTER 9 ; S$
1440    FOR C=1 TO 15
1450    ON ERROR GOTO 1490
1460       D(I,C+G+1)=VAL (S$[C*4-3,C*4])
1470    NEXT C
1480  NEXT I
1490 OFF ERROR
1500 !
1510 !           THE NEXT ENTER STATEMENT STORES ANY PARTIAL SCALE DATA LEFT
1520 !           AT THE END OF THE SCALE FILE.  IT IS NOT USED IN ANY
1530 !           COMPUTATIONS.
1540 !
1550 ENTER 9 ; PART_SCALE$
1560 !
1570 DISP USING "2/,K" ; "DATA RECEIVED !    YOU CAN TURN OFF THE HP-75." @ WAIT
 3000
1580 GOTO MAIN_MENU
1590 !
1600 !
1610 STORE_DATA: ! ************************************************************
1620 CLEAR
1630 DISP USING "5/,K" ; "ENTER :msus OF YOUR STORAGE DISC" @ INPUT Drive$
1640 DISP
1650 DISP USING "2/,K" ; "LOAD YOUR DISC IN THE DRIVE YOU SPECIFIED"
1660 DISP
1670 DISP "PRESS THE [CONT] KEY TO CONTINUE"
1680 PAUSE
1690 DISP USING "2/,K" ; "ENTER FILE NAME OF STORAGE FILE"
1700 DISP
1710 DISP "USE THE SAME NAME AS THE HP-75 FILE TRANSMITTED"
1720 DISP
1730 DISP "THIS WILL SIMPLIFY RECORDS AND AVOID CONFUSION" @ INPUT F$
1740 CREATE F$,1,200
1750 CREATE F$&"TME",VAL (T1$),8*(G+16)
1760 CREATE F$&"DLY",IDELAY+2,32 ! 8*4
1770 ASSIGN# 1 TO  F$
1780 ASSIGN# 2 TO  F$&"TME"
1790 ASSIGN# 3 TO  F$&"DLY"
```

```
1800 PRINT# 1 ; D$
1810 PRINT# 1 ; A1$
1820 ON ERROR GOTO 1850
1830 PRINT# 2 ; G$,A3$,T1$
1840 PRINT# 2 ; D()
1850 OFF ERROR
1860 ON ERROR GOTO 1890
1870 PRINT# 3 ; A4$,IDELAY
1880 PRINT# 3 ; E()
1890 OFF ERROR
1900 ASSIGN# 1 TO  * @ ASSIGN# 2 TO  * @ ASSIGN# 3 TO  *
1910 GOTO MAIN_MENU
1920 !
1930 !
1940 PRINT_OUT: ! ************************************************************
1950 K=0 @ CFLAG 2 @ CFLAG 3
1960 CLEAR
1970 OFF KEY#
1980 IF FLAG (5) THEN GOTO 2050
1990 DISP USING "2/,K" ; "TURN ON PRINTER"
2000 DISP
2010 DISP "ENTER PRINTER ADDRESS"
2020 INPUT PRTADD
2030 PRINTER IS PRTADD,132
2040 SFLAG 5
2050 CLEAR
2060 DISP
2070 DISP "USE THE APPROPRIATE SPECIAL FUNCTION KEY TO MAKE YOUR PRINT SELECTION
"
2080 DISP
2090 DISP
2100 DISP "    NOTE:"
2110 DISP "          'TITLE'       : Prints out the general time study information
"
2120 DISP "          'UNCOR TIME' : Prints out element times that are uncorrected
 for delay"
2130 DISP "          'DELAY ONLY' : Prints out delays only"
2140 DISP "          'UNCOR ALL'  : Prints out full data table using times uncorr
ected"
2150 DISP "                          for delays"
2160 DISP "          'COR TIME'   : Prints out element times that are corrected f
or delay"
2170 DISP "          'COR ALL'    : Prints out full data table using times correc
ted"
2180 DISP "                          for delay"
2190 DISP
2200 DISP
2210 OFF KEY#
2220 ON KEY# 1,"TITLE" GOTO PRINT_TITLE
2230 ON KEY# 2,"UNCOR TIME" GOTO PRINT_TIME
2240 ON KEY# 3,"DELAY ONLY" GOTO PRINT_DELAY
2250 ON KEY# 4,"UNCOR ALL" GOTO PRINT_ALL
2260 ON KEY# 6,"COR TIME" GOTO PURE_TIME
2270 ON KEY# 7,"COR ALL" GOTO PURE_ALL
2280 KEY LABEL
2290 GOTO 2290
2300 !
2310 !
2320 PRINT_TITLE: ! ***********************************************************
2330 GOSUB 3260 ! Prints title information
2340 GOTO MAIN_MENU
2350 !
```

```
2360 !
2370 PRINT_TIME: ! **********************************************************
2380 PRINT "UNCORRECTED TIME STUDY DATA FOR:  ";D$
2390 PRINT
2400 PRINT "NOTE: DELAYS ARE STILL INCLUDED WITHIN ELEMENT TIMES."
2410 PRINT "       TIMES SHOWN ARE NOT DELAY FREE."
2420 GOSUB 3460 ! Prints time table headings
2430 GOSUB 4010 ! Prints uncorrected times
2440 GOTO MAIN_MENU
2450 !
2460 !
2470 PRINT_DELAY: ! ********************************************************
2480 K=0
2490 PRINT "DELAY DATA FOR:  ";D$
2500 PRINT
2510 PRINT CHR$ (27)&"&k2S"
2520 SET I/O 7,16,0
2530 R=VAL (T1$)-1
2540 GOSUB 4340 ! Prints delay times
2550 SET I/O 7,16,2
2560 PRINT CHR$ (27)&"&k0S"
2570 GOTO MAIN_MENU
2580 !
2590 !
2600 PRINT_ALL: ! *********************************************************
2610 SFLAG 3
2620 GOSUB 3260 ! Prints title information
2630 PRINT
2640 PRINT "UNCORRECTED TIME STUDY DATA FOR:  ";D$
2650 PRINT
2660 PRINT "NOTE: DELAYS ARE STILL INCLUDED WITHIN ELEMENT TIMES."
2670 PRINT "       TIMES SHOWN ARE NOT DELAY FREE."
2680 GOSUB 3460 ! Prints time table headings
2690 GOSUB 4010 ! Prints uncorrected times & delays using flag 3
2700 CFLAG 3
2710 GOTO MAIN_MENU
2720 !
2730 !
2740 PURE_TIME: ! *********************************************************
2750 PRINT "CORRECTED TIME STUDY DATA FOR:  ";D$
2760 PRINT
2770 PRINT "NOTE: DELAYS HAVE BEEN SUBTRACTED FROM ELEMENT TIMES."
2780 PRINT "       TIMES SHOWN ARE DELAY FREE."
2790 SFLAG 4
2800 GOSUB 3460 ! Prints time table headings
2810 GOSUB 4010 ! Prints corrected times using flag 4
2820 CFLAG 4
2830 GOTO MAIN_MENU
2840 !
2850 !
2860 PURE_ALL: ! **********************************************************
2870 SFLAG 3 @ SFLAG 4
2880 GOSUB 3260 ! Prints title information
2890 PRINT
2900 PRINT "CORRECTED TIME STUDY DATA FOR:  ";D$
2910 PRINT
2920 PRINT "NOTE: DELAYS HAVE BEEN SUBTRACTED FROM ELEMENT TIMES."
2930 PRINT "       TIMES SHOWN ARE DELAY FREE TIMES."
2940 GOSUB 3460 ! Prints time table headings
2950 GOSUB 4010 ! Prints corrected times & delays using flags 3 & 4
2960 CFLAG 3 @ CFLAG 4
2970 GOTO MAIN_MENU
```

```
2980 !
2990 !
3000 RECALL_DATA: ! **************************************************
3010 CLEAR
3020 DISP USING "2/K" ; "ENTER THE NAME OF THE FILE YOU WISH TO RECALL."
3030 INPUT H$
3040 ASSIGN# 1 TO  H$
3050 ASSIGN# 2 TO  H$&"TME"
3060 ASSIGN# 3 TO  H$&"DLY"
3070 READ# 1 ; D$
3080 READ# 1 ; A1$
3090 READ# 2 ; G$,A3$,T1$
3100 SFLAG 1
3110 GOSUB 830
3120 ON ERROR GOTO 3140
3130    READ# 2 ; D()
3140 OFF ERROR
3150 READ# 3 ; A4$,IDELAY
3160 ON ERROR GOTO 3180
3170    READ# 3 ; E()
3180 OFF ERROR
3190 ASSIGN# 1 TO  * @ ASSIGN# 2 TO  * @ ASSIGN# 3 TO  *
3200 DISP USING "2/,K,K,K" ; "FILE ",D$," RECALLED FROM STORAGE." @ WAIT 3000
3210 GOTO MAIN_MENU
3220 EXIT: ! ************************************************************
3230 CLEAR
3240 DISP USING "5/,K" ; "                   *******     PROGRAM COMPLETED     *
******"
3250 END
3260 !
3270 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
3280 !
3290 !       THIS SUBROUTINE PRINTS OUT THE GENERAL TIME STUDY INFORMATION
3300 !
3310 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - 1
0026 !
3320 PRINT "TIME STUDY:    ";D$
3330 PRINT
3340 PRINT "     DATE         ";A1$[1,8]
3350 PRINT "     TIME         ";A1$[11,18]
3360 PRINT "     EQUIPMENT    ";A1$[21,40]
3370 PRINT "     LAYOUT       ";A1$[41,60]
3380 PRINT "     LANDING      ";A1$[61,80]
3390 PRINT "     CORRIDOR     ";A1$[81,100]
3400 PRINT "     OBSERVERS    ";A1$[101,120]
3410 PRINT "     CREW SIZE    ";A1$[121,140]
3420 PRINT "     SLOPE        ";A1$[141,160]
3430 PRINT "     WEATHER      ";A1$[161,180]
3440 PRINT USING "2/"
3450 RETURN
3460 !
3470 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
3480 !
3490 !       THIS SUBROUTINE PRINTS OUT THE TABLE HEADINGS
3500 !
3510 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
3520 !
3530 PRINT CHR$ (27)&"&k2S"
3540 !
3550 !         THIS PART COMPOSES LARGE STRING ARRAYS OF COLUMN HEADINGS TO
3560 !         SIMPLIFY LABELING PRINT STATEMENTS
3570 !
```

```
3580 B1$="    "&RPT$ ("          ",G)
3590 B2$="    "&RPT$ ("          ",G)
3600 B3$="    "&RPT$ ("          ",G)
3610 B4$="    "
3620 B5$="    "
3630 B6$="    "
3640 B7$="  T"
3650 B8$="  U"
3660 B9$="  R"
3670 B0$="  N"
3680 FOR L=1 TO G
3690       B4$=B4$&"    "&A3$[L*7-6,L*7-6]&"    "
3700       B5$=B5$&"    "&A3$[L*7-5,L*7-5]&"    "
3710       B6$=B6$&"    "&A3$[L*7-4,L*7-4]&"    "
3720       B7$=B7$&"    "&A3$[L*7-3,L*7-3]&"    "
3730       B8$=B8$&"    "&A3$[L*7-2,L*7-2]&"    "
3740       B9$=B9$&"    "&A3$[L*7-1,L*7-1]&"    "
3750       B0$=B0$&"    "&A3$[L*7,L*7]&"    "
3760 NEXT L
3770 B1$=B1$&"   S   L     "&RPT$ ("          ",6)
3780 B2$=B2$&"   L   A   L         DIAMETER/LENGTH OF LOGS"
3790 B3$=B3$&"           O"
3800 B4$=B4$&"   Y   Y   G             ( 6 LOGS MAXIMUM )"
3810 B5$=B5$&"   D   D   S"
3820 B6$=B6$&"           /         DIAMETERS ARE IN INCHES"
3830 B7$=B7$&"   D   D   T"
3840 B8$=B8$&"   I   I   U             LENGTHS ARE IN FEET"
3850 B9$=B9$&"   S   S   R"
3860 B0$=B0$&"   T   T   N !  1   !  2   !  3   !  4   !  5   !  6   !"
3870 IMAGE 132A
3880 PRINT USING 3870 ; B1$
3890 PRINT USING 3870 ; B2$
3900 PRINT USING 3870 ; B3$
3910 PRINT USING 3870 ; B4$
3920 PRINT USING 3870 ; B5$
3930 PRINT USING 3870 ; B6$
3940 PRINT USING 3870 ; B7$
3950 PRINT USING 3870 ; B8$
3960 PRINT USING 3870 ; B9$
3970 PRINT USING 3870 ; B0$
3980 PRINT USING 3870 ; RPT$ ("_",132-(9-G)*7-3)
3990 PRINT CHR$ (27)&"&k0S"
4000 RETURN
4010 !
4020 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4030 !
4040 !          THIS SUBROUTINE PRINTS OUT THE ELEMENT TIMES IN A TABLE
4050 !
4060 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4070 !
4080 PRINT CHR$ (27)&"&k2S"
4090 SET I/O 7,16,0
4100 FOR R=1 TO VAL (T1$)-1
4110    FOR C=1 TO G+2 ! STOPS AT THE FIRST COLUMN OF THE 15 PARAMETERS
4120        IF C=1 THEN PRINT USING "3D" ; D(R,C) @ GOTO 4200
4130        IF C<= G+1 AND FLAG (4) THEN GOTO 4850
4140        IF C<= G+1 THEN PRINT USING "4D.2D,X" ; D(R,C) @ GOTO 4200
4150        PRINT USING "X,4D,X,3D,X,2D" ; D(R,C),D(R,C+1),D(R,C+2)
4160        PRINT USING 4170 ; D(R,C+3),D(R,C+4),D(R,C+5),D(R,C+6),D(R,C+7),D(R,
C+8)
4170        IMAGE 2X,2D,"/",2D,2X,2D,"/",2D,2X,2D,"/",2D
4180        PRINT USING 4190 ; D(R,C+9),D(R,C+10),D(R,C+11),D(R,C+12),D(R,C+13),
```

```
D(R,C+14),CHR$ (13)&CHR$ (10)
4190        IMAGE 2X,2D,"/",2D,2X,2D,"/",2D,2X,2D,"/",2D,2A
4200    NEXT C
4210    IF FLAG (3) THEN GOSUB 4260
4220 NEXT R
4230 SET I/O 7,16,2
4240 PRINT CHR$ (27)&"&kOS"
4250 RETURN
4260 !
4270 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4280 !
4290 !       THIS SUBROUTINE PRINTS OUT DELAY TIMES IN A TABLE
4300 !
4310 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4320 !
4330 IF E(K+1,1)#R THEN 4460
4340 PRINT USING "2A" ; CHR$ (13)&CHR$ (10)
4350 IF FLAG (2) THEN GOTO 4380
4360 PRINT USING "10X,6A,8X,7A,6X,10A,5X,10A,2A" ; "TURN #","ELEMENT","DELAY TIM
E","DELAY TYPE",CHR$ (13)&CHR$ (10)
4370 SFLAG 2
4380 K=K+1
4390 ON ERROR GOTO 4440
4400 GOSUB 4470
4410 IF E(K+1,1)=0 THEN GOTO 4440
4420 IF E(K+1,1)>R THEN GOTO 4440
4430 GOTO 4380
4440 OFF ERROR
4450 PRINT USING "2A" ; CHR$ (13)&CHR$ (10)
4460 RETURN
4470 !
4480 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4490 !
4500 !                 THIS SUBROUTINE REPLACES DELAY AND ELEMENT CODE NUMBERS
4510 !                 WITH NAMES AND PRINTS THE DELAY INFORMATION
4520 !
4530 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4540 !
4550 IMAGE 11X,3D,10X,7A,7X,4D.2D,8X,10A,2A
4560 IF E(K,4)=0 THEN TYPE$="ERROR" @ GOTO 4630
4570 IF E(K,4)=1 THEN TYPE$=A4$[1,10] @ GOTO 4630
4580 IF E(K,4)=2 THEN TYPE$=A4$[11,20] @ GOTO 4630
4590 IF E(K,4)=3 THEN TYPE$=A4$[21,30] @ GOTO 4630
4600 IF E(K,4)=4 THEN TYPE$=A4$[31,40] @ GOTO 4630
4610 IF E(K,4)=5 THEN TYPE$=A4$[41,50] @ GOTO 4630
4620 IF E(K,4)=6 THEN TYPE$=A4$[51,60]
4630 IF E(K,2)=1 THEN ELEM$=A3$[1,7] @ GOTO 4720
4640 IF E(K,2)=2 THEN ELEM$=A3$[8,14] @ GOTO 4720
4650 IF E(K,2)=3 THEN ELEM$=A3$[15,21] @ GOTO 4720
4660 IF E(K,2)=4 THEN ELEM$=A3$[22,28] @ GOTO 4720
4670 IF E(K,2)=5 THEN ELEM$=A3$[29,35] @ GOTO 4720
4680 IF E(K,2)=6 THEN ELEM$=A3$[36,42] @ GOTO 4720
4690 IF E(K,2)=7 THEN ELEM$=A3$[43,49] @ GOTO 4720
4700 IF E(K,2)=8 THEN ELEM$=A3$[50,56] @ GOTO 4720
4710 IF E(K,2)=9 THEN ELEM$=A3$[57,63] @ GOTO 4720
4720 PRINT USING 4550 ; E(K,1),ELEM$,E(K,3),TYPE$,CHR$ (13)&CHR$ (10)
4730 RETURN
4740 !
4750 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4760 !
4770 !                 THIS SUBROUTINE CORRECTS FOR ZERO VALUES IN THE
4780 !                 ADDITIONAL INFORMATION WITHOUT ERROR STATEMENTS
```

```
4790 !
4800 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4810 !
4820 D(I,C+G+1)=0
4830 OFF ERROR
4840 GOTO 1470
4850 !
4860 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4870 !
4880 !        THIS SUBROUTINE SUBTRACTS THE DELAY TIMES FROM THE ELEMENT TIMES
4890 !        BEFORE PRINTING TO GIVE ERROR FREE TIMES
4900 !
4910 ! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
4920 !
4930 HOLD=D(R,C)
4940 ON ERROR GOTO 4990
4950 FOR I=1 TO IDELAY
4960      IF E(I,1)=R AND E(I,2)=C-1 AND E(I,4)=0 THEN HOLD=0 @ GOTO 4990
4970      IF E(I,1)=R AND E(I,2)=C-1 THEN HOLD=HOLD-E(I,3)
4980 NEXT I
4990 OFF ERROR
5000 PRINT USING "4D.2D,X" ; HOLD
5010 GOTO 4200
```

HP-75 Time Study Program ELEMENT

```
10 DISP 'TIME STUDY PROGRAM ELEMEN';CHR$(212)
20 WIDTH 32 @ DELAY 1.5
30 !
40 !
50 ! This section initializes program
60 INTEGER F2,F3,G,H,I,J,L,M1,M2,M4,T
70 SHORT T1,T3
80 F2,G,H,I,J,M2,T0,T1,T2,T3,T4=0
90 DIM A1$[180],A2$[3],A3$[63],A4$[60],D$[8],D1$[8],D2$[8],E$[24]
   G1$[3],S$[60],T$[60]
100 A1$,A2$,A3$,A4$,E$,G1$,S$,T$=' '
110 A4$[1,10]='Reset'
120 A4$[11,20]='Rigging'
130 A4$[21,30]='Personal'
140 A4$[31,40]='Mechanical'
150 DISP 'Input file name? (5 spaces max)'
160 INPUT 'File Name =';D$
170 ASSIGN # 1 TO D$
180 !
190 !
200 ! This section records operations data, 20 spaces per
    category
210 DISP 'Enter general information'
220 DISP 'Date and Time already entered'
230 A1$[1,8]=DATE$
240 A1$[11,18]=TIME$
250 DISP DATE$,TIME$
260 FOR I=1 TO 8
270 ON I GOSUB 2360,2370,2380,2390,2400,2410,2420,2430
280 INPUT A1$[I*20+1,I*20+20]
290 NEXT I
300 !
310 !
320 ! This section reviews general data and allows for revision
330 GOSUB 2470
340 INPUT 'Any corrections ? Yes or No ?';A2$
350 IF UPRC$(A2$[1,1])='N' THEN 500
360 DISP 'Key number of erroneous subject.'
370 DISP '1 Equipment';TAB(18);'2 Layout'
380 DISP '3 Landing';TAB(18);'4 Corridor'
390 DISP '5 Observers';TAB(18);'6 Crew Size'
400 DISP '7 Slope';TAB(18);'8 Weather'
410 INPUT 'Number = ';G
420 ON G GOSUB 2600,2610,2620,2630,2640,2650,2660,2670
430 A2$=' ' @ INPUT 'Review entires? Yes or No ?';A2$
440 IF UPRC$(A2$[1,1])='N' THEN 460
450 GOSUB 2470
460 A2$=' ' @ INPUT 'More corrections ?  Yes or No ?';A2$
```

```
470 IF UPRC$(A2$[1,1])='N' THEN 500
480 A2$=' ' @ INPUT 'Repeat subject numbers?  Yes or No ?';A2$
490 IF UPRC$(A2$[1,1])='Y' THEN 370 ELSE 410
500 PRINT # 1 ; A1$[1,80]
510 PRINT # 1 ; A1$[81,160]
520 PRINT # 1 ; A1$[161,180]
530 ASSIGN # 1 TO *
540 !
550 !
560 ! This part chooses how many elements and their names
570 DISP 'Choose 1 to 9 study elements'
580 INPUT 'Number of Elements= ';G
590 G1$[3,3]='='
600 DISP 'Key element names, 7 spaces max.'
610 FOR I=1 TO G
620 G1$[1,2]=STR$(I)
630 DISP 'Element ';G1$;
640 INPUT A3$[I*7-6,I*7]
650 NEXT I
660 !
670 !
680 ! This part reviews element names and makes corrections
690 DISP 'Element names are now reviewed.'
700 GOSUB 2270
710 A2$=' ' @ INPUT 'Any corrections ?  Yes or No ?';A2$
720 IF UPRC$(A2$[1,1])='N' THEN 860
730 DISP 'Key number of erroneous element.'
740 GOSUB 2270
750 INPUT 'Number= ';F2
760 G1$[1,2]=STR$(F2)
770 DISP 'Element ';G1$;'  ';A3$[F2*7-6,F2*7];
780 INPUT A3$[F2*7-6,F2*7]
790 A2$=' ' @ INPUT 'Review entries?  Yes or No ?';A2$
800 IF UPRC$(A2$[1,1])='Y' THEN GOSUB 2270
810 A2$=' ' @ INPUT 'More corrections ?  Yes or No ?';A2$
820 IF UPRC$(A2$[1,1])='Y' THEN 730
830 !
840 !
850 ! This part sets up the time study file
860 D1$=D$&'TME'
870 ASSIGN # 2 TO D1$
880 PRINT # 2 ; STR$(G)
890 PRINT # 2 ; A3$
900 PRINT # 2,3 ; 'T'
910 !
920 !
930 ! This part of the program sets up the delay file and assigns
    codes
940 D2$=D$&'DLY'
950 ASSIGN # 3 TO D2$
```

```
960 DISP 'Four delay codes are assigned
970 H=4 @ GOSUB 1980
980 DISP 'Two other codes can be assigned.'
990 DISP 'Do you want assignable codes ?' @ A2$=' '
1000 INPUT 'Yes or No ?';A2$
1010 IF UPRC$(A2$[1,1])='Y' THEN 2060
1020 GOTO 2330
1030 GOSUB 1980
1040 ! This part sets up the scale file
1050 D3$=D$&'SCL'
1060 ASSIGN # 4 TO D3$
1070 !
1080 !
1090 ! This section is the stopwatch
1100 DELAY .5
1110 DISP 'Ready for time study'
1120 DISP 'Turn  1';TAB(12);A3$[1,7];TAB(22);'Ready'
1130 K$=KEY$ @ IF K$=' ' THEN 1130
1140 IF K$=CHR$(32) THEN TO=TIME ELSE 1130
1150 F3,T=1
1160 T$[1,6]=STR$(T)
1170 FOR J=2 TO G+1
1180 DISP 'Turn ';T;TAB(12);A3$[(J-1)*7-6,(J-1)*7];TAB(22);
     'Recording'
1190 K$=KEY$ @ IF K$=' 'THEN 1190
1200 IF K$=CHR$(0) THEN 3240
1210 IF K$=CHR$(77) or K$=CHR$(109) THEN M4=1 @ GOTO 2710
1220 IF K$=CHR$(44) THEN M4=1 @ GOTO 2740
1230 IF K$=CHR$(45) THEN M4=1 @ GOTO 2770
1240 IF K$=CHR$(47) THEN M4=1 @ GOTO 2800
1250 IF K$=CHR$(122) OR K$=CHR$(90) THEN 1380
1260 IF K$=CHR$(32) THEN T1=TIME-TO ELSE 1190
1270 TO=TIME
1280 T$[(J-1)*6+1,(J-1)*6+6]=STR$(T1)
1290 NEXT J
1300 PRINT # 2 ; T$ @ T$=' '
1310 PRINT # 4 ; S$ @ S$=' '
1320 T=T+1
1330 GOTO 1160
1340 !
1350 !
1360 ! This section records delays
1370 ! This sub-part records the first serial delay
1380 T2=TIME
1390 DISP 'Turn ';T;TAB(11);A3$[(J-1)*7-6,(J-1)*7];TAB(20);'
     Delay ';F3
1400 DISP 'Delay Code ?'
1410 K$=KEY$ @ IF K$=' ' THEN 1410
1420 IF K$=CHR$(48) THEN E$[19,24]=CHR$(48) @ GOTO 1490
1430 IF K$=CHR$(49) THEN E$[19,24]=CHR$(49) @ GOTO 1490
```

```
1440 IF K$=CHR$(50) THEN E$[19,24]=CHR$(50) @ GOTO 1490
1450 IF K$=CHR$(51) THEN E$[19,24]=CHR$(51) @ GOTO 1490
1460 IF K$=CHR$(52) THEN E$[19,24]=CHR$(52) @ GOTO 1490
1470 IF K$=CHR$(53) THEN E$[19,24]=CHR$(53) @ GOTO 1490
1480 IF K$=CHR$(54) THEN E$[19,24]=CHR$(54) ELSE GOTO 1400
1490 DISP 'Turn ';T;TAB(11);A3$[(J-1)*7-6,(J-1)*7];TAB(20);
     'Delay ';F3
1500 K1$=KEY$ @ IF K1$=' ' THEN 1500
1510 IF K1$=CHR$(77) OR K1$=CHR$(109) THEN M4=2 @ GOTO 2710
1520 IF K1$=CHR$(44) THEN M4=2 @ GOTO 2740
1530 IF K1$=CHR$(46) THEN M4=2 @ GOTO 2770
1540 IF K1$=CHR$(47) THEN M4=2 @ GOTO 2800
1550 IF K1$=CHR$(120) OR K1$=CHR$(88) THEN GOTO 1660
1560 IF K1$=CHR$(122) OR K1$=CHR$(90) THEN T3=TIME-T2 ELSE 1500
1570 E$[1,6]=STR$(T)
1580 E$[7,12]=STR$(J-1)
1590 E$[13,18]=STR$(T3)
1600 F3=F3+1
1610 PRINT # 3 ; E$ @ E$=' '
1620 GOTO 1180
1630 !
1640 !
1650 ! This section records subsequent delays
1660 T4=TIME
1670 T3=T4-T2
1680 E$[1,6]=STR$(T)
1690 E$[7,12]=STR$(J-1)
1700 E$[13,18]=STR$(T3)
1710 F3=F3+1
1720 PRINT # 3 ; E$ @ E$=' '
1730 DISP 'Turn ';T;TAB(11);A3$[(J-1)*7-6,(J-1)*7];' Delay ';F3
1740 DISP 'Delay Code ?'
1750 K$=KEY$ @ IF K$=' ' THEN 1750
1760 IF K$=CHR$(48) THEN E$[19,24]=CHR$(48) @ GOTO 1830
1770 IF K$=CHR$(49) THEN E$[19,24]=CHR$(49) @ GOTO 1830
1780 IF K$=CHR$(50) THEN E$[19,24]=CHR$(50) @ GOTO 1830
1790 IF K$=CHR$(51) THEN E$[19,24]=CHR$(51) @ GOTO 1830
1800 IF K$=CHR$(52) THEN E$[19,24]=CHR$(52) @ GOTO 1830
1810 IF K$=CHR$(53) THEN E$[19,24]=CHR$(53) @ GOTO 1830
1820 IF K$=CHR$(54) THEN E$[19,24]=CHR$(54) ELSE GOTO 1740
1830 DISP 'Turn ';T;TAB(11);A3$[(J-1)*7-6,(J-1)*7];' Delay ';F3
1840 K1$=KEY$ @ IF K1$=' ' THEN 1840
1850 IF K1$=CHR$(77) OR K1$=CHR$(109) THEN M4=3 @ GOTO 2710
1860 IF K1$=CHR$(44) THEN M4=3 @ GOTO 2740
1870 IF K1$=CHR$(46) THEN M4=3 @ GOTO 2770
1880 IF K1$=CHR$(47) THEN M4=3 @ GOTO 2800
1890 IF K1$=CHR$(122) OR K1$=CHR$(90) THEN 1930
1900 IF K1$=CHR$(120) or K1$=CHR$(88) THEN T3=TIME-T4 ELSE 1840
1910 T4=TIME
1920 GOTO 1680
```

```
1930 T3=TIME-T4
1940 GOTO 1570
1950 !
1960 !
1970 ! Subroutine for Delay Code Review
1980 FOR I=1 TO H
1990 G1$[1,2]=STR$(I)
2000 DISP 'Delay Code ';G1$;A4$[I*10-9,I*10]
2010 NEXT I
2020 RETURN
2030 !
2040 !
2050 ! Subroutine for Additional Delay Codes
2060 INPUT 'How many ? 1 or 2 ?';H
2070 DISP 'Input code, 10 spaces max.'
2080 INPUT 'Code 5 = ';A4$[41,50]
2090 DISP 'Code 5 = ';A4$[41,50] @ A2$=' '
2100 INPUT 'Any corrections ? Yes or No ?';A2$
2110 IF UPRC$(A2$[1,1])='N' THEN 2140
2120 DISP 'Make corrections.' '
2130 INPUT 'Code = ',A4$[41,50];A4$[41,50]
2140 IF H=1 THEN H=H+4 @ GOTO 2230
2150 DISP 'Input code, 10 spaces max.'
2160 INPUT 'Code 6 = ';A4$[51,60]
2170 DISP 'Code 6 = ';A4$[51,60] @ A2$=' '
2180 INPUT 'Any corrections ? Yes or No ?';A2$
2190 IF UPRC$(A2$[1,1])='N' THEN 2220
2200 DISP 'Make corrections.'
2210 INPUT 'Code = ',A4$[51,60];A4$[51,60]
2220 H=H+4
2230 PRINT # 3 ; A4$
2240 GOTO 1030
2250 !
2260 !
2270 ! Subroutine for Element Review
2280 FOR I=1 TO G
2290 G1$[1,2]=STR$(I)
2300 DISP 'Element ';G1$;A3$[I*7-6,I*7]
2310 NEXT I
2320 RETURN
2330 !
2340 !
2350 ! Subroutine to Enter Operations Data
2360 DISP 'Equipment '; @ RETURN
2370 DISP 'Layout '; @ RETURN
2380 DISP 'Landing '; @ RETURN
2390 DISP 'Corridor '; @ RETURN
2400 DISP 'Observers '; @ RETURN
2410 DISP 'Crew Size '; @ RETURN
2420 DISP 'Slope '; @ RETURN
```

```
2430 DISP 'Weather '; @ RETURN
2440 !
2450 !
2460 ! Subroutine to review operations data input
2470 DISP 'Oper. input is now reviewed.'
2480 DISP 'Date ';A1$[1,8];TAB(18);'Time ';A1$[11,18]
2490 DISP 'Equipment: ';A1$[21,40]
2500 DISP 'Layout: ';A1$[41,60]
2510 DISP 'Landing: ';A1$[61,80]
2520 DISP 'Corridor: ';A1$[81,100]
2530 DISP 'Observers: ';A1$[101,120]
2540 DISP 'Crew Size: ';A1$[121,140]
2550 DISP 'Slope: ';A1$[141,160]
2560 DISP 'Weather: ';A1$[161,180] @ RETURN
2570 !
2580 !
2590 ! Subroutine to Correct Entered Data
2600 INPUT 'Equipment: ',A1$[G*20+1,G*20+20]; A1$[G*20+1,G*20+20]
     @ RETURN
2610 INPUT 'Layout: ',A1$[G*20+1,G*20+20]; A1$[G*20+1,G*20+20] @
     RETURN
2620 INPUT 'Landing: ',A1$[G*20+1,G*20+20]; A1$[G*20+1,G*20+20] @
     RETURN
2630 INPUT 'Corridor: ',A1$[G*20+1,G*20+20]; A1$[G*20+1,G*20+20]
     @ RETURN
2640 INPUT 'Observers: ',A1$[G*20+1,G*20+20]; A1$[G*20+1,G*20+20]
     @ RETURN
2650 INPUT 'Crew Size: ',A1$[G*20+1,G*20+20]; A1$[G*20+1,G*20+20]
     @ RETURN
2660 INPUT 'Slope: ',A1$[G*20+1,G*20+20]; A1$[G*20+1,G*20+20]
     @ RETURN
2670 INPUT 'Weather: ',A1$[G*20+1,G+20+20]; A1$[G*20+1,G*20+20]
     @ RETURN
2680 !
2690 !
2700 ! Subroutines to enter yarder log scale data
2710 ! ON ERROR GOTO 2730
2720 INPUT 'Slope Yarding Distance ?'; Q @ S$[1,4]=STR$(Q) @ GOTO
     2850
2730 OFF ERROR @ GOTO 2710
2740 ON ERROR GOTO 2760
2750 INPUT 'Lateral Yarding Distance ?'; Q @ S$[5,8]=STR$(Q) @
     GOTO 2850
2760 OFF ERROR @ GOTO 2740
2770 ON ERROR GOTO 2790
2780 INPUT 'Loss Per Turn (6 max.) ?'; Q @ S$[9,12]=STR$(Q) @
     M3=VAL(S$[9,12]) @ GOTO 2850
2790 OFF ERROR @ GOTO 2770
2800 IF M2=T THEN 2820
2810 M2=T @ M1=1
```

```
2820 IF M1>M3 THEN 2850
2830 ON M1 GOSUB 2880,2940,3000,3060,3120,3180
2840 A2$=' ' @ M1=M1+1
2850 IF M4=1 THEN 1180
2860 IF M4=2 THEN 1490
2870 IF M4=3 THEN 1830
2880 ON ERROR GOTO 2900
2890 INPUT 'Diameter Log 1 ?'; Q @ S$[13,16]=STR$(Q) @ GOTO 2910
2900 OFF ERROR @ GOTO 2880
2910 ON ERROR GOTO 2930
2920 INPUT 'Length Log 1 ?'; Q @ S$[17,20]=STR$(Q) @ RETURN
2930 OFF ERROR @ GOTO 2910
2940 ON ERROR GOTO 2960
2950 INPUT 'Diameter Log 2 ?'; Q @ S$[21,24]=STR$(Q) @ GOTO 2970
2960 OFF ERROR @ GOTO 2940
2970 ON ERROR GOTO 2990
2980 INPUT 'Length Log 2 ?'; Q @ S$[25,28]=STR$(Q) @ RETURN
2990 OFF ERROR @ GOTO 2970
3000 ON ERROR GOTO 3020
3010 INPUT 'Diameter Log 3 ?'; Q @ S$[29,32]=STR$(Q) @ GOTO 3030
3020 OFF ERROR @ GOTO 3000
3030 ON ERROR GOTO 3050
3040 INPUT 'Length Log 3 ?'; Q @ S$[33,36]=STR$(Q) @ RETURN
3050 OFF ERROR @ GOTO 3030
3060 ON ERROR GOTO 3080
3070 INPUT 'Diameter Log 4 ?'; Q @ S$[37,40]=STR$(Q) @ GOTO 3090
3080 OFF ERROR @ GOTO 3060
3090 ON ERROR GOTO 3110
3100 INPUT 'Length Log 4 ?'; Q @ S$[41,44]=STR$(Q) @ RETURN
3110 OFF ERROR @ GOTO 3090
3120 ON ERROR GOTO 3140
3130 INPUT 'Diameter Log 5 ?'; Q @ S$[45,48]=STR$(Q) @ GOTO 3150
3140 OFF ERROR @ GOTO 3120
3150 ON ERROR GOTO 3170
3160 INPUT 'Length Log 5 ?'; Q @ S$[49,52]=STR$(Q) @ RETURN
3170 OFF ERROR @ GOTO 3150
3180 ON ERROR GOTO 3200
3190 INPUT 'Diameter Log 6 ?'; Q @ S$[53,56]=STR$(Q) @ GOTO 3210
3200 OFF ERROR @ GOTO 3180
3210 ON ERROR GOTO 3230
3220 INPUT 'Length Log 6 ?'; Q @ S$[57,60]=STR$(Q) @ RETURN
3230 OFF ERROR @ GOTO 3210
3240 PRINT # 2 ; T$
3250 PRINT # 4 ; S$
3260 PRINT # 2,3; STR$(T)
3270 ASSIGN # 2 TO * @ ASSIGN # 3 TO * @ ASSIGN # 4 TO *
3280 DISP 'DONE  DONE  DONE  DONE'
```