Topic 3 Section 1

Introduction to Estimating and Project Cost Control

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Introduction

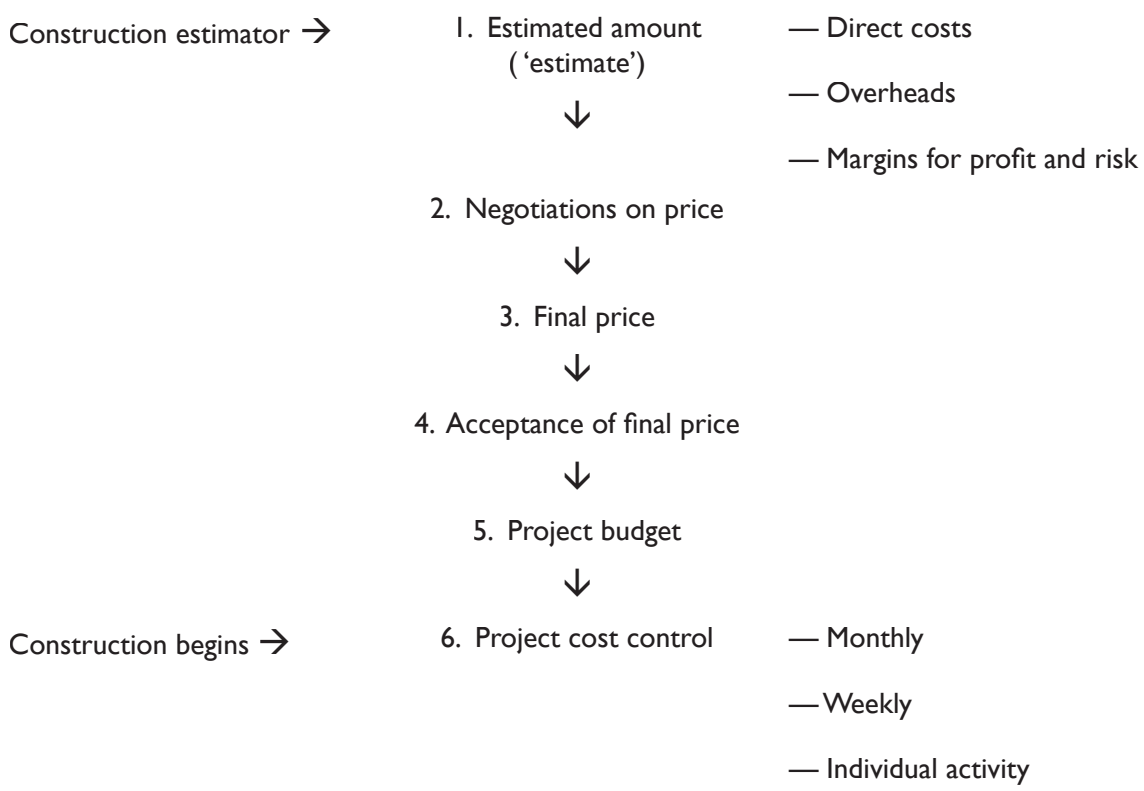
The first step taken when a civil construction project is required is to draw up an estimate; that is, a calculated guess about how much it will cost to do the work. A person called a construction estimator performs this task. The estimate includes:

- the direct costs of the project
- overheads
- margins to cover the contractor's profit and risks associated with the project.

However, as shown in the chart below, the estimate is used as the starting-point for negotiations between the principal (the person paying for the work to be done) and the contractor (the person doing the work). The amount initially estimated by the construction estimator changes as the negotiations proceed. Finally, the principal and contractor agree on a price and the principal issues a letter of acceptance. The project can then commence.

The contractor draws up a budget for the project, using the final price. However, when dividing up the money in the project budget, he may be guided by the various amounts shown in the original estimate (e.g. for earthworks and drainage).

The budget shows the project supervisor how much he expects to spend on the various parts of the job, and each week or month as the project proceeds. The project supervisor can therefore use the budgeted amounts when controlling the money spent on the project.



During the course of a civil construction project, the term 'estimate' is therefore used in two ways. It can mean:

- The initial estimate for the project, as prepared by the construction estimator, or
- Any process of making a judgement about a quantity or a length of time involved in the project.

In this topic, we use the term 'estimate' so that it has the second meaning. However, the first meaning is still important, as it represents the first step in drawing up a construction project.

Why are Estimates Carried Out?

An estimate is that part of the planning process where we are called on to estimate or to make an approximate judgement on:

- how long a job will take to complete
- how much material is required to carry out the task
- how many people we will need to assist in completing the task.
- what plant and equipment are required to complete the job

Once we have identified these important factors we can consider the cost and quantity of each item used, and the total cost of a project.

Estimates are used in all stages of construction work, from the initial development of a bid or tender, through to the day-to-day management of actual construction work on site.

Everyday Estimating

A dictionary definition of Estimate is: To assign a value to; assess; appraise. Most people make estimates or appraisals on a day-to-day basis, as part of their normal activities. For example, on a normal working day, a person may estimate:

- How far to turn the steering wheel of a car to negotiate a corner
- The selling price of a car or a house
- How long it is till lunch-time.

On a weekend, a person working in the garden may estimate the:

- Length of time to mow the lawn
- Number of trailer loads of rubbish to take to the dump
- Amount of soil required to top dress the garden
- Number of mates required to help paint the house.

What is Estimating?

In civil construction, estimation is the ability to predict the types and quantities of resources that will be needed on a work site for a given activity. The prime objective of the estimate is to:

- determine the method of construction
- identify quantities of work
- apply costs to the quantities
- classify and summarise the estimated resources and costs

Construction supervisors use both the knowledge they have gained from past jobs of a similar nature, and records from past work, when making estimates. The final estimate involves careful calculations of all the factors at hand.

There are three basic types of estimates that supervisors use to evaluate the costs of civil engineering projects. These include:

- approximate or rough estimates
- preliminary estimates
- detailed estimates

Each type of estimate has its place, depending upon the accuracy required.

Approximate (Rough) Estimates

We use approximate or rough estimates to assess the size of a project. Little preparation is needed to produce a rough estimate as we could say that they are an intelligent guess and accurate to within perhaps 20 to 25 percent of the final calculated cost. The basis for this type of estimate is the known overall cost of similar work.

Preliminary Estimates

Preliminary estimates are used for assessing the relative costs of alternative schemes before the final details of a project are prepared. This type of estimate is valuable when making a more accurate judgement about the size of the project.

When we prepare a preliminary estimate we must ensure that we take time to estimate the major quantities that are required for the project and use the current costs for each class of work in the project.

This type of estimate should be accurate to within 10% to 15 % of the value of the final work.

Detailed Estimates

Detailed estimates are required for the final assessment of the costs of a project. They are compiled from a detailed bill of quantities based upon the standard working drawings and the specifications. There are two methods for preparing detailed estimates:

- Unit rate method
- Basic cost method

Unit Rate

A unit cost rate is assessed for each item in the schedule, based upon previous experience and current costs records. This single rate includes the cost of:

- labour
- materials
- stores
- temporary materials
- plant

The unit rate method is frequently adopted in estimates for buildings because of the wide variety of items involved.

This form of estimating is more suitable for organisations that obtain the major part of their work by contracting.

Basic Cost

The basic cost method consists of estimating separately the amounts of labour, materials and equipment required for every single operation on the project.

The costs of these items are then assembled and totalled for the various operations and processes included in the job.

The basic cost method of estimating is more accurate than unit rate estimating and is more suitable for contractors and authorities who undertake work by day labour.

Estimating by the basic cost method involves:

- preparing a practical plan for carrying out the work
- determining the resources required
- estimating the cost of the resources using the best construction methods available according to whether:
  - resources are the ruling factor
  - completion time is the ruling factor

What do I Need to Make an Estimate?

The first requirement for most estimating tasks is practical experience with the work involved. In large organisations this experience may be only in handling cost, production, and time figures.

In smaller firms, the estimating is often done by the same person who performs or directs the work. That person should be familiar with civil construction in general, as well as with the specific type or types of work to be done (e.g. excavation, drainage).

Six main inputs are used to make estimates of project costs:

- developing a work programme
- identification of resource requirements
- corporate chart of accounts
- activity duration statements
- historical information and estimating publications
- risks

Check List

Every person performing an estimate needs a checklist of items involved in the project.

For simple work or rough estimates, the estimate may be made by mental arithmetic, but it is better practice to put the details in writing and to refer to the figures regularly.

The purpose of a checklist is to remind the estimator of items that may be forgotten over a period of time. An experienced person may not see the need for a checklist, but anybody can forget minor details; sometimes people forget details that have important effects on the project outcomes.

Anyone making an estimate should document the calculations carried out for each item on the checklist, then refer to it and add details whenever necessary. Excel or similar files on computer, or even a field notebook containing documented estimates, may become a valuable asset by saving time spent on estimates in the future.

Note!

An estimate is an informed guess. No matter how solidly it is founded in experience and knowledge, it deals with materials, methods and quantities that may change in the future.

Work Programme

It is much easier to solve a large problem by breaking it down into smaller parts. This is what the work programme does for the construction project. The work programme itemises the many tasks that make up the project.

The first step in constructing the work programme is to list in detail the sequence of operations for the entire project. Each basic process is then studied, taking into account of:

- the demands of the specifications
- the quantities of work involved
- plant and materials needed
- labour force
- time required
- prepare an outline of the construction work required highlighting probable methods and procedures
- draw up a tentative broad construction programme
- visit the site and study
  - power supply
  - fuel supply
  - water supply
  - access roads
  - geology
  - topography
  - climatic conditions
  - housing facilities
  - cost of labour and materials
  - specification requirements
- Revise the written outline and plan and then make designs for all:
  - temporary works
  - service relocations
  - formwork
  - false work
  - special equipment

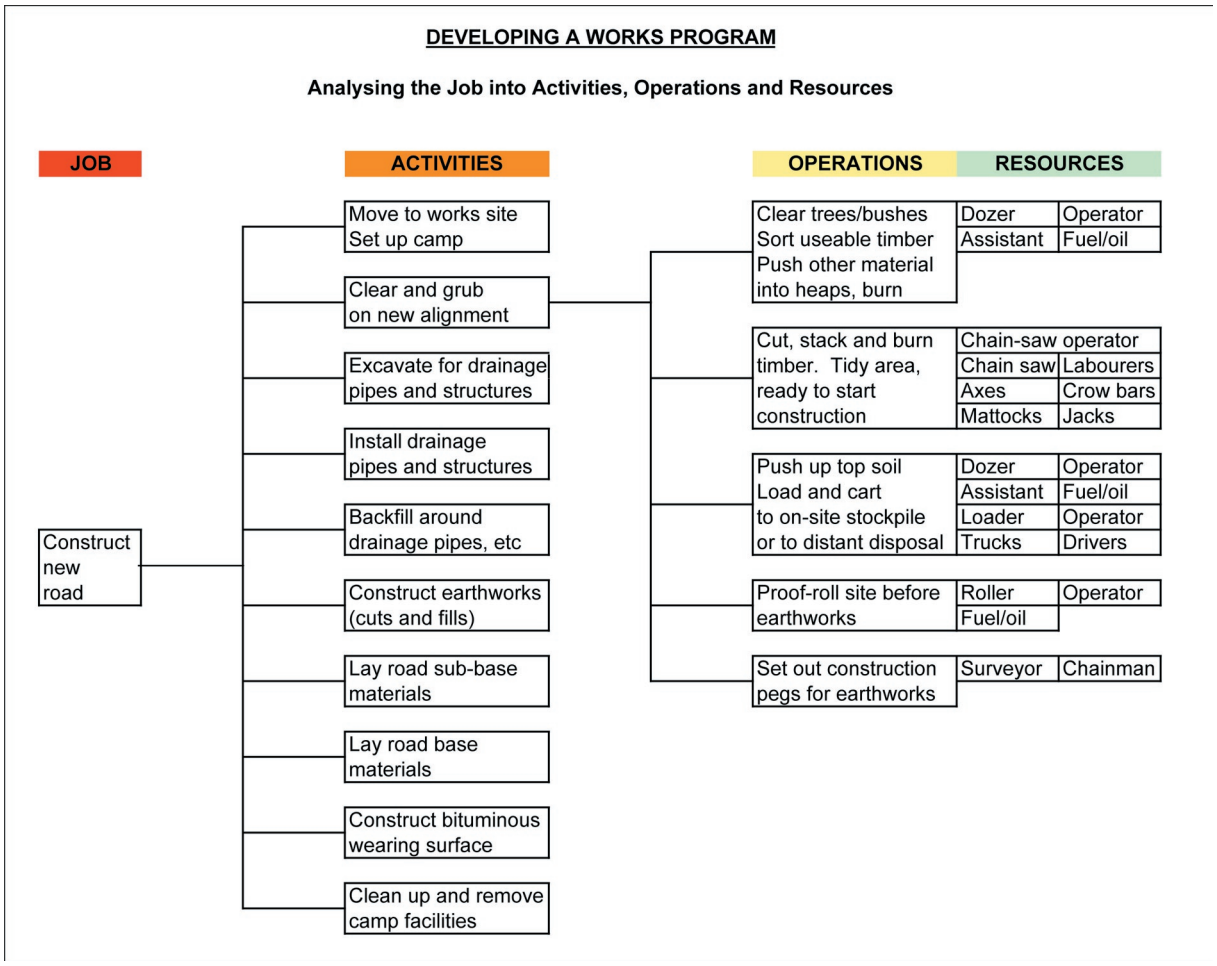
The process of developing a works programme is covered in detail in Topic 2 (Planning and Scheduling) in the Civil Construction Supervisory Learning Resource. The scope of the works programme includes the entire project, i.e. all work that must be completed in order to finish the project. For the purposes of the current topic (3), we need to understand the term 'work breakdown structure'.

Throughout the cost estimating process, the works programme is used to ensure that cost estimates have been prepared for all activities in the project.

The work programme allows estimators to:

- Present cost estimates in an organised manner
- Identify each project activity that generates costs
- Summarise the scope of the project and represent it graphically.

The following illustration shows that the work involved in a civil construction project can be progressively broken down into activities, operations and resources.



The 'job' (i.e. the project as a whole) is broken down into activities. These are the major steps that need to be completed, and are presented in a logical order from project start to finish. Each of the activities can be broken down into operations.

For example, the activity 'Clear and grub on new alignment' can be broken down into the following operations:

- Clear trees/bushes; sort useable timber; push other material into heaps and burn
- Cut, stack and burn timber; tidy area, ready to start construction
- Push up top soil; load and cart to on-site stockpile or to distant disposal
- Proof-roll site before earthworks
- Set out construction pegs for earthworks.

For each of these operations, we can estimate the resource required to complete the activity; for example, in the example shown, the initial estimate of resources to 'Clear trees/bushes; sort useable timber; push other material into heaps and burn' is:

- One dozer (of specified size)
- Dozer operator
- Assistant
- Fuel and oil.

This basic estimate can be improved by adding details of:

- Type of dozer
- Number of dozer hours
- Operator's efficiency factor
- Quantities of fuel and oil required.

The term Work Breakdown Structure (WBS) is often used when this process of subdividing the job is formalised and recorded; an alternative term is 'job dissection'.

Work Breakdown Structure

The example of a WBS shown on the following page is for a project that includes the construction of a bridge. The process of constructing the bridge has been broken down into:

- Bridge Substructure (item 7000)
- Bridge Superstructure (item 8000).

Under Bridge Superstructure, the subdivision "Prestressed concrete deck and kerb units (no. 8100)' has been further broken down into:

- Supply of prestressed concrete deck and kerb units, transverse bars and bearings
- Transport and erection of deck and kerb units.

Each of these, in turn, has been subdivided into individual parts. The subdivision 'Supply of prestressed concrete deck and kerb units, transverse bars and bearings' includes two operations; these are described in detail as items 8101 and 8102 in the contract for the job. Similarly, the subdivision 'Transport and erection of deck and kerb units' includes 39 operations; these are identified and described in detail in the contract as items 8103 to 8141 inclusive.

Work Breakdown Structure								Unit
Level 1		Level 2		Level 3		Level 4		
						6803-6804	Installation of switch board equipment	each
				6811-6825	Supply & installation of electrical cable			m
						6811-6819	Supply of electrical cable	m
						6821-6825	Installation of electrical cable	m
				6826-6827	Removal of existing underground and aerial cable			m
				6831-6832	Supply & installation of mains connection			m
						6831	Supply of mains connection equipment	each
						6832	Installation of mains connection equipment	each
7000	**BRIDGE SUBSTRUCTURE**							
		7300	Bridge substructure					
				7301-7305	Concrete in pier			m^3
				7311-7315	Concrete in abutment			m^3
				7321	Steel reinforcing bars			tonnes
		7400	Cast-in-place piles					m
				7401-7403	Supply & installation of concrete pipe liners			m
						7401	Supply of concrete pipe liners	m
						7402-7403	Installation of concrete pipe liners	m
				7404-7408	Supply & installation of steel liners			m
						7404-7405	Supply of steel liners	m
						7406-7408	Installation of steel liners	m
				7411-7414	Excavation of liners			m^3
				7415	Excavation of bored piles			m^3
				7421-7424	Concrete in liners & bored piles			m^3
				7425	Steel reinforcing bars			tonnes
		7500	Precast prestressed concrete piles					m

Work Breakdown Structure								Unit
Level 1		Level 2		Level 3		Level 4		
				7501-7514	Supply & installation of precast concrete piles			m
						7501-7502	Supply & transport of prestressed concrete piles	m
						7503-7514	Installation of prestressed concrete piles	m
		7600	Driven steel piles					m
				7601-7613	Supply & installation of steel piles			m
						7601	Supply of steel piles	m
						7602-7613	Installation of steel piles	m
		7700	Bitumen slip layer					m
		7800	Dynamic testing of piles					each
8000	**BRIDGE SUPERSTRUCTURE**							
		8100	Prestressed concrete deck & kerb units					each
				8101-8141	Supply & erection on prestressed concrete deck & kerb units			each
						8101-8102	Supply of prestressed concrete deck & kerb units, transverse stressing bars & bearings	each
						8103-8141	Transport and erection of deck & kerb units	each
		8200	Prestressed concrete girders					each
				8201-8231	Supply & erection on prestressed concrete girders			each
						8201& 8211	Supply of prestressed concrete girders	each
						8202-8203 8212-8213	Transport and erection of prestressed concrete girders	each
						8221-8231	Bearings & girder restraints	each
		8250	Steel girders					each
				8251-8271	Supply & erection of steel girders			each
						8251-8252	Supply of steel girders	each

Work Breakdown Structure								Unit
Level 1		Level 2		Level 3		Level 4		
						8253-8257	Transport and erection of steel girders	each
						8261-8271	Bearings & girder restraints	each
		8300	Bridge deck					m^3
				8301-8306 &8321	Concrete in bridge decks			m^3
				8311-8316	Reinforcing steel in bridge deck			tonnes
				8331-8334	Cast-in anchors			lump sum
				8341-8343	Miscellaneous cast-in items			lump sum
				8351-8362	Joints & fillers			lump sum
				8371-8372	Footway			lump sum
				8381-8384	Electrical items			lump sum
		8400	Bridge barriers					m
				8401-8406	Supply, transport & erect steel barriers			m
				8411-8416	Supply, transport & erect aluminium barriers			m
				8451-8453	Bridge expansion joints			lump sum
		8500	Anti-graffiti protection					m^2
		8600	Deck wearing surface					tonnes
		8700	Repainting steel bridges					lump sum
		8800	Preparation for bridge widening					lump sum
9000	**MISCELLANEOUS**							

When completing a job dissection or work breakdown, it is important to:

- Remember that some activities or operations have a more detailed breakdown than others.
- Ensure that the lowest level operations are real operations and can be measured for completion.
- Verify the correctness of the dissection by comparing it to similar projects or else have a qualified person review the programme.
- Assign a unique identifier to each item that corresponds to your firm's code of accounts

The next step is the most important step in regard to cost estimating. It is very important that each step is appropriately scheduled, budgeted and assigned to a specific team or person who is responsible to complete the task.

You are able to produce fairly accurate and detailed cost estimates if each activity is measurable. That is you must be able to assign a time and a list of required resources, including human resources, materials and plant and equipment to each operation.

The work programme makes it easy to find the total cost estimate. Once the work of the project is sufficiently broken down into measurable, verifiable activities, you can assign a cost to each item. The process of totalling 'above the line' operations, assigning a level to the task, totalling all tasks belonging to a deliverable activity, is called rolling up the estimates.

Supervisors and foremen should frequently refer to the work programme during the life of the project. At no stage is it more important than when you are preparing cost estimates for the project.

Resource Requirements, Rates and Chart of Accounts

Resources, rates and the firms chart of accounts are closely linked and they are important inputs to the cost estimating process.

Resource Requirements

A project's resource requirements are important inputs to cost estimating. These requirements come in the form of a list of items needed to complete the project. The list is produced during the resource planning phase.

Resource requirements refer to the types and quantities of resources needed to complete each activity listed in the work programme. This information helps to determine project costs.

Typically, a project's resource requirements fall into five categories:

- Labour — includes all of the human resources needed for the project and include labourers, operators, technical personnel, leading hands and foremen.
- Materials — include the inputs you need for production or delivery of a service. Materials are usually purchased from an external supplier, or from another division of your own firm, if it owns the raw materials you need for production.

- Plant and Equipment — includes machinery, mobile equipment and transport that is required to complete the construction project. When estimating costs for plant and equipment you must consider hire rates, length of time required for the job and how long equipment will remain useful until it must be replaced.
- Overhead costs — may include costs associated with the facilities in which your project is carried out.
- Contingency costs — are allowances made for risk and uncertainty. A project's budget should contain a buffer to allow for unexpected costs. Examples include:
  - natural disasters
  - equipment breakdowns
  - accidents
  - strikes
  - unexpected increases in the cost of supplies

When considering a list of resource requirements it is necessary to consult the works programme. The works programme should identify the quantities of resources needed to complete each activity. You are then able to assign estimated costs to each resource.

Rates

Another requirement for cost estimating is resource rates. Resource rates refer to the per unit cost of each resource required to complete the project. If the exact rates applicable to the use of a resource are not known, you may need to estimate them. A field notebook containing previously documented estimates is useful for this purpose.

Cost estimating is virtually impossible without the unit rates for each resource required. The following are examples of resource rates:

- labour cost per hour
- equipment cost per day
- fill cost per tonne
- component cost per part.

You may like to add other resource rates to this list.

Cost Codes

When calculating your cost estimates you should allocate resources to the project based as closely as possible to your organisation's cost codes.

The cost codes are available as a table that shows the coding or numbering system used to monitor expenses. Categories of expenses may include:

- labour costs
- equipment hire
- material costs
- subcontractors
- overheads
- materials testing
- plans and surveys
- transportation of plant and machinery

Each time an amount is recorded in connection with the project, whether as an estimate or as an input cost, it must be accompanied by the correct, relevant cost code.

Information recorded in this way can assist in:

- Preparing estimates for future projects
- Reporting on performance of a completed project
- Conducting a post-mortem analysis on a completed project
- Comparing performances of a number of completed projects.

Note!
The essential point is that it is much easier to record, analyse and compare information about projects if everyone uses the same codes.

Activity Duration Estimates

It is important to establish forecasted times that it will take to complete various tasks in the work programme for your project. By doing this you prepare another important input to cost estimating — activity duration estimates.

Activity duration estimates are primarily used for schedule development, although they also play an important role for cost estimating as well.

Importance of Activity Duration Estimate

Activity duration estimates assess the amount of time required to complete an activity. Activity duration is important when you are estimating labour costs and equipment costs.

When you estimate activity duration for each activity included in the project and then add the results, you can determine a cost estimate for the entire project.

Calculating Cost of Activity Duration

As already discussed it is easier to estimate a projects total cost when you already know how long it will take.

Multiply the rates for an activity by the estimated duration in order to estimate its total cost. For example if you have estimated that an activity is going to take 100 days to complete, and you know that leasing an excavator costs $500 per day.

Then total cost = Activity duration x rate/day

= 100 days x $500/day

= $50 000

There are three things to remember when using activity duration to calculate cost estimates.

Activity duration estimates usually include a range of possible results. For example when you lease heavy equipment it is necessary to add several days either side of the activity to allow for delays such as weather and machinery breakdowns.

When using activity durations to estimate costs, it is important to convert months or weeks into working days or working hours to calculate costs. There are usually conventions for determining how many production hours are included in a week, month or year.

Finally remember to consider downtime in your calculations. People do not work '24/7' and machinery needs time allocated for preventative maintenance schedules. Always include weekends and holidays in your calculations.

The steps in estimating costs using activity duration estimates include:

- establish the activity duration estimate
- check the resource rates that apply to this activity
- convert units of time if necessary
- multiply the estimated duration by the rate for the activity.

Historical Information

Historical information is important to cost estimating because it serves as a benchmark. This is information about previous projects that you can use to help with a current project.

Four sources of historical information that you can use for estimating include:

- project files
- project team knowledge
- commercial cost estimating databases
- estimating publications.

Project Files

It is not uncommon for current projects to be similar to projects carried out in the past. Each finalised project should have a file whether it is a hard copy file or an electronic file.

Consider both the similarities and the differences between past and present projects when consulting closed-out project files.

One way to do this is to carefully compare the project scope statements of each project.

Complete Files

Every construction company maintains a complete set of files of all planning inputs, work results, performance reports and correspondence for past projects. If external organisations also worked on the project, you can obtain copies of their records for the project as well.

The documents most relevant to cost estimating include:

- previous cost estimates
- budgets
- reports on cost performance that include actual costs
- documents showing the rationale behind revised cost estimates and budget changes

Team Knowledge

The knowledge of your team members is another form of historical information. Employees with experience and maturity are a great asset when it comes to cost estimating.

Each supervisor, foreman and ganger is able to draw on experience when cost estimating since they are likely to recall cost information about the various projects they have worked on.

Commercial Databases

Commercial databases are another source of historical information from which you can obtain cost information about previous projects. Publicly owned corporations are required to make such information available. If you find a number of projects that are similar to your own, in a database, compare them to your project and make adjustments for differences. You should always arrive at fairly accurate cost estimates for your project.

Note!
You must consider certain factors such as inflation when basing current cost estimates on former projects.

Estimating Publications

Estimating publications are similar to databases as they contain commercially available analyses of raw data that you are able to use for preparing estimates. These publications help team members who are preparing cost estimates and they are able to customise general information to their specific project.

This process streamlines the cost estimating process and increases efficiency. Estimating publications usually include things like industry-specific case studies and journal articles.

Risks

Risks are uncertain occurrences that may affect the outcome of the project. Since they can have a significant effect on project costs, they are an important input when developing the project's cost estimates. You can divide risks into two distinct types:

- internal risks
- external risks

Internal Risks

Internal risks are occurrences within the company that may affect the project cost. These may include:

- labour shortages
- poor planning and design
- low productivity

External Risks

External risks are generally outside influences that the company can do little to control. These risks may include:

- Supply delays
- Material cost changes
- Natural disasters

- Weather/environment
- Industrial relations
- Community resistance
- Political decisions.

Identifying Risks

Identifying risks as either internal or external is a very basic way to organise them. The project team who are developing the cost estimate for the project must specifically identify as many project risks as possible in order to plan for their effects on project costs.

Internal and external risks are separated into five different categories:

- predictable
- unpredictable
- technical
- non-technical
- legal

Predictable Risks

Predictable risks are manageable by the project team but their extent and direction may be uncertain. These risks may include market shifts, cost and availability of material.

Unpredictable Risks

Unpredictable risks are unforeseeable risks and are beyond the control and influence of the project team. Unpredictable risks include:

- Vandalism, sabotage or theft
- Secondary effects of industrial action, e.g. restrictions on fuel supply
- Natural disasters such as fire, flooding or storm damage.

Technical Risks

Technical risks are associated with the use and application of technology. Some of these risks can be controlled by the project team. Technical risks may include:

- Changes to specifications
- Contractual requirements
- Design elements
- Material suitability and availability
- Software changes.

Non-Technical Risks

Non-technical risks are other events that can affect costs but are not directly related to technology. Human resource issues, schedule delays, inadequate planning, management difficulties are examples of non-technical risks.

Legal Risks

Legal risks relate to, or are concerned with, the law. Legal risks that could affect project costs include:

- licences
- contracts
- law suits

Identifying and planning around potential project risks is an important input to cost estimating. Including risks in the cost estimate will help the project team to develop an accurate cost estimate and keep the project on track.

Why Does Estimating Affect Me?

The construction estimator submits the initial estimate used when the contractor tenders for a project. However, as described in the following sections, leading hands, foremen and supervisors all have roles to play in day-to-day estimating on the job.

Leading Hand

Leading hands are in charge of a small workforce that must complete a wide range of tasks on the project. They are often in the best position to advise their foremen on the type of equipment that is required and the type and number of resources that they require for each particular job.

For example, the leading hand in charge of the clearing operation should be able to carry out an estimate of the requirements of that task. The ganger should know from experience what plant and equipment is required and this may include:

- Dozer/excavator
- Operator
- Assistant
- Fuel and oil
- Time to complete the task

The leading hand then passes this information on to the foreman.

Supervisor/Foreman

The planning stage of the project provides an opportunity for the supervisor and foreman to identify the resources required to carry out the project. Supervisors are involved in this process because it is their responsibility to work out the cost of reaching the goals of the project.

The foreman is able to conduct an estimate for all the activities that he/she is in charge of by using the leading hands' estimates of the operations.

This information is in turn passed on to the project supervisor who is responsible for combining all of the activities in the project.

Each member of the supervisory team plays a vital role in the gathering of information for the final estimate.

When Do I Get Involved in Estimating?

Estimating is an ongoing process throughout the entire project. The supervisor at every level is often faced with the need to perform some type of estimating exercise.

Different types of estimating that the supervisor is required to carry out at the construction site include:

- Measurement exercises
- Estimating the labour force for the task at hand
- Identifying the types and quantities of materials required to complete the project
- Estimating the number of machines required to carry out a job, based on the productivity of the machines.

What is Project Cost Control?

Accurate estimates and planning at the start of the project helps to ensure work at the construction site is performed in a safe and efficient manner. Job costing and cost control throughout the project ensures that the actual costs of the project are maintained in line with the estimated costs of the project.

It is essential for construction supervisors to know why costing is carried out, and also to know the ways in which costing can help them achieve an efficient and well-organised job.

Job costing is performed by dissecting each activity of the project and recording all output and expenditure for the activities.

What Do I Need to Perform a Project Cost Control?

Job costing, the procedure of recording project information is initiated by the foreman. The foreman must record:

- times worked by personnel
- time of plant and machinery operation
- quantities of materials used on the job.

The foreman must also indicate which part of the project was being worked on at any particular time throughout the day. This information is passed on to the cost clerk regularly throughout the project.

Cost Clerks

In the following discussion, 'cost clerk' is used as a generic term. Depending on the construction organisation's policy, the title of a person who performs this role on site may be site clerk, cost clerk, or financial administration officer.

Cost clerks record the above information and convert these times and quantities into costs. They use the hourly rates of the personnel and plant and the unit costs of the materials. They also record the cost of any work carried out by subcontractors.

The costs of the items identified in the estimate are recorded separately as the tasks are carried out.

Foremen and/or engineers measure the completed quantities of the items identified in the estimate and supply this information to the cost clerk.

Cost clerks calculate the actual unit cost of each estimated item by dividing the estimated total cost of that item by the quantity which has been completed.

The engineer updates the works programme and with the assistance of the foreman and cost clerk forecasts the projected monthly and final costs of the job for the labour, plant, materials, subcontractors and overhead requirements indicated on the updated programme.

This information is reported at least once a month to keep head office informed of the progress and efficiency of the job.

How is a Project Cost Control Carried Out?

Costing

Consideration of the operation which costing embraces shows that the supervisor plays a very important role in achieving accurate costing.

Never assume that a good cost clerk automatically produces accurate costing figures. It is important for the supervisor to supply the information that is required by the cost clerk to make these calculations.

The information required by the cost clerk includes:

- The item dissection of the hours worked by the personnel and plant
- The materials used to complete the job
- The measured quantities of work carried out.

The engineer must ensure that this information is provided, and that it is correct. In addition he/she must update the works programme regularly throughout the project.

Role of the Supervisor

The supervisor plays an important role in achieving prompt costing. It is important for the foreman to supply the dissections and tallies to the cost clerk on a daily basis.

As well as this, the measured quantities of the work performed are required by the cost clerk each month, or at other intervals required to meet company accounting requirements. This procedure allows the cost clerk to produce the information required to determine how the project is shaping up compared to the estimate performed at the start of the project.

Cost Control

Cost control is the process which attempts to ensure the activities of the project conform to the work programme. There is a close relationship between planning and cost control. Cost control cannot take place unless there is a plan and a plan has little chance of success unless some efforts are made to monitor its progress.

'Cost control' is the process of comparing the actual cost of a project with the estimated or budgeted costs of a project. If the actual costs and the estimated cost are too different you may find it necessary to make adjustments to the plan. Adjustments may include:

- Altering activities to ensure results reflect what is in the plan
- Revision of the plan
- Re-evaluation of the cost controls

Trainees are advised to check the specific procedures applicable to their company.

Cost Reports

Note!

The following discussion describes the process of cost control for a company that requires monthly reports. Not all organisations use the procedures described here. For example, some may require reports on a weekly basis or for each activity. Trainees are advised to check the specific procedures applicable to their company.

The engineer and the foreman are responsible for ensuring all work on the job is measured accurately on the specified day of each month. They must pay particular attention to major items such as earthworks volumes.

The cost clerk shows the measured quantity of each item in the ledger alongside the total cost to date of that item. The cost clerk then completes the monthly report. The foreman and the cost clerk must sign the cost report before it is submitted it to head office.

At the end of each month the cost clerk totals up the journal and the ledger and ensures that they balance. If the books do not balance, or there is an error in the entries, such faults must be rectified.

The monthly cost report prepared in this way is a useful document for the foreman to use to control costs at the construction site. The report is either made up of a series of forms or is available on-line through the company's accounting software:

- Cost Summary— summarises the actual costs incurred to date and the forecasted costs to complete the job. The sum of all costs is the forecast total cost for the job. This form also shows the original estimated costs of the work completed to date and of the work remaining. These costs are compared with the actual costs and the costs currently forecasted.
- Distribution of Costs Form— shows the actual expenses incurred in each month of the job, up to the end of the job. It also shows the total forecasted costs for each financial year, to assist the company's managers with annual funds budgeting.
- Analysis of Costs form— shows the various items and dissections given on the estimate and compares the actual costs with each of the estimated costs. At the start of the job the supervising engineer may decide to combine some of the smaller items into one item, or split up the important items into a number of operations.
- Work Output Statement— covers the major scheduled items and is submitted as part of the monthly expenditure report. Details of the items of plant used and the output yielded on individual items are obtained from the job dissections.

The supervising engineer nominates the scheduled items covered in the monthly cost report.

Some items in the report are further divided into individual operations. The report includes the following items:

- Expenditure graph
- Reconciliation statement
- Details of suspense account, materials on hand etc.

Process for Preparation of a Cost Report

The foreman or the engineer must supply the measured quantities on the specified day of each month. The cost clerk fills out the historical costs on the monthly report forms. The forecasted costs are not filled out until they are received from the foreman or the supervising engineer.

The procedure for completing the monthly report is as follows:

- Update the works programme for the job. This is performed by the foreman and the engineer together. The engineer uses the foreman's practical experience in determining the ideal number of workers and the ideal types and quantities of plant required on the job. The times that the various operations will take are also identified.
- Calculate the cost of the resources (labour, plant, materials, and subcontractors) that are required to complete the task.
- All of these resources are shown on the works programme or attached to it in tabular form. Worksheets are then used to calculate the cost of these resources. The cost clerk assists in this process by supplying wage rates, plant hire rates and materials costs. This procedure is carried out by the foreman, the engineer and the cost clerk together.

Effects of Cost Controls on the Job?

The supervisor and the foreman play an important role in the development of controls used for checking project costs. It is very important that the supervisor and foreman continue to pass on the required information to the cost clerk, or to input the required information to the company's financial management system.

If the cost controls are developed correctly, they become an invaluable resource for the supervisor to use to check the progress of the project.

The size of the work force and the types of plant required should be identified well in advance of the project commencement. This allows plenty of time to hire personnel and obtain plant.

The quantities and the types of materials should be calculated well in advance, allowing plenty of time to order and have the materials delivered before they are required.

The work methods should be identified and discussed well in advance.

The cost of the remaining work should be forecast and if the cost of the work is too high, there may be a need to review work methods.

The actual cost of the work done in the previous month compared with the forecast figure for that month will show up any inaccuracies in the works program, or any unforeseen difficulties.

Getting Involved in Cost Control

It is often necessary for supervisors to carry out work studies to ensure work activities are carried out in the most cost-efficient manner. You can perform a work study by monitoring the operations involved in an activity to see how you can improve productivity.

This does not imply making people work harder but rather making work more efficient and consequently reducing the time taken to carry out the task. It involves eliminating lost time.

Reducing Lost Time on the Job

Consider, for example, an earthmoving activity involving three scrapers and a pusher. The main objective is to identify where you can save time in the scraper load and dump cycle and ensure the pusher is fully employed at all times.

At the same time it is necessary to make work easier for the scrapers and to save time in their operation.

When loading the scraper always ensure operators are using the correct loading techniques to improve their outputs. This includes ensuring that:

- all hard ground is ripped before loading
- the correct cutting edge is used for all operations
- the cutting floor is even before beginning the operation
- the loading operation is carried out running the scraper down hill

Note!
It is not necessary to load loose sand in this manner

- the pusher is in the correct position to assist in the loading operations
- the scraper is fully loaded in the correct time
- the apron is raised and the pusher helps the scraper to accelerate when it is loaded
- the scraper is loaded in the direction of travel
- a supervisor is directing the work
- the straddle loading technique is used where appropriate

Time is wasted during the hauling stage of the operation if the correct hauling techniques are not used by the operator. The supervisor must continue to monitor the hauling operation to ensure:

- operators use the circuit with the fewest number of turns
- haul roads are in good condition
- the scrapers' tyres are inflated to the correct pressure
- earthmoving traffic is properly routed to prevent hold ups in the hauling operation
- the bowl of the scraper is at the correct height

Always ensure the scraper operators are performing the correct spreading techniques.

- Load and spread the material in the highest possible gear
- Spread the material uniformly over the fill area and ensure it is at the correct depth
- Operators must leave the fill site as quickly as possible.

It is the supervisor's responsibility to monitor all activities at the construction site in the attempt to eliminate wasted time. In order to carry out an effective work study, select the activities that are worthwhile investigating and examine them in a systematic manner. The main aim of the exercise is to eliminate unnecessary work or else to combine, rearrange and simplify the existing operations.

Once you have selected the activity that you wish to examine you must look at:

- the reason for the operation
- the place or area in which it is being carried out
- the sequence of operations
- the plant and operators carrying out the work
- means by which the task is done.

Obviously, the resources available for monitoring tasks are limited so you must select tasks where the greatest savings for the project are made.

Selecting Work Study Tasks

It is obviously a waste of time to put a lot of effort into trying to improve a very minor operation. You should look at an estimate and choose an activity which has the highest costs.

Activities where a small saving in unit costs could amount to a considerable saving overall are the ones that you should perform the work study on. For example if there are 200 000m^3 of earthworks on a job, every cent saved per cubic metre represents $2 000 off the cost of the job.

You must look at operations that are repeated throughout the course of the project. For example, moving the 200 000m^3 of earth might involve 20 000 scraper trips. If it is possible to save one minute per cycle, you will save a total of 334 hours over the whole job. Assuming the scraper cost is approximately $150 per hour, this represents a saving of $50 000.

It is important that you look closely at operations which have the potential of holding up other operations. For example, loading gravel onto trucks has this potential. You must ensure that there is a balance between the loader size and the truck capacity.

In summary, activities that you should examine to control the cost of the operation are ones that:

- involve large expenditure
- are repeated a considerable number of times
- may delay other operations
- require a large amount of plant or expensive plant
- involve moving considerable quantities of material over long distances.

When is a Work Study Carried Out?

Work studies are put in place to control the costs of the project; therefore it is important to carry out the study before the cost of the activity has exceeded the planned estimate. The best time to undertake a work study into any major activity is at the start of the activity.

If a study is performed at this stage of the operation, you are able to identify any problems before they get out of hand and blow out the cost of the activity.

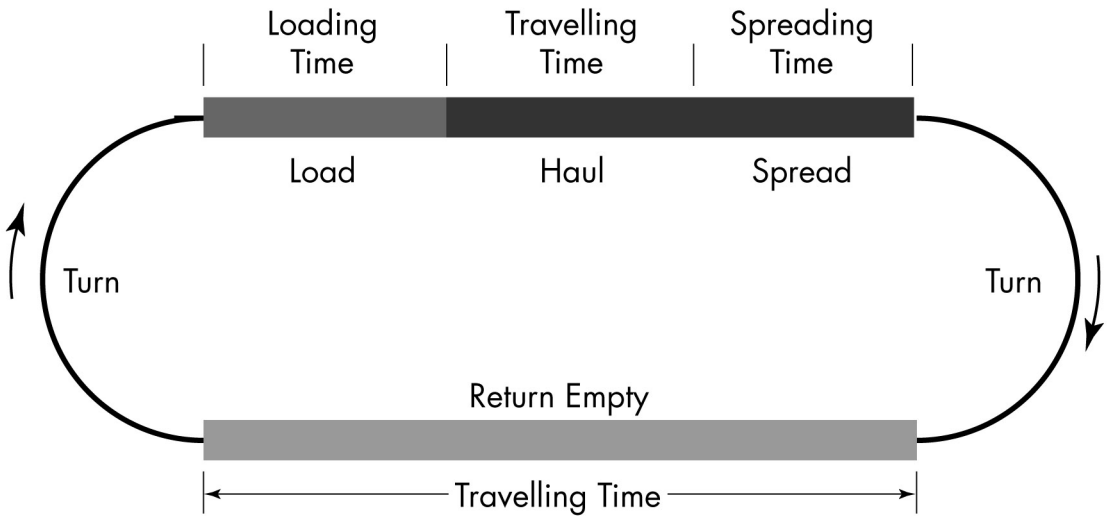
You will also need to perform a work study if costs of the project rise or if job conditions change radically. Sudden rises in the cost of the project mean that activities are not being carried in accordance with the estimated cost of the activity. It is important to identify these problems as soon as possible.

How are Work Studies Conducted?

The work study attempts to find the best way of performing the tasks in a given activity. The first thing to do after selecting the operation is to observe and write down the actions that took place. Your observations must include:

- what is being done
- the sequence of the operations
- the time each operation takes
- the output achieved by the operator

If you are checking the scraper operations record the cycle of operations, the time taken to complete a cycle, elements of the cycle as well as the daily output.



Typical Scraper Cycle

When you examine an activity, ask yourself questions to assist in improving the operation.

Ask why an operation is carried out. For example why is it necessary to add water to fill during earthwork operations? Water is added to bring it a suitable uniform moisture content which will enable the rollers to compact the fill to the correct density. Then ask if the operation is necessary.

Ask yourself where you should carry out the operation. Often you will have no choice on the location of the operation (e.g. excavation) although some operations allow a choice of location (e.g. you can add water into fill material on the fill-site or in the borrow-pit. If you add the water to fill in the borrow-pit it is possible for the earthmoving plant to do a lot of the mixing while excavating, loading and spreading thus saving time and effort on the fill.

Ask yourself when you should carry out the operation. For example should a scraper turn before or after the loading operation.

Ask who or what machine should do the work. For example, is it more cost-effective to use a dozer or a scraper to move earth over a distance of 300m? If the material has to be moved

three kilometers, an excavator and trucks may be used. Consider the most cost-effective way of doing this — for example, how many trucks should be used?

Ask how to operate the machine in the most efficient manner.

After you examine an activity and identified the best method of performing the task under the prevailing circumstances, you must put the technique into operation.

When the operation is performed for the first time, always check to ensure it is working properly. At the same time check the cycle times and measure the output achieved.

If the new technique is helping to save time and to increase productivity, ensure that it is maintained until there are changes in material circumstances. At this time carry out another work study on the operation.

Use daily (or weekly) checks on the operational output to ensure the team is using the most efficient technique for performing the job.

Monitoring Costs of Operations

It is quite often necessary to change the size of the plant fleet due to preventative maintenance schedules, increase or decrease in truck requirements or to monitor alternative methods of operation.

It is never sufficient to monitor output alone during these cases. You must check the unit cost of an activity or the individual operations that make up an activity to determine the correct cost.

In order to do this, you must record the activity duration cost of labour and plant. As well as this record the on-costs or overheads associated with each activity under the heading of each operation. Once all costs are recorded you must add the costs to determine the total cost of the activity.

The work completed during the period is measured and this measured quantity is divided into the cost of each operation and the cost of the total activity. This gives a unit cost for each operation and the whole activity.

If it is desired to have an accurate comparison between the actual unit cost of an activity and the unit cost shown on the job estimate, you must measure the quantity in the manner stated in the specifications (e.g. for gravel paving, length x specified or ordered width x compacted depth). This ensures that any overspreading, loss or wastage of material is allowed for in the unit rate.

Section 1 – Assessment Activities

For information on how these assessment activities may be used as part of the learning process, see the section on 'Assessment' in the 'Topic Descriptor' section at the front of this topic.

Theory Questions

The following questions allow you to assess your progress in understanding the material presented in Section 1. The questions may be of any of the following types:

- multiple choice (identify correct answer or answers)
- multiple choice (identify incorrect answer or answers)
- fill in the gaps in a sentence or statement
- identify a sentence or statement as TRUE or FALSE
- write a few sentences or a short paragraph.

Answers to the question are shown in the separate 'Answer' section.

Question 1

Why are estimates needed on civil engineering projects?

_____

_____

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Question 2

Define rough and preliminary estimate.

_____

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Question 3

Name and describe the two methods used to prepare detailed estimates. Which is more accurate?

Question 4

Name three of the six inputs needed to make an estimate.

Question 5

What is the purpose of the 'works programme'?

Question 6

Overhead and contingency costs are part of a project's resource requirements. What do these costs cover?

Question 7

Why should the cost codes given in the chart of accounts be used?

Question 8

Name the four types of historical information that can be consulted for estimation purposes.

Question 9

Give two examples for each type of risk (internal and external risk). Which type of risk would be predictable? Which would be unpredictable?

Question 10

What is the purpose of project cost control? What information is needed for effective project cost control?

Question 11

Name the major headings of the monthly cost report.

Question 12

What steps are needed to compile the monthly report?

Question 13

Why would a work study be needed?

Question 14

Assume that a scraper operation is taking longer than expected and the cost of operation has become too high. What would a work study consider when investigating the scraper operations?

Question 15

The work study for the scraper operations found that hauling time was taking too long. What should the investigator consider when trying to improve this part of the operation?