UNIT 4

COST ESTIMATION

4.1 TYPES OF ESTIMATE

Estimates can be developed in a variety of different ways depending upon the use of the estimates
and the amount of detail provided to the estimator.

Every estimator should understand every estimating method and when to apply each, because no one estimating method will solve all estimating problems.

4.1.1 Guesstimates

Guesstimates is a slang term used to describe as estimate than lacks detail. This type of estimate
relies on the estimators experience and judgment.

Usually, the tool and die estimator is estimating tool cost without any tool or die drawings. The estimator typically works from a piece part drawing and must visualize what the tool or die looks like. Some estimators develop some level of detail in their estimate.

Material cost, for example, is usually priced out in some detail, and this brings greater accuracy to the estimator by reducing error. If the material part of the estimate has an estimating error of plus or minus 5 per cent and the reminder of the estimate has an estimating error of plus or minus 10 per cent, the overall error is reduced.

4.1.2 Budgetary

The budgetary estimate can also be a guesstimate but is used for a different purpose. The budgetary estimate is used for planning the cost of a piece part, assembly, or project.

This type of estimate is typically on the high side because the estimator understands that a low estimate could create real problems.

4.1.3 Using Past History

Using past history is a very popular way of developing estimates for new work. Some companies go to great lengths to ensure that estimates are developed in the same way actual cost is conducted.

This provides a way past history in developing new estimates. New advancements in group
technology now provide a way for the microcomputer to assist in this effort.

4.1.4 Estimating in Some Detail

Some estimators vary the amount of detail in an estimate depending on the risk and dollar Amount of the estimate. This is true in most contract shops. This level of detail might be at the operation level where operation 10 might be a turning operation and the estimator would estimate the setup time at 0.5 hours and the run time at 5.00 minutes. The material part of the estimate is usually calculated out in detail to reduce estimating error.

4.1.5 Estimating in Complete Detail

When the risk of being wrong is high or the dollar amount of the estimate is high, the estimator will develop the estimate in as much detail as possible.

Detailed estimates for machinery operations, for example, would include calculations for speeds, feeds, cutting times, load and unload times and even machine manipulations factors.

These time values are calculated as standard time and adjusted with an efficiency factor

to predict actual performance.

4.1.6 Parametric Estimating

Parametric estimating is an estimating method developed and used by trade associations. New housing constructions can be estimated on the basis of cost per square.

There would be different figures for wood construction as compared with brick and for single strong construction as compared with multilevel construction.

Some heat-beating companies price work on a cost per pound basis and have different cost curves for different heat-treating methods.

4.1.7 Project Estimating

Project estimating is by far the most complex of all estimating tasks. This is especially true if the project is a lengthy one. A good example of project estimating is the time and cost of developing a new missile.

The project might take 5 years and cost millions of dollars. The actual manufacturing cost of the missile might be a fraction of the total cost.

Major projects of this nature will have a PERT network to keep track of the many complexities of the project. A team of people with a project leader is usually required to develop a project estimate.

4.2 STANDARDDATA

Standard data are defined as standard time values for all the manual work in an estimate standard
data provide the opportunity for the estimator to be consistent in developing an estimate.

4.2.1 How Standard Data are Developed?

Standard data are developed in a variety of ways depending on the industry that uses them. Experience shows that it is easier to develop standard data for machinery operation as compared with fabrication operation.

This is because machinery operations can be calculated by using speeds, feeds and lengths of cut to determine time values.

Most of the work content of a fabrication operation is manual effort rather than machine time, and for this reason reliable standard data for the fabrication industry are difficult to find. Listed below are the basic methods used to develop standard data.

4.2.2 Past History

Many companies use past history or actual performance on joules produced to develop standard data.

Developing standard data this way rarely considers the best method of organizing work. This method is popular in smaller companies that do not have industrial engineers or time study engineers.

4.2.3 Time Study

Larger, well-organised companies will develop standard data from stop-watch time studies. Time studies are used to establish rates of production.

However, when time studies are also used to establish standard data, care must be taken in defining element content so work content can be isolated.

Time study engineers must be taught how to establish the element content of their studies in a way that will permit the development of standard data.

4.2.4 Predetermined Time Standards

Another approach in the development of standard data is to use one of the many predetermined time standard systems like MTM or MOST.

This method has its advantages and disadvantages. The chiefly advantage is consistency of data, and the chief disadvantage is the amount of time necessary to develop the data.

Some predetermined time standard systems are now computerized, which shortens the development time.

4.2.5 Standard Data Specific to a Shop and Lot Size

It should be pointed out that ―all standard data are specific to a given shop and lot size.‖ Standard data developed in a high-production shop under ideal methods are of little value to a job shop that runs lot, sizes of 10 parts each. The reverse is also true.

The use of efficiency factors or off standard factors can assist in using the same data for both conditions, but this is less than ideal.

The reverse use of learning curves, that is, backing up the curve, is a better method of repricing work for small lot sizes using this method, the same standard data can be used for high and low production.

4.3 MATERIALS AVAILABLE TO DEVELOP ANESTIMATE

Materials available for developing an estimate vary widely depending on what is being estimated.

In most cases the quality of the estimate will depend on the amount of materials to make the estimate.

Estimating materials shown below is a listing of the materials available for making an estimate.

No drawings

In many cases there are no drawings of what is being estimated. One clear example of this is tool estimating. The estimator will develop an estimate for a progressive die, for example, by reviewing the price part drawing. Some die estimators will develop a strip layout for the part and then estimate the die cost station by station.

Sketches

Sometimes sketches of the parts represent the only information available. This is typically true for a budgetary estimate.

Line drawings

Loftings or line drawings are used for estimating in some industries. The pleasure boat industry represents an example. A full-scale lofting of a deck and hull is used to estimate both the material and labour for a new fiber glass boat.

Complete drawings

Complete drawings and specifications are available for estimating some work. The aircraft industry is one good example.

Many times the estimator will spend more time reading the specifications than developing the estimate. This is necessary because the specifications will often determine the part process.

4.4 METHODS OFESTIMATES

4.4.1 Computer Estimating

Computer estimating has become very popular in recent years primarily because of the advent of the micro computer. Early efforts of computer estimating date back to the early 1970s but were cumbersome to use because they were on a mainframe and were card-driven.

No less than 15 U.S. companies now offer estimating software for a microcomputer. Because the computer estimating industry is new, there are no real standards for estimating programs. Some programs are nothing more than a way to organize the calculations of an estimate, while others calculate all the details of the estimate.

Advantages and disadvantages

Shown below are some of the major advantages of computer cost estimating.

Accuracy versus consistency

Computer estimates are very consistent, provided they calculate the detail of an estimate. Because these estimates are consistent, they can be made to be accurate.

Through the use of consistent efficiency factors or leaving curves, estimates can be adjusted up or down. This is one of the chief advantages of computer cost estimating.

Levels of details

Some computer estimating systems provide different levels of estimating cost. The level of detail selected by the user depends on the dollar risk.

Many estimators produce an estimate in more detail because the computer can calculate speeds and feeds, for example, much faster than an estimator can a hand-held calculators.

Refinements

Some computer estimating systems provide many refinements that would be impossible for the estimator to do in any timely manner. One example is to adjust speeds and feeds for material hardness.

Typically, the harder the material the more slowly a part will be turned or bored. Another refinement is the ability to calculate a feed state and adjust it based on the width of a form tool.

Source code

Some companies offer the source code uncompiled to their users. This is important because it affords the user the opportunity to customize the software.

In addition, many companies have written their

own software to do something that is not available on the market. If the source code is not compiled, the users can build upon a computer estimating system.

Disadvantages

The chief disadvantage of computer estimating is that no one estimating system can suit every ones need. This is especially true if the source code is compiled and not customizable.

Another problem with computer estimating is that the estimator will, in all probability, have to change some estimating methods. Computer software for estimating cost is seldom written around one method of estimating.

4.4.2 Group Technology

Group technology is not new. It was invented by a Russian engineer over 30 years ago. Unfortunately the subject is not taught in many of our colleges and universities.

Group technology (GT) is a coding system to describe something. Several proprietary systems are on the market.

One such system, the MICAPP system, uses four code lengths, a 10-,15-,20-,25- digit code. The code length selected is based on the complexity of the piece part or tool being described.

Use for group technology

Shown below are several uses for group technology along with several examples of use both internally
and externally.

Cost estimating

GT can be used very efficiently in estimating cost. Assume a company manufactures shaft-type parts. Also arsum there is a computer data base named SHAFT that contains 10-digit code followed by a part number, that is, code part number, and so on.

When an estimator must estimate the cost of a new shaft, the process starts by developing a code that describes the characteristics of the part. The first digit in the code might be assigned the part length, while the second digit is assigned the largest diameter and so on.

Next, the code is keyed in and the computer finds all the parts that meet the numeric descriptions and points out the part numbers. The best fit is selected to be modified into a new part.

All the details of each description are retrieved. These include diameter, length of cut, number of surfaces, and the like. The estimator can alter these features and make the old part into a new one.

Actual performance

As the part is being produced, the estimated information is updated with actual performance and refined. This gives the estimator the ability to improve estimating accuracy, because the next time, the computer finds that part as one to be modified into a new one, the estimator is working with actual performance.

Other use for GT

There are many other uses for group technology one that is similar to estimating is variant process planning, in which a standard process plan is on file for each operation and can be modified into a new plan. One carbide tool manufacturer produced a line of carbide drills and reamers and in their series 10 line and they had 758 different designs.

After a matrix to describe these tools was developed, a code for each tool was developed and the database was established. The company conducted a redundancy search and found that 9% of the existing designs were either look-alikes or very similar. Now the company conducts a database search first when confronted with a new design.

4.4.3 Parametric Estimating

Parametric estimating is the act of estimating cost or time by the application of mathematical formulas.

These formulas can be as simple as multiplices or as complex as regression models. Parametric estimating, sometimes refused as statistical modeling, was first documented by the Rard Corporation in the early 1950_s in an attempt to predict military hardware cost.

Use of parametric estimating

Many companies use some form of parametric estimating to develop sales forecasting. The four
examples cited below will give the reader a good feel of how parametric estimating is used in a variety of different industries.

Construction industry

In developing a cost estimate for residential buildings, some cost estimators use a dollar value per square foot. The estimator constitutes curves based on different construction such as wood on brick buildings and single or multi-storey dwellings.

These numbers can then be multiplied by the number of square feet in the building. Some construction companies have refined this process to provide additional detail carpeting, for example, could have a separate multiplier.

Heat treating

Most commercial heat-treating companies price their work based on a cost per pound and heat treating method.

Heat-treating costs are very difficult to define because many times more than one type of part is in the heat-treating furnace at the same time.

It is difficult to think of a more effective way to estimate cost for this type of industry.

Tool and die industry

As pointed out earlier, estimating cost for a progressive die can be very difficult because the estimator seldom has a die drawing to work from some tool and die shops have developed parametric estimating methods that take out some of the guestimating.

This method is known as the ―unit value‖ method over a period of time, the estimator collects actual time values about dies being produced. Once the estimator is satisfied that the data are correct, they are over aged into usable hours.

As an example, this might include 4 hours for every inch of forming or 3 hours for every hole under 2 inches in diameter. The unit value can stand for several meanings. For flowing it is a number of inches being formed.

For holes under 2 inches, in diameter, it represents the number of holes. The estimator might establish a factor of 40 hours for a degree of difficulty. If the scrap cutter is _Standard‖ the unit value is 1.

If the scrap cutter is more difficult, the unit value might have a value of 1.5 where the hours allotted would be 60.

Helicopter transmission

A helicopter transmission is a large complicated assembly comprised of a planetary gear system, bevel gears, shafting, and housings. Budgetary estimates for a transmission are usually developed using a variety of parametric methods.

The housing costs are based on weight. The bevel gear cost is based on number of teeth, and the planetary gear cost is based on gear face width and number of teeth. If methods like these were not employed, it would take hundred man-hour to produce an estimate.

Collecting and testing data

The single most important activity in parametric estimating is data collection and testing. Once the estimator develops the estimating methods, enough sample data should be collected for a natural bell curve. Statistical testing of the curve is also very important.

Once the parametric data are used for estimating it is important to continually test them against actual performance and refine them as necessary.

(a) Other factors that affect cost estimating

There are other factors that affect the accuracy of a cost estimate. Several of these are cited below.

Project estimating

Inflation analysis and risk analysis come into play in project estimating. A multi-year estimate, such as many government contracts, is especially sensitive to both these factors.

Inflation

When the estimate is being developed for future time periods, inflation rates are very important considerations.

The three most popular measurements of inflation are the wholesale price index, the implicit price index, and the consumer index, the last being the most quoted.

Because inflation rates are difficult to estimate accurately most multi-year contracts have some provisions reopeners to renegotiate. An after-tax evaluation of a multi-year project provides a more accurate assessment because it take into consideration costs that are not sensitive to inflation.

These costs might be loans repayment, leases, and depreciation costs.

Risk analysis

Risk analysis is a series of methods used to quantify uncertainty. Most of these methods are math models. Three broad classifications of risk associated with a project are cost, schedule, and performance. Some of the most popular methods of risk analysis are:

1. Program Evaluation and Review Technique(PERT).
2. Probabilistic Analysis of Network(PAN).
3. Risk Information System and Network Evaluation Technique(RISNET).

4.4.4 Statistical Estimating

The analysis of data through the use of statistical methods has been used for centuries. These data can be cost versus other information that leads to cost development.

The practitioner must have a well-founded background in the use and application of statistical methods because an endless array of methods is available, several of which are described below.

Parametric estimating

Statistical estimating is another form of parametric estimating. The parametric methods made industry oriented whereas the methods discussed below are universal.

Regression analysis

They form most popular of regression analysis are simple regression, multiple regression, log-linear regression and curvilinear regression.

Each math model is different and is designed for a specific use. Information can be regressed along a straight line or along a curve.

Statistical estimating methods are very useful in parametric estimating. To use any of these methods also requires the user to have a sound knowledge of ―goodness of data fit‖.

Math models are available to determine how well data fit a straight line, curve or log-linear relationship.

Computers

Because of the complex nature of statistical estimating, the use of a computer is required. Fortunately, many good commercial programs, many of which are not expensive, are available on the market.

4.5 IMPORTANCE OF REALISTIC ESTIMATES

If the estimated cost of a product proves later on, to be almost same as the actual cost of that product, it is a realistic estimate. The cost estimate may prove to be

(i) A realistic estimate,

(ii) An over-estimate ,or

(iii) Anunder-estimate.

• An over-estimate, later on, proves to be much more than the actual cost of that product.

• An under-estimate, later on, proves to be much lower than the actual cost of that product.

• Both over-estimate and under-estimate may prove to be dangerous and harmful for a concern. Assume that on the basis of an estimate, the concern has to fill up a tender enquiry.

The over estimate means the concern will quote a higher rate and thus will not get the job or contract. In case of an under-estimate, the concern will get the contract but it will not be able to complete the work within that small quoted amount and hence will suffer heavy losses.

This emphasizes the importance of making realistic estimates. Realistic estimates are very essential for the survival and growth of a concern.

4.6 ESTIMATINGPROCEDURE

The estimating department is generally attached with the planning department and is controlled by production manager. The total procedure is considered to have three stages.

(i) Fixing of design, accuracy and finish.

(ii) Proper working of estimating department.

(iii) Obtaining a delivery promise from the progress department in view of existing load on the shop.

The planning department sets down the requirements and specifications, type and quantities of materials, make out the drawing, lays down the methods and sequence of operations, machines to be used, allowed times and rates of labour etc. Main items to be estimated in order of sequence are as follows:

1. *Price list:* To prepare the list of all the components of the product.

2. *Buy or Manufacture:* To decide which components should be made in the factory itself and which component should be procured from the market.

3. *Weight of material:* Determination of the weight of the materials with various allowances.

4. *Material cost:* Determination of the material cost either at market price or at a forecast price.

5. *Outside purchases:* Determination of prices of outside purchases.

6. *Machinery or processing data:* Determination of cutting speeds and feeds for the materials selected and machining times for all operations.

7. *Labourcost:*Determinationoflabourcostofeachoperationfromperformancetimes and wage rates, including manufacturing and assembly and testing.

8. *Cost of tools and equipment:* Determination of cost of necessary special tools or equipment etc.

9. *Prime cost:* Determination of prime cost by adding labour cost into material cost.

10. *Factory overheads:* Determination of factory on cost and general overhead charges.

11. *Package and delivery charges:* Determination of package and delivery charges and also insurance charges if necessary.

12. *Total cost:* To calculate the total cost.

13. Standard profit and sales price: To decide standard profit and adding this into total cost so as to fix the sale price.

14. *Discount to be allowed:* To decide discount allowed to the distributors and adding this into sale price to get market price or catalogue price.

15. *Time of delivery:* Determination of time of delivery in collaboration with the progress department.

16. *Approval of management:* When the estimate is complete, it is entered intothe _Estimate form_ and submitted to the directors and sales department for dispatch of the quotation or tender.

Estimate Form

Description…… Date……

Quantity…… Enquiry No……

Drawing No…… Customer……

	Item	*Total Cost*	*Cost of Item*
1.	Material (……) No. of Components Batch No……		
2.	Operation Labour Overhead *(a)* *(b)* *(c)* *(d)* Total: (Factory cost)		
3.	Office and Administrative Expenses. Total: (Induction cost)		
4.	Selling Expenses *(a)* Packing and Carriage *(b)* Advertisement and Publicity *(c)* Other Allied Expenses Total: (Ultimate cost)		
5.	Profit Total: (Selling price)		

4.7 DIVISION OF ESTIMATINGPROCEDURE

The above said procedure for simplicity can be divided into following major groups: 1. Material Cost. 2. Direct Labour Cost.
3. Direct Expenses. 4. Various Overhead Expenses.

1. Material cost

This estimation is most important in cost estimation. In calculating material cost both direct and indirect materials should be taken into account. The estimation of materials for this job or product includes the calculation of quantities to be provided including allowances for scrap and wastage in cutting, punching, turning etc. and for spoilage in processing.

After calculating weights or volumes of materials required, the cost of materials is estimated from rate of material. The estimator should have full information about the availability of the material.

2. Labour cost

Next stage is the estimation of labour cost. For this purpose the estimator must have the knowledge of the operations which will be performed, tools to be used, machine that will be employed and the department in which the product is to work for different operations.

The labour cost is calculated by multiplying hourly rate of the worker by total time spent in processing a job. The total time spent includes the set up time, tear down time, operation time and other miscellaneous allowances such as personal, fatigue, tool sharpening and charging,

checking etc.

3. Direct expenses

It includes any expenditure other than direct material and direct labour incurred on a specific cost unit such as

(i) Hire charges of special tools or equipments for a particular production order or product.

(ii) Cost of special layout, design or drawing.

(iii) Cost of jigs and fixtures/pattern specially meant for the particular job only.

4. Various overhead expenses

All expenses other than direct material, direct labour and other direct expenses are called overhead expenses. These include the expenses such as

(i) Indirect material cost: These expenses include the cost of oil greases, coolants, cotton waste, etc.

(ii) Industrial labour cost: These expenses include the salaries of supervisors, foreman, draftsman, designers, chowkidars, storekeepers,etc.

4.8 CONSTITUENTS OF A JOBESTIMATE

The various constituents of estimating the cost of a product may be sub-divided as under:

(a) Design time.

(b) Drafting time.

(c) Method studies, time studies, planning and production time.

(d) Design, procurement and manufacture of special patterns, cores, core boxes, flasks, tools, dies, jigs and fixtures etc.

(e) Experimental work.

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(f) Materials.

(g) Labour.

(h) Overheads.

Design time

The time required for designing a product is estimated either on the basis of similar product previously manufactured or on the judgement of the designer. This time is generally considerable in quantity. It should be taken as the important.

(i) Repairs and maintenances expenses of machines and tools.

(ii) Insurance premium on building and plants.

(iii) Expenses of power such as steam, gas, electricity, etc.

(iv) Depreciation on building, furniture and equipment.

(v) Administrative overhead or expenses: These expenses include the salaries of high officials, persons working in general office, telephone telegraph, stationary etc.

(vi) Selling expenses: These expenses include the salaries of salesman, commission to salesman, advertising, publicity expenditure.

(vii) Light and power expenses.

(viii) Packing expenses.

(ix) Supervisory staff expenses.

Planned as regard the various processes and time to be taken by each. In case of routine or repetitive jobs, the planning would be available in the records. This may be checked up and the necessary modifications required may be made. In case of new jobs its method studies and time studies must be carried out.

The jobs should be broken down into its elements. For each part, sub-assembly and complete assembly, the type and sequence of operation should be studied and planned. Times for various operation and the schedules for doing the work should be seen.

This time setting effect both the delivery date as well as the cost. In case of a special order requiring considerable time, a special calculation should be made by making some allowance factor in estimating the cost of the product. The standard man hour rate should be used for calculating the cost of the designing time.

Drafting time

The next step after the design of the component is the preparation of its drawing to be used by the worker during production. An experienced draughtsman is required to prepare them. He also estimates the time and cost of drafting a new product. The probable time for drafting and the cost of drafting are estimated on the basis of drawing of similar previous components, and the standard man hour rate.

Method studies, time studies, planning and production time

Before the product is actually put into production, the material situation and purchase requisition
are investigated for different materials required for the product.

Now, the job must be produced. The main points to be considered for this purpose are cost of the equipment, labour, material, depreciation, overheads, repair and maintenance, special buildings if required, supervision and the time required to conduct the experimental work.

Materials

It is the most important factor in cost estimation of any component. While computing the cost of
material both the direct and indirect material should be taken into account. For this purpose the calculations of the quantities of raw materials allowances for scrap, spoilage and wastage during cutting, punching, turning etc. should be made.

Now the cost of the material is estimated from the rate of the material design, procurement and manufacture of special patterns, core boxes etc. The cost of special patterns, core boxes, tools, jigs, fixtures, gauges, consumable cutting fads etc. required for manufacturing a product should be considered for estimation. This cost should be added to the estimated cost. This cost is generally estimated in close coordination with Tool Department.

Experimental work

Certain types of experimental work has to be carried out in case of new type of products or inventions. The main purpose of experimental work is to find the quickest, easiest, and cheapest way of manufacture product. When estimating the cost of the new or undeveloped type of products the estimator should be very careful to make proper allowances to the experimental work.

Labour

For estimating the labour cost, the estimator is to go into greater details. He must be in knowledge of the various operations to be performed, tool to be used, machines employed and the departments in which the product is to be manufactured.

He must also be conversant with the wage rate for different operations. For time calculations we must consider. —The set up time; the operation time including the handling and machine time; the tear down time and various allowances like personal fatigue, tool sharpening or changing, checking etc.,

4.9 COLLECTION OFCOST

The various components of cost of any product manufacturing in any production concern are

1. Prime cost = Direct material cost + Direct labour cost + Direct expenses (if any)
2. Factory cost = Prime cost + Factory overheads
3. Cost of production = Factory cost + Administrative overheads + Miscellaneous overheads (if any)
4. Total cost = Cost of production + Selling and distribution overheads

The selling price of any product manufactured can be arrived at by adding a certain percentage of profit to total cost.

The given stepped diagram explains the step-by-step procedure of arriving at selling price of any product manufactured.

4.1 ALLOWANCES INESTIMATION

A worker cannot work continuously without rest. His efficiency decreases as time passes due to fatigue etc. He also requires time for tool sharpening checking measurements and for personal calls. All these allowance are called miscellaneous allowances.

The allowances amount to 15% of total time. Miscellaneous allowances are classified as personal fatigue, tool changing of grinding, checking, oiling and cleaning allowances, filling coolant reservoir and disposing off scraps and surplus, stock, etc.