CHAPTER 22

COST MODELS AND COST ESTIMATING SOFTWARE

1. INTRODUCTION

Discussions in previous chapters have made the following points about cost estimating methods.

- Cost estimating requires separate arithmetic operations, many of which must be performed in a specified sequence.

- These operations in turn require numeric inputs, or selected descriptive details of the specific estimate.

- Results of selected arithmetic operations are sometimes used as inputs for others in the estimation process.

It becomes apparent that if the above items are formalized, a specific methodology for obtaining cost estimates is the result. It is a method that produces the same results when the same inputs are used. This formalized methodology is basically a cost model, which forms the basis for estimating software.

2. DEFINITION OF A COST MODEL

A cost model is a set of mathematical relationships arranged in a systematic sequence to formulate a cost methodology in which outputs, namely cost estimates, are derived from inputs. These inputs include quantities and prices. Cost models can vary from a simple one-formula model to an extremely complex model that involves hundreds or even thousands of calculations. As an example of a very simple cost model or cost estimating relationship (CER), the cost of an item might be related directly to its weight; that is $C = DW$:

where C = cost of item
D = cost in dollars per pound of weight
W = weight in pounds

Here, D and W are inputs to the model and C is the output. Although this is a very simple model, it nevertheless performs the function of providing a cost estimate for given inputs.

Because the term cost model is used in various situations, it can have a variety of specific meanings. However, it still has the general connotation of an integrating device designed to facilitate the analytical process of obtaining cost estimates. In brief, it is a stylized representation of a part of the real world and can be used to gain insights into the cause-and-effect relationships existing in this world.

A distinction should be made between the term cost model and its representation in a computer program. Sometimes it is preferable to consider primarily the concept of the model and to treat the computer program as a less interesting tool. This distinction between the model and its representation on a computer may be especially useful in avoiding a tendency to focus attention on the wrong aspect—a common error when the advantages of a proposed cost model are being described. Speed and printed output are related to the computer, not to the use of the model. Although the term “cost model” is sometimes used to include the computer program, the advantages and limitations of cost models should not be confused with those of computers.

A. Types of Cost Models

Cost models can be classified in several ways. One basis for classification would be the complexity of manipulation of the inputs. On this basis, the very simplest cost model gives only a summary of facts provided by the analyst. The model may provide rules for subtotaling and totaling of information supplied as inputs. Models of this sort often use computers to perform the functions of an adding machine and typewriter. A slightly more complex model may require a minor amount of multiplication in order to find a few intermediate values to be summarized and displayed. Somewhat more complex models may involve choices of estimating techniques that depend on specific inputs. The most complex models may involve fairly sophisticated analytical techniques, such as nonlinear programming or probabilistic iterations.

Cost models can be categorized according to the function they serve. Some models are designed to assist long-range planners; others are for use in programming, where this term applies a more detailed level of planning and application in the near future. Still others are designed for budgetary use. The function to be served influences the design of the model in many ways, with the level of detail to be represented as one of the most obvious. A model designed for budget use would not usually be applied to long-range planning because it would require as inputs detail that is unavailable.

Cost models can also be classified according to the likelihood of repetitive use. Some are used for one application only. They may require considerable design and involved preparation of the input data, but they are developed for specific applications. Once the need has been met, the model is a thing of the past. It may still exist in files, and reference to it may be helpful in designing a later model. A model developed for a single use can be contrasted with a cost model designed to be used many times, and to give many cost estimates. The latter may require more care in design because of the likelihood that it will be used when the designer is not available; in other words, a model for general use should be user-oriented.

A cost model can be considered in the context of the subject matter that it is intended to represent. Some models deal with relatively minor parts of the total problem to be considered by a decision maker; others attempt to represent almost all of the problem areas faced by the decision maker.

1. Advantages

Just as there are many kinds of models, so are there many kinds of benefits that can be obtained from models. In cost analysis, one of the most important functions of a model is that of providing a framework for analysis. The analyst finds that construction of a model requires precision, and that the need to identify each functional relationship imposes a discipline. The attempt to establish specific mathematical expressions aids the analyst in recognizing those elements of the total problem that require the most effort. The development of a model thus serves to give insight.

Isaac Newton observed that free-falling objects accelerated downward, and his observation can be expressed in a mathematical relationship, or a simple model:

$$d = \frac{1}{2} gt^2$$

where $g = 32$ ft/sec^2
t = time of fall in seconds
d = vertical distance fallen in feet after t seconds

The model explains that gravitational acceleration at the earth's surface is about 32 feet each second. This specific statement enables an observer to test Newton's hypothesis by comparing actual observations with the model's prediction. A cost model can be used similarly to test hypotheses about costs. The typical hypothesis, however, cannot be proved through use of a cost model. A series of tests can either show that it is unsatisfactory or let it remain as a reasonable hypothesis.

A model will give the same output when given the same inputs. This ability to reproduce outputs is a great advantage when compared with the use of unstructured best judgment to provide cost estimates. Both the user and the supplier of estimates usually prefer that a given problem yield the same result no matter how many times it is examined. Lack of reproducibility leads to lack of credibility.

The consistency of response inherent in cost models enables the analyst to make comparisons among alternatives. He can be sure that identical inputs are treated alike and that the differences in cost estimates (outputs) are based on differences in inputs. The ability to compare on a consistent basis is one of the most attractive features of cost models. However, the analyst must always be aware that the outputs are only as good as the assumptions of the model and the input data permit.

Cost-sensitivity analysis, an important analytical tool, tests the sensitivity of outputs to changes in one or more inputs. This is done usually through repetitive cost estimates that keep certain inputs unchanged while others are varied in a controlled manner. This sort of analysis can be performed only if there is a technique for using the inputs to obtain cost estimates)in other words, only if there is a cost model.

Another important analytical tool is called contingency analysis. Instead of changing one input to the cost model, the analyst changes one or more aspects of the problem. It might even require that the analyst change the basic assumptions of the model. In such cases, a more general model may be needed before estimates and comparisons can be completed. Contingency analysis is another kind of sensitivity testing. It helps to show whether the item (or system or force) that is being costed is appropriate for only one contingency or for a range of contingencies. An unambiguous, reproducible set of estimates is essential for both sensitivity and contingency analyses.

A model is an excellent tool for organizing research. It highlights those areas of cost-analysis methodology needing improvement or further research. At the same time, it provides a device for incorporating the results of current research into the methodology depicted by the model.

2. Limitations

The benefits that analysts can obtain by the proper use of cost models are impressive. However, there are undeniable limitations, and the development and use of cost models present problems that might not otherwise have to be met.

Most cost models are of expected value in nature (deterministic) (i.e., estimating relationships are expressed as direct mathematical functions so that the output is determined specifically when the inputs have been furnished). The numeric values used as inputs and in the estimating relationships are best estimates or expected values that are intended to represent a real world that is not so easily reproduced. Estimating relationships always involve uncertainty. Unfortunately, the use of a deterministic model may encourage the analyst to feel that he has a technique for estimating the only output that is correct. Failure to recognize inherent uncertainty could be a serious error in analysis, and the use of expected-value models may make such failures more likely.

Cost models may be broadened to address the problem of uncertainty;[1] however, analysts have found a fairly strong demand for point estimates of cost. No matter what supplementary information the cost analyst wants to supply, he is usually asked for one best estimate of the cost of each item, and no matter how desirable probabilistic cost models may seem in concept, the working analyst continues to find that he is asked to use expected-value cost models.

The model designer selects essential relations to include in his model, and, unfortunately, the model user might readily develop the habit of thinking about only those relations represented in the model. Of course, the designer should always be aware that the model is a simplification and that its use involves the assumption that all outside relations are unimportant (e.g., Newton's model of a falling object neglects atmospheric drag). However, repetitive use of the same model may focus undue attention on those functions that are represented and may lead to unexamined belief (or feeling) that no other functions can be of interest. For example, Newton's model also assumes g to be constant, although in fact, g is not exactly constant.

The preceding comments relate to problems that arise from misdirected attention on the part of the operator of a cost model. They are representative of an almost unlimited class of such problems. However, it can be argued that the use of a model does not necessarily increase the likelihood of misdirected attention. The advantages, or perhaps the necessity, of using cost models will usually outweigh the possible limitations. Models, as any tool, must be used with proper care, skill, and judgment.

B. Model Maintenance

A model must be an adequate representation of the current real world to be useful. An excellent model developed in the past to represent the world as it existed in the past may still be an excellent model of today's world, but the analyst who uses an existing model must be aware that, in effect, he is deciding that the model is still good. To make sure that the model will merit this confidence, proprietors of cost models must provide for continuing maintenance. They must make sure that the

1 P.F. Dienemann, "Estimating Cost Uncertainty Using Monte Carlo Techniques," The Rand Corporation, RM-4854-PR, January 1996.

estimating techniques that are in the models not only continue to be of the correct functional form but that they also continue to have the best numeric values for all coefficients or parameters. This assurance is not possible without a positive program to monitor relations in the real world. Every cost model imposes a duty on its operator, who must arrange (or be satisfied with existing arrangements) for an information system that can be expected to give appropriate notice when the model should be modified.

The need for information about values and relations that are inside the model is evident. A less obvious need is frequently a greater problem. The model operator must be ready to use the model for a fairly wide range of cases. This readiness requirement implies the availability of reasonable values for all inputs that might be needed. The model operator must have a continuing program to stay informed on the wide range of cases that can be studied using his model.

C. Computerized Cost Models

The application of computers to cost models offers many advantages to cost analysts who use these models. First, the computer is fast and relieves the analyst of much of the tedium of making numerous calculations (which also involve many chances for making errors). It should be noted that although the computer may be able to complete a job in a matter of seconds, the time required for developing and entering the inputs and processing the outputs may create a total turnaround time of several hours or days. Also, the input can be saved on magnetic tape or a diskette for future use, which facilitates revision and reprocessing.

In addition to the obvious advantages of speed and accuracy, a computerized cost model provides a useful documentation aid. Once the computer program is operable, the analyst has the cost methodology actually documented within the computer program. Cost-sensitivity analysis, which attempts to demonstrate the effect on the outputs of changes in the inputs, becomes much more practical when a computerized model is available to examine a range of cases and numerous variations in each case.

Another advantage of a computerized cost model is that in its development the analyst is often forced to make decisions that clarify potentially troublesome areas of the model that cannot always be foreseen and which might be overlooked. Other kinds of troublesome areas may exist in which estimating relationships are either unknown or seldom used. A computerized program can provide for these by means of throughputs. A throughput is a data input that has been calculated outside of the computer and that is intended to be included in the final tabulations and summaries without further processing. In other words, the computerized cost model must be a precise, bounded framework of a specific methodology. Often, either in the programming or initial operation of a model, these areas (including illogical steps) are highlighted because many runs can be made on the computer to explore many kinds of situations.

A computerized cost model program and data inputs may be stored in easily retrievable form on tape or disk. With occasional revision as the data and relationships require updating, they are available for use whenever necessary.

One of the disadvantages of using a computerized cost model is that sometimes the model is almost too automated for the benefit of the user. A model can never be a substitute for the ability of the analyst to perform the estimating job (i.e., his ability to develop reasonable and realistic inputs based on judgment and experience). The analyst must continue to be aware that the outputs of the model are only as good as the inputs that produced those outputs. Such outputs must always be judged in the context of the model that is used.

Generally, a large, complex model that is to be used many times is the most suitable for programming on a computer. For a model that is developed for one specific application, the question of whether to program such a model for computer use depends on several factors. Basically, one must decide whether the advantages of the computer model would offset the time and effort required for programming and verifying such a model. For some operations it might be advantageous to program the model even if it is to be used only once. In other cases, based on judgment of the analyst, it might be more expedient to use a desk calculator.

In developing a computerized cost model, analysts often faces the need to communicate the description of the model to the computer programmers. The analysts must not only show all of the mathematical relationships in the models to the programmers, but, perhaps even more important, they must also show the sequence of operations. Specifically, they must show the logic of the models. It must be realized that a computer, like a person, performs only one calculation at a time. There are no parallel paths in a computer program where several calculations are performed simultaneously; therefore, all calculations must be shown sequentially.

One way that analysts can communicate this information to programmers is through the use of flow charts that depict the sequence of operations through a program. Such charts can be used to depict various calculations according to their functions within the program. Once these are established, charts may be constructed in greater detail, including the estimating relationships. Finally, a highly detailed flow chart may be prepared that depicts every step of the program, including loops for repetitive calculations.

Figure 22-1 shows a simplified cost model flow chart that gives the sequence of operations for a computer program that calculates total facility costs. More detailed flow charts could be developed later. Generally, in developing a detailed flow chart, the analyst need only ask, "If I were doing this problem by hand, what is the first step I would perform; then what is the second step; what is the third step; etc.?" A computer performs in exactly the same way and must be told how to perform every step through a program.

3. ESTIMATING SOFTWARE

Computerized cost estimating began more than 25 years ago on mainframe computers. However, due to the cost and difficulty of running a mainframe computer, most estimating departments still used manual methods until personal computers (PCs) evolved. In the early 1980s, PCs developed sufficient speed and power to easily handle the amount of data generated in detailed cost estimates. As computerized cost estimating gained popularity, more and more software packages were developed, both commercially and in-house by DOE cost departments. The software ranges from parametric to detailed estimating packages, and many are owned by the DOE. Some were developed by the Office of Infrastructure Acquisition (FM-50).

A. Survey of Available Software

In the past, FM-50 has conducted a survey of available software, including DOE-owned and commercial packages. It was found that most cost-estimating programs are written for use in one of four categories:

- programs for use by general contractors,
- programs for use by architects,
- programs for check estimates on quotations received from contractors, and
- highly specialized programs related to cost estimating.

The general contractor programs are used for the preparation of cost estimates associated with design project bids. The architect programs are used to estimate the cost of projects prior to completion of project design. The check estimate programs are used to check the contractor's cost estimate of a designed project or to do conceptual cost estimates. The specialized programs include such things as life-cycle costs, bid day, heavy-equipment rental/charge rates, cost program data bases, highly specialized cost estimating programs for painting, windows, etc., and design and cost programs for highly specialized equipment, etc.

Programs for use by architects differ from the contractor programs in three ways. They generally provide a national cost data base. They do not need the job-costing, accounting, inventory, etc., capabilities or interface. Also, a computer-aided drafting (CAD) interface benefits architects more than contractors.

Programs that perform check estimates or conceptual or budget estimates typically use algorithms and assemblies to generate estimates. They typically do not generate detailed estimates like the contractor or architectural application programs.

The specialty programs relate to cost estimating but cannot be categorized as one of the other three types. These include such things as programs to manage historical cost data, calculate contingency, or track escalation factors.

All of the cost estimating programs access and extract information from a summary cost data base. Users can extract the data and create the estimate (a secondary data base). The programs provide mechanisms for manipulating the estimate data base and for preparing or modifying the summary cost data base. All programs also contain various reporting functions.

Some of the cost programs can read drawings created by CAD or manufacturing programs. Such programs allow the draftsperson to attach to the drawing all the supporting information necessary to prepare the cost estimate. For example, in drawing a building floor plan, the draftsperson must draw doors, which require information about size, type, function, part number, manufacturer, etc. All this information can be attached to the drawing in a data base. As the CAD system generates the floor plan, it also generates a large volume of data that can be used by the cost estimator.

B. DOE-Owned Software Packages

DOE has developed several software packages for all levels of estimating. FM-50 developed (1) a statistical package for developing CERs, (2) a historical cost data management program, (3) a contingency analysis program, and (4) two detailed estimating programs. Other DOE-owned software packages are typically detailed estimating programs developed in-house by various cost departments.

1. The Enhanced Cost Estimating Relationship Program

The Enhanced Cost Estimating Relationship (ECER) Program operates on International Business Machines (IBM)-compatible equipment and formulates equations from data provided by the user. A simplified version of this program that uses statistical procedures to formulate cost equations was developed in 1985 (the CER program). Users needed only limited knowledge of statistics. The original program communicated with the user in simple, easy to understand terms, and the statistical aspects were handled “behind the scenes.” The program required minimal working knowledge of microcomputers.

ECER communicates with users in the same easy-to-understand terms, and it requires only a minimal working knowledge of personal computers. The

ECER program, however, was designed for users with a statistical background. ECER includes t and F factors, the Durbin-Watson statistic, confidence intervals, and correlation coefficients for the independent variables.

The program requires Microsoft or PC Disk Operating System (DOS) and Beginner's All-Purpose Symbolic Instruction Code, which are copyrighted and must be obtained separately and installed on the machine.

The ECER program performs regression analyses on data sets by three different independent variable functions. The equations analyzed by the program are shown in Table 22-1. The program generates equation coefficients and correlation coefficients for these equations. Although the program selects an equation with the largest overall correlation coefficient, the user can analyze any of the available equations.

The data base capabilities of the ECER allows users to enter values for up to 15 variables. When developing the equations, users must select up to three independent and one dependent variables. Users must also specify which of the variables must be escalated. ECER has two modes, automatic and interactive. In the automatic mode when users chose three independent variables, the computer finds the best fit equation for each level: three variables, two variables, and one variable. Then the ECER program selects the "best" (highest R) equation for each level and prints the statistical results for each of the three equations. ECER also saves the regression analyses results on the disk so that they can be recalled later. The results that are printed and saved include the correlation coefficient, adjusted correlation coefficient, t's for Y and each of the independent variables, the Durbin-Watson statistic, F, table values of F and the Durbin-Watson statistic, and actual and predicted Y's. The interactive mode prompts users through the regression analysis. It also allows users to estimate the dependent variable by inputting values for the independent variables. The program displays the predicted value of Y and the confidence interval.

An option allows the user to update the costs to a common date by using previously loaded cost indices. The cost indices can be loaded by month or year. The cost indices may also be edited, and the user may store multiple escalation indices and then specify which index is to be used for a given set of data. This allows the user to store indices for different types of commodities as well as indices projecting different rates of inflation that can be used for sensitivity analysis.

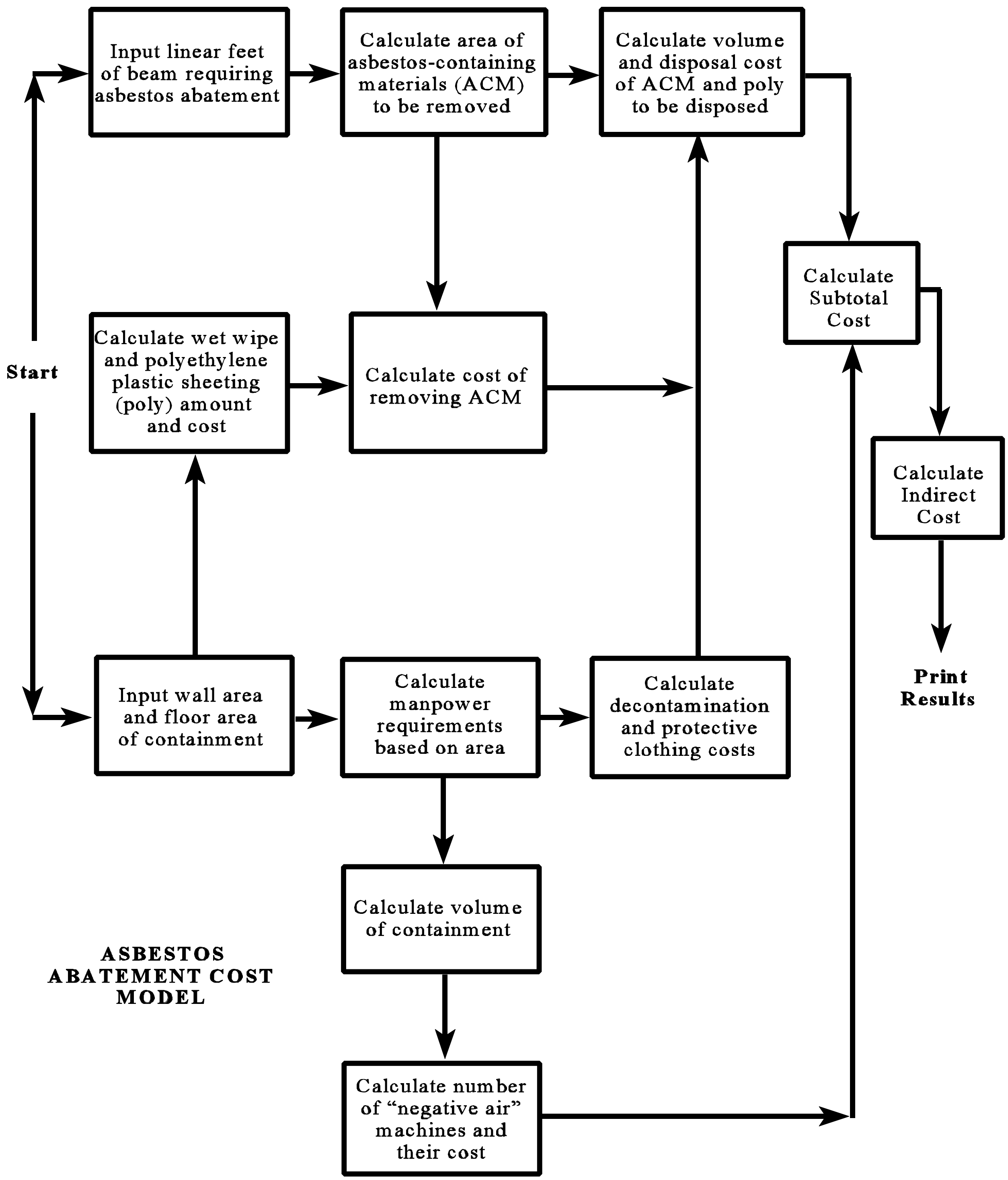

Figure 22-1. Simplified Cost Model Flow Diagram.

TABLE 22-1

EQUATIONS ANALYZED BY THE ECER PROGRAM

Three Independent Variables

1. COST = a + b1x(X1) = b2x(X2) + b3x(X3)
2. COST = a + b1x(X1) = b2x(X2) + b3/(X3)
3. COST = a + b1x(X1) = b2x(X2) + b3xLOG(X3)
4. COST = a + b1x(X1) = b2x(X2) + b3x(X3)
5. COST = a + b1x(X1) = b2x(X2) + b3/(X3)
6. COST = a + b1x(X1) = b2x(X2) + b3xLOG(X3)
7. COST = a + b1x(X1) = b2xLOG(X2) + b3x(X3)
8. COST = a + b1x(X1) = b2xLOG(X2) + b3/(X3)
9. COST = a + b1x(X1) = b2xLOG(X2) + b3xLOG(X3)
10. COST = a + b1/(X1) = b2x(X2) + b3x(X3)
11. COST = a + b1/(X1) = b2x(X2) + b3/(X3)
12. COST = a + b1/(X1) = b2x(X2) + b3x(X3)
13. COST = a + b1/(X1) = b2/(X2) + b3x(X3)
14. COST = a + b1/(X1) = b2/(X2) + b3x(X3)
15. COST = a + b1/(X1) = b2/(X2) + b3x(X3)
16. COST = a + b1/(X1) = b2xLOG(X2) + b3x(X3)
17. COST = a + b1/(X1) = b2xLOG(X2) + b3/(X3)
18. COST = a + b1/(X1) = b2xLOG(X2) + b3xLOG(X3)
19. COST = a + b1xLOG(X1) = b2x(X2) + b3x(X3)
20. COST = a + b1xLOG(X1) = b2x(X2) + b3x(X3)
21. COST = a + b1x(X1) = b2x(X2) + b3x(X3)
22. COST = a + b1x(X1) = b2x(X2) + b3x(X3)
23. COST = a + b1xLOG(X1) = b2x(X2) + b3/(X3)
24. COST = a + b1xLOG(X1) = b2x(X2) + b3xLOG(X3)
25. COST = a + b1xLOG(X1) = b2x(X2) + b3x(X3)
26. COST = a + b1xLOG(X1) = b2x(X2) + b3/(X3)
27. COST = a + b1xLOG(X1) = b2x(X2) + b3xLOG(X3)

Two Independent Variables

1. COST = a + b1x(X1) + b2x(X2)
2. COST = a + b1x(X1) + b2/(X2)
3. COST = a + b1x(X1) + b2xLOG(X2)
4. COST = a + b1/(X1) + b2x(X2)
5. COST = a + b1/(X1) + b2/(X2)
6. COST = a + b1x(X1) + b2xLOG(X2)
7. COST = a + b1xLOG(X1) + b2x(X2)
8. COST = a + b1xLOG(X1) = b2/(X2)
9. COST = a + b1xLOG(X1) + b2xLOG(X2)

One Independent Variable

1. COST = a + b1x(X1)
2. COST = a + b1/(X1)
3. COST = a + b1xLOG(X1)

In most statistical programs, once the data are entered and the program is run, those data cannot be changed. If a new data point is found, or one of the old data points needs to be changed, the entire data set must be reentered. This statistical program provides the flexibility for the user to change a single data point or add additional points without reentering the rest of the data.

2. The Historical Cost Data Base Management Program

The Historical Cost Estimating program operates on IBM-compatible PCs. It is a vehicle for organizing and storing cost estimates done in the past. The program is tailored to each user to allow the estimates to be stored in their format. Normally, estimates are broken down into 10 or 20 major codes of accounts for storage in this program. Users also input their own escalation factors, which are then used to automatically escalate the cost data to the desired year.

To use this program to estimate the cost of a new project, the user first selects one or more projects in the historical file that are similar to the project requiring an estimate. The program provides several ways to locate data so that the user can easily find the appropriate projects. The user inputs the date for the new costs and the program escalates the similar projects to that date. The user also inputs a cost driver (such as square footage for buildings) for the new project. The program then ratios the costs of the historically-selected projects to the cost of the new project.

The program outputs the cost of the new project using the same code of accounts used to load the historical projects. The user can change any of the costs or quantities to reflect unique attributes of the new project.

3. The Independent Cost Estimating Contingency Analyzer

The Independent Cost Estimating Contingency Analyzer (ICECAN) uses a Monte Carlo method to calculate the contingency that should be added to an estimate for a given probability of budget overrun. Estimators enter one or more costs and their associated probabilities for the different parts of an estimate. The probability distribution for a cost variable can be any one of four types: fixed, normal, discrete, or step-rectangular. The following parameters are input for each distribution.

a. Fixed - a single cost value is entered. The probability of 100 percent is not entered. The cost will be this fixed value in all samples.

b. Normal - a mean (or average) cost value is entered. The probability is assigned a standard deviation.

c. Discrete - up to 19 cumulative probabilities (i.e., the final entry must be 1.0) are entered. Up to 19 cost values are entered such that the probability of cost value I occurring is equal to the difference between probability entries I and I-1.

d. Step-rectangular - up to 20 cumulative probability/cost value pairs as above. The probability of a variable having a linearly distributed value between cost value I-1 and cost value I is the difference between probability value I and probability value I-1. The user must supply the base cost.

When all of the cost and probability data are entered, the program asks the user to select the number of iterations. ICECAN executes the model by taking the specified number of samples. For each sample, ICECAN calculates the total cost by randomly selecting values for each cost variable based on the probabilities entered. The frequency distribution of the total cost is used to calculate the required contingency based on the desired possibility of overrunning the budget.

4. Detailed Cost Estimating Programs

Two detailed estimating programs were developed by FM-50: the Holmes & Narver (H&N) and Los Alamos National Laboratory (LANL) programs. The H&N program was developed jointly with the H&N Cost Department at the Nevada Test Site. The LANL program was developed jointly with the Los Alamos National Laboratory Cost Department. A third program called Automated Estimating System (AES) was developed by the Martin Marietta Cost Department at Oak Ridge National Laboratory (ORNL).

a. The H&N Cost Estimating Program: The H&N Cost Estimating program is used to create cost estimates by pulling detailed cost items from the Corps of Engineers' Computer-Aided Cost Engineering System (CACES) data base. Any data base can be formatted so that it can be used with the program. The program can conduct yearly updates of the data base. The program uses rate tables, which contain labor and equipment rates used in the cost estimate. The user can also create custom rate table adders. The program contains four estimate reports. However, the reports can be modified by the user to fit any format. Users can scan through the data base by using a look-up routine. With the look-up routine, the user chooses the main division, then the subdivision, then scrolls that portion of the data base until the desired record is located.

The hardware requirements include an IBM-compatible PC with one diskette drive, a fixed disk with at least four megabytes of disk space, and a 132-column printer. An 80286 or 80386 processor is recommended.

b. LANL Estimating System: The LANL program was originally written by the Los Alamos National Laboratory to run on a Data General mini-computer and is used by the Cost Department at Los Alamos for all their estimating. DOE funded Los Alamos to develop a PC version of this program. FM-50 converted the Corps of Engineers' CACES data base so it could be read by the LANL program. The hardware required includes a DOS-compatible PC with at least 5 megabytes of hard disk space, 512K internal memory, and a math co-processor.

The program provides a large selection of output formats. A user can load a single estimate and, by tagging individual line items to appear in different places, output up to four distinct formats (e.g., a Construction Specification Index output and a DOE code of accounts output). As each line item is called up, the user may change any parameter in the data base. Although DOE can supply the user with a site-specific data base, the program does not allow the user to make any permanent changes in the data base or to add any items to the data base.

The data base used in the program is the same one used nationwide by the U. S. Corps of Engineers. This is a very detailed data base containing approximately 19,000 line items. The data base is updated annually by the Corps. Every line item in the data base is keyed to one of approximately 200 selected line items that are used to create a site-specific data base. To obtain a site-specific material data base, the user finds the cost in his area for each of the 200 line items, and a program is then run to adjust the 19,000 line items based on these 200 items. The user can also submit local labor rates which can be incorporated into the data base.

c. AES: The AES was developed by Martin Marietta at ORNL. Through a special agreement with DOE, Martin Marietta maintains all rights to the commercial use of this program, but DOE estimators and DOE contractors are free to use the program on DOE projects. The hardware required includes a DOS compatible PC with a hard disk.

AES is a detailed estimating program that can access the CACES data base. The user inputs the item description, quantity, unit cost, installation hours, and craft code or selects an item from the data base. The program has a craft rate data base that the user inputs. Several rates can be entered for each craft and called upon when doing estimates.

The estimate is broken down into separate work breakdown structures by the user. Users can input headings and subheadings in place of costs in the line items that will be printed in the output. The program allows the user to input escalation rates and start and end dates for the work breakdown structures. The program outputs an expenditure schedule for the project by quarter. Several S-shaped project expense rate curves are stored in the program, which may be specified by the user to scale the expenditure rate through the life of the project.

C. Commercial Software

In addition to the DOE-owned software, many companies market software for cost estimating. Like the DOE-owned software, they cover all types of estimating. The survey report discussed earlier in this chapter discusses many of the programs available and also provides an overview of the trends in estimating software. The survey contains descriptive information of several programs. A copy of the latest survey is available from FM-50.