

CoTM 6203 Advanced Construction Material & Equipment Management

Lecture 7 - Construction Economics

Introduction

- With the growing maintenance cost, especially in the infrastructure sector, it has been realized that not only the initial cost, but also the overall *life-cycle cost* of a project should be taken into account when evaluating options.
- In fact, in the case of construction projects, economics affects decision-making in many ways - from the cost of materials to purchase and scrapping of equipment, bonus and/or penalty clauses, and so on.
- It is, therefore, **extremely important that engineers and construction managers have a working knowledge of economic principles, terminology and methods.**

Foundation for a construction professional

- Construction contracting is a **highly competitive business**.
- Therefore, the **financial management** of a construction company is equally as important to company success as is its **technical management**.
- As a matter of fact, many successful constructors have evolved from a background of business and finance rather than from construction itself.
- However, there is little doubt that a ***strong technical base*** supported by ***business skills*** and ***management ability*** provides the best foundation for success as a ***construction professional***.

Time value of money

- Everyone is aware that the amount of money held in a savings account will increase with time if interest payments are allowed to remain on deposit (compound) in the account. The value of a sum of money left on deposit after any period of time may be calculated using:

$$F = P (1 + i)^n$$

- where
 - F = value at end of n periods (future value)
 - P = present value
 - i = interest rate per period
 - n = number of periods

Time value ...

- The expression $(1 + i)^n$ is often called the *single-payment compound interest factor*.
- The above equation can be solved to find the present value (present worth) of some future amount, resulting in:

$$p = \frac{F}{(1 + i)^n}$$

Time value ...

- The expression $1/(1 + i)^n$ is called *the single-payment present worth factor*.
- Expressions have also been developed that yield the value of a series of equal periodic payments at the end of any number of periods (*uniform series compound amount factor*), the present worth of such a series (*uniform series present worth factor*), the periodic payment required to accumulate a desired amount at some future date (*sinking fund factor*), and the *annual cost to recover an investment*, including the payment of interest, over a given period of time (*capital recovery factor*).
- Other expressions have been developed to find the present and future worth of *gradient (non-uniform)* series of payments.

Limitations of the equation for construction industry

- These equations form the basis of a type of economic analysis commonly called *engineering economy*.
- The methods of engineering economy are widely used to analyze the *economic feasibility* of proposed projects, to compare alternative investments, and to determine the *rate of return on an investment*.
- However, because of their complexity and the *difficulty of accounting for the effects of inflation and taxes*, these techniques have not been widely used within the construction industry.

Economic decision-making

- There are various situations :-
 - a) Comparison of designs or elimination of over - design
 - b) Designing for economy of production/maintenance/transportation
 - c) Economy of selection
 - d) Economy of perfection
 - e) Economy of relative size
 - f) Economy and location
 - g) Economy and standardization and simplification
- In which an engineer has to take a decision among the competing alternatives.

Economic ...

- These are referred to as *problems of present economy*. In such situations, the decision maker may not consider the time value of money.
- The 3 most common methods of evaluation:
 1. *'Out-of-pocket commitment' comparison,*
 2. *'payback period', and*
 3. *The 'average annual rate of return' methods*
- In which the time value of money is not considered.

Out-of-Pocket Commitment

- Suppose a pre-cast concrete factory has to produce 100,000 railway sleepers per year.
- An economic choice has to be made between using steel formwork and wooden formwork.
- The life of steel formwork is estimated to be 1 year, while that of wooden formwork is 1 month.
- The costs of preparing one set of steel formwork and one set of wooden formwork are Birr 400,000 and Birr 50,000, respectively.

Out-of-Pocket ...

- It is further estimated that the labour costs for fixing and removing the steel and wooden formwork are Birr 10 and Birr 9 per sleeper, respectively.
- Now, this is a situation wherein we may not need to consider time value of money, and use the lowest *out-of-pocket commitment criteria* to choose the most economical alternative.
- The out-of-pocket commitment is the total expense required for an alternative.

Out-of-Pocket ...

- For example, the out-of-pocket commitment for steel formwork option would be the sum of total labour cost incurred for production of one 10^5 sleepers/year plus the cost of the steel formwork/year, that is, $100,000 \times 10 + 400,000 = \text{Birr } 1,400,000$. Similarly, for wooden formwork option is $= 9 \times 100,000 + 50,000 \times 12 = \text{Birr } 1,500,000$.
- Since the out-of-pocket commitment for steel formwork is lesser than that for wooden formwork, the decision would be to choose the '*steel formwork*' option.

Payback Period (PBP)

- The *PBP* for an investment may be taken as the number of years it takes to **repay the original invested capital**, and serves as a very simple method for *evaluation of projects and investments*.
- Though this method **does not take into account the cash flows occurring after the payback period**, given the ease of computation involved, the method is widely used in practice, and it is understood that the ***shorter the payback period***, the higher the likelihood of the project being profitable, *i.e.*, the option with the shorter payback period should be selected.

Example

- A contractor have two brands of excavators, A and B, to choose from. Both the brands are available for a down payment of 400,000 Birr. Both brands can be useful for a period of 4 years.
- Brand A is estimated to give a return of Birr 50,000 for the 1st year, 150,000 for the 2nd year, and 200,000 for the 3rd and 4th year.
- Brand B, on the other hand, is expected to give a return of 150,000 for all the 4 years. Calculate the payback period for both brands select preferred alternative.

Solution

- The payback period for Brand A = 4 years, as the initial investment of 400,000 Birr is recovered in 3 years ($50,000 + 150,000 + 200,000 = 400,000$). The method does not consider the returns after the payback period. Hence, in this case the return of 4th year (200,000) is simply overlooked.
- For Brand B, the return is 300,000 up to the end of 2nd year and in the 3rd year it equals 450,000. Thus, the investment amount of 400,000 is recovered somewhere between 2nd & 3rd year, which can be found out by interpolation.

= 2.67 years or 2 years and 8 months

- Here also, as in the first case we neglect the return that is expected beyond the *PBP*.
- Hence, it is beneficial to buy Brand B excavator as it has a lesser *PBP*.
- Although we have taken the equal initial investment and time period for the two alternatives, the *PBP* can also be used when these values are not same, *i.e.*, we can use *PBP* for problems involving unequal initial investment and service life.

Average Annual Rate of Return (AARR)

- In this method, the alternatives are evaluated on the basis of only the ***average rate of return as expressed in terms of a percentage (of the original capital)***.
- Since this method does not distinguish the period at which transactions take place, or ***the timings of cash flow, it is not possible to account for the concept of 'time value of money'*** in this approach.

- We use the previous example (used in *PBP* comparison method) to illustrate the computations involved.

$$= 150,000$$

- Here, 4 is the number of years. The above-average annual return is converted into percentage to get the *AARR*.
- Here, 400,000 is the original invested capital.

= 150,000

- This is also the same as Brand A. Thus, as far as AARR is concerned, both the brands are equivalent.
- However, given a choice between the two brands A and B, which one would you prefer? We would go for Brand B. This is *because we are getting higher returns in the initial years for Brand B when compared to Brand A.*
- The basis for taking such decisions is inherent in the **'time value of money'** concept.

Real worth of money

- Although monetary units (*Euro, dollar, etc.*) serve as an excellent tool to compare otherwise incomparable things, e.g., a *bag of cement and tons of sand*, we know that the **real worth of a certain amount of money is not invariant** on account of factors such as inflation, dynamic interactions *between demand and supply*, etc.
- Hence, ***time value of money is a simple concept that accounts for variations in the value of a sum of money over time.***

Real ...

- In most decisions, the change in the value of money needs to be accounted for, and this section seeks to present simple tools of analysis to help a construction engineer make logical decisions based on sound economic principles.
- The most important principle involved is that of '*interest*', which could be looked upon as the cost of using capital, or the (additional) money (in any form) paid by the borrower for *the use of funds provided by the lender*.
- According to Riggs *et al.* (2004), the *interest* represents the earning power of money, and is the **premium paid to compensate a lender for the administrative cost of making a loan, the risk of non-repayment, and the loss of use of the loaned money.**

Simple and compound interest

- A borrower pays interest charges for the **opportunity** to do something now that otherwise would have to be delayed or would never be done.
- In simple terms, interest could be simple or compound, where in the former case, the interest component does not attract any interest during the repayment period, whereas in the latter case, the **interest amount itself also attracts further interest**, as we know from traditional arithmetic.

Simple ...

- Let us consider the following statement by a bank: *Interest on the deposit will be payable at the rate of 8% compounded quarterly.*
- Here, the period of compounding represents the interval of time at which interest will be added to the principal, and the revised principal used to calculate the interest on the next time step.
- Thus, in a year, for quarterly compounding of interest, four periods (of 3 months each) should be considered.

- Now, if the principal amount was 100 Birr, at the end of the first three-month period, the new principal (to calculate interest on the second quarter) should be taken as

$$= 102.00 \text{ Birr}$$

W

- and so on. At the end of one year, the principal would become Birr 108.24. In other words, it can be stated that the value of Birr 100 changes to 108.24 under the given conditions of 8% nominal interest and quarterly compounding.

Effective rate of interest

- Modified rate of interest is sometimes referred to as the *effective rate of interest* (i_{eff}), which in addition to the *nominal rate of interest* (i_{nom}) also depends on the period of compounding.
- One can work out that the i_{eff} taking i_{nom} to be 5% and 10%, will be 5.09% and 10.38%, respectively, for quarterly compounding, and 5.12% and 10.47% for monthly compounding.

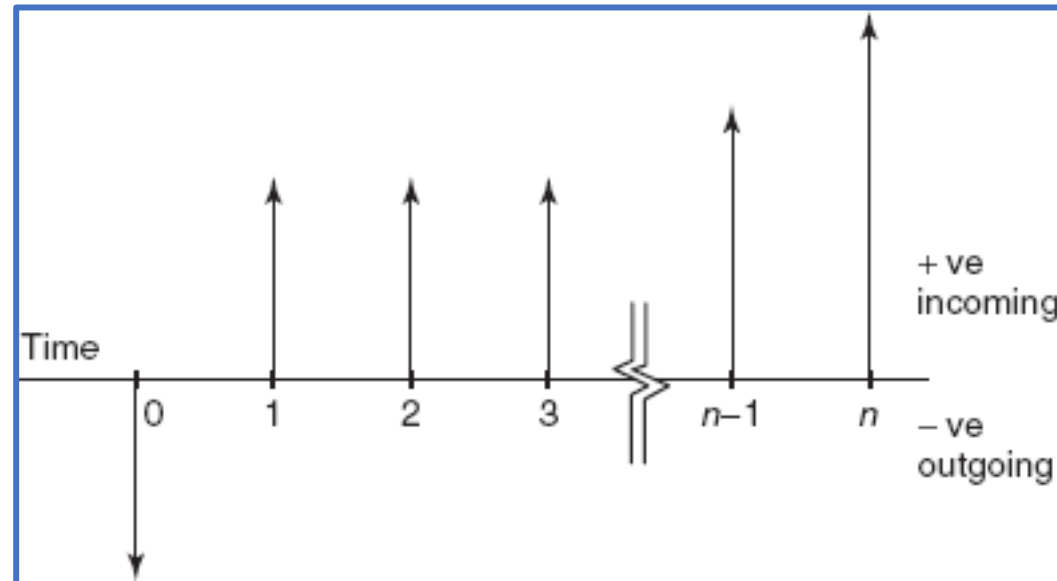
In general, given the number of periods in a year to be taken for compounding (m) and the i_{nom} , the i_{eff} , can be calculated as below:

$$i_{eff} = \left(1 + \left(\frac{i_{nom}}{m \times 100} \right)^m - 1 \right)$$

Cash-flow diagrams

- Any organization involved in a project receives and spends different amounts of money at different points in time, and a cash-flow diagram is a visual representation of this inflow and outflow of funds.
- Although in practice this inflow and outflow does not necessarily follow any pattern, it is sometimes assumed that all transactions (inwards or outwards) take place either at the beginning or end of a particular period, which may be a week, a month, a quarter, or a year, simply to simplify the analysis. All are valid as long as consistent.

- In a cash-flow diagram, usually time is drawn on the horizontal (X) axis in an appropriate scale, in terms of weeks, months, years, etc., whereas the Y -axis represents the amount involved in the transaction, with the receipts and disbursements being drawn on the positive and negative side, respectively, of the Y -axis.
- While scale is maintained for the time axis, the representation on the Y -axis is sometimes not to scale; however, effort should be made to maintain a semblance of balance.



Project Cash-flow Diagram

- The project cash flow is basically a graph (pictorial representation) of receipts and disbursements versus time.
- The project cash flow can be prepared from different perspectives—of contractor, owner, etc.
- It is usual to represent time in terms of month for project cash-flow diagram.
- For executing a construction project, a constructor spends and receives the money at different points of time.

Project ...

- In order to draw a project cash-flow diagram, the following details are required.
 1. The **gross bill** value and its time of submission
 2. The **measurement period**. It is usual for contractors to be paid on a monthly basis. The payment can be made **fortnightly or sometimes bimonthly as well**. These conditions can be found under 'terms of payment' given in the tender document
 3. The **certification time taken by the owner**. In normal conditions, the owner takes about 3 to 4 weeks to process the bill and release the payment to the constructor or the contractor

Project ...

4. The **retention money** deducted by the owner and the time to release the retention money
5. The **mobilization advance**, the **plant & equipment** advance, and the **material** advance, and the **terms of their recovery**
6. The details of cost incurred by the contractor for raising a particular bill value. This break-up of costs should be in terms of **labour** cost, **materials** cost, **plant & equipment** cost, **subcontractors** cost and project **overheads**
7. The **credit period** (delay between incurring a cost and the actual time at which the cost is reimbursed) enjoyed by the contractor in meeting the costs towards labour, materials, plant and equipment, and overheads

Example

Let us assume that the contractor has been awarded this contract on the following terms:

- Advance payment of 5 Million Birr, to be recovered in 5 equal instalments from the 3rd running account bill onwards
- The total cost for the contractor to execute a particular item is **90% of the quoted rate**
- The total cost for a particular item consists of labour (20%), material (55%), plant & machinery (10%), subcontractor cost (10%) and project overheads (5%)
- Assume that there is no delay in payment towards labour costs and overhead costs, but a delay of one month occurs in paying to the subcontractors, material suppliers, and plant & machinery supplier
- Retention is 10% of billed amount in every bill, 50% retention amount is payable after one month of practical completion, while the remaining 50% is payable 6 months later

Monthly invoice for the example problem (values in 10^5 Birr)

Item description	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Earthwork: All soils	0.25	0.75	1.00	1.25	1.25	0.50				
Concrete works		8.00	16.00	16.00	20.00	12.00	8.00			
Formwork		4.20	8.40	8.40	10.50	6.30	4.20			
Reinforcement works		11.25	22.50	22.50	28.125	16.875	11.25			
Brickwork			3.40	5.10	6.80	6.80	6.80	3.40	1.70	
Plastering: All types				1.50	2.250	3.00	3.00	3.00	1.50	0.75
Painting: All types				0.50	0.75	1.00	1.00	1.00	0.50	0.25
Flooring: All types				11.00	16.50	22.00	22.00	22.00	11.00	5.50
Waterproofing works							6.00	6.00		
Aluminium work					3.375	3.375	3.375	3.375		
Electrical work						8.75	8.75	8.75	5.25	3.50
Sanitary and plumbing works			1.00	2.00	3.00	4.00	3.00	3.00	2.00	2.00
Road works						8.00	8.00			
Total	0.25	24.20	52.30	68.25	92.55	92.60	85.375	50.525	21.95	12.00
Cumulative	0.25	24.45	76.75	145.00	237.55	330.15	415.525	466.05	488.00	500.00

Computation of cash *inflow and cash outflow* for the example problem

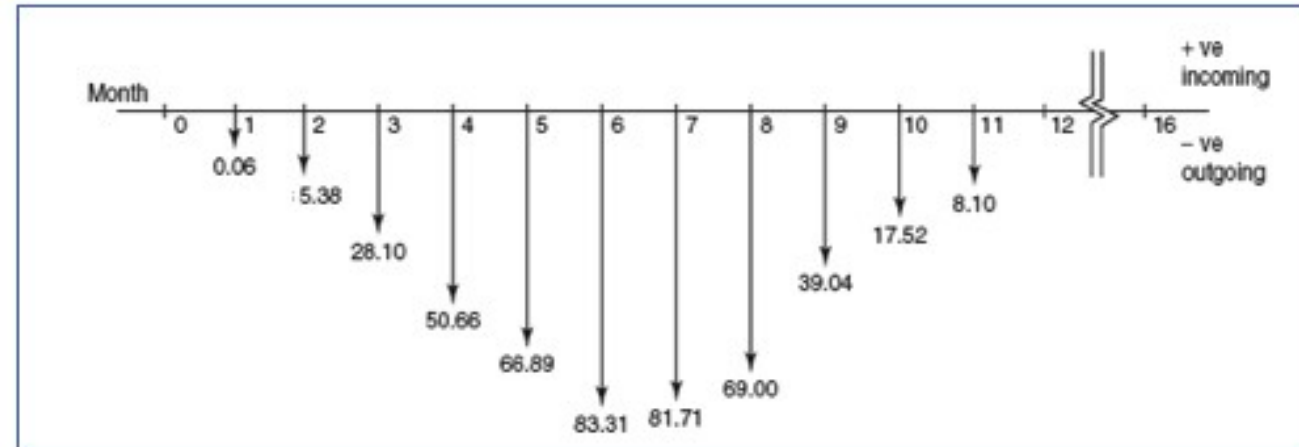
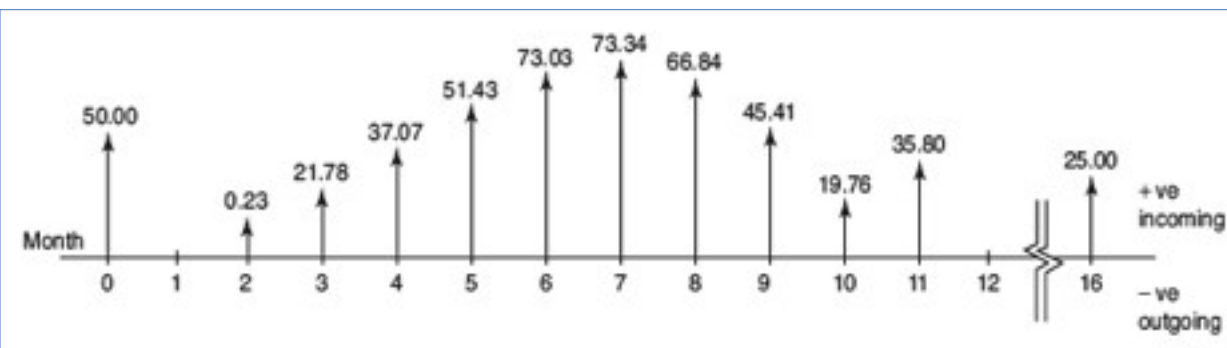
	Description	t = 0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M15	M16
1	Work done by measurement		0.25	24.20	52.30	68.25	92.55	92.60	85.375	50.525	21.95	12.00			
2	Recoveries towards advance payment				10.00	10.00	10.00	10.00	10.00						
3	Retention @10% of gross invoice (0.1× row 1)		0.03	2.42	5.23	6.83	9.26	9.26	8.54	5.05	2.20	1.20			
4	Payment due (1-3)		0.23	21.78	37.07	51.43	73.30	73.34	66.84	45.47	19.76	10.80			
5	Cash received (one-month delay)			0.23	21.78	37.07	51.43	73.30	73.34	66.84	45.47	19.76	10.80		
6	Release of retention												25.00		25.00
7	Total incomings	50.00	0.00	0.23	21.78	37.07	51.43	73.30	73.34	66.84	45.47	19.76	35.80	0.00	25.00
8	Cumulative incomings	50.00	50.00	50.23	72.01	109.08	160.50	233.80	307.14	373.97	419.45	439.20	475.00	475.00	500.00

Computation of cash *inflow and cash outflow* ...

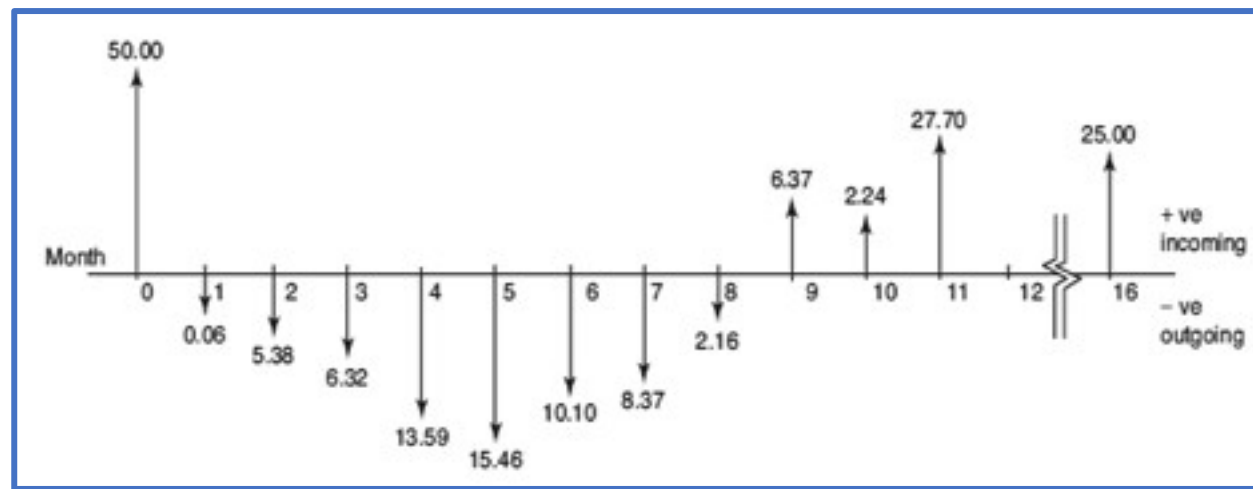
	Description	t = 0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M15	M16
9	Total cost (0.9 of 1)		0.23	21.78	47.07	61.43	83.30	83.34	76.84	45.47	19.76	10.80			
10	Cost towards labour @20% of total cost		0.05	4.36	9.41	12.29	16.66	16.67	15.37	9.09	3.95	2.16			
11	Cost towards material @55% of total cost		0.12	11.98	25.89	33.78	45.81	45.84	42.26	25.01	10.87	5.94			
12	Cost towards subcontractors @10% of total cost		0.02	2.18	4.71	6.14	8.33	8.33	7.68	4.55	1.98	1.08			
13	Cost towards plant and machinery @10% of total cost		0.02	2.18	4.71	6.14	8.33	8.33	7.68	4.55	1.98	1.08			
14	Project overheads @5% of total cost		0.01	1.09	2.35	3.07	4.16	4.17	3.84	2.27	0.99	0.54			
15	Labour payment (no delay)		0.05	4.36	9.41	12.29	16.66	16.67	15.37	9.09	3.95	2.16			
16	Material suppliers' payment (one- month delay)			0.12	11.98	25.89	33.78	45.81	45.84	42.26	25.01	10.87	5.94		

Computation of cash *inflow and cash outflow* ...

	Description	t = 0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M15	M16
17	Subcontractors' payment (one-month delay)			0.02	2.18	4.71	6.14	8.33	8.33	7.68	4.55	1.98	1.08		
18	Plant and machinery supplier's payment (one-month delay)			0.02	2.18	4.71	6.14	8.33	8.33	7.68	4.55	1.98	1.08		
19	Overhead cost payment (no delay)		0.01	1.09	2.35	3.07	4.16	4.17	3.84	2.27	0.99	0.54			
20	Outgoings total		0.06	5.61	28.10	50.66	66.89	83.31	81.71	69.00	39.04	17.52	8.10		
21	Cumulative outgoings		0.06	5.67	33.77	84.43	151.32	234.63	316.34	385.34	424.38	441.90	450.00	450.00	450.00
22	Cumulative cash flow (8–21)	50.00	49.94	44.56	38.23	24.64	9.18	−0.84	−9.21	−11.37	−4.94	−2.70	25.00	25.00	50.00



Cash *inflow* and *outflow* diagrams



The **resultant** cash-flow diagram

Factors Affecting Project Cash-flow

- In addition to the mobilization advance, there are many factors that affect the project cash :
 - 1) The margin in a project
 - 2) Retention
 - 3) Extra claims
 - 4) Distribution of margin such as front loading and back loading
 - 5) Certification type such as over-measurement and under-measurement
 - 6) Certification period, and
 - 7) Credit arrangement of the contractor with labour, material, and plant and equipment suppliers, and other subcontractors.

Factors ...

- **Margin** : The margin (profit margin or contribution) is the excess over costs. Thus, the higher the margin in a project, the better it is for the contractor's cash flow.
- We illustrate this aspect with the help of a fictitious project of 10 months duration.
- It is also assumed that Birr 100 (cost) is incurred every month and the margin is 10% of the cost.
- The retention amount is 5% of the bill value and the whole retention money is to be released 6 months after practical completion (i.e., 10 months).
- Further, it is also assumed that the owner delays the payment by 1 month.

Cash-flow computations for the fictitious example

S.		MONTHS													
No.	Description	1	2	3	4	5	6	7	8	9	10	11	15	16	
A	Cost	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
B	Margin @10% of cost (B*0.1)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00			
C	Value (A + B)	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00			
D	Retention @5% (C*0.05)	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50			
E	Monies due (C – D)	104.50	104.50	104.50	104.50	104.50	104.50	104.50	104.5	104.50	104.50			55.00	
F	Money receipt delay by one month	0.00	104.50	104.50	104.50	104.50	104.50	104.50	104.50	104.50	104.50	104.50		55.00	
G	Net cash flow (F – A)	–100.00	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	104.50		55.00	

Summary of net cash-flow for different margins

- Similar computations for cash flow can be performed assuming different margin percentages - say, 5% and 15% - keeping all the conditions same as in the case of 10% margin.
- The results associated with different margin percentages are summarized in Table.
- It can be clearly seen that as the *margin increases*, there is betterment in the contractor's cash-flow position, keeping all other factors same.

End of month	Variation in net cash-flow for different margin %		
	5%	10%	15%
1	-100.00	-100.00	-100.00
2	-0.25	4.50	9.25
3	-0.25	4.50	9.25
4	-0.25	4.50	9.25
5	-0.25	4.50	9.25
6	-0.25	4.50	9.25
7	-0.25	4.50	9.25
8	-0.25	4.50	9.25
9	-0.25	4.50	9.25
10	-0.25	4.50	9.25
11	99.75	104.50	109.25
12	—	—	—
13	—	—	—
14	—	—	—
15	—	—	—
16	52.50	55.00	57.50

Retention

- Retention tends to reduce the margin obtained from a project.
- In case of very low margins, the retention can even reduce the margin to zero or less.
- Thus, retention affects the contractor's cash flow in a negative manner.
- The higher the retention, the bigger is the cash-flow problem.
- In order to address this issue, some contractors request the owners to get away with **retention amount in lieu of bank guarantee.**

Extra claims

- Extra claims in a project may result on account of many reasons such as **extra work**, **changes in quantity** and **specification** and so on.
- In general claims take a **long time to settle**.
- Sometimes it may be settled even after the completion of project.
- Thus in practice the **extra claims tend to worsen the cash flow position of the contractor**, though after the claim is settled the contractor may be even able to achieve the original intended level of profit margin.

Distribution of margin

- Keeping the **overall margin amount same**, the margin can be distributed across different items of a project, either in a **uniform manner** or it can be **front-** or **back-loaded**.
- In case of uniform loading, all the items of the project carry equal margin percentage, while in **front-end-rate loading**, the **items to be executed early** in the project carry a **higher margin** than the later items.
- By doing so, the cash-flow position of the contractor improves, even though the overall margin derived from the project would be the same as that obtained in case of uniform loading.

Back-loaded

- In the **back-end-rate loading**, the items to be **executed later** in the project carry higher margin, while the items to be executed early in the project carry lower margin.
- This has a tendency to increase the negative cash flow and contractors resort to such means in a market where the **inflation rate is higher than the interest rate**.
- This way, the contractors hope to recover a substantial amount on account of price escalation.

Certification type

- *Over-measurement* : Over-measurement is the device whereby the amount of work certified in the early months of a contract is greater than the amount of work done. This is compensated for in later measurements.
- Thus, over-measurement has the **same effect as front-end loading**; it improves the cash in the early stages and reduces the capital lock-up.

Certification type

- *Under-measurement:* Under-measurement is the situation whereby the amount of work certified in the early months of a contract is less than the amount actually done. This has the effect of increasing the negative cash flow for the contractor in a project.

Certification type

- **Delay in receiving payment from client:** The time between interim measurement, issuing the certificate, and receiving payment is an important variable in the calculation of cash flows.
 - Any increase in the delay in receiving this money delays all the income for the contract, with a resulting increase in the capital lock-up.
- **Delay in paying labour, plant hires, materials suppliers and subcontractors:** The time interval between receiving goods or services and paying for these is the credit the contractor receives from his suppliers.

The Company Cash-flow Diagram

- For running the projects efficiently, a company usually maintains a head office and a number of regional offices or branch offices. The expenses incurred and the revenues generated by these offices are commonly known as head office outgoings or incomings.
- Some examples of head office outgoings would be rents, electricity charges, water charges, telephone and tax bills, hire charges for office equipment, payment to shareholders, taxes, etc.
- The examples of head office incomings would be claims made in past projects, realization of retention money not settled for past projects, *etc.*

The Company Cash-flow Diagram

- A construction company executes a number of projects at any time.
- The company cash-flow diagram is an aggregation (sum) of all the outgoings and incomings for all the projects that the company is executing, besides the head office outgoings and incomings.

Determining Capital Lock-up

- While estimating the effect of margin and retention money on contractor's cash-flow diagram, one can notice that the contracting company sometimes faces negative cash flow in the early stages of the project.
- This negative cash flow experienced in the early stages of projects represents **locked-up capital** that is either supplied from the contracting company's **cash reserves or borrowed**.
- If the company borrows the cash, it will have to pay interest charged to the project; if the company uses its own cash reserves, it is being deprived of the interest-earning capability of the cash and should, therefore, charge the project for this interest loss.

Determining the Cash Requirement of a Project

- With the knowledge of cumulative cash outflow and cumulative cash receipt, we can **determine the maximum cash required for a project.**
- For illustration, let us take the same problem that was used for drawing a project cash-flow diagram.
- The cumulative outgoings and cumulative incomings data is taken as they are for the case in which there is no mobilization advance given to the contractor.

Computation of month-wise cash requirement for the project (all values in 10^5)

Month	Outgoings for the month	Incomings for the month	Money required for the month when it is assumed that incoming is received at discrete points of time while outgoings are paid continuously	Money required for the month when it is assumed that both incoming and outgoing are occurring at discrete points of time
(1)	(2)	(3)	(4)	(5)=(2) - (3)
M1	0.06	0.00	0.06	0.06
M2	5.61	0.23	$5.61 - 0.00 = 5.61$	5.39
M3	28.10	21.78	$28.10 - 0.23 = 27.88$	6.32
M4	50.66	47.07	$50.66 - 21.78 = 28.88$	3.59
M5	66.89	61.43	$66.89 - 47.07 = 19.82$	5.47
M6	83.31	83.30	$83.31 - 61.43 = 21.88$	0.01
M7	81.71	83.34	$81.71 - 83.30 = -1.58$	-1.63
M8	69.00	76.84	$69.00 - 83.34 = -14.34$	-7.84
M9	39.04	45.47	$39.04 - 76.84 = -37.79$	-6.43
M10	17.52	19.76	$17.52 - 45.47 = -27.96$	-2.24
M11	8.10	35.80	$8.10 - 19.76 = -11.66$	-27.70
M12	0.00	0.00	$0.00 - 35.80 = -35.80$	0.00
M13	0.00	0.00	$0.00 - 0.00 = 0.00$	0.00
M14	0.00	0.00	$0.00 - 0.00 = 0.00$	0.00
M15	0.00	0.00	$0.00 - 0.00 = 0.00$	0.00
M16	0.00	25.00	$0.00 - 0.00 = 0.00$	-25.00

Financial management of construction

- Statistics compiled by Dun & Bradstreet on construction company failure in the *US* indicate that the 4 major factors of ***inadequate financing, underestimating costs, inadequate cost accounting, and poor management account for over 80%*** of all failures.
- Thus the basis for the statement that ***“the financial management of a construction company is equally as important to company success as is its technical management”*** is apparent.

Financial ...

- Financial planning for a construction project includes cost estimating prior to bidding or negotiating a contract, forecasting project income and expenditure (or cash flow), and determining the amount of work that a construction firm can safely undertake at one time.
- Cost estimating for a project, as the name implies, involves estimating the total cost to carry out a construction project in accordance with the plans and specifications.

Financial ...

- A **finance schedule or cash flow schedule shows** the planned rate of project expenditure and project income.
- It is common practice in the construction industry for the owner to withhold payment for a percentage of the value of completed work (referred to as **“retainage”**) as a guarantee until acceptance of the entire project.
- Even when periodic progress payments are made for the value of completed work, such payments (less retainage) are not received until some time after the **end of each accounting period**.

Financial ...

- Hence project income will almost always lag behind project expenditure.
- The difference must be provided in cash from company assets or borrowed funds.
- The construction industry relies heavily on the use of borrowed funds (**bridging fund**) for this purpose.
- Therefore, the finance charges associated with the use of such funds, as well as the maximum amount of funds available, are important considerations in the financial planning for a construction project.

Financial ...

- While a financial schedule may be developed manually from any type of project schedule, the use of **CPM methods** facilitates preparation of a financial schedule.
- The use of CPM procedures also makes it easy to determine the effect on cash flow of different project schedules.

Scheduling issues

- When using a schedule to control a project, a decision must be made about the use of **float**.
 - **Float** is the leeway that is assigned to various activities in a network.
- This leeway may be effectively manipulated by a project manager.
- A very basic approach is to use either an “**early start**” or a “**late start**” schedule.
- In an early-start schedule, all of the available float of each activity remains controllable, while in a late-start schedule, the float of each activity has been reduced to 0.
- In a late-start schedule, all **activities are critical**.

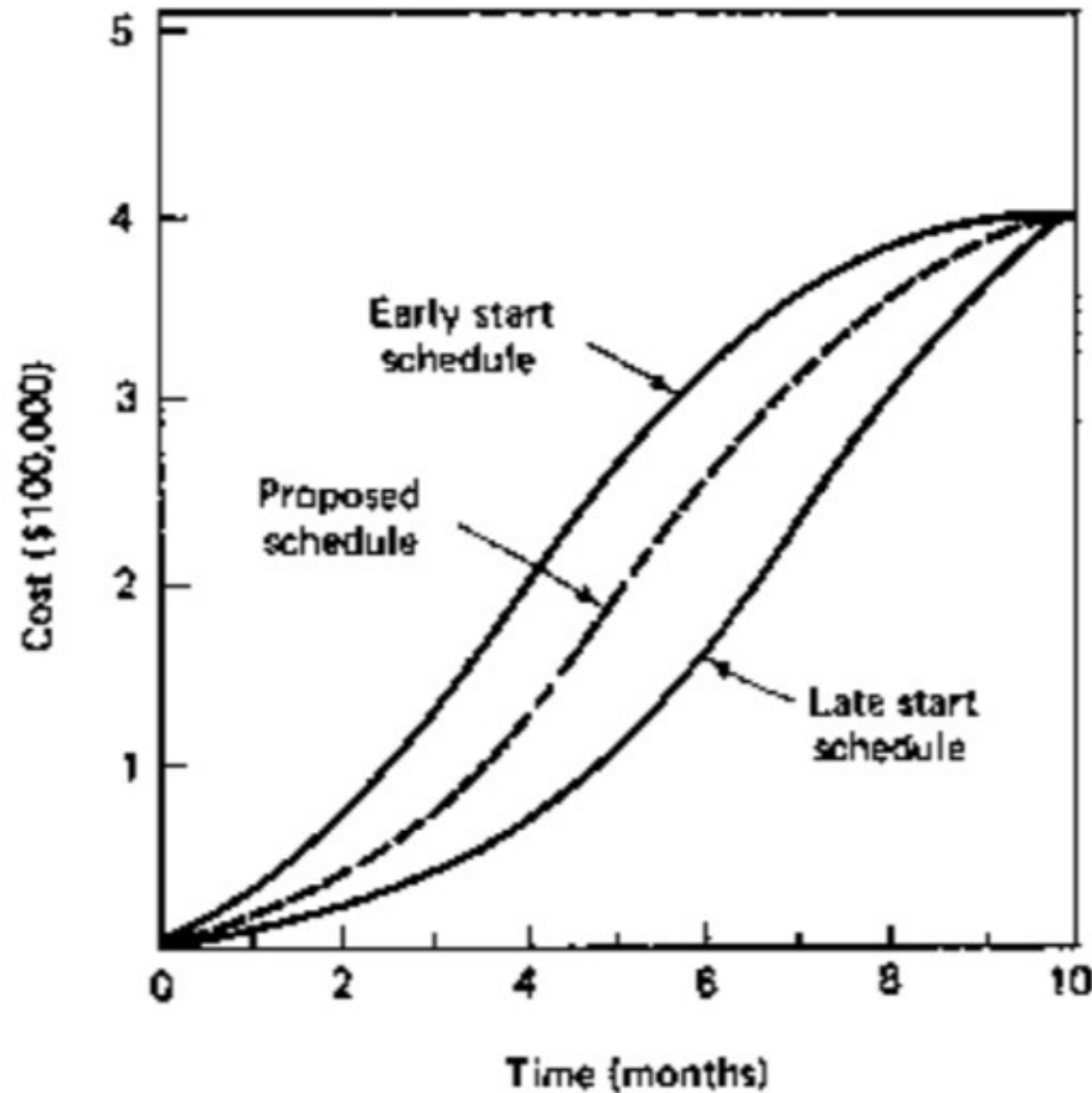


Figure shows a graph of project cost versus time for 3 different schedules: an *early start schedule*, a *late start schedule*, and a *proposed schedule* which is between these limits

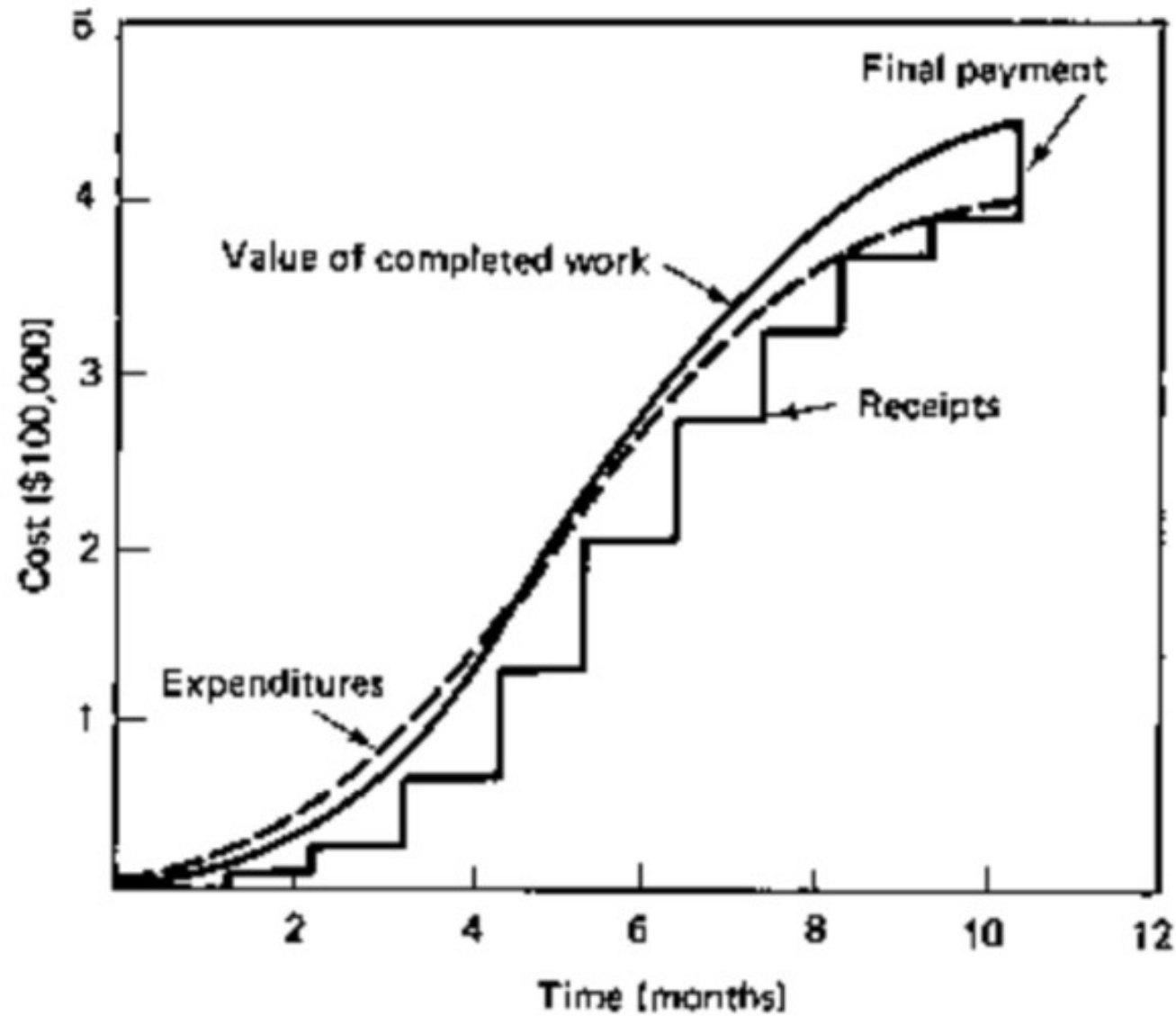


Figure illustrates a financial schedule showing project *expenditures*, *value of completed work*, and receipts for a particular project schedule

Capacity for undertaking additional projects

- Another important consideration in financial planning is the capacity of a firm to undertake additional projects.
- It has been found that most construction contracts require a **minimum working capital of about 10% of the contract value**.
- This working capital is needed to cover the difference between project income and project expenditures.
- The availability of **working capital** also affects the **type of construction contract** that might be appropriate for any additional work to be undertaken.
- When working capital is marginal, any additional work should be limited to low-risk projects such as cost-reimbursable contracts.

Project Cost Control

- Project **cost control** involves the measurement and recording of project costs and progress and a comparison between *actual and planned performance*.
- The principal objective of project cost control is to *maximize profit* while completing the project *on time* at a *satisfactory level of quality*.
- Proper cost control procedures will also result in the accumulation of *historical cost data*, which are *invaluable in estimating and controlling* future project costs.

Project ...

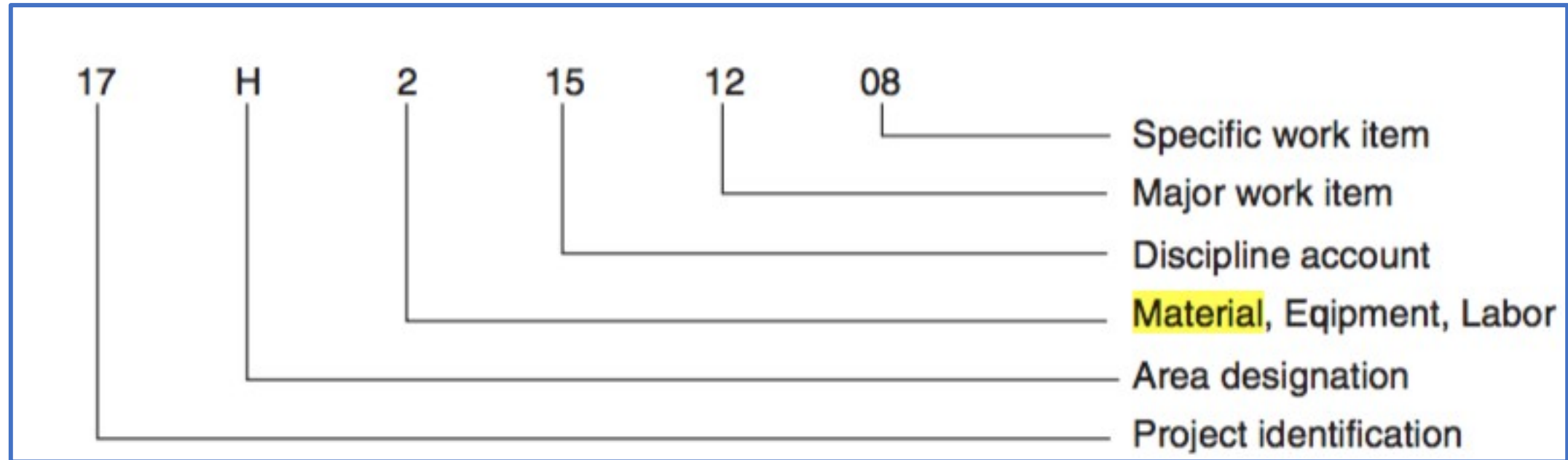
- To carry out project cost control it is necessary to have a method for identifying cost and progress by project work element.
- The use of *CPM* procedures greatly simplifies this process, because major work items have already been identified as activities when preparing the project network diagram.
- A *cost code system* is usually combined with activity numbering to yield a complete *system of project cost accounts*.

Project ...

- It is essential that the coding system permit charging all *labor, material, equipment*, and *subcontract costs* to the *appropriate work item*.
- *Indirect* and *overhead costs* for the project are usually assigned a separate cost code.
- Record-keeping requirements for *foremen* and *other supervisors* should be kept to a minimum consistent with meeting the objectives of accurate and timely reporting.

Project ...

- **Labor costs** may be easily computed if **time sheets are coded** to identify the activity on which the time is expended.
- **Plant & equipment costs** may be similarly computed if a record is kept of the time spent on each activity by each machine.
- The **cost of materials** used may be based on **priced delivery invoices coded** to the appropriate activity.
- Since **subcontract and service work may not be billed** at the same interval at which costs are recorded, it may be necessary to **apportion such costs to the appropriate activity at each costing interval.**



Example of a Cost Code System

Project reporting interval

- To permit a comparison of project progress versus cost, it is necessary that progress reporting intervals coincide with cost reporting intervals.
- The interval between reports will depend on the nature and importance of the project.
- Monthly intervals are commonly used as the basis for requesting progress payments.
- However, construction management may desire weekly or even daily cost and performance reports for the control of critical construction projects.