

# CENG 6101 Project Management

## **Detailed Estimating and Bidding Preparation**

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# Tools and Techniques for Cost Estimating

- Top-down estimating (Analogous estimating, based on previous projects, conceptual cost estimating)
- Bottom-up estimating (detailed, first principles, lowest elements in WBS)
- Parametric estimating (statistical relationship between historical data and project variables/characteristics)

# Basic Elements of Costing Work

- Labour
- Equipment
- Materials – temporary, permanent
- Subcontracts
- Management, Engineering, Supervision
- Project Indirect Costs (Project Overheads)
- Risk and Opportunity (Contingency)
- Corporate Overheads
- Profit

# Basic Elements of Costing Work

1. Direct Costs
2. Indirect Costs
  - overheads, preliminaries
3. Risk and Opportunity Allowance
  - contingency
4. Margin/Markup
  - = corporate overheads + profit

TENDER PRICE  
JOB COST COMPONENTS

		Civil (%)	Building (%)	
Labour		15-25	25-40	
Plant and Equipment		5-10	<5	
Materials	- Permanent - Temporary	50-70 5	60 <5	
Subcontracts		10	Incl.	
<b>SUB TOTAL</b>	<b>Direct Job Cost</b>	<b>100</b>	<b>100</b>	
Management Engineering and Supervision	( 5-15% DJC ( 10-20% DJC ( ) ( )	5-6% DJC	( ) ( )	5-10% DJC
Job Indirect Costs	( 5-10% DJC	3-5% DJC	( )	
<b>SUB TOTAL</b>	<b>Total Job Cost</b>	<b>TJC</b>	<b>TJC</b>	
Corporate Overheads	( 3-4% TJC ( 7-15% TJC ( )	2-3% TJC	( ) ( )	3-5% TJC
Profit	( 5-10% TJC	2-5% TJC	( )	
<b>GRAND TOTAL</b>	<b>TENDER PRICE</b>			

Figure 3.05

# Steps in Estimating Process

1. **Identify bid opportunity:** public notices, trades newsletters, trade magazines, invitation to bid
2. **Make decision to bid:** corporate strategy, need for work, type and location of project, competition
3. **Study plans and specifications:** review scope, visit site, send out requests for quotations, prepare estimating schedule
4. **Break project into work packages – WBS**
5. **Do quantity takeoff** of each work package: record quantity and unit measure
6. **Determine construction methods (CMS), equipment and labour requirements (crews)**

# Steps in Estimating Process

7. Estimate labour and equipment productivity for each operation
8. Obtain and evaluate quotations from subcontractors and suppliers: consider both price and quality of work
9. Price items of work in WBS: direct costs
10. Prepare project schedule
11. Price indirect (overhead) costs: time-based
12. Consider alternatives, “what-if” scenarios
13. Perform risk/opportunity analysis
14. Add corporate overhead and profit margin
15. Spread costs – bid unbalancing, strategic
16. Calculate unit prices and prepare owner’s unit rate schedule or bill of quantities (BOQ)

# How Do We Measure Productivity?

- Productivity =  $\frac{\text{Output (units of products)}}{\text{Input (Resources)}}$
- Labour Productivity =  $\frac{\text{Output (installed qty)}}{\text{Work Hours}}$
- Productivity refers to how efficiently and effectively a company can turn its input (labour and capital) into products and services

## Labour Productivity

= units of input (work hours) per unit of output (input/output)  
(e.g. 0.5 mhrs/m<sup>3</sup> for placing concrete)

OR

= output/input (e.g. 2 m<sup>3</sup>/mhr)



# Definition of Productivity

## Production

= units of output per unit time  
(e.g. 100 m<sup>3</sup>/hour for placing concrete,  
50 m<sup>2</sup>/hour for formwork erection)

Can change production rate by changing number of manhours available in one hour, by changing crew size or shift length

i.e., production (m<sup>3</sup>/h)  
= productivity (m<sup>3</sup>/mhr) \* (mhr/h)

# Productivity vs. Production

- **Production** indicates how much work is being done in a given time interval; how fast work is progressing; indicates if schedule objectives will be met; not an indication of how much money is being spent
- **Productivity** is a measure of *efficiency* of labour and/or equipment crew; indicates if cost objectives will be met

# Estimating Direct Costs

## RESOURCE CATEGORIES

<b>LABOUR</b>	<b>EQUIPMENT</b>	<b>MATERIALS PERMANENT</b>	<b>MATERIALS TEMPORARY</b>	<b>SUB / SUPPLY CONTRACTS</b>
Labourers	Crane	Concrete	Formwork	Fabrication of structural steel
Carpenters	Grader	Structural Steel	Falsework	Precast concrete
Steelworkers	Scraper	Timber	Curing Blankets	Linemarking
Cement Finishers	Backhoe	Reinforcing Steel	Tarps	Pile Driving

# Cost Elements of Labour

- basic wage rate, overtime wage rate
- shift pay differentials
- site allowance, foreman allowance
- travel allowance
- meal allowance (subsistence pay)
- vacation pay, sick pay, statutory holidays
- unemployment insurance, payroll tax
- workers' compensation and other insurance
- retirement savings (pension) plan (optional)
- health insurance (optional)
- **Average labour burden: 30%** of base wage

### EXAMPLE 5.1

An ironworker works 10 hr/day, 6 days/week. A base wage of \$20.97 per hour is paid for all straight-time work, 8 hr/day, 5 days/week. An overtime rate of time and one-half is paid for all hours over 8 hr/day, Monday through Friday, and double time is paid for all Saturday work. The social security tax is 7.65 percent, and the unemployment tax is 3 percent of actual wages. The rate for worker's compensation insurance is \$12.50 per \$100.00 of base wage, and public liability and property damage insurance rate is \$3.25 per \$100.00 of base wages. Fringe benefits are \$3.15 per hour. Calculate the average hourly cost to hire the ironworker.

Estimating Construction Costs, Peurifoy and Oberlender, 2002, McGraw-Hill

# Example of Labour Estimate

$$\begin{aligned}\text{Pay Hours} &= \text{Weekly straight time} + \text{Weekly overtime} + \text{Saturday overtime} \\ &= \left(5 \text{ days} \times 8 \frac{\text{hr}}{\text{day}} @ 1.0\right) + \left(5 \text{ days} \times 2 \frac{\text{hr}}{\text{day}} @ 1.5\right) + (1 \text{ day} \times 10 \text{ hr/day} \times 2.0) \\ &= 40.0 + 15.0 + 20.0 \\ &= 75 \text{ hr}\end{aligned}$$

$$\text{Actual Hours} = (10 \text{ hr/day} \times 5 \text{ days}) + (10 \text{ hr/day} \times 1 \text{ day}) = 60 \text{ hr}$$

$$\text{Average Hourly Pay} = [(\text{Pay Hours}) / (\text{Actual Hours})] \times \text{Base Wage}$$

## **Ironworker Costs:**

$$\text{Average hourly pay} = (75/60 \times \$20.97/\text{hr}) = \$26.2125/\text{hr}$$

$$\text{Social Security Tax} = 7.65\% \times \$26.2125/\text{hr} = \$2.0053/\text{hr}$$

$$\text{Unemployment Tax} = 3.0\% \times \$26.2125/\text{hr} = \$0.7864/\text{hr}$$

$$\text{Workers' compensation} = \$12.50/\$100 \times \$20.97/\text{hr} = \$2.6213/\text{hr}$$

$$\text{Public Liability/property damage} = \$3.25/\$100 \times \$20.97/\text{hr} = \$0.6815/\text{hr}$$

$$\text{Fringe benefits} = \$3.15/\text{hour}$$

$$\therefore \text{Ironworker average hourly cost} = \frac{\$35.4570}{\text{hr}} = \frac{\$35.46}{\text{hr}} \cong 1.69 * \text{Base wage}$$

# Cost Elements of Labour

## General Requirements

**R011**

## Overhead & Miscellaneous Data

### R01100-110 Overtime

One way to improve the completion date of a project or eliminate negative float from a schedule is to compress activity duration times. This can be achieved by increasing the crew size or working overtime with the proposed crew.

cost chart based on a five, six, or seven day week with an eight through twelve hour day. Payroll percentage increases for time and one half and double time are shown for the various working days.

To determine the costs of working overtime to compress activity duration times, consider the following examples. Below is an overtime efficiency and

Days per Week	Hours per Day	Production Efficiency				Payroll Cost Factors		
		1 Week	2 Weeks	3 Weeks	4 Weeks	Average 4 Weeks	@ 1-1/2 Times	@ 2 Times
5	8	100%	100%	100%	100%	100 %	100 %	100 %
	9	100	100	95	90	96.25	105.6	111.1
	10	100	95	90	85	91.25	110.0	120.0
	11	95	90	75	65	81.25	113.6	127.3
	12	90	85	70	60	76.25	116.7	133.3
6	8	100	100	95	90	96.25	108.3	116.7
	9	100	95	90	85	92.50	113.0	125.9
	10	95	90	85	80	87.50	116.7	133.3
	11	95	85	70	65	78.75	119.7	139.4
	12	90	80	65	60	73.75	122.2	144.4
7	8	100	95	85	75	88.75	114.3	128.6
	9	95	90	80	70	83.75	118.3	136.5
	10	90	85	75	65	78.75	121.4	142.9
	11	85	80	65	60	72.50	124.0	148.1
	12	85	75	60	55	68.75	126.2	152.4

RS Means

# Cost of Equipment

- Purchase
  - Extensive use time in operation
- Rent
  - Limited use time
- Lease
  - “Rent” first
    - A specific monthly rate
  - “Purchase” later
    - Option for purchase amount



# Cost Elements of Owned Equipment

- depreciation cost
- salvage value
- annual ownership cost
- replacement of wearing parts and major overhauls
- routine maintenance cost
- fuel or electricity cost
- operator cost

# Cost Elements of Owned Equipment

## Capital Recovery Equation

$$A = P \left[ \frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

where  $P$  = purchase price

$A$  = equivalent annual value

$i$  = annual interest rate

$n$  = useful life, in years

The capital recovery equation gives the equivalent annual value ( $A$ ) of the purchase price ( $P$ ), assuming an annual interest rate ( $i$ ) during the useful life of ( $n$ ).

$i$  = **MARR** (minimum attractive rate of return) = interest for borrowing money + risk + average cost for taxes, insurance, storage

Estimating Construction Costs, Peurifoy and Oberlender, 2002, McGraw-Hill

# Cost Elements of Owned Equipment

## Sinking Fund Equation

$$A = F \left[ \frac{i}{(1 + i)^n - 1} \right]$$

where  $A$  = equivalent annual value

$F$  = future salvage value

$i$  = annual interest rate

$n$  = useful life, in years

The sinking fund equation gives the equivalent annual value ( $A$ ) of the future salvage value ( $F$ ), assuming an annual interest rate of ( $i$ ) during the useful life of ( $n$ ).

Estimating Construction Costs, Peurifoy and Oberlender, 2002, McGraw-Hill

# Example of Equipment Estimate

## EXAMPLE 5.3

The purchase price of new equipment is \$145,000. The estimated salvage value is \$25,000 after the end of its expected useful life of 6 years. Assume interest for borrowing money is 9 percent, 5 percent for risk and 3 percent as the equivalent interest rate for taxes, insurance, and storage.

Estimating Construction Costs, Peurifoy and Oberlender, 2002, McGraw-Hill

# Example of Equipment Estimate

$$\text{Interest Rate } (i) = 9 + 5 + 3 = 17\%$$

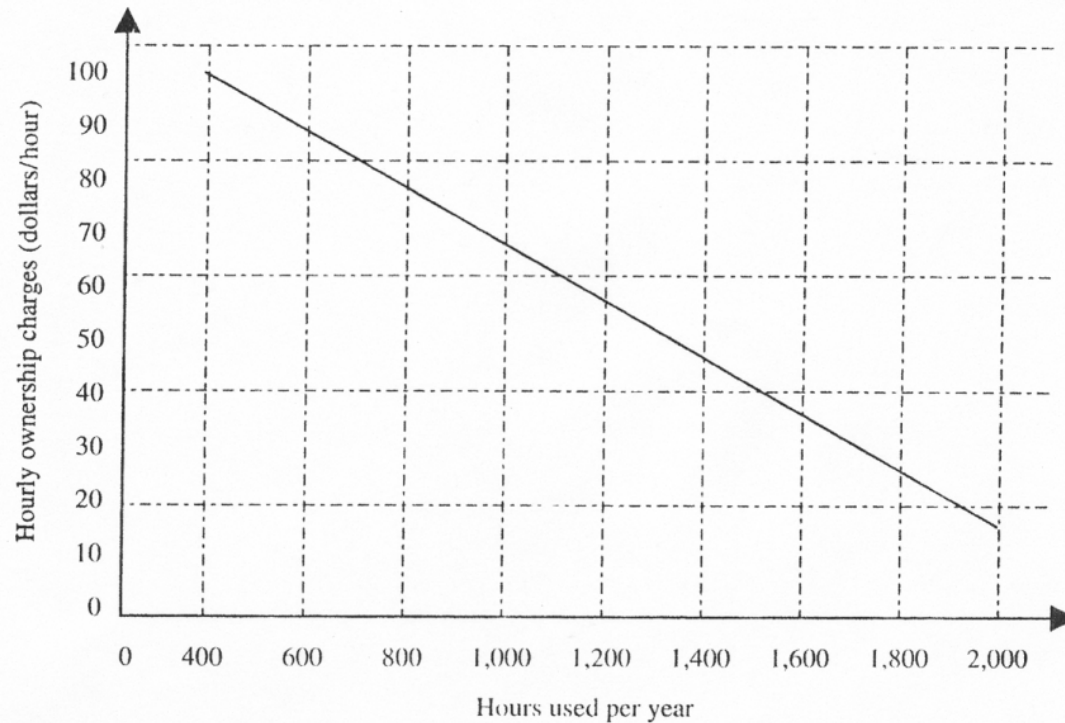
$$\text{Annual Ownership Cost } (A) = P \left[ \frac{i(1+i)^n}{(1+i)^n - 1} \right] - E \left[ \frac{i}{(1+i)^n - 1} \right]$$

$$A = \$145,000 \left[ \frac{0.17(1+0.17)^6}{(1+0.17)^6 - 1} \right] - \$25,000 \left[ \frac{0.17}{(1+0.17)^6 - 1} \right] = \$37,683.48$$

$$\text{Cost per hour} = \text{Annual ownership cost} / \text{Working hours per year}$$

$$\text{Cost per hour} = \$37,683.48 / 2,000 \text{ hours} = \$18.84$$

# Example of Equipment Estimate



**FIGURE 5.1** | Distribution of hourly charges of equipment in Example 5.4.

Estimating Construction Costs, Peurifoy and Oberlender, 2002, McGraw-Hill

# Cost Elements of Rented Equipment

- rental rate
- replacement of wearing parts and major overhauls beyond conditions covered by rental rate
- routine maintenance cost
- fuel or electricity cost
- operator cost

# Operating Cost of Equipment

- Accrue only when the equipment is being used.
- Include minor maintenance and repairs, fuel, oil and lubricants.
- Be familiar with type and size of equipment
  - The conditions under which it is operated
  - The location
- Equipment is seldom used 60 mins/hr.
- Fuel consumption should be based on actual operating conditions.
- *Average demand on an engine 50% of its maximum power for an average 45 mins/hr.*



# Operating Cost of Equipment

- Maintenance and Repair Cost
  - Expenditure for replacement parts and the labor, to keep the equipment in good working condition
  - Annual cost expressed as a *percentage of purchase price (P)* or a *percentage of straight-line depreciation cost*

$$(P - F) / n$$

- Average M&R cost of an excavator varies 80 to 120 percent of the depreciation cost for rock-crushing equipment, much higher; Compressor, lower.

# Operating Cost of Equipment

- Fuel Consumption

- When operating under standard conditions namely, *at a barometric pressure at 29.9 in. of mercury, at a temperature of 68°F*, a gasoline engine will consume approximately 0.06 gal of fuel for each actual horsepower hour developed:

$$[0.06 \text{ gal}/(\text{hp} \cdot \text{hr})]$$

- .
- A diesel engine:  $[0.04 \text{ gal}/(\text{hp} \cdot \text{hr})]$

## Operating Cost of Equipment

- Example: Fuel Consumption
  - A shovel with a diesel engine rated at 160 hp during a cycle of 20 sec. The engine operates at full power while filling the bucket in tough ground, require 5 sec; in the balance of the cycle, the engine operates at not more than 50% at its rated power.
  - The shovel may not operate more than 45 minutes per hour on average.
  - The approximate amount of fuel consumed during 1 hour.

# Operating Cost of Equipment

- Fuel Consumption

- Rated power: 160 hp

- Engine factor:

- Filling the bucket:  $5/20 \times 100\% = 0.250$

- Rest of cycle:  $15/20 \times 50\% = 0.375$

- Total Engine Factor: 0.625

- Time Factor:  $45/60 = 0.75$

- Operating Factor:  $0.625 \times 0.75 = 0.47$

- Fuel consumption per hour:

- $$0.47 \times 160 \text{ hp} \times [0.04 \text{ gal}/(\text{hp} \cdot \text{hr})] = 3.0 \text{ gal/hr}$$

# Operating Cost of Equipment

- Lubricating oil consumed
  - Quantity will vary with
    - Size of the engine
    - Capacity of the crankcase
    - Condition of the pistons
    - Number of hours between oil changes (every 100 to 200 hours)

# Operating Cost of Equipment

- Lubricating oil consumed

- $$Q = \frac{\text{hp} \times 0.6 \times 0.006 \text{ lb}/(\text{hp} \cdot \text{hr})}{7.4 \text{ lb/gal}} + \frac{C}{t}$$

- Q: Quantity consumed in gallons per hour
    - hp: rate horse power of engine
    - C: Capacity of crankcase, in gallons
    - t: hours between oil changes
    - 0.60: Operating factor
    - 0.006 lb/(hp·hr): Quantity of oil consumed between oil changes

## Operating Cost of Equipment

- Example

- A 100-hp engine with a crankcase capacity of 4 gals requiring a change every 100 hrs.

$$Q = \frac{100 \text{ hp} \times 0.6 \times 0.006 \text{ lb}/(\text{hp} \cdot \text{hr})}{7.4 \text{ lb/gal}} + \frac{4 \text{ gals}}{100 \text{ hrs}}$$
$$= 0.089 \text{ gal/hr}$$

## Operating Cost of Equipment

- Cost of Rubber Tires
  - Equipment lasts 6 years, tires on the equipment last only 2 years.
  - Three sets of tires required during the 6-years of equipment use.
  - Cost of D&R on tires should be estimated separately from the equipment.



## Operating Cost of Equipment

- Cost of Rubber Tires

- A set of tires cost \$3,800, with estimated life of 2,500 hrs. The repairs during the life of tires costing 15% of the initial cost of the tires.
- Depreciation:  $\$3,800 / 2500\text{hrs} = \$1.52/\text{hr}$
- Repairs of tires:  $0.15 \times \$1.52/\text{hr} = \$0.23/\text{hr}$
- Total:  $\$1.75/\text{hr}$

# Cost Elements of Materials and Subcontracts

## Materials (Permanent and Temporary)

- unit cost and quantity
- transportation and delivery cost
- escalation and/or rise and fall

## Subcontracts

- unit cost and quantity

ITEM  
QUANTITY

Bridge  
1

Activity	Labour	Equipment Owned	Equipment Rented	Materials Perm.	Materials Temp.	Supply	Subcontr.	Total Cost of Activity
Excavation	4000	8000	0	0	0	0	0	12000
Footings								
Form	1500	500	0	0	6000	0	0	8000
Reinforce	1200	0	600	10000	0	0	0	11800
Concrete	<b>1600</b>	<b>750</b>	<b>0</b>	<b>2000</b>	<b>400</b>	<b>11200</b>	<b>0</b>	<b>15950</b>
Bridge Deck	3000	2000	1000	5000	1000	0	0	12000
Paving	0	0	0	0	0	0	12000	12000
Sound Barriers	0	0	0	0	0	0	8000	8000
Landscaping	0	0	0	0	0	0	5000	5000
<b>Total Res. Cost of Item</b>	11300	11250	1600	17000	7400	11200	25000	84750

**Total Cost  
of Item**

**ACTIVITY** Footings  
**OPERATION** Supply, place, finish concrete  
**QUANTITY** 100 m3

Resource Category	Description	Units	Unit Rate (\$/unit) (e.g.\$/mhr)	Productivity Rate (units/unit qty) (e.g. mhr/m3)	Unit Cost (\$/unit qty) (e.g.\$/m3) (6) = (4)(5)	Cost (\$) (7)=(6)*unit qty (from takeoff)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Labour	Concreters	mhr	32	0.5	16	1600
Supply	Supply concrete	m3	112	1	112	11200
Equipment	Concrete vibrator	hr	10	0.5	5	500
Equipment	Screeds, Trowels, etc.	hr	5	0.5	2.5	250
Materials (Perm.)	Surface curing retarder	m2	5	4	20	2000
Materials (Temp.)	Curing blankets	m2	1	4	4	400
<b>TOTAL COST</b>						<b>15950</b>

**TABLE 1.11** | Form to estimate construction costs.

Item no.	Description	Calculations	Number of units	Unit cost	Material cost	Equipment cost	Labor cost	Total cost
2350-0	Furnish and drive 200 creosote-treated piles. Drive piles to full penetration into normal soil. Piles size: 50 ft length, 14-in. butt, 6-in. tip	$200 \times 50 \text{ ft} = 10,000 \text{ lin ft}$	10,000 lin ft					
-10	<b>Materials</b> Piles; add 5 for possible breakage	$205 \times 50 \text{ ft} = 10,250 \text{ lin ft}$	10,250 lin ft	\$4.20/lin ft	\$43,050			\$43,050
-20	<b>Equipment</b> Moving to and from the job Crane, 12-ton Hammer, single-acting, 15,000 foot pound Air compressor equipment Leads and sundry equipment	$200 \text{ piles} / (2\frac{1}{2} \text{ piles/hr}) = 80 \text{ hr}$	lump sum 80 hr 80 hr 80 hr 80 hr	 \$145/hr \$15/hr \$9/hr \$5/hr		\$7,000 \$11,600 \$1,200 \$720 \$400		\$7,000 \$11,600 \$1,200 \$720 \$400
-30	<b>Labor</b> (add 16 hr to set up and take down equipment)	$80 + 16 = 96 \text{ hr}$						
-32	Foreman	96 hr	96 hr	\$25/hr			\$2,400	\$2,400
-34	Crane operator	96 hr	96 hr	\$18/hr			\$1,728	\$1,728
-36	Laborer (1 total)	96 hr	96 hr	\$14/hr			\$1,344	\$1,344
-38	Workers on hammer (2 total)	$96 \text{ hr} \times 2 = 192 \text{ hr}$	192 hr	\$15/hr			\$2,880	\$2,880
-39	Helpers (2 total)	$96 \text{ hr} \times 2 = 192 \text{ hr}$	192 hr	\$12/hr			\$2,304	\$2,304
-40	<b>Subtotal direct costs</b>				\$43,050	\$20,920	\$10,656	\$74,626
-50	<b>Indirect costs</b>							
-51	Material taxes							
-511	State sales tax	$5\% \times \$43,050$						\$2,052
-512	County sales tax	$1\% \times \$43,050$						\$431
-520	Labor taxes							
-521	FICA (social security tax)	$7.65\% \times \$10,656$						\$815
-522	Unemployment tax	$3\% \times \$10,656$						\$320
-530	Insurance							
-531	Workman's compensation insurance	$9\% \times \$10,656$						\$959
-532	Contractor's liability insurance	$4\% \times \$10,656$						\$426
-540	Overhead							
-541	Job overhead	$8\% \times \$74,626$						\$5,970
-542	Office overhead	$2\% \times \$74,626$						\$1,493
-60	<b>Subtotal indirect costs</b>							\$11,651
-70	<b>Total direct and indirect costs</b>							\$86,277
-80	<b>Add-ons</b>							
-811	Contingency	$5\% \times \$86,277$						\$4,314
-812	Profit	$10\% \times \$86,277$						\$8,628
	<b>Subtotal of add-ons</b>							\$12,942
-90	Performance bond	$1\% \times (\$86,277 + \$12,942)$						\$922
-91	<b>Total cost, amount of bid</b>	$\$86,277 + \$12,942 + \$922$						\$100,141
-92	Cost per lin ft	$\$100,141 / 10,000 \text{ lin ft}$						\$10.01 per lin ft

# Estimating Construction Costs, Peurifoy and Oberlender, 2002, McGraw-Hill

**PRELIMINARIES  
PROJECT OVERHEAD COSTS  
INDIRECT COSTS**

**FIXED COSTS:**

**Mobilisation**

- Building and planning authority fees
- Administration finance charges
- Fees for provision of guarantees and bonds
- Insurance premiums
- Setting out work (surveying)
- Purchasing and setting up of site offices and sheds
- Purchasing of wet weather gear and safety equipment
- Building temporary roads
- Installation of fencing around site
- Transportation of personnel (to remote site)
- Installation of utilities

**Demobilisation**

- Dismantling and removal of site offices and sheds
- Dismantling and removal of fencing
- Cleaning up of site
- Dismantling and transportation of plant and equipment (e.g. cranes)
- Transportation of personnel (from remote site)
- Provision of warranties to client
- Provision of shop drawings, as-built drawings, schedules, cash flow, and manuals to client
- Salvage recovery from sale of site equipment
- Maintenance during defects liability period

**PRELIMINARIES  
PROJECT OVERHEAD COSTS  
INDIRECT COSTS**

**RECURRING COSTS:**

**Based on project schedule**

- Salaries of site supervisors, engineers, project managers, safety officers, site secretaries
- Salaries of general field staff
- Rental, maintenance, and running of vehicles for site personnel
- Consumables: coffee/tea, first aid supplies
- Small tool consumables
- Running of utilities: water, electricity, gas
- Communication facilities: telephones, mobile telephones, faxes, couriers, postage
- Site administration
- Site rubbish disposal
- Accommodation of site personnel (on remote site)
- Minor plant and equipment hire (e.g. drills, jackhammers)
- Major plant and equipment hire (e.g. cranes)
- Fuel and maintenance costs for plant and equipment
- Periodic inspections and testing
- Maintenance of site records
- Design and documentation coordination and production
- Financing costs
- Retention amounts
- Accident payments
- Taxes and duties

# Estimating Vs. Tendering

## ESTIMATING:

- Assessing direct costs and indirect costs

## TENDERING/BIDDING:

- Assessing risk and opportunity allowance and margin

## RISK AND OPPORTUNITY ASSESSMENT:

- Identifying and assessing the impact on costs of potential project risks (monetary losses) and opportunities (monetary gains)



## Factors affecting Risk and Opportunity Allowance

### Project Characteristics

Size of project (dollar value)  
 Duration of contract period  
 Location with respect to head or branch office

### Design Characteristics

Degree of contractor involvement in design phase  
 Proportion of design complete at time of tendering  
 Confidence in design  
 Company relationship with design team and consultants

### Cost Estimate Characteristics

Time allowed for submitting bids  
 Proportion of time-based overheads to contract value  
 Amount of negative cashflow on project  
 Amount of external financing required for project  
 Likelihood of escalation and/or rise and fall  
 Likelihood of changes in labour market supply  
 Likelihood of increase in foreign exchange rates

### Subcontractors and Suppliers

Proportion of work (\$) subcontracted to total contract value  
 Number of major supply and/or subcontracts on project  
 Lack of guaranteed price over duration of supply/subcontracts  
 Likelihood of negotiating lower price on supply/subcontracts  
 Quality of work and credit worthiness of subcontractors/suppliers  
 Current workload of subcontractors and/or suppliers  
 Company's relationship with subcontractors/suppliers  
 Company's quoted prices from subcontractors/suppliers with respect to competitors:

Commercial advantages  
 Commercial disadvantages

### Project-Related Risks

Likelihood of unexpected climatic conditions  
 Likelihood of unexpected job site conditions  
 Degree of safety hazard on project  
 Completeness and clarity of tender documents and specifications  
 Amount of contractor coverage (e.g. latent conditions clause)  
 Amount of liquidated damages  
 Likelihood of regulatory restrictions causing delays  
 Complexity in project design  
 Complexity in construction methods  
 Likelihood of a schedule delay  
 Uncertainty in estimated quantities, productivity, and/or price rates for:

Labour  
 Plant  
 Materials

Proportion of labour cost to total project cost  
 Proportion of hired to owned plant on project  
 Material delivery reliability

### Project-Related Opportunities

Innovation in design  
 Innovation in construction methods  
 Amount of contract bonuses  
 Likelihood of an acceleration in schedule  
 Likelihood of changes in contract:

Scope  
 Conditions  
 Quantities  
 Rates

# Risk and Opportunity Assessment

- Identify items in the project which may have potential cost overruns (risks) or cost savings (opportunities)
- Assess the most likely \$ cost or savings associated with each item
- Assess the probability of each cost or savings occurring
- Multiply the \$ cost or savings by its probability of occurrence
- Sum up the total resultant costs and the total resultant savings; the difference between the two is the net project risk/opportunity allowance (contingency) (may be + or - )

# Risk Factors

- Unexpected climatic conditions
- Unexpected geological or soil conditions
- Uncertainty in estimated productivity
- Delay in schedule
- Delay in delivery of materials

# Opportunity Factors

- Innovation in project design or construction methods
- Negotiated deals with supplier(s)
- Acceleration in schedule
- Changes in contract scope

# Other Methods of R/O Assessment

- **By cost category breakdown**, to reflect amount of risk inherent in each category: labour, equipment, materials, subcontracts
- Using “what-if” scenarios – best, most likely, worst
- Included in direct job cost items
- Included in margin (markup)
- **Risk analysis modeling**, e.g. using @RISK and Monte Carlo Simulation

# Margin/Markup Assessment

- Must at least cover corporate overheads, based on budgeted turnover
- Depends on the objectives of the company in tendering
- Depends on the amount of risk/opportunity assigned
- Depends on conditions within the company, advantages and disadvantages, client, competition, state of the market, economy

# Items Covered by Markup

- Corporate overheads
- Profit
- Risk and opportunity allowance (in some cases)

# Objectives in Tendering

- To win the project
- To meet budgeted turnover requirements; to deploy idle resources
- To be seen as competitive; to build a reputation
- To break into a new market; strategic value
- To test a new geographical area
- To maximize project's contribution to profit



## Factors Affecting Margin Size

### Company Characteristics

Need for work  
Desire for project  
Likelihood of winning project  
Availability of other projects over remainder of fiscal year  
Likelihood of winning future tenders over remainder of fiscal year  
Targeting of more desirable projects over remainder of fiscal year  
Capacity to supply resources for construction  
Availability of key personnel (management) in company  
Capacity to supply resources for financing  
Company's strength in the industry  
Experience on similar projects  
Past profit on similar projects  
Familiarity with geographical area  
Familiarity with market  
Amount of contingency (risk/opportunity allowance) in estimate

### Corporate and Budgetary Considerations

Margin required of project by corporate budget  
Rate of return required from investment in project  
Tax liabilities of project  
Proportion of fiscal year already over  
Actual versus budgeted turnover to date  
Actual versus budgeted corporate overheads to date  
Actual versus projected amount of work won to date  
Corporate strategy or business plan for this market

### The Client

Company's relationship with the client  
Major competitors' relationship with the client  
Credit worthiness and fairness of the client

### Competition

Number of competitors for the project  
Competitors' current workload in this market  
Number of competitors with strong desire for this project  
Likelihood of any of competitors having an advantage in:  
Design  
Construction methods  
Labour productivity  
Plant  
Materials  
Previous experience of competitors on similar projects  
Competitors' performance on past projects in this market  
Competitors' ranking in past bids in this market  
Competitors' current workload in other markets

### Economic and Political Conditions

Current state of the economy  
Current unemployment rate  
Current interest rates  
Likelihood of increase in interest rates  
Likelihood of changes in tax laws  
Expected market trend in this sector of industry  
Amount of work available to contractors in this sector of industry  
Amount of other work available to subcontractors and/or suppliers on this project

# Methods of Setting Markup

- Based on minimum or base margin - break even analysis
- Based on resource cost category breakdown (to reflect risks inherent in each)
- Based on experience and market conditions

# Break Even Analysis

To determine minimum (base) markup

OR

To determine minimum volume of work (turnover) for firm to break even (i.e. to cover corporate overhead costs, without making any profit).

## Method A:

Predict turnover level (\$) for coming year and calculate minimum markup (%).

## Method B:

Determine gross markup (%) (i.e. profit plus corporate overheads) on projects in coming year and calculate minimum volume of work (turnover) (\$).

# Steps in Break Even Analysis

Forecast corporate overheads for coming year:

Previous year = \$200,000

10% inflation = \$20,000

(can be applied before or after firm growth)

Firm growth = \$20,000

→Forecasted corporate overheads \$240,000

# Steps in Break Even Analysis

## Method A:

- Forecast turnover level, e.g. \$2,000,000
- Minimum Markup  
= Corporate Overheads / Turnover  
= \$240,000/\$2,000,000  
= 12%

## Method B:

- Forecast gross markup, e.g. 12%
- Use break even analysis equations:  
Revenue - Project Costs = Gross Profit [1]  
Gross Profit - Corporate Overheads = Net Profit [2]  
Gross Profit / Revenue = Gross Markup [3]

# Steps in Break Even Analysis

At Break Even point, Net Profit = 0, so:

From [2], Gross profit = Corporate Overheads

From [1], Revenue = Project Costs + Corporate Overheads

From [3], Corporate Overheads / Revenue = Gross Markup

Revenue = Corporate Overheads/Gross Markup

In our example:

Revenue = \$240,000 / 0.12 = \$2,000,000

# Bid Summary Process

- Turning estimate into bid
- Step 1
  - Summarize all costs to the bid item level
- Step 2
  - Compute indirect costs, bonds, add-ons (contingency), markup, profit and spread them back to the various bid items to arrive at bid prices
- Step 3
  - Each cost category can be marked up a different percentage, e.g. most contractors have high markup on labor because it is high risk, low markup on subcontractor and material because it is lower risk
- Step 4
  - Ways to spread markup: On labor, On total cost, On total cost less subcontract cost

# Finalizing a Bid Proposal

- **Balanced bidding:**
  - Distribute indirects and markup to all items proportional to their relative direct costs.
- **Unbalanced bidding:**
  - Raising the prices on certain bid items and decreasing the prices on others so that the total bid price remains the same.
  - Improving project financing
    - Raise the unit prices for the bid items that come early in the schedule and also reduce the prices for later items.
    - Enables the contractor to charge more for early work and accordingly receive a higher owner payment such that his own financing cost is less.



# Finalizing a Bid Proposal

- Unbalanced bidding:
  - Adjusting the bid under expected quantity change
    - Raise the unit prices for the bid items that are expected to have much more quantity than stated in the bid package; reduce the unit prices for those with expected less quantity.
    - Enable the contractor to attain a competitive edge and possibly a more potential profit.
  - Unbalanced (Shift costs) from items that are likely to underrun in quantity to those that may overrun
    - To shelter risks
    - Exploit errors in quantities
  - Be aware
    - Doing this conspicuously is considered illegal on many government bids

# Strategic Spreading

- For unit price contracts: paid on basis of actual quantities installed
- Strategic spreading to benefit from errors in owner's quantities
- **Increase** unit prices of items that are **underestimated** by owner (load these items)
- **Decrease** unit prices of items that are **overestimated** by owner
- Can be used to (1) reduce overall bid price to be more competitive, or (2) to increase profit margin while maintaining original bid price

TENDER SUMMARY

Bill Item	Description	Quantity			Labour	Temp Material	Perm Material	Owned Equipt	Rented Equipt	Subs	Total DC	IDC Spread	Subtotal Cost	Conting. Spread	Margin Spread	Total Bid Price	Final Bid	
		Bill	Est	Unit													Bid Rate	Bid Price
1.1	River Diversion	1	1	LS	35000	5000	50000	100000	16000	0	206000	300000	506000	400000	54314	960314	960314	960314
2.1	Excavate Foundations	77000	80000	m3	316300	154000	0	450000	135600	0	1055900	450000	1505900	100000	161642	1767542	22.96	1767542
8.1	Excavate rock and deliver	320000	350000	m3	1591000	1878000	0	473000	1000000	0	4942000	600000	5542000	0	594873	6136873	19.18	6136873
16.1	Dirll grout holes-provis.	600	600	m	33600	7400	0	38000	0	0	79000	0	79000	0	8480	87480	145.80	87480
16.2	Grouting - provisional	2000	2000	bags	148400	0	37600	112000	0	0	298000	0	298000	0	31987	329987	164.99	329987
17.1	Metalwork - prime cost	1	1	LS	0	0	0	0	0	600000	600000	0	600000	0	0	600000	600000	600000
20.1	Concrete in pier shafts	460	485	m3	16435	6280	58200	0	9950	3700	94565	150000	244565	0	26251	270816	588.73	270816
TOTALS					2140735	2050680	145800	1173000	1161550	603700	7275465	1500000	8775465	500000	877547	10153012		10153012

Indirect costs = 1500000

Contingency = 500000

Indirect costs and contingency spread to front-end load bid

Margin = 10% of subtotal costs = 0.10x8775465 = 877547

Total subtotal cost of items that receive margin spread = 8775465-600000 = 8175465

Example of **front-end loading** of bid prices

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- *Project Management: Techniques in Planning and Controlling Construction Projects*, 2<sup>nd</sup> Edition, Ahuja, Dozzi, and AbouRizk, John Wiley and Sons, 1994.
- *Estimating Construction Costs*, Peurifoy and Oberlender, 2002, McGraw-Hill.