

AD-A060 872

ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND DOVER--ETC F/G 5/9
INTERACTIVE COMPUTER PROGRAM FOR LEARNING CURVE COMPUTATIONS.(U)
SEP 78 T E MITSOCK
ARSEC-78-5

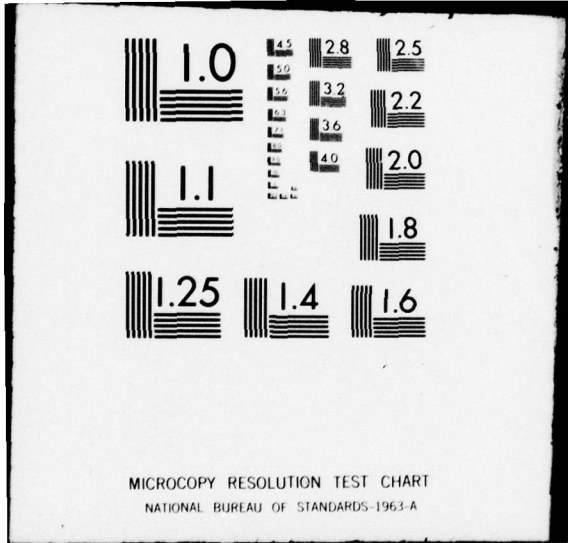
UNCLASSIFIED

NL

[OF]
AD
A060872



END
DATE
FILMED
01 -79
DDC



LEVEL

Handwritten signature

AD-

ARSEC 78-5

AD A060872

DDC FILE COPY

**INTERACTIVE COMPUTER PROGRAM
FOR
LEARNING CURVE COMPUTATIONS**



DDC
RECEIVED
NOV 6 1978
Handwritten signature

**PREPARED BY
SYSTEMS EVALUATION OFFICE
COST ANALYSIS DIVISION**

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

**HEADQUARTERS
US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
DOVER, NEW JERSEY 07801**

SEPTEMBER 1978


78 10 23 088

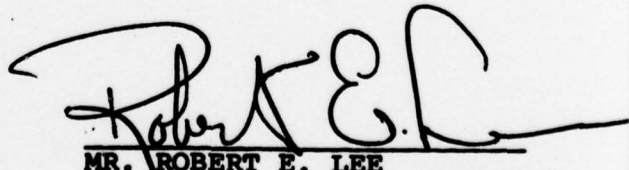
ARSEC: 78-5

Interactive Computer Program
For
Learning Curve Computations

Prepared by:
Mr. T. E. Mitsock
DRDAR-SEC

ACQUISITION NO.	
BY	Write Section <input checked="" type="checkbox"/>
DDO	Def Section <input type="checkbox"/>
UNCLASSIFIED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. ADD. OR SPECIAL
A	


JOHN S. CHESBRO
COL, GS
C, Systems Evaluation Office


MR. ROBERT E. LEE
C, Cost Analysis Division
Systems Evaluation Office

September 1978

78 10 23 088

"The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation."

Abstract

Learning curves or improvement curves have been in use for a few decades. The theory is based on the fact that as an operation is repeated many times, learning occurs and the operation is able to be performed more efficiently. The theory was originally based on manual operations, but it was later discovered that management type improvements such as value engineering, work simplification, better tooling, more efficient repetitive procurements, etc. also occurred, rendering learning curve theory useful to almost all production.

Learning curves are time independent. The only terms in the equations are unit numbers and costs. Learning curves generally only deal with constant year dollars due to the large fluctuation in inflation rates. In many cases, the entire effect of learning is overridden by the increase in costs due to inflation.

The learning curve is a curve on square graph paper, asymptotically approaching zero cost as the unit number approaches infinity. It is, however, a straight line on log-log paper where the distance between doubled quantities is equal. The "slope" comes from the slope of the straight line on the log-log paper. A plot of the learning curve on log-log paper can be used to estimate future costs for individual units. It is more difficult, however, to estimate the average unit cost for an entire production lot since the cost of each unit will be different. The algebraic lot midpoint is the unit number in a lot that has the average unit cost for that particular lot. The computer program described in the handbook necessary to utilize learning curves for estimating future costs.

This computer program was written with the casual computer user or a person who never used a computer in mind. The user, however, should be familiar with the usage of learning curves in order to interpret the results. An English language question asking for data prompts the user. There is no required format for data entry. If "meaningless" data is entered, the user will be given another chance to enter "meaningful" data. The user is given a chance to correct any data before the calculations are made.

Any comments for improvements or corrections to this program or requests for a source code listing should be directed to the Cost Analysis Division, Systems Evaluation Office (DRDAR-SEC), ARRADCOM, Dover, NJ 07801.

INTRODUCTION

This interactive computer program uses the unit learning curve of the form $y = AX^B$ where y = cost of unit x , A = theoretical first unit cost and $B = \text{Log}(\text{learning slope})/\text{Log}(2)$. With this curve, the cost of unit #2N will be equal to the cost of unit #N times the learning slope, i.e. for a 90% learning slope, unit #2 will cost 90% of what unit #1 did; the cost of unit #200 will be 90% of the cost of #100.

This free format input program operates in the following modes:

<u>Mode</u>	<u>Operation</u>
1	(input) - you input data to find the slope and theoretical first unit cost by regression analysis
2	(input) - you input slope and first unit cost or the average cost for a given lot.
3	(output) - will give you predicted average unit costs for up to 100 production lots.
S	Stops the program.
I	Lists instructions.
M	Lists modes.

- You can go back and forth between modes as many times as you like. The computer will ask you what mode you want. You respond by entering 1, 2, 3, I, M, or S.

- When in mode 3, the slope and first unit cost from the last time you specified them (as in mode 1 or mode 2) will be used. You will be able to change modes if you wish.

- You must enter the slope and first unit cost via mode 1 or 2. If you enter mode 3 before 1 or 2, the program will automatically put you in mode 2 then return to mode 3.

- When entering unit or quantity numbers, you must include all zeroes, i.e., 1 million must be entered as 1000000. The decimal point is optional. You cannot simplify by considering K units or million units. You cannot enter commas.

- When entering costs, you can enter all costs as dollars, K dollars or M dollars just as long as you are consistent throughout. The output of costs will be in the same scale as the input. The decimal point is optional.

- Trailing zeroes after the decimal in any input need not be entered.

- Leading zeroes before a decimal in any input need not be entered.

Program Access

- Log-in with your valid user name and password.*
- Extend the time limit, attach and execute the program as follows:

<u>Computer Types</u>	<u>You Type</u> (followed by carriage return)
COMMAND-	ATTACH,A,LCURVE,CY=1,ID=DRDAR,MR=1
COMMAND-	ETL,100
COMMAND-	A

- Answer all questions as asked by the computer.
- All input is free format up to 10 characters with one input per line entry, followed by a carriage return.
- To correct data before you hit carriage return "CNTRL" and "H" will backspace 1 space when simultaneously pushed.

"CNTRL" and "X" simultaneously pushed will "erase" the entire line input in the buffer memory, but does not physically backspace the carriage.

"CNTRL" and "Z" simultaneously pushed will stop program output.

%A Will abort program execution.

You can use "y" for "yes" and "n" for "no" when answering questions.

*To get your own username and password, contact MISD, X6303.

MODE 1 OPERATION

Mode 1 will calculate the slope and first unit cost resulting from a least squares curve fit of the data to the equation $y = ax^B$. It also gives you a correlation coefficient, r , to tell you how well the data fits the curve. R will vary from +1 to -1, with -1 being a perfect fit and -.8 being an acceptable fit.

You must enter at least two data points. When you enter only two, the line will go through both points and R will be equal to -1.0. It is best to use as many data points as you can to minimize the effects of any one "bad" data point, i.e., one that may be too low due to a contractor's "buying in" or one too high due to hidden costs.

Each data point must contain the following information: the unit number of the first unit of the lot, the quantity of items in the lot, and the average unit cost for that lot. The quantity in the lot must be greater than or equal to 1.

The average unit cost for the lot is found by dividing the total cost for the lot by the quantity in the lot.

The lots do not have to be consecutive or in any particular order.

When you enter a lot with a quantity greater than 1, the computer calculates the unit number of the lot midpoint, which has the average unit cost for that lot. The regression is done on the basis of unit number being the independent variable and cost being the dependent variable. The equations used for calculating the lot midpoint and for the regression equations are presented in Appendix A.

After you enter your data, you will be given a chance to make corrections to any of the data you previously entered, or add more lots. If you have no changes or when you are done making changes, the computer will type out the slope, theoretical first unit cost and the correlation coefficient. You will then be asked if you want a table of the predicted unit costs vs your inputted unit costs for all of the lots you entered. After this, you will be given a chance to change modes. If you go to Mode 3, the value of the slope and first unit cost will be automatically transferred.

MODE 2

Input in mode 2 consists of one data point and the slope. The slope can be entered as a decimal or a whole number. For example 90% can be entered as 90 or .9. The data point consists of a lot and its average unit cost. For entering the lot information the number of the first unit of the lot and the quantity of units in the lot must be entered. Both numbers must be greater than or equal to 1. When entering the first unit cost in this mode, the first unit in the lot is 1 and the quantity in the lot is 1. Neither quantity can be in any units other than 1, i.e., not thousands or millions. Decimals are optional when entering unit numbers, quantities, or costs. Cost can be entered as dollars, K dollars, M dollars or any other units such as foreign currency, labor hours, etc.

MODE 3

This is the output mode that puts the learning curve to work for you, estimating future costs. You must have entered enough information about the learning curve before you can start using it. This information must come through mode 1 or mode 2. If you enter mode 3 before providing any input in mode 1 or 2, the program will automatically put you in mode 2 before proceeding with mode 3. This input defines where the curve starts and the direction it takes. Now you have to tell the computer where on the curve you want the average unit cost calculated. To do this, you must enter the unit number of the first unit in the lot and either the quantity of units in the lot or the number of the last unit of the lot. This can be done in a number of ways. At least 1 unit must be in each lot.

For the first lot entry you must enter the number of the first unit of this lot when asked. You will then be asked for the quantity of units in the lot. If you respond with a number greater than or equal to 1, the computer will have enough information to make all remaining calculations and will do so. If you respond with a question mark (?), then the computer will ask you the unit number of the last unit of the lot. You must respond by entering a number greater than or equal to the number of the first unit of the lot. The computer will then make all the remaining calculations for the lot.

You will then be asked if you want to get information on another lot. Your response must be "yes", "no", or "=" (Y, N, or =). If you respond "yes", you will be asked to enter the first unit in the lot and the lot quantity or last unit number in the lot as before. If your answer is "=", the computer will add a lot with the quantity equal to the last entered quantity beginning with the unit after the last unit of the previously entered lot. If you answer "no", the computer will go on to the next phase. You can enter up to 100 lots. The lots do not have to be in any particular order and may be overlapping. The lots can contain as little as 1 unit. Remember that unit numbers and quantities are in quantities of units. They cannot be simplified by considering them as thousands of units or millions of units because the answers will be different.

When you have no more lots to enter, respond to "another lot: with "no." The computer will then ask if you want to see all the above input and output in tabular form. If you respond "yes", you will get it. If you respond "no" or when the computer has finished printing out the table, you will be asked if you wish to see what would happen if the lots you inputted were on a different learning curve. If you do want to see the results on a different learning curve, answer "yes." You will then have to enter input as though through mode 2: the slope and one lot data point (quantities and cost). The data point can be the same as you entered when you did the original run or it can be different and the slope unchanged, but you must reenter it. You may repeat this section as many times as you like, seeing the effect that different changes to the learning curve have on the average unit costs for each of the lots.

When you have finished mode 3, you will be asked which mode you wish to use just as you were asked when you finished modes 1 and 2. You can go back and forth between modes as many times as you wish before stopping the program.

To stop the program use mode "stop" or "s."

When you do stop the program, remember to type LOGOUT when the computer types COMMAND. When the computer finishes typing out the charges to your cost center, turn the terminal off.

Examples

The following examples demonstrate operation of all models/options of this program:

Example 1 shows how to access program, get instructions, stop the program and get off the computer.

Example 2 shows how to utilize all other features of the program.

Note that all inputs to the computer were circled for clarity.

A carriage return follows every line entry. In example 1, the program user logged in with his user name and password. The password is always typed over to protect it from being copied. You have to obtain your own user name and password from MISD (6303) before you can use the computer. You will also get a list of phone numbers for using dial-up terminals.* When you dial up/turn on the terminal, you will be given a short message including the date and time, then you will be asked to log in. You will then have to type - LOGIN, your username. When asked to enter your password, you will have to enter it. You will be given three chances to correctly log in and enter a password before getting any warning messages.

When you are correctly logged in, the computer will type out the date, time and other messages, then put you in the COMMAND mode, prompting you with the work "COMMAND" when it is ready for another instruction from you.

To access the learning curve computer program, you will have to enter the following three instructions when the computer types "COMMAND." At the end of each instruction you must depress the carriage return key.

<u>Computer types</u>	<u>You type</u>
COMMAND	- ATTACH,A,LCURVE,CY=1,ID=DRDAR,MR=1
COMMAND	- ETL, 100
COMMAND	- A

You will then be operating the interactive learning curve program. It will list the modes of operation and ask which mode you want to use. The example shows the results you get when you use mode "M", mode "I", and mode "S" for listing modes, getting additional instructions and stopping the program respectively. When you stop the program, you will return to the computer COMMAND mode. If you wish to run the learning curve program again you only have to type the third instruction when the computer prompts you for a command as follows:

*Note: User names, passwords and computer phone numbers in combination are classified For Official Use Only.

Computer types

You type

COMMAND

A

If you want to get off the computer, respond to "COMMAND" with "LOGOUT."
Turn off the terminal when the computer completes typing out the billing
message.

EXAMPLE 1:

Shows how to access the learning curve computer program, get instructions, stop the program and get off the computer.

Note: You will need a valid user name and password to use any of the computer facilities. Contact MISD, x6303 for further instructions on how to get a user name and password. Appendix B contains a list of all ARRADCOM terminal locations/types. (All "user" inputs have been circled for demonstrative purposes.)

A INTERCOM 4.5
DATE 06/28/78
TIME 13.22.14.

PLEASE LOGIN
login, (ltembf1100)

***** ENTER PASSWORD-

06/28/78 LOGGED IN AT 13.22.41.
WITH USER-ID IM
EQUIP/PORT 41/015

COMMAND- attach,a,lcurve,cy=1,id=drdar,mr=1.

COMMAND- et1,100

COMMAND- a.

THIS PROGRAM OPERATES IN THE FOLLOWING MODES
MODE OPERATION
----- -----

1	REGRESSION TO FIND LEARNING SLOPE
2	NORMAL INPUT TO GENERATE LEARNING CURVE
3	OUTPUT OF ESTIMATED COSTS USING LEARNING CURVES
S	STOP
I	INSTRUCTIONS
L	LIST MODES

WHICH MODE DO YOU WANT?

MODE m

THIS PROGRAM OPERATES IN THE FOLLOWING MODES

MODE OPERATION

- 1 REGRESSION TO FIND LEARNING SLOPE
- 2 NORMAL INPUT TO GENERATE LEARNING CURVE
- 3 OUTPUT OF ESTIMATED COSTS USING LEARNING CURVES
- S STOP
- I INSTRUCTIONS
- M LIST MODES

WHICH MODE DO YOU WANT?

MODE I

INSTRUCTIONS

MODE 1

REQUIRES INPUT FOR TWO OR MORE LOTS AS FOLLOWS
THE NUMBER OF THE FIRST UNIT IN THE LOT
AND
THE QUANTITY OF UNITS IN THE LOT
OR
THE LAST UNIT NUMBER IN THE LOT
AND
THE AVERAGE UNIT COST FOR THE LOT

MODE 2

REQUIRES INPUT FOR ONLY 1 LOT AS ABOVE
PLUS
THE LEARNING SLOPE

MODE 3

REQUIRES THE THE FOLLOWING FOR EACH LOT YOU WANT A COST
THE NUMBER OF THE FIRST UNIT IN THE LOT (IT WILL BE SET
EQUAL TO 1 PLUS THE NUMBER OF THE LAST UNIT OF THE
PREVIOUS LOT IF YOU ENTER AN EQUAL SIGN (=)
AND
THE QUANTITY OF UNITS IN THE LOT
OR
THE LAST UNIT NUMBER OF THE LOT

MODE S

STOPS THE PROGRAM

MODE ~~S~~

STOP

.063 CP SECONDS EXECUTION TIME

COMMAND- logout

CPA 1.724 SEC. 1.724 ADJ.
SYS TIME 2.916
EST. COST AT \$390/HR. - \$.31
CONNECT TIME 0 HRS. 2 MIN.
06/28/78 LOGGED OUT AT 13.24.46.

EXAMPLE 2:

Shows how to use Mode 1 for curve fitting, Mode 2 for general input and Mode 3 to get expected unit costs from the learning curve, and demonstrates method for switching between modes.

(All "user" inputs have been circled for demonstrative purposes.)

COMMAND- (a)

Example 2a

THIS PROGRAM OPERATES IN THE FOLLOWING MODES
MODE OPERATION

1 REGRESSION TO FIND LEARNING SLOPE
2 NORMAL INPUT TO GENERATE LEARNING CURVE
3 OUTPUT OF ESTIMATED COSTS USING LEARNING CURVES
S STOP
I INSTRUCTIONS
M LIST MODES
WHICH MODE DO YOU WANT?

MODE = 1

THIS MODE WILL GIVE YOU THE SLOPE AND FIRST UNIT COST
YOU WILL HAVE TO ENTER THE NUMBER OF LOTS
PLUS
THE FIRST UNIT NUMBER IN EACH LOT - AND -
THE QUANTITY IN EACH LOT - AND -
THE AVERAGE UNIT COST FOR THE LOT

PLEASE ENTER THE NUMBER OF LOTS... 2
ENTER FIRST UNIT OF LOT OR "=" 1 1000
ENTER TOTAL QUANTITY IN THIS LOT 1000
ENTER AVERAGE UNIT COST OF THIS LOT 10000
ENTER FIRST UNIT OF LOT OR "=" 2 5000
ENTER TOTAL QUANTITY IN THIS LOT 500
ENTER AVERAGE UNIT COST OF THIS LOT 9700

DO YOU WANT TO MAKE ANY CORRECTIONS?
YES OR NO no

Example 2 demonstrates this usage of modes 1, 2, and 3. The first part of this example (2a) shows usage of mode 1, regression analysis, using only two points. Since only two points are required to define a line, the line will exactly go through both points and the correlation coefficient will equal -1.0. Note that the first lot entered was for a lot of 1000 units beginning with unit #1000 and that the second lot was for a quantity of 500 units beginning at unit #5000. If the lots were to be entered in the reverse order, the results would still remain the same.

In this case the results were:

slope = 98.354235%
first unit cost = 11907.779
correlation coefficient = -1.00000

In the tabular output you can see that the estimated costs were equal to the inputted costs for both lots. This would not be true if there were more than two points and if the correlation coefficient was not -1.0. The six columns for the tabular output are as follows: lot number (lot), unit number of the first unit of the lot (First Unit), lot quantity (Quantity), lot algebraic mid-point (Avg Unit), inputted average unit cost for the lot (Your Cost), and predicted or estimated average unit cost for the lot (Est Cost).

SLOPE = 98.354235% FIRST UNIT COST = 11907.779

THE CORRELATION COEFFICIENT, R = -1.00000

DO YOU WANT TO SEE A TABLE OF PREDICTED COSTS
VS. YOUR INPUTTED COSTS FOR EACH LOT?

YES OR NO yes

LOT	FIRST UNIT	QUANTITY	AVG UNIT	YOUR COST	EST COST
1	1000.	1000.	1470.	10000.00	10000.00
2	5000.	500.	5247.	9700.00	9700.00

MODE = 5

STOP

.127 CP SECONDS EXECUTION TIME

Example 2b shows the usage of mode 1 with six data points to determine the learning slope and how well the "curve" fits the data. The first lot started with unit 1 and contained 100 units at an average unit cost of \$1000. Note that for the second lot, when the computer asked for the unit number of the first unit, the response was "=". This told the computer that this new lot would immediately follow the preceding lot. Lot 2 contained 100 units at an average unit cost of \$950. The following chart summarizes the input for lots 3 through 6.

<u>Lot #</u>	<u>First Unit</u>	<u>Quantity</u>	<u>Average Unit Cost</u>
3	1000	497	672
4	1700	350	699
5	2500	500	500
6	5000	1000	422

In the example, it was decided to make a correction to lot 4, changing the first unit to 1701, the quantity to 300 and the average unit cost to \$350. That was the only correction to be made. The computer then fit a learning curve to the data with the following results:

Learning slope = 87.309%
 Cost of unit #1 = 2195.897
 Correlation coefficient = -.87978

While this is a reasonable fit of the learning curve to the data point (correlation coefficient less than -.8), none of the data points fall exactly on the line. This would be expected in a real life situation. From the table of predicted costs vs inputted costs, you can see the differences as calculated below.

<u>lot</u>	<u>% ratio of inputted to estimated costs</u>
1	91%
2	115%
3	124%
4	70%
5	107%
6	104%

WHICH MODE DO YOU WANT?

MODE 1

Example 2b

THIS MODE WILL GIVE YOU THE SLOPE AND FIRST UNIT COST
YOU WILL HAVE TO ENTER THE NUMBER OF LOTS

PLUS

THE FIRST UNIT NUMBER IN EACH LOT - AND -
THE QUANTITY IN EACH LOT - AND -
THE AVERAGE UNIT COST FOR THE LOT

PLEASE ENTER THE NUMBER OF LOTS... 6
ENTER FIRST UNIT OF LOT OR "=" 1 1
ENTER TOTAL QUANTITY IN THIS LOT 100
ENTER AVERAGE UNIT COST OF THIS LOT 1000
ENTER FIRST UNIT OF LOT OR "=" 2 =
ENTER TOTAL QUANTITY IN THIS LOT 100
ENTER AVERAGE UNIT COST OF THIS LOT 950
ENTER FIRST UNIT OF LOT OR "=" 3 1000
ENTER TOTAL QUANTITY IN THIS LOT 497
ENTER AVERAGE UNIT COST OF THIS LOT 672
ENTER FIRST UNIT OF LOT OR "=" 4 1700
ENTER TOTAL QUANTITY IN THIS LOT 350
ENTER AVERAGE UNIT COST OF THIS LOT 699
ENTER FIRST UNIT OF LOT OR "=" 5 2500
ENTER TOTAL QUANTITY IN THIS LOT 500
ENTER AVERAGE UNIT COST OF THIS LOT 500
ENTER FIRST UNIT OF LOT OR "=" 6 5000
ENTER TOTAL QUANTITY IN THIS LOT 1000
ENTER AVERAGE UNIT COST OF THIS LOT 422

DO YOU WANT TO MAKE ANY CORRECTIONS?
YES OR NO yes

ENTER LOT NUMBER 4

ENTER FIRST UNIT OF LOT OR "=" 4 1701

ENTER TOTAL QUANTITY IN THIS LOT 300

ENTER AVERAGE UNIT COST OF THIS LOT 350

DO YOU WANT TO MAKE ANY CORRECTIONS?
YES OR NO no

SLOPE = 87.309497% FIRST UNIT COST = 2195.897
THE CORRELATION COEFFICIENT, R= -.87970

DO YOU WANT TO SEE A TABLE OF PREDICTED COSTS
VS. YOUR INPUTTED COSTS FOR EACH LOT?
YES OR NO yes

LOT	FIRST UNIT	QUANTITY	AVG UNIT	YOUR COST	EST COST
1	1.	100.	35.	1000.00	1097.23
2	101.	100.	147.	950.00	826.45
3	1000.	497.	1238.	672.00	544.61
4	1701.	300.	1848.	350.00	503.53
5	2500.	500.	2745.	500.00	466.00
6	5000.	1000.	5490.	422.00	406.85

Example 2c shows a mode 1 (regression) using only 4 data points. Note that in this case the correlation coefficient is only $-.67$, indicating a rather poor fit. In a case such as this, you could not reasonably use the resulting 75% learning curve as an effective predictor of costs. The errors would be too large.

Example 2d shows entry of data through mode 2. A slope of 93% was entered as $.93$. In this case, the first unit cost is being entered. Since all quantities must be entered as though for a lot, the first unit in this "lot" is 1 and the quantity is 1. The cost was entered as 2357.

Example 2e shows the usage of mode 3 using the learning curve inputted through mode 2 in example 2d. Mode 3 is the mode that puts the learning curve to work as a predictive tool. When entering information about the lots you want average unit costs for, you must enter the unit number of the first unit in the lot and either the quantity of units in the lot or the last unit number in the lot. If an equal sign (=) is entered for the first unit number in the lot, the computer will add 1 to the last unit number of the previously entered lot and use the result as the first unit this new lot. If the response is a question mark (?) for the lot quantity, the computer will ask for the last unit number of the lot. This number must be entered. After all this information is entered, the computer will calculate the lot midpoint, average unit cost and total lot cost. In this example the unit number of the first unit of the lot was entered as 50 and the lot quantity was entered as 50. The computer calculated the unit number of the last unit of the lot to be 99, the lot midpoint to be unit 73, the average unit cost to be 1504.28 and the total lot cost equal to 75214. After doing the calculation for this lot, the computer asked if the user wanted to do another lot. There are three acceptable replies: Yes (Y), No (N), or equal (=). The first two are obvious. If you respond "=", the computer will construct another lot equal in quantity to the previous lot immediately following that lot. In this case, the answer to another lot was "yes" and the response for the first unit in the lot was "=" with a quantity of 100, meaning that the user wanted to have another lot beginning with unit 100 having 100 units in it. After the computer printed out the costs for this lot it asked if there was to be another lot. In this case the response was "=" so the computer did the calculations for a third lot with a quantity of 100 beginning at unit 200. In this example, 10 different lots were entered before answering "no" to "another lot." Then when the computer asked if the user wanted a summary of the output in tabular form, the response was yes. This table appears right above the beginning of example 2f on page 26.

Example 2f shows how a sensitivity analysis can be performed to see what would happen to unit and total costs for the same lots if a different learning curve were to be used. The computer then gives the user a chance to add new lots or make corrections to existing lots before changing the learning curve. In this example, lot 3 was changed from a quantity of 100 units beginning with unit 200 to a lot of 200 units beginning with unit

201. Another correction was made. The response to "which lot" was 123. Since it was greater than 100, the lot number had to be reentered. The reply was 99 for the lot number which was acceptable, but since there were only 10 other lots, this lot was packed down to lot number 11 by the computer. This added a new lot to those to be looked at on the new learning curve.

Since the user wanted to see the results on a new learning curve, he had to enter the slope, unit number of the first unit of the lot, the lot quantity and average unit cost for the lot exactly as though in mode 2. In the example a 90% slope was chosen with the lot being only unit 1 with unit cost of 2357. This happens to correspond to the same first unit cost from the preceding example with a different slope. The resulting table shows that the effect of the steeper slope is lower costs (as would be expected).

MODE

THIS MODE WILL GIVE YOU THE SLOPE AND FIRST UNIT COST
YOU WILL HAVE TO ENTER THE NUMBER OF LOTS
PLUS
THE FIRST UNIT NUMBER IN EACH LOT - AND -
THE QUANTITY IN EACH LOT - AND -
THE AVERAGE UNIT COST FOR THE LOT

Example 2c

PLEASE ENTER THE NUMBER OF LOTS...
ENTER FIRST UNIT OF LOT OR "=" 1
ENTER TOTAL QUANTITY IN THIS LOT
ENTER AVERAGE UNIT COST OF THIS LOT
ENTER FIRST UNIT OF LOT OR "=" 2
ENTER TOTAL QUANTITY IN THIS LOT
ENTER AVERAGE UNIT COST OF THIS LOT
ENTER FIRST UNIT OF LOT OR "=" 3
ENTER TOTAL QUANTITY IN THIS LOT
ENTER AVERAGE UNIT COST OF THIS LOT
ENTER FIRST UNIT OF LOT OR "=" 4
ENTER TOTAL QUANTITY IN THIS LOT
ENTER AVERAGE UNIT COST OF THIS LOT

DO YOU WANT TO MAKE ANY CORRECTIONS?
YES OR NO

SLOPE = 75.374957% FIRST UNIT COST = 4972.454

THE CORRELATION COEFFICIENT, R = -.67180

DO YOU WANT TO SEE A TABLE OF PREDICTED COSTS
VS. YOUR INPUTTED COSTS FOR EACH LOT?

YES OR NO

LOT	FIRST UNIT	QUANTITY	AVG UNIT	YOUR COST	EST COST
1	1.	100.	31.	1000.00	1231.82
2	500.	100.	548.	1000.00	379.70
3	601.	400.	789.	350.00	327.42
4	1001.	350.	1169.	122.00	278.82

MODE = 2

Example 2d

ENTER SLOPE AS A DECIMAL

.93

ENTER THE UNIT NUMBER OF THE FIRST UNIT
IN THE SAMPLE LOT

1

ENTER THE TOTAL QUANTITY OF ITEMS IN THIS
SAMPLE LOT

1

ENTER AVERAGE UNIT COST FOR THE SAMPLE LOT

2357

SAMPLE LOT DATA FOLLOWS.

SLOPE = .9300

FIRST UNIT NUMBER = 1.

LAST UNIT NUMBER = 1.

TOTAL LOT QUANTITY = 1.

AVERAGE UNIT COST FOR THIS LOT = 2357.00

THEORETICAL FIRST UNIT COST = 2357.00

MODE = 3

Example 2e

THIS MODE WILL GIVE YOU THE ESTIMATED AVERAGE
UNIT COST FOR ANY LOT QUANTITY. INPUT TO THIS MODE
MUST COME FROM MODE1 OR MODE2.

DO YOU WANT TO CHANGE MODES? no

DATA ENTRY FOR EACH LOT WILL BE

FIRST UNIT NUMBER =

QUANTITY IN LOT =

LAST UNIT NUMBER =

IF YOU RESPOND TO "ANOTHER LOT?" WITH AN EQUAL SIGN (=),
YOU WILL GET AN ADD-ON LOT OF EQUAL QUANTITY TO THE LAST
AFTER THE PREVIOUSLY ENTERED LOT

NEED MORE INSTRUCTIONS? yes

IF YOU ENTER "=" FOR FIRST UNIT NUMBER, IT WILL
AUTOMATICALLY BE SET EQUAL TO THE LAST UNIT NUMBER
OF THE PREVIOUS LOT PLUS 1.

IF YOU ENTER "?" FOR LOT QUANTITY, YOU WILL HAVE TO
ENTER THE UNIT NUMBER OF THE LAST UNIT IN THE LOT
LEARNING SLOPE = .930

ENTER FIRST UNIT NUMBER OR "=" 50

ENTER QUANTITY IN LOT OR "?" 50

LAST UNIT NUMBER	=	99.
LOT MIDPOINT	=	73.
AVERAGE UNIT COST		1504.28
TOTAL LOT COST		75214.

ANOTHER LOT?

Y, N, OR =

yes

ENTER FIRST UNIT NUMBER OR "="

=

ENTER QUANTITY IN LOT OR "?"

100

LAST UNIT NUMBER	=	199.
LOT MIDPOINT	=	146.
AVERAGE UNIT COST		1398.47
TOTAL LOT COST		139847.

ANOTHER LOT?

Y, N, OR =

=

FIRST UNIT NUMBER	=	200.
QUANTITY IN LOT	=	100.
LAST UNIT NUMBER	=	299.
LOT MIDPOINT	=	248.
AVERAGE UNIT COST		1323.53
TOTAL LOT COST		132353.

ANOTHER LOT?

Y, N, OR =

yes

ENTER FIRST UNIT NUMBER OR "="

1000

ENTER QUANTITY IN LOT OR "?"

500

LAST UNIT NUMBER	=	1499.
LOT MIDPOINT	=	1240.
AVERAGE UNIT COST		1118.10
TOTAL LOT COST		559048.

ANOTHER LOT?

Y, N, OR =

yes

ENTER FIRST UNIT NUMBER OR "="

2500

ENTER QUANTITY IN LOT OR "?"

2500

LAST UNIT NUMBER	=	4999.
LOT MIDPOINT	=	3671.
AVERAGE UNIT COST		998.02
TOTAL LOT COST		2495049.

ANOTHER LOT?

Y, N, OR =

FIRST UNIT NUMBER	=	5000.
QUANTITY IN LOT	=	2500.
LAST UNIT NUMBER	=	7499.
LOT MIDPOINT	=	6203.
AVERAGE UNIT COST		944.68
TOTAL LOT COST		2361695.

ANOTHER LOT?

Y, N, OR =

ENTER FIRST UNIT NUMBER OR "="

ENTER QUANTITY IN LOT OR "?"

LAST UNIT NUMBER	=	7500.
LOT MIDPOINT	=	2611.
AVERAGE UNIT COST		1034.26
TOTAL LOT COST		7756913.

ANOTHER LOT?

Y, N, OR =

FIRST UNIT NUMBER	=	7501.
QUANTITY IN LOT	=	7500.
LAST UNIT NUMBER	=	15000.
LOT MIDPOINT	=	11014.
AVERAGE UNIT COST		889.56
TOTAL LOT COST		6671732.

ANOTHER LOT?

Y, N, OR =

ENTER FIRST UNIT NUMBER OR "="

ENTER QUANTITY IN LOT OR "?"

LAST UNIT NUMBER	=	10000.
LOT MIDPOINT	=	10000.
AVERAGE UNIT COST		898.61
TOTAL LOT COST		899.

ANOTHER LOT?
Y, N, OR =

yes

ENTER FIRST UNIT NUMBER OR "=" 20000

ENTER QUANTITY IN LOT OR "?" 1

LAST UNIT NUMBER = 20000.
LOT MIDPOINT = 20000.
AVERAGE UNIT COST 835.71
TOTAL LOT COST 836.

ANOTHER LOT?
Y, N, OR =

no

DO YOU WANT TO SEE OUTPUT IN TABULAR FORM? yes

LEARNING SLOPE = .930
THEORETICAL FIRST UNIT COST = 2357.00

LOT #	FIRST UNIT NUMBER	QUANTITY IN LOT	LOT MIDPOINT	AVERAGE UNIT COST	TOTAL LOT COST
1	50.	50.	73.	1504.28	75214.
2	100.	100.	146.	1398.47	139847.
3	200.	100.	248.	1323.53	132353.
4	1000.	500.	1240.	1118.10	559048.
5	2500.	2500.	3671.	998.02	2495049.
6	5000.	2500.	6203.	944.68	2361695.
7	1.	7500.	2611.	1034.26	756913.
8	7501.	7500.	11014.	889.56	6671732.
9	10000.	1.	10000.	898.61	899.
10	20000.	1.	20000.	835.71	836.

DO YOU WISH TO SEE THE RESULTS OF THE ABOVE LOTS
ON A DIFFERENT LEARNING SLOPE? yes

DO YOU WANT TO MAKE ANY CORRECTIONS TO ANY OF THE
ABOVE LOTS, OR ADD ANY NEW LOTS? YES OR NO yes

Example 2f

WHICH LOT? 3

ENTER FIRST UNIT NUMBER OF LOT 201

ENTER QUANTITY IN LOT OR "?" 200

LAST UNIT NUMBER = 400.

ANOTHER CORRECTION? yes

WHICH LOT? 123

SORRY, NOT MORE THAN 100 LOTS

WHICH LOT? 99

ENTER FIRST UNIT NUMBER OF LOT 50000

ENTER QUANTITY IN LOT OR "?" 10000

LAST UNIT NUMBER = 59999.

ANOTHER CORRECTION? no

ENTER SLOPE AS A DECIMAL .90

ENTER THE UNIT NUMBER OF THE FIRST UNIT IN THE SAMPLE LOT 1

ENTER THE TOTAL QUANTITY OF ITEMS IN THIS SAMPLE LOT 1

ENTER AVERAGE UNIT COST FOR THE SAMPLE LOT 2357

SAMPLE LOT DATA FOLLOWS.

SLOPE = .9000

FIRST UNIT NUMBER = 1.

LAST UNIT NUMBER = 1.

TOTAL LOT QUANTITY = 1.

AVERAGE UNIT COST FOR THIS LOT = 2357.00

THEORETICAL FIRST UNIT COST = 2357.00

LOT #	FIRST UNIT NUMBER	QUANTITY IN LOT	LOT MIDPOINT	AVERAGE UNIT COST	TOTAL LOT COST
1	50.	50.	73.	1228.20	61410.
2	100.	100.	146.	1104.79	110479.
3	201.	200.	294.	993.52	198704.
4	1000.	500.	1240.	798.29	399145.
5	2500.	2500.	3667.	676.97	1692416.
6	5000.	2500.	6201.	625.02	1562547.
7	1.	7500.	2539.	715.89	5369143.
8	7501.	7500.	11004.	572.84	4296276.
9	10000.	1.	10000.	581.23	581.
10	20000.	1.	20000.	523.11	523.
11	50000.	10000.	54912.	448.66	4486580.

Example 2g shows the results of the previous 11 lots on still another learning curve. This time it is a 85% curve based on a lot of 50 items beginning at unit #50 with an average unit cost for the lot of 1228.20. The table shows the resulting unit cost for all 11 lots.

Example 2h shows using mode 1 to generate a learning curve to be used in mode 3. It is exactly the same as using mode 1 without going into mode 3.

Example 2i shows the output of 5 lots from the curve generated in mode 1.

Example 2j shows mode "s" usage to stop the program and the LOGOUT procedure and messages.

DO YOU WISH TO SEE THE RESULTS OF THE ABOVE LOTS
ON A DIFFERENT LEARNING SLOPE? yes

Example 2g

DO YOU WANT TO MAKE ANY CORRECTIONS TO ANY OF THE
ABOVE LOTS, OR ADD ANY NEW LOTS? YES OR NO no

ENTER SLOPE AS A DECIMAL .85

ENTER THE UNIT NUMBER OF THE FIRST UNIT
IN THE SAMPLE LOT 50

ENTER THE TOTAL QUANTITY OF ITEMS IN THIS
SAMPLE LOT 50

ENTER AVERAGE UNIT COST FOR THE SAMPLE LOT 1228.20

SAMPLE LOT DATA FOLLOWS.

SLOPE = .8500

FIRST UNIT NUMBER = 50.

LAST UNIT NUMBER = 99.

TOTAL LOT QUANTITY = 50.

AVERAGE UNIT COST FOR THIS LOT = 1228.20

THEORETICAL FIRST UNIT COST = 3355.60

LOT #	FIRST UNIT NUMBER	QUANTITY IN LOT	LOT MIDPOINT	AVERAGE UNIT COST	TOTAL LOT COST
1	50.	50.	73.	1228.20	61410.
2	100.	100.	146.	1043.11	104311.
3	201.	200.	293.	885.55	177110.
4	1000.	500.	1239.	631.75	315874.
5	2500.	2500.	3661.	490.03	1225064.
6	5000.	2500.	6198.	433.14	1082845.
7	1.	7500.	2406.	540.73	4055511.
8	7501.	7500.	10986.	378.73	2840487.
9	10000.	1.	10000.	387.18	387.
10	20000.	1.	20000.	329.10	329.
11	50000.	10000.	54906.	259.71	2597135.

DO YOU WISH TO SEE THE RESULTS OF THE ABOVE LOTS
ON A DIFFERENT LEARNING SLOPE? no

MODE 3

Example 2h

THIS MODE WILL GIVE YOU THE ESTIMATED AVERAGE UNIT COST FOR ANY LOT QUANTITY. INPUT TO THIS MODE MUST COME FROM MODE1 OR MODE2.
DO YOU WANT TO CHANGE MODES? yes

MODE 1

THIS MODE WILL GIVE YOU THE SLOPE AND FIRST UNIT COST YOU WILL HAVE TO ENTER THE NUMBER OF LOTS PLUS THE FIRST UNIT NUMBER IN EACH LOT - AND - THE QUANTITY IN EACH LOT - AND - THE AVERAGE UNIT COST FOR THE LOT

PLEASE ENTER THE NUMBER OF LOTS... 1

THE NUMBER OF LOTS MUST BE TWO OR MORE
HOW MANY LOTS 105

...SORRY, NOT MORE THAN 100 LOTS
HOW MANY LOTS? 3

ENTER FIRST UNIT OF LOT OR "=" 1 =

ENTER TOTAL QUANTITY IN THIS LOT 1

ENTER AVERAGE UNIT COST OF THIS LOT 2357

ENTER FIRST UNIT OF LOT OR "=" 2 100

ENTER TOTAL QUANTITY IN THIS LOT 100

ENTER AVERAGE UNIT COST OF THIS LOT 1105

ENTER FIRST UNIT OF LOT OR "=" 3 20000

ENTER TOTAL QUANTITY IN THIS LOT 1

ENTER AVERAGE UNIT COST OF THIS LOT 500

DO YOU WANT TO MAKE ANY CORRECTIONS?
YES OR NO no

SLOPE = 89.716522% FIRST UNIT COST = 2374.951
THE CORRELATION COEFFICIENT, R = -.99985

DO YOU WANT TO SEE A TABLE OF PREDICTED COSTS
 VS. YOUR INPUTTED COSTS FOR EACH LOT?
 YES OR NO yes

LOT	FIRST UNIT	QUANTITY	AVG UNIT	YOUR COST	EST COST
1	1.	1.	1.	2357.00	2374.95
2	100.	100.	146.	1105.00	1088.25
3	20000.	1.	20000.	500.00	503.86

MODE 3 Example 2i

THIS MODE WILL GIVE YOU THE ESTIMATED AVERAGE
 UNIT COST FOR ANY LOT QUANTITY. INPUT TO THIS MODE
 MUST COME FROM MODE1 OR MODE2.
 DO YOU WANT TO CHANGE MODES? no

DATA ENTRY FOR EACH LOT WILL BE
 FIRST UNIT NUMBER =
 QUANTITY IN LOT =
 LAST UNIT NUMBER =

IF YOU RESPOND TO "ANOTHER LOT?" WITH AN EQUAL SIGN (=),
 YOU WILL GET AN ADD-ON LOT OF EQUAL QUANTITY TO THE LAST
 AFTER THE PREVIOUSLY ENTERED LOT
 NEED MORE INSTRUCTIONS? no

LEARNING SLOPE = .897
 ENTER FIRST UNIT NUMBER OR "=" =

ENTER QUANTITY IN LOT OR "?" ?

ENTER LAST UNIT NUMBER (1000)

QUANTITY IN LOT = 1000.
 LOT MIDPOINT = 340.
 AVERAGE UNIT COST 953.68
 TOTAL LOT COST 953682.

ANOTHER LOT?
 Y, N, OR = =

FIRST UNIT NUMBER = 1001.
 QUANTITY IN LOT = 1000.
 LAST UNIT NUMBER = 2000.
 LOT MIDPOINT = 1468.
 AVERAGE UNIT COST 758.42
 TOTAL LOT COST 758424.

ANOTHER LOT?
Y, N, OR =

FIRST UNIT NUMBER = 2001.
QUANTITY IN LOT = 1000.
LAST UNIT NUMBER = 3000.
LOT MIDPOINT = 2481.
AVERAGE UNIT COST 698.57
TOTAL LOT COST 698570.

ANOTHER LOT?
Y, N, OR =

FIRST UNIT NUMBER = 3001.
QUANTITY IN LOT = 1000.
LAST UNIT NUMBER = 4000.
LOT MIDPOINT = 3487.
AVERAGE UNIT COST 662.33
TOTAL LOT COST 662330.

ANOTHER LOT?
Y, N, OR =

ENTER FIRST UNIT NUMBER OR "="

ENTER QUANTITY IN LOT OR "?" =

LAST UNIT NUMBER = 4000.
LOT MIDPOINT = 1352.
AVERAGE UNIT COST 768.25
TOTAL LOT COST 3073006.

ANOTHER LOT?
Y, N, OR =

DO YOU WANT TO SEE OUTPUT IN TABULAR FORM?

LEARNING SLOPE = .897
THEORETICAL FIRST UNIT COST = 2374.95

LOT #	FIRST UNIT NUMBER	QUANTITY IN LOT	LOT MIDPOINT	AVERAGE UNIT COST	TOTAL LOT COST
1	1.	1000.	340.	953.68	953682.
2	1001.	1000.	1468.	758.42	758424.
3	2001.	1000.	2481.	698.57	698570.
4	3001.	1000.	3487.	662.33	662330.
5	1.	4000.	1352.	768.25	3073006.

DO YOU WISH TO SEE THE RESULTS OF THE ABOVE LOTS ON A DIFFERENT LEARNING SLOPE?

MODE s

Example 2j

STOP
1.459 CP SECONDS EXECUTION TIME
COMMAND- logout

CPA 5.011 SEC. 5.011 ADJ.
CPB .000 SEC. .000 ADJ.
SYS TIME 7.528
EST. COST AT \$390/HR. - \$.81
CONNECT TIME 0 HRS. 26 MIN.
06/28/78 LOGGED OUT AT 13.51.15.

Appendix A

LEARNING CURVE EQUATIONS

Equation 1 is the equation of the unit learning curve.

$$(1) \quad Y = A * X^B$$

with

$$(2) \quad B = \frac{\text{LOG (SLOPE)}}{\text{LOG (2)}}$$

The algebraic lot midpoint (Equation 3) is used in conjunction with the learning curve equation to calculate the average unit cost for a lot quantity. The algebraic midpoint is the unit in the lot that has the average unit cost.

$$(3) \quad K = \left[\frac{N * (1+B)}{N1(1+B) - N2(1+B)} \right]^{-\frac{1}{B}}$$

Equations 4 and 5 are the equations used to fit a learning curve to the data using the least square technique. Equation 6 is the equation for the correlation coefficient, a statistical measure of how well the curve fits the data.

$$(4) \quad B = \frac{N * \{\Sigma (\text{LOG}(X) * \text{LOG}(Y))\} - \Sigma \text{LOG}(X) * \Sigma \text{LOG}(Y)}{N * \Sigma (\text{LOG}(X))^2 - (\Sigma \text{LOG}(X))^2}$$

$$(5) \quad A = \text{ANTILOG} ((\Sigma \text{LOG}(Y) - B * \Sigma \text{LOG}(X)) / N)$$

$$(6) \quad r = \frac{N * \Sigma (\text{LOG}(X) * \text{LOG}(Y)) - \Sigma \text{LOG}(X) * \Sigma \text{LOG}(Y)}{\sqrt{N * \{\Sigma (\text{LOG}(X))^2\} - (\Sigma \text{LOG}(X))^2} * \sqrt{N * \{\Sigma (\text{LOG}(Y))^2\} - (\Sigma \text{LOG}(Y))^2}}$$

Where

Y is the cost of unit X
 A is the cost of unit 1
 B is the "exponent" of the slope
 K is the algebraic mid-point of the lot
 N is the quantity of units in the lot
 N1 is the last unit in the lot plus ½
 N2 is the first unit in the lot minus ½
 r is the correlation coefficient
 Σ is a symbol to indicate summation
 LOG is the logarithm to the base 10

Appendix B

REMOTE TERMINAL INFORMATION
01/04/78

MODEL	TERM ID	TYPE	BAUD RATE	DATA SET	H-D	PORT NO	LOCATION	RESPONSIBLE INDIVIDUAL	EXT
CDC 1700		BATCH			H	DUM	B/ 353	ISAKOWER, R.	5184
CDC 2000T	AC	BATCH	4800	208A	H	01	B/ 62	PAP, G.	5588
CDC 2000T	AD	BATCH	4800	208A	H	02	B/ 65S	MESSINEO, V.	4552
CDC 2000T	AG	BATCH	4800	208A	H	05	B/ 94	BROMLEY, J.	3268
CDC 2000T	AE	BATCH	4800	208A	H	03	B/ 266	FRIEDMAN, G.	5862
CDC 2000T	AF	BATCH	4800	208A	H	04	B/3359	KWATNOSKI, R.	6556
MDS 2400	BZ	BATCH	2000	201	D	DUM	B/ 171	SEYMOUR, J.	4005
MDS 2400	A1	BATCH	4800	208	D	07	B/ 350	DEMITRACK, G.	2219
ADDS 880		CRT	300		D	DUM	B/1510	KEMMEY, P.	6306
HAZELTINE 2000		CRT	300		D	DUM	B/ 65N	FASANO, J.	4920
HAZELTINE 2000		CRT	300	113A	D	DUM	B/ 151	PEARCY, S.	
HAZELTINE 2000		CRT	300	113A	D	DUM	B/ 351	O-BRIEN, J.	4912
HAZELTINE 2000		CRT	300		D	DUM	B/ 407	WALKER, R.	3016
UNISCOPE		CRT	300		D	DUM	B/ 59		
UNISCOPE		CRT	300		D	DUM	B/3401		
TEK 4010		GRAPHICS	300		D	DUM	B/ 171	SEYMOUR, J.	4005
TEK 4014		GRAPHICS	300		D	DUM	B/ 65S	GOODMAN, S.	7227
TEK 4014		GRAPHICS	300	113A	D	DUM	B/ 65S	MESSINEO, V.	4552
TEK 4014		GRAPHICS	300	113	D	DUM	B/ 94	CUMMING, B.	2490
TEK 4014		GRAPHICS	4800	201	D	DUM	B/ 171		
TEK 4014		GRAPHICS	4800	201	D	DUM	B/ 350	DEMITRACK, G.	2219
TEK 4014		GRAPHICS	4800	201	D	DUM	B/ 353	ISAKOWER, R.	5184
TEK 4014		GRAPHICS	4800	201	D	DUM	B/ 525	RAND, HANK	5655
TEK 4014		GRAPHICS	300	113A	D	DUM	B/3025	ALSTER, J.	2583
BELL ASR-33		INTERACTIVE	110		H	34	B/ 4	BARRETT, B.	3780
BELL ASR-35		INTERACTIVE	110	103F	H	00	B/ 31	SARTELL, M.	3802
BELL ASR-35		INTERACTIVE	110	103F	D	34	B/ 62N	PAP, G.	5588
BELL ASR-35		INTERACTIVE	110	108	H	23	B/ 65	OLIVERI, P.	
BELL ASR-35		INTERACTIVE	110	103F	H	04	B/ 65S	MESSINEO, V.	4552

Appendix B

REMOTE TERMINAL INFORMATION
01/04/78

MODEL	TERM ID	TYPE	BAUD RATE	DATA SET	H-D	PORT NO	LOCATION	RESPONSIBLE INDIVIDUAL	EXT
BELL ASR-35		INTERACTIVE	110	103F	H	07	B/ 94	BARRIERES, E.	3985
BELL ASR-35		INTERACTIVE	110	103F	H	12	B/ 171	SEYMOUR, J.	4005
BELL ASR-35		INTERACTIVE	110	108F	H	14	B/ 183	DAVIS, J.	4597
BELL ASR-35		INTERACTIVE	110	103F	H	16	B/ 351	O-BRIEN, J.	4912
BELL KSR-35		INTERACTIVE	110	103F	H	03	B/ 61	RAND, HANK	2017
BELL KSR-35		INTERACTIVE	110	103F	H	01	B/ 62S	PAP, G.	5588
BELL KSR-35		INTERACTIVE	110	103F	H	10	B/ 94-2	BROMLEY, J.	3268
BELL KSR-35		INTERACTIVE	110	103F	H	15	B/ 350	DEMITRACK, G.	2219
BELL KSR-35		INTERACTIVE	110	103F	H	34	B/ 352	CONWAY, W.	4249
BELL KSR-35		INTERACTIVE	110	103F	D	DUM	B/ 350	PISANI, J.	6442
DIABLO 450		INTERACTIVE	300	OMNI	D	DUM	B/ 351	O-BRIEN, J.	4912
GENCOM		INTERACTIVE	300	113A	D	DUM	B/ 350	BARONI, A.	6393
NCR 260-6		INTERACTIVE	300	113A	D	DUM	B/ 351	ALFONSIN, J.	2105
NCS 260-6		INTERACTIVE	300	113A	D	DUM	B/ 353	BARNETT, B.	3908
NCR 260-6		INTERACTIVE	300	113A	D	DUM	B/3410	KWATNOSKI, R.	6556
NCR 260-6		INTERACTIVE	300	113A	D	DUM	B/ 407	MAPES, J.	2826
TI 733		INTERACTIVE	300	113A	D	DUM	B/1515	MAPES, J.	2826
TI 733		INTERACTIVE	300	113A	D	DUM	B/3021S	MAPES, J.	2826
TI 733		INTERACTIVE	300	113A	D	DUM	B/ 65N	NICHOLS, L.	6361
TI 733 ASR		INTERACTIVE	300	113A	D	DUM	B/ 353	ISAKOWER, R.	5184
TI 733 KSR		INTERACTIVE	300	113A	D	DUM	B/ 31	PAP, G.	5588
CMTI MINI-COMP		MINI COMPUTER			D	DUM	B/ 62	MESSINEO, V.	4552
HOUSTON INSTRUMENTS		PLOTTER				DUM	B/ 65N	BROMLEY, J.	3268
HOUSTON INSTRUMENTS		PLOTTER				DUM	B/ 94	RAND, HANK	5655
HOUSTON INSTRUMENTS		PLOTTER				DUM	B/ 61	NICHOLS, L.	2359
CDI 1030		PORTABLE	300		D	DUM	B/ 65N	RAND, HANK	5655
CDI 1030		PORTABLE	300		D	DUM	B/ 61	O-CONNER, D.	3802
CDI 1132		PORTABLE	300		D	DUM	B/ 31	PAP, G.	5588
CTSI EXECUPORT		PORTABLE	300	INT	D	DUM	B/ 62	GRESHAM, E.	7483
TI 735		PORTABLE	300	INT	D	DUM	B/ 65S		
TI 735		PORTABLE	300	INT	D	DUM			

Appendix B

REMOTE TERMINAL INFORMATION
01/04/78

MODEL	TERM ID	TYPE	BAUD RATE	DATA SET	H-D	PORT NO	LOCATION	RESPONSIBLE INDIVIDUAL	EXT
TI 735		PORTABLE	300	INT	D	DUM	B/ 176	SMITH, LOU	4743
TI 735		PORTABLE	300	INT	D	DUM	B/ 350	GROBSTEIN, D.	3196
TI 735		PORTABLE	300	INT	D	DUM	B/ 350	MCDONALD, M.	5878
TI 735		PORTABLE	300	INT	D	DUM	B/ 352	LAWSON, RUBY	5435
TI 735		PORTABLE	300	INT	D	DUM	B/ 354	BERNSTEIN, S.	
TI 735		PORTABLE	300	INT	D	DUM	LOANER	STEIN, W.	6303
TI 735		PORTABLE	300	INT	D	DUM	LOANER	STEIN, W.	6303
TI 735		PORTABLE	300	INT	D	DUM	LOANER	STEIN, W.	6303
TI 745		PORTABLE	300	INT	D	DUM	B/ 65S	WEBSTER, BOB	
TI 745		PORTABLE	300	INT	D	DUM	B/ 65S	LEGGIO, LOU	4552
TI 745		PORTABLE	300	INT	D	DUM	B/ 151	PEARCY, S.	5552
TI 745		PORTABLE	300	INT	D	DUM	B/ 171	SEYMOUR, J.	4005
TI 745		PORTABLE	300	INT	D	DUM	B/ 350	BARONI, T.	6393
TI 745		PORTABLE	300	INT	D	DUM	B/ 351	ALFONSIN, J.	2071
TI 745		PORTABLE	300	INT	D	DUM	B/ 455	GOLDSTEIN, SID	
TI 745		PORTABLE	300	INT	D	DUM	B/3408	GEREPKA, JULES	
TI 745		PORTABLE	300	INT	D	DUM	B/3410	KWATNOSKI, R.	6556

DISTRIBUTION:

Commander/Dir LCWSL
Commander/Dir FC&SCWSL
Commander/Dir CSL
Comptroller
Dir, MISD
Dir, TSD
Dir, PAD
Dir, P&FDD
Dir, Proc Dir
Dir, ASA
Chief, ACO
Chief, PMSO
Sec Gen Staff
PM, Fuzes
PM, CAWS
PM, SA
PM, DIVADS
PM, PBM
PM, NUC
Prod Mgr, 30MM Ammo
Asst Prod Mgr, XM1 Tank System
C, US Army Human Eng Lab Det
DRDAR-MSP
DRDAR-TS

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 14 ARSEC-78-5	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 INTERACTIVE COMPUTER PROGRAM FOR LEARNING CURVE COMPUTATIONS		5. TYPE OF REPORT & PERIOD COVERED 9 Final Report
7. AUTHOR(s) 10 Thomas E. Mitsock		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Cost Analysis Division SEC Systems Evaluation Office SE HQ, US Army ARRADCOM, Dover, NJ 07801		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Headquarters US Army Armament Research & Development Command Dover, NJ 07801		12. REPORT DATE 11 September 1978
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12 43 p.		13. NUMBER OF PAGES
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; distribution unlimited.		15. SECURITY CLASS. (of this report) Unclassified
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Learning, Improvement, Regression, Cost Estimates, Cost Analysis, Interactive Computer Program.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes the usage of an interactive FORTRAN computer program written for use on a CDC 6500/6600 computer to perform regression of data onto unit learning curves and estimation of costs from unit learning curves. No prior computer experience is necessary to run this program as all data prompts are English language questions and all data entries are free format. A source code listing of this program can be obtained from the performing organization. Minor I/O modifications may be necessary for other than CDC computer systems.		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

410 927

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Table of Contents

<u>Title</u>	<u>Page</u>
Abstract	1
Introduction	2
Program Access	4
Mode 1	5
Mode 2	6
Mode 3	7
Examples	9
Appendix A, Learning Curve Equations	34
B, Location of Interactive Terminals - ARRADCOM Dover Site	35