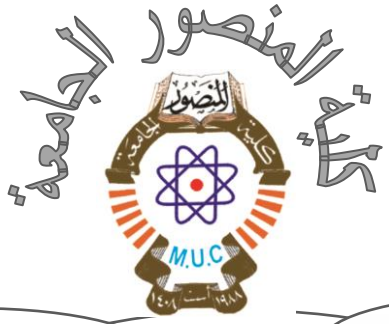

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Civil Eng. Dept
3rd. Stage

Engineering Management

2022 - 2023

Lec.1

إدارة مشـــاريع

Lec. Dr. Qassim Ali Alquraishy

Engineering Management

Lecture -1-

Engineering management

A management specialization that is concerned with the application of management principles in engineering.

Engineering project management

Syllabus:

- **Definitions**
- **Planning methods**
  - ❖ Bar Chart
  - ❖ Network analysis
  - ❖ Grid method
- Resources Allocation

References:

- ❖ **Construction Management and Accounts: N. L. Pandy.**
- ❖ **Project Management with CPM, PERT, and Precedence Diagramming, 3rd Edition, by Moder J., Phillips, C., and Davis, E.**
- ❖ **Construction Management: Daniel W. Halpin.**
- ❖ **Construction Project Management Handbook : Federal Transit Administration.**

1-The Need for Project Management:

The construction industry is the largest industry in the world. It is more of a service than a manufacturing industry. Growth in this in fact is an indicator of the economic conditions of a country. This is because the construction industry consumes

2-WHAT IS A PROJECT? / (Definition of a Project): A project is made up of a group of interrelated work activities constrained by a specific scope, budget, and schedule to deliver capital assets needed to achieve the strategic goals of an Agency. This Handbook is intended for management of capital projects involving construction of facilities or systems.

Important to Know

- All projects must have a beginning and an end.
- Project managers with prior relevant experience help keep projects on track.
- Projects are defined by their scope, budget, and schedule.
- Project life cycle phases for a typical construction project are initiation, planning, design, construction, commissioning, and closeout.
- The level of project management effort depends on project size, type, and phase.

Characteristics of Projects

- Projects are defined by their **scope**, **budget**, and **schedule**.
- For example, an Agency is to undertake a project to *design and build a new maintenance facility for its fleet of buses* (**scope**), at an *estimate of $30 million* (preliminary **budget**) over a *three-year period* (**schedule**).
- The schedule *specifies* a defined **beginning** and **end**.
- Projects go through a life cycle of phases between their beginnings and ends that for construction projects are : *initiation, planning, design, construction, commissioning,* and *closeout.*

3-Definition of Engineering management:

- Engineering Management (EM) is a specialized form of management that is required to successfully lead engineering or technical personnel and projects.
- Engineering Management is a career that brings together the technological problem-solving savvy of engineering and the organizational, administrative, and planning abilities of management in order to oversee complex enterprises from conception to completion.
- Engineering Management programs typically include instruction in accounting, economics, finance, project management, sy perspectives, team relations, safety and health.
- It empowers engineering managers with knowledge, and skills needed to lead technical organizations or processes to success.

4-What the Functions of Management?

They include several interrelated functions which are:

1) **Planning**
2) **Organizing**
3) **Coordinating / Directing**
4) **Communicating**
5) **Motivating**
6) **Controlling**

1) *What is planning?*

- It is the process of setting goals, developing strategies, and outlining tasks and schedules to accomplish the goals.
- A process is Sequence of interdependent and linked procedures which, at every stage, consume one time, energy, machines, and money) to convert inputs (data, material, parts, etc.) into outputs. These outputs

then serve as inputs for the next stage until a known goal or end result is reached.

Planning can be viewed from following points:

- Subject:- Financial Planning, Time Planning, Quality Planning, Organizational Planning, …….
- Organization:- Corporate Planning, Project Planning,…….
- nning, Weekly Planning, ….

2) *What is organizing?*

- It is the process of determining the responsibilities and scope of authority of each position in the company structure and defining how each company segment interrelates with the others.
- It is the arranging several elements into a purposeful sequential or spatial (or both) order or structure.
- It is the assembling required resources to attain organizational objectives.

3) *What is coordinating?*

- The synchronization and integration of activities, responsibilities, and command and control structures to ensure that the resources of an organization are used most efficiently in pursuit of the spec nctions of management.

4) *What is communicating?*

- Engineering Communication: The ability to effectively communicate information about the design and engineering process. To that end, the competition requires teams to submit technical reports, prepare and deliver engineering presentations, and create poster displays.
- Business Communication: communication used to promote a product, service, or organization; relay information within the business; or deal with legal and similar issues. It is also a means of relaying between a supply chain, for example the consumer and manufacturer.

5) What is motivating?

1. Internal and external factors that stimulate desire and energy in people to be continually interested in and committed to a job, role, or subject, and to exert persistent effort in attaining a goal
2. Motivation results from the interactions among conscious and unconscious factors such as the (1) intensity of desire or need, (2) incentive or reward value of the goal, and (3) expectations of the individu s.

6) *What is controlling?*

- The basic management function of (1) establishing benchmarks or standards, (2) comparing actual performance against them, and (3) taking corrective action, if required.

Controlling is comprised of activities that measure and **evaluate** the **outcome** of planning, organizing, staffing, and leading efforts.

Controlling helps to determine the **fruitfulness** that **deviates** from the standards.

Control function can be viewed as follow:

- Controlling involves making sure that the results achieved are in line with the planned results.
- The main feature of control is action to correct performance deviations and to insure that expected results are forthcoming.
- Control = Monitor + Compare + Analysis + Action

5-Who is the project manager?

He is the professional specialist who plans and controls a project. He is the person who acts in a transparent manner for the sake of the whole project to satisfy the expectations of the customers, the partners delivering goods an her interested parties.

6-Project management vs. general management:

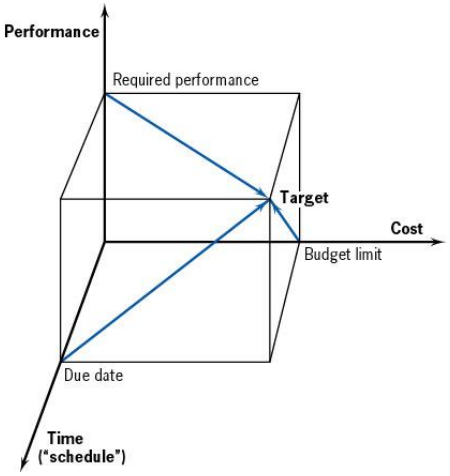
Skill Requirements for Effective Project Management

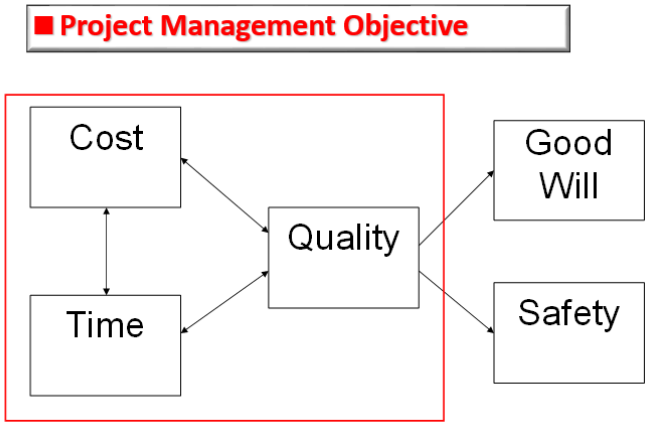
- Conflict Resolution
- Creativity and Flexibility
- Ability to Adjust to Change
- Good Planning
- Negotiation

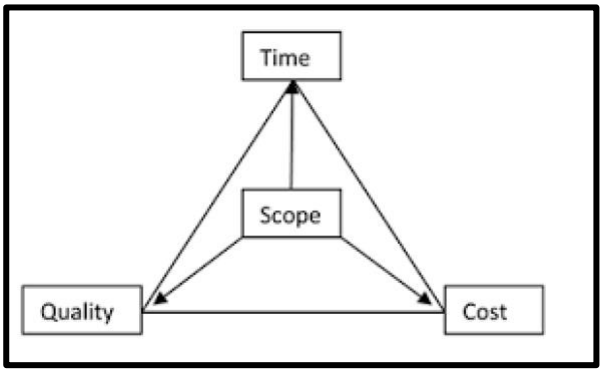
7-Project Management Objectives:

The objectives of project management are to execute a project so that deliverables can meet scope requirements on **budget** and **schedule**, and at ***acceptable*** **risk**, **quality**, **safety**, and **security** levels.

- The example maintenance facility project is to deliver a five bay facility that meets pre-determined performance specifications with ction contractor.
- The schedule can be made up by paying **additional costs** for contractor overtime to make up the delay. This is a cost/schedule trade-off.
- The greatest threat to project success is **scope creep**. The addition of a sixth bay to the maintenance facility we mentioned earlier is a clear example of added scope.
- In addition to scope, **budget**, and **schedule**, it is extremely **important** that the project manager facilitates a discussion of the project risk, quality, and safety and security objectives and incorporates the outcome in the Project Management Plan (PMP).
- Projects require well-defined configuration management, change control systems, and procedures for scope and change control.







$$\text{Optimization} = f(\textbf{Quality}, \frac{1}{\textbf{Cost}}, \frac{1}{\textbf{time}}, \frac{1}{Risk}, Safty, Security)$$

Fig. (1) Performance, Cost, and Time Project Targets.

THE LIFE CYCLES OF PROJECTS

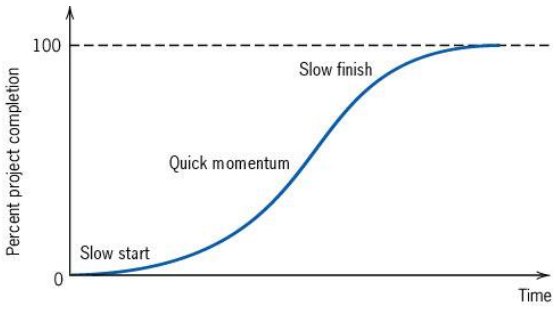


Fig. (2) The Project Life Cycle

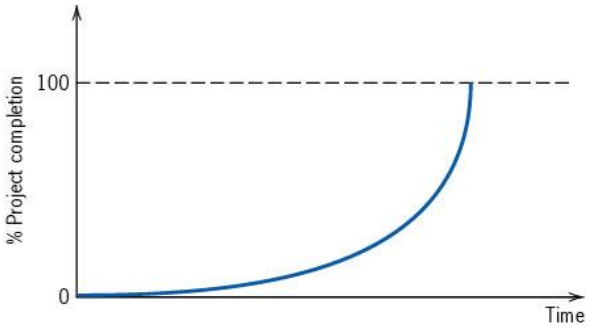


Fig. (3) An Alternate Project Life Cycle

8-SELECTION OF A PROJECT MANAGER:

Virtual Project Manager

- Geographically dispersed projects
- Communication via
  - Email

  - Web
  - Telephone
  - Video conferencing
- "Never let the boss be surprised!"

- *Credibility* - The PM is believable
- *Sensiti* onal conflict
- *Leadership, Style, Ethics* - Ability to direct project in ethical manner

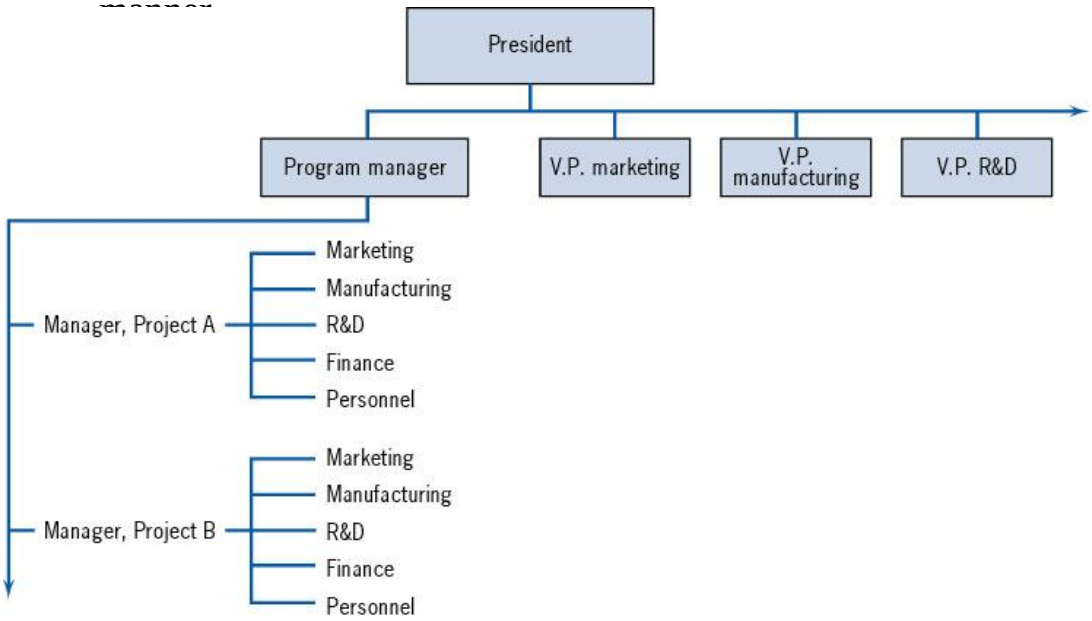


Fig. (4) The Pure Project Organization.

9-The Construction Project:

A project is defined, whether it is in construction or not, by the following characteristics:

- A defined goal or objective.
- Specific tasks to be performed.
- A defined beginning and end.
- Resources being consumed.

10- The Project Scope and Goals

Project Goal Setting

You can't hit a target if you don't know what it looks like. Similarly, you can't possibly reach your project's goal if you don't know what it is. When you understand how your project fits in with the broader company direction, it's time to really pin down your goal.

Getting your goal straight

Say your project involves training new employees in a new software system. Your goal in training them on this software could be to:

- Make employees more productive in their jobs.
- Enable employees to better serve customers.
- Create a prototype program with reduced training costs that can be used to reduce overall training costs across the company.
- Increase employee retention by providing useful on-the-job skills. These goals suggest different priorities as well as different measurements for gauging the degree to which your project has succeeded in meeting its goal.

Writing a goal statement

A goal statement outlines why you're doing this project and what you hope to accomplish at the end.

Project scope

When you understand your goal, you can begin to define the specific parameters of the project. This is often referred to as a project's scope. ***It is necessary to know that a scope is not a goal***.

Writing a scope statement

Scope statements define both what a project will involve and what it will not involve.

Breaking Your Project into Phases

Knowing your goal and scope helps you to identify the steps you should be performing to accomplish them.

11-Major Types of Construction Projects:

In planning for various types of construction, the methods of procuring professional

services, awarding construction contracts, and financing the constructed facility can be quite different. The broad spectrum of constructed facilities may be classified into four major categories, each with its own characteristics.

1-Residential Housing Construction

Residential housing construction includes houses and high-rise apartments. Residential housing designs are usually performed by architects and engineers, and the construction executed by builders who hire subcontractors for the structural, mechanical, electrical and other specialty work.

2-Institutional and Commercial Building Construction

Institutional and commercial building encompasses a great variety of project types and sizes, such as schools and universities, medical centers and hospitals, sports facilities, shopping centers, warehouses and light manufacturing plants, and skyscrapers for offices and hotels.

3-Specialized Industrial Construction

Specialized industrial construction usually involves very large scale projects with a high degree of technological complexity, such as oil refineries, steel mills, chemical processing plants and coal-fired or nuclear power plants.

4- Infrastructure and Heavy Construction

Infrastructure and heavy construction includes projects such as highways, tunnels, bridges, pipelines, drainage systems and sewage treatment plants.

12- Construction Projects Participants:

1- The Owner (The Client)

2-The Design Professionals

3-The Construction Professionals

4-The Project Manager

As these groups plan, design and construct together. There are two contracts that arise while constructing a structure:

- The first contract is known as the owner and designer contract which involves the planning, designing and some possible factors of construction.

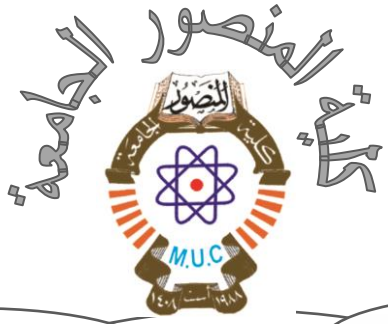
- The second contract is known as the owner and builder contract that involves the actual construction.

13-Important to Know

- Successful projects balance project scope, cost, and schedule with user needs and project constraints.
- Identification of the user needs, project constraints, and resource requirements early in the project life cycle help projects meet their objectives.
- The greatest risk to project success is scope creep.
- Well-defined configuration management and change procedures are needed to control scope.

14-Project Management Process

- The project management process begins with identification of the user requirement, project constraints, resource needs, and establishment of realistic objectives to meet the strategic goals.
- Many times this will be an **iterative** process as new information becomes available through efforts by various professionals on the project and input from third parties, communities, users, and agencies having jurisdiction.
- The project manager must have prior experience (or should consult with peers with prior experience) with the particular project type to balance the above competing objectives in a timely manner to adequately plan the project.
- Lack of prior experience will increase risks of not achieving the project objectives.



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Engineering Management

2022 - 2023

Lec.2

إدارة مشـــاريع

Lec. Dr. Qassim Ali Alquraishy

Engineering Management
Lecture -2-

1-Break Down System (WBS):

- A **complex** project is made manageable by first breaking it down into **individual components** in a hierarchical structure, known as the work breakdown structure, or the WBS.

The Project Action Plan

- ❖ Project activities identified and arranged in Type and quantity of each required resource identified for each activity.
- ❖ Predecessors and durations estimated for each activity.
- ❖ Milestones identified.
- ❖ Individual or group assigned to perform the work identified for all activities.

Using the Project Action Plan

- ❖ Project master schedule created by combining milestones, durations, and predecessors (used to compare actual and planned performance).
- ❖ Use of templates.
- Such a structure defines **tasks** that can be complete *urement* and *control* of the project.

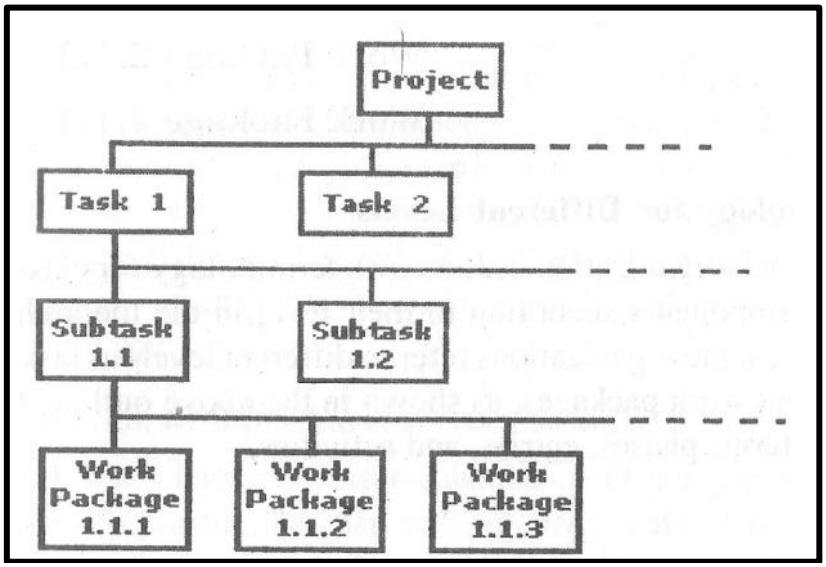


Fig. (1) Work Breakdown Structure Diagram.

How to Make a Work Breakdown Structure

A good Work Breakdown Structure is created using an iterative process by following these steps and meeting these guidelines:

1. Gather critical documents
2. Identify key team members
3. Define level 1 elements
4. Decompose (breakdown) e hedule

Table (1): Standard Measurement (Bill of Quantities).

Sample : Bill of Quantities (BOQ)					
N	**Item**	**Unit**	**Quantity**	**Unit Price**	**Item Price**
1	Mobilization	Lump Sum			
2	Site clearing (small area) Site clearing (Large area)	Lump Sum m^2			
3	Earthwork: Excavation (Cut) Embankment (Fill)	 m^3 m^3			
4	Preparation under Foundation: Spreading and compaction of boulders under foundation (thickness *5-10 cm*) Subbase (thickness *10* cm) Pouring of blinding concrete *10 cm*				
5	Concreting: Specifications in details: (f'c), mixing rate, ….) 1. Foundation Plain concrete for *foundation* einforced concrete 2. Beams Reinforced concrete 3. Slabs Reinforced concrete	 m^3 m^3 m^3 m^3			

	5. Other members Reinforced concrete 6. DPC (Damp proofing in construction) layer Concrete 10cm, 15 cm 7. Beams over openings (windows, doors, …)	m^3 m m			
6	Masonry works: 1. Brick walls 24 cm thickness or (36, 48 2. Brick partitions 12 cm thickness 3. Brick partitions 8 cm thickness 4. Thermo-stone partitions 5. Concrete blocks partitions	 m^3 m^2 m^2 m^2 m^2			
7	External plastering	m^2			
8	Internal plastering	m^2			
9	Painting	m^2			
10	Flooring: 1. Pouring of plain (*or reinforced with fabric wire net: bar diameter 4, 5, 6, .. mm*) concrete under tiles 2. Paving of floor by tiles (type ling of joints among the tiles with white cement mortar. 3. Curb stone 4. Walkway construction: including subbase layer and concreting (10cm, 15cm thickness) 5. Colored Tiles (hexagonal shape)	 m^2 m^2 m m^2 m^2			
11	Skirting with ceramic tiles (height 10, 15, 20, … cm	m			
12	Installation of ceramic tiles for kitchen, toilets, bathrooms, washing rooms, ….	m^2			
13	Roofing: • Cleaning of the roof • Spreading of film coat (emulsified asphalt) • Spreading of hot tar • Spreading of asphaltic sheets • Spreading of clean silt layer thickness not less than 10cm • Installation of concrete tiles 80x80	 m^2			

	cm conceding correct slope for drainage • Filling of joints with approved sealant				
14	Doors: Include all details of door: di re details. Samples may be required. 1. Steel doors 2. Wooden doors 3. Aluminum doors 4. Plastic doors 5. Composite doors	Each (Number)			
15	Windows: Include all details *Same as doors* in addition to glass thickness and color if included: 1. Steel windows 2. Wooden windows 3. Aluminum windows 4. Plastic windows 5. Composite windows	m^2			
16	Glazing: Refer to thickness, color, brand	m^2			
17	Partitioning: 1. Gypsum board 2. Aluminum partitions 3. Glass bricks partitions 4. Plastic partitions 5. Wooden partitions	m^2			
18	False ceilings	m^2			
19	Mechanical Plumbing: 1. Galvanized steel pipes (1in, 3/4in, 1/2in, …) including all fixtures 2. Hand wash basin 3. Sink 4. Water cooler 5. Water Heater 6. Water Tank	m Each Each Each Each Each			

	7. Water Bump 8. Water mixer 9. Water Tab 10. Valve (diameter) 11. Shower 12. Connect with public system Sanitary: 1. Plastic pipe (10cm, 15cm, 20cm .. 2. Manhole 3. Oriental toilet base 4. Western toilet base 5. Shower basin 6. Bathtub 7. Connect with public system Heating, Ventilation, Air-conditioning: 1. Ducts (dimensions, thickness) 2. Equipment (chiller) Heater (include all details)	Each Each Each Each Each LS m Each Each Each Each Each LS m HP or Ton Each Each Each Each			
20	Electrical: 1. Internal Light (describe details) 2. External Light 3. Switch 4. Socket 13A, 15A, 20A, .. 5. Industrial Socket 6. Circuit breaker 25A, 30A, 60A, 100A, …. 7. Board 8. Electric meter 9. Cable supply (details) 10. Connect with public system	 Each Each Each Each Each Each Each Each m LS			
21	Stair: Mosaic steps Stair rail	 Each m			
22	Sheds	m^2			
	Other works				
	Special works				
	Demobilization	LS			

2-BAR CHART:

Scheduling is the process of fitting the work plan to a **time**, frame and the conventional method of **representing** the **sequence** in which various activiti a **construction** project has been Bar Chart.

✪ Also known as Gantt chart, after Henry Gantt who developed this specialized chart around the years 1910 - 1915 and popularized in West.

Construction of Bar Chart

☞ A Bar Chart is a **linear calendar** of Project activities for planning of a project.

☞ The chart is **two-dimensional** with time spread along X - axis and activities list on Y-axis.

☞ The level of detailing required would decide the **number of activities** to be included and **unit used for time**, which may be days, weeks or months.

☞ In line with the title of activity a horizontal bar is drawn, the **start of bar indicates the start of an activity**.

☞

whereas in case of **sequential activities**, when a **succeeding** activity can commence only on **completion of preceding activity**, the bar of second activity will commence from the time when first activity ends.

The activities which can run **concurrently** are represented by **parallel bars**.

As an example let us consider the job of construction of column footings in a building:

Table (2): Example on construction of column.

Activity	**Duration**
A - Layout and excavation of column footings.	4 Days
B - Laying of lean concrete and curing.	5 Days
C - Fabrication of foundation reinforcement.	3 Days
D -Erection of shuttering and placing of reinforcement.	3 Days
E - Casting of column foundations.	6 Days

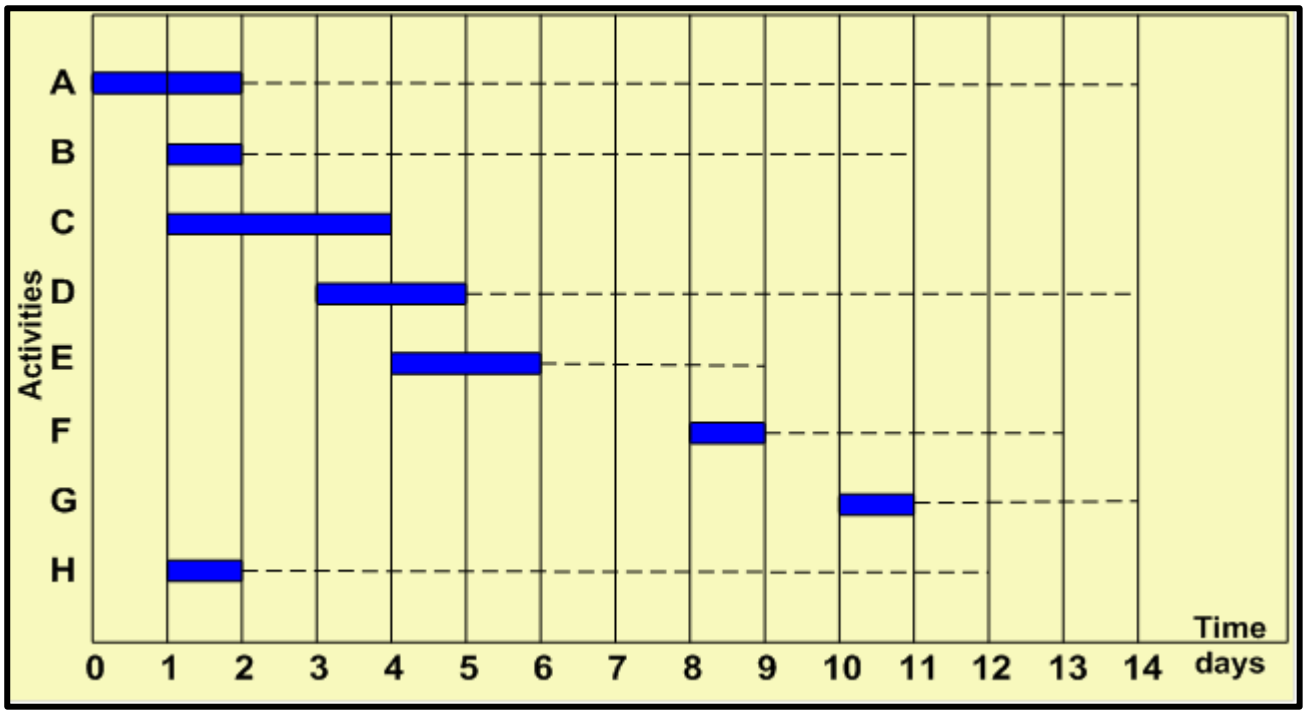
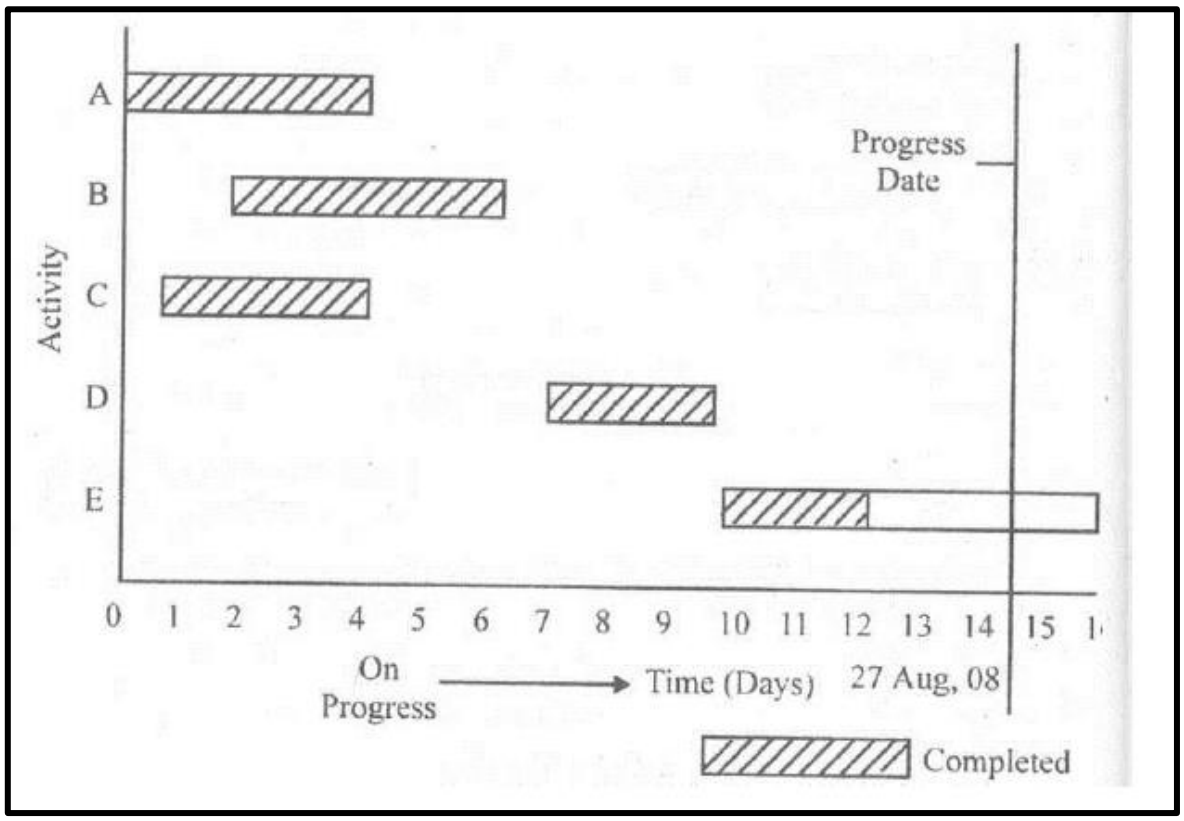


Fig. (2) Bar Chart.

Monitoring

✪ One of the techniques known as COLOURING/ HATCHING BARS



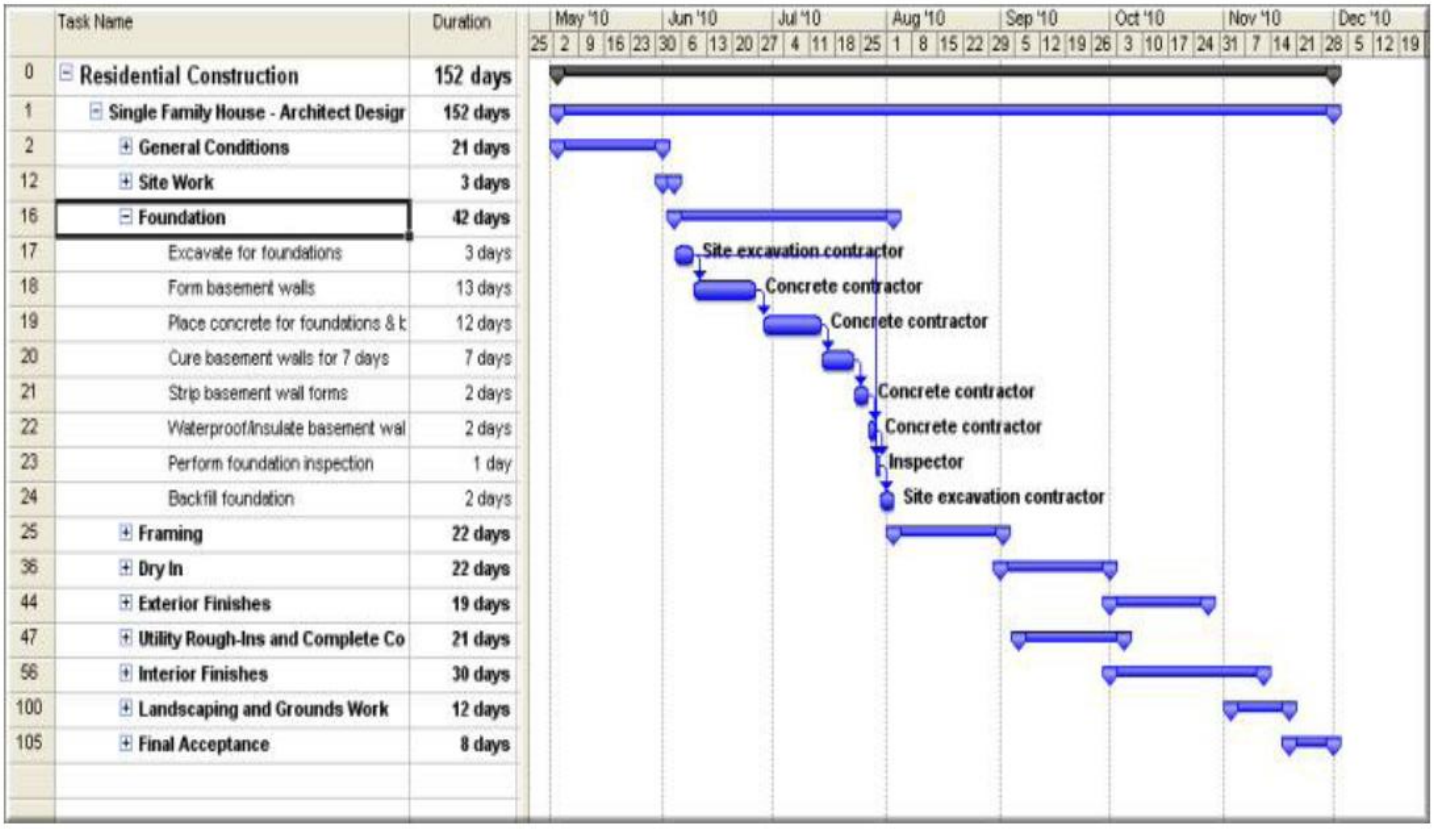
Limitations of Bar Charts (Disadvantages)

- ❖ **Interdependency of activities:** does not indicate independency of one activity or more of the other activities.
- ❖ **Monitoring of progress:** cannot be used as a monitoring tool, thus depriving the executives of opportunity to initiate the corrective actions in time.
- ❖ **Critical activities:** d be carried out in each activity are not indicated, thus not a convenient tool to work out the resources required for execution.

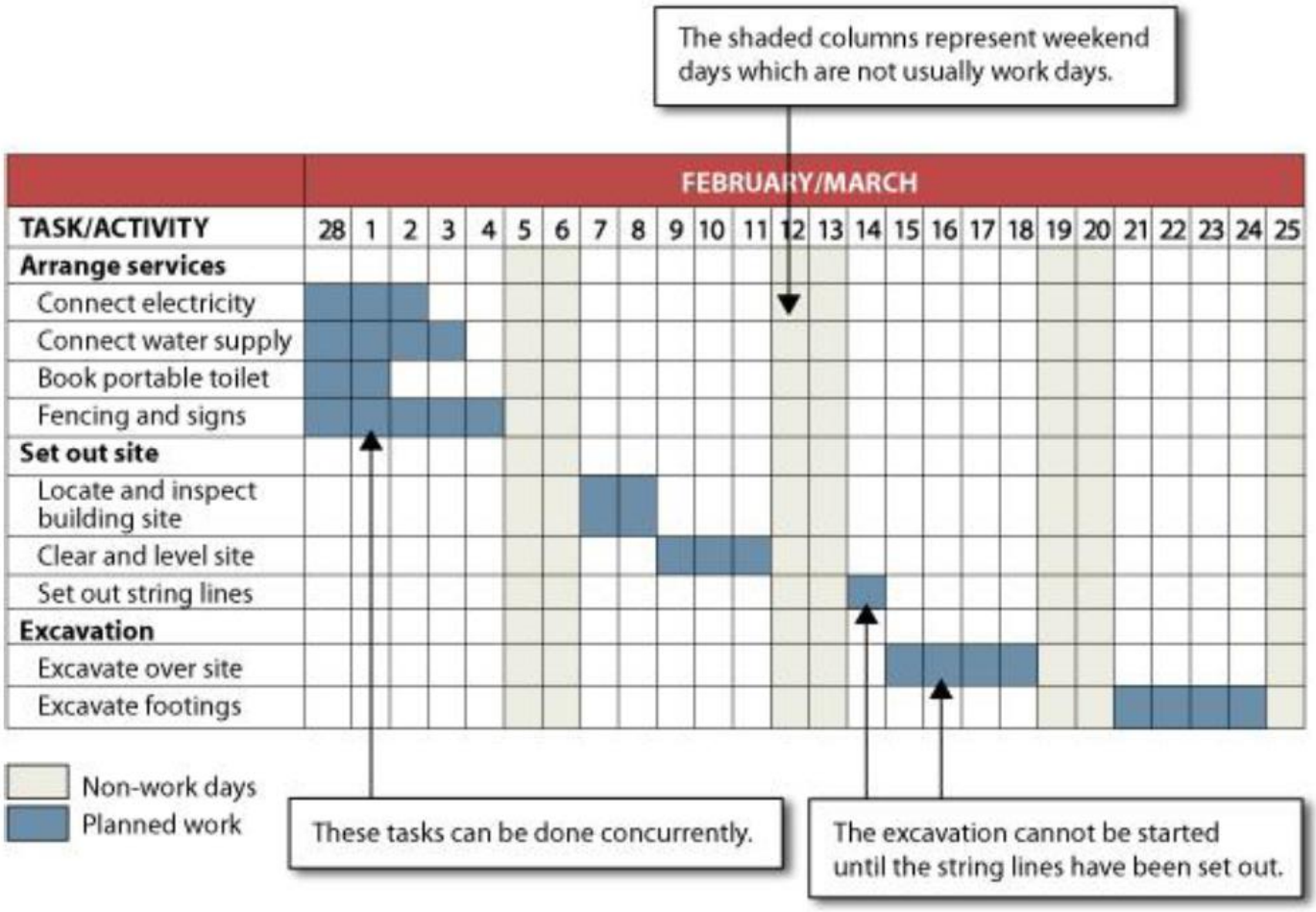
Advantages of Bar Chart

✓ Successfully employed in **small projects** having limited number of activities.

✓ Even in the case of a large project, Bar Chart can be an excellent planning tool at **Foreman level**, where a main activity in project execution could be split into sub-activities and can be planned and executed at Foreman level.



	Wk. 1	Wk. 2	Wk. 3	Wk. 4	Wk. 5	Wk. 6	Wk. 7	Wk. 8	Wk. 9	Wk. 10	Wk. 11	Wk. 12
EXCAVATION												
Utility Clearance	■											
Surface Scraping	■											
Major Excavation		■	■	■								
Periodic Surveying	■	■	■	■	■	■						
Shoring (none expected)												
FOUNDATION												
Place Forms			■	■	■							
Tie Rebar				■	■	■						
Inspection				■	■	■						
Pour Concrete					■	■	■					
Test Concrete							■	■	■			
STEEL WORK												
Check Anchor Locations				■	■	■						
Complete First Level										■		
Complete Second Level											■	
Complete Roof Trusses												■
Inspection										■	■	■

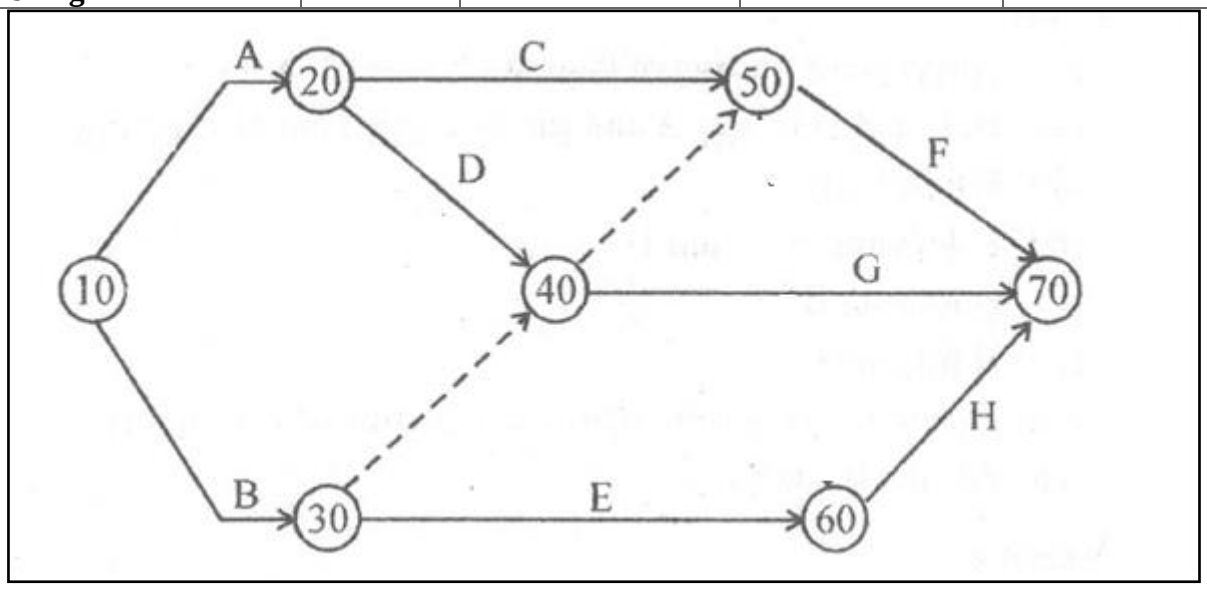


Example:

Solve and Draw the schedule event by Activity-On-Arrow (A-O-A) networks and bar chart for the following activities?

1. A and B are initial activities and can be carried out independent of each other.
2. C and D depend on A.
3. E depends on B.
4. F depends on B, D and C.
5. G depends on B and D.
6. H depends on E, D and C.
7. Project finishes on completion of F, G and H.

Activity	Activity code	Duration	Activity that Preceded	Activity that successor
Site Clearing	A		--	C,D
Foundation Excavation	B		--	E,G,F
Reinforcement fabrication for foundation	C		A	F,H
Concrete placing for foundation	D		A	G,F
Formwork of columns and Reinforcement and casting	E		B	H
Formwork of slabs and Reinforcement and casting	F		B,D,C	--
Masonry work	G		B,D	--
Finishing	H		E	--

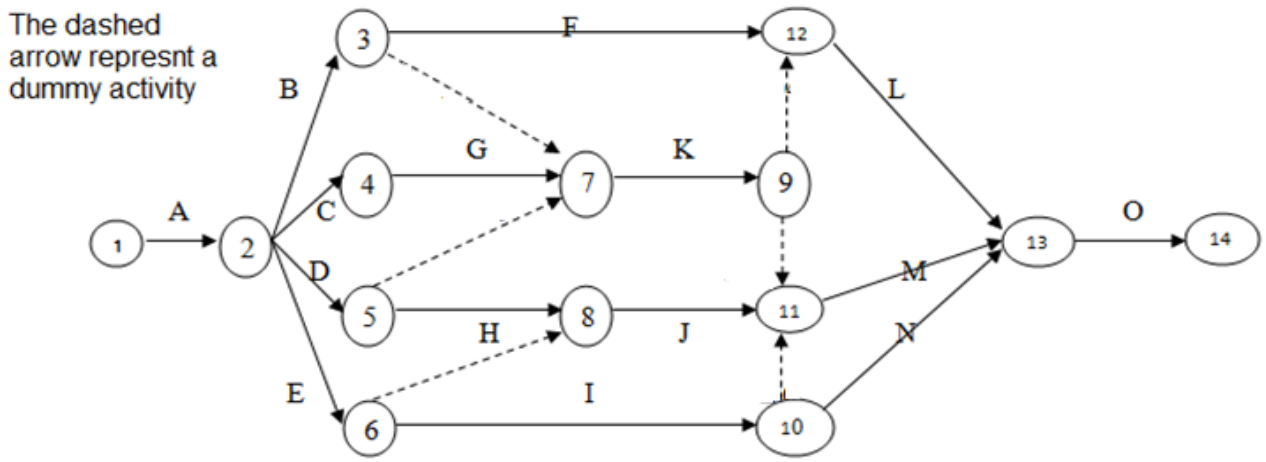


A-O-A networks

Example:

Solve and Draw the schedule event by A-O-A networks and bar chart for the following activities?

Activity code	Duration	Activity that Preceded	Activity that successor
A		---	
B		A	
C		A	
D		A	
E		A	
F		B	
G		C	
H		D	
I		E	
J		H,E	
K		B,G,D	
L		F,K	
M		K,J,I	
N		I	
O		L,M,N	

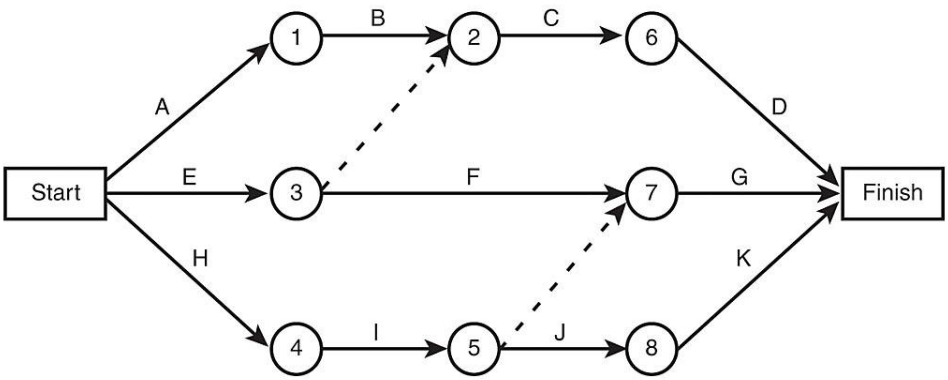


Example:

Solve and Draw the schedule event by A-O-A networks and bar chart for the following activities?

Activity code	Duration	Activity that Preceded	Activity that successor
A		--	
B		A	
C		B,E	
D		C	
E		---	
F		E	
G		F,I	
H		---	
I		H	
J		I	

K		J	



A-O-A networks

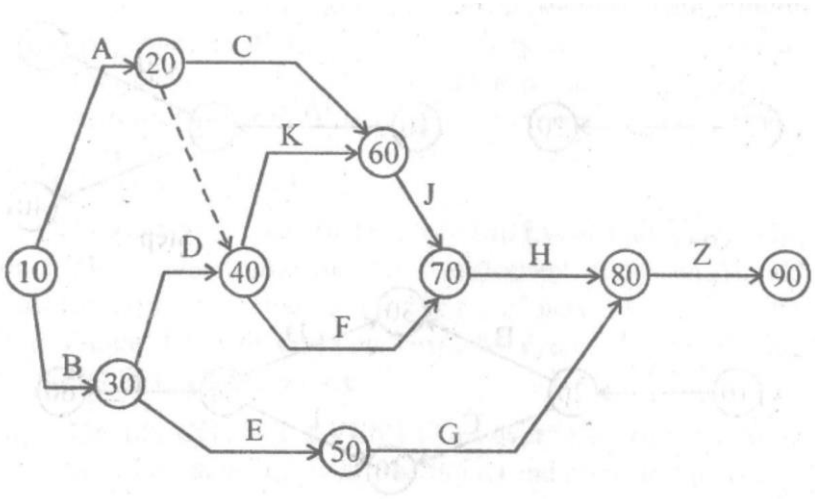
Example:

Solve and Draw the schedule event by A-O-A networks and bar chart for the following activities?

A, B, C, D, E, F, *G*, H, J. K and Z Logic.

1. A and B represent starting of the job and can be carried out at the same time.
2. C follows A.
3. D and E can be executed at the same time after completion of B.
4. K and F be executed at the same time after completion of A and D
5. G follows E.
6. J cannot start before completion of C and K.
7. H follows F and J.
8. Z can be started when G and H are finished.
9. Z is the last activity.

Activity code	Duration	Activity that Preceded	Activity that successor
A		--	C,K,F
B		--	D,E
C		A	J
D		B	K,F
E		B	G
F		A,D	H
G		E	Z
H		J,F	Z
J		C,K	H
K		A,D	J
Z		H,G	--



A-O-A networks

Example:

Solve and Draw the schedule event by A-O-A networks and bar chart for the following activities?

(a) Activities A and B are the initial activities and are independent of each other.

(b) C and D depend on A but are independent of each other.

(c) E depends on Band D.

(d) F follows B and G follow C.

(e) H depends in E and G.

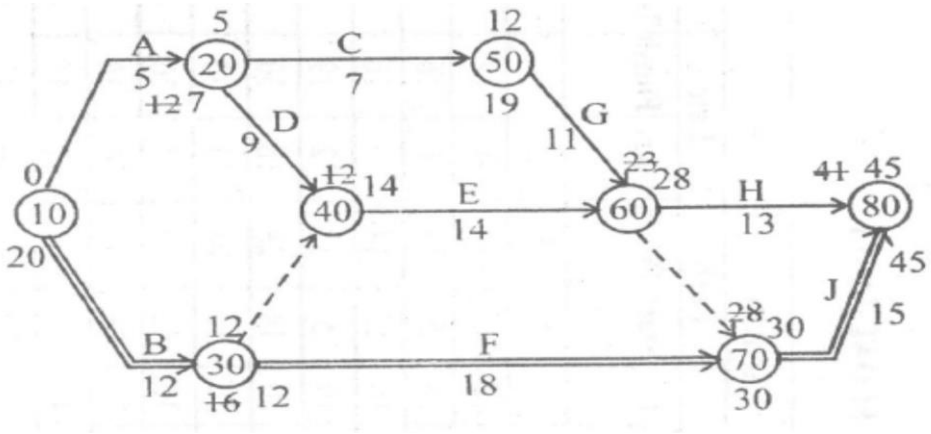
(O J depends in E, F and G.

(g) Project is complete in completion of J and H.

Duration of activities in days

A = 5 days, B = 12 days, C = 7 days, D = 9 days, E = 14 days, F = 18 days, G = 11 days, H = 13 days and J = 15 days.

Activity code	Duration	Activity that Preceded	Activity that successor
A	5	--	
B	12	--	
C	7	A	
D	9	A	
E	14	D,B	
F	18	B	
G	11	C	
H	13	G,E	
J	15	E,G,F	



A-O-A networks