

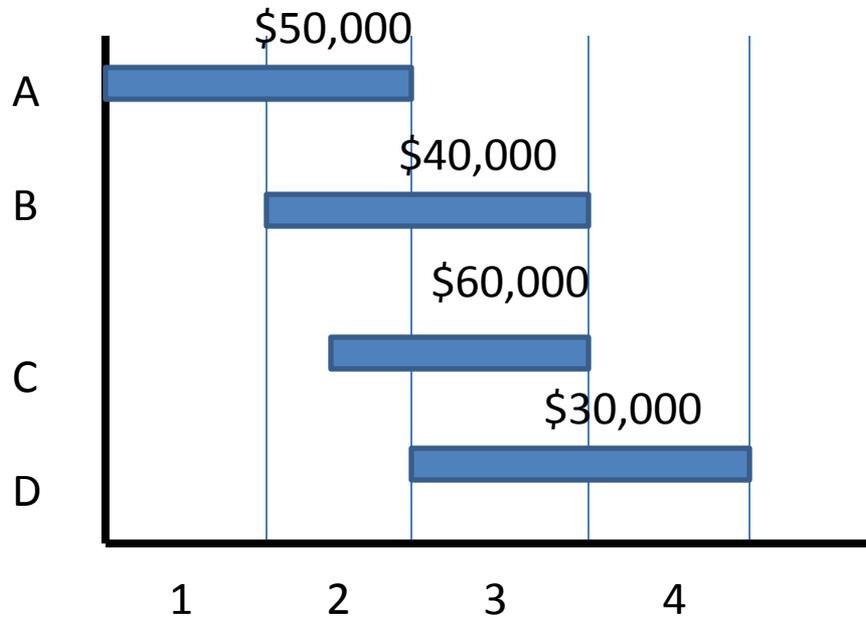
CASH FLOW ANALYSIS

- Projection of Income and Expenses during the life of the project
- Important for obtaining financing for (owner) and estimating line of credit requirements and cost of financing
- Most commonly represented using an S-curve

CASH FLOW ANALYSIS

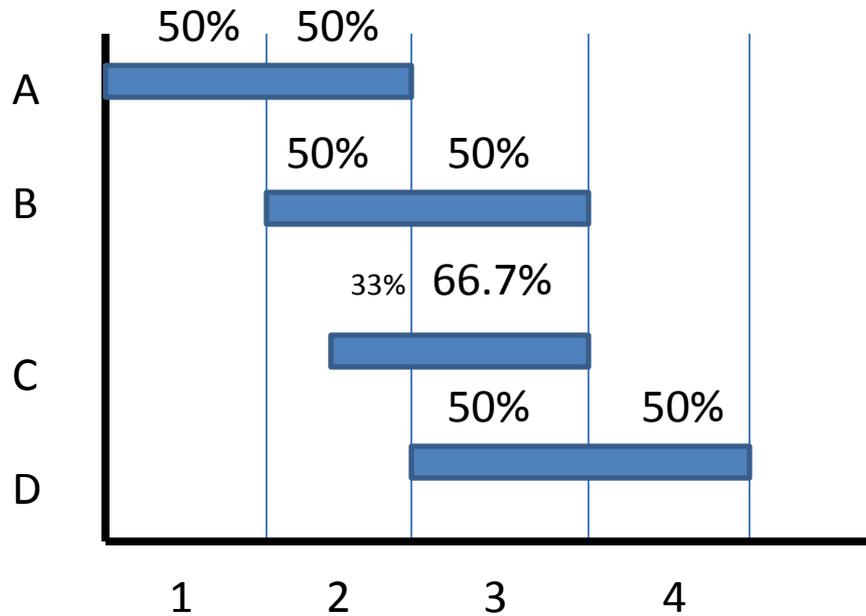
- Generated using the project's bar chart
- Representing cumulative costs along the life of project
- Assumptions:
 1. Expenditures for a given activity are proportional to % of activity scheduled for each period (e.g month, week)
 2. Expenditure are evenly distributed over each time period
- Often owners require contractors to provide an S-Curve of estimated progress and costs

CASH FLOW ANALYSIS



Indirect cost \$5,000/month

CASH FLOW ANALYSIS



Indirect cost \$5,000/month

CASH FLOW ANALYSIS

- Compute total monthly cost
- Compute cumulative monthly cost

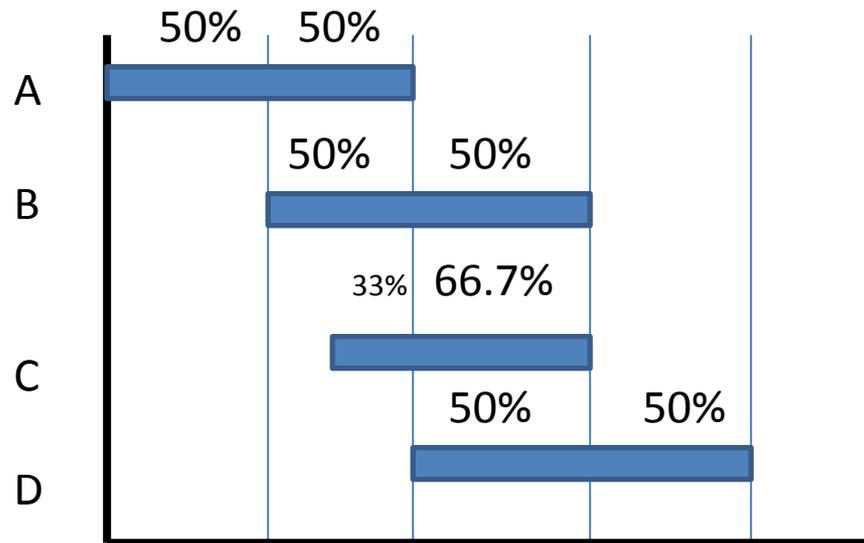
Month 1

$$50\% \times \$50,000 + \$5,000 = \$30,000$$

Month 2

$$50\% \times \$50,000 + 50\% \times \$40,000 + 33.3\% \times \$60,000 + \$5,000 = \$70,000$$

CASH FLOW ANALYSIS



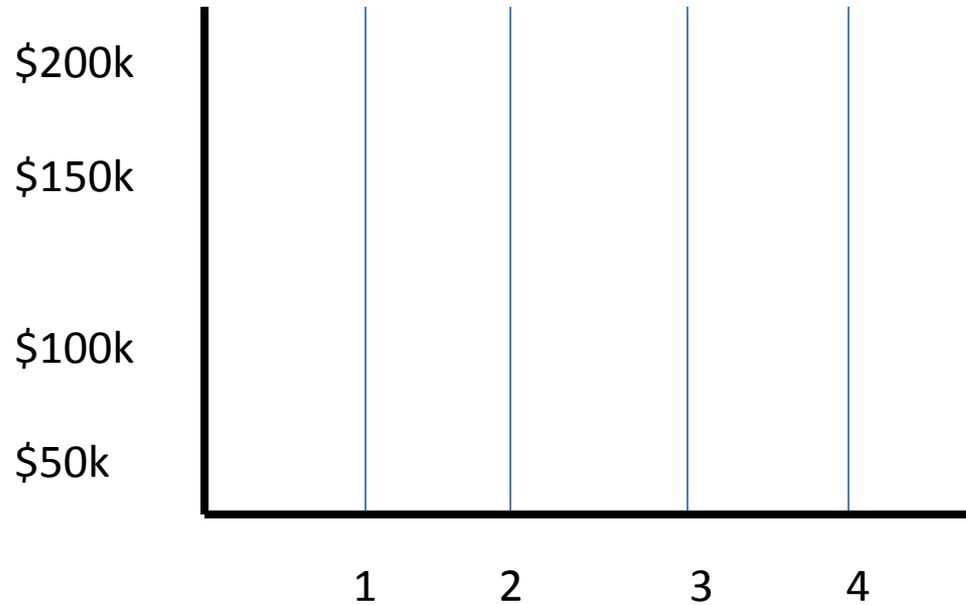
Monthly Direct Cost

Monthly Indirect Cost

Total Monthly Cost

Cumulative Monthly cost

CASH FLOW ANALYSIS



Connect dots using a smooth curve

Cash Flow - Contractor

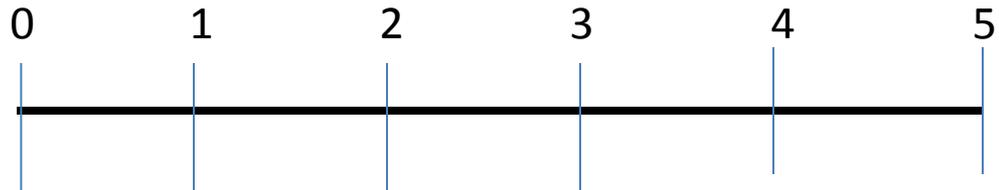
- Paid via progress payment – a series of discrete payment by owner to contractor
- Based on estimates of work completed by the contractor as verified by owner's representative usually monthly
- Evaluation based on type of contract
 1. Lump Sum: percentage of total contract completion
 2. Unit Price: Actual field measurements of work completed

Progress Payments

- Contractor prepares a monthly progress claim usually at the end of each month
- Owner evaluates the bill and pay contractor within the time period stipulated in the contract (usually within 30 days)
- Owner keeps a retainage of 10% of each payment (usually until cumulative progress bills reach 50% of total contract sum)

Contractors Income Profile

For same example (assume markup is 25%)



Billed by Contractor

0 \$37,500 \$87,500 \$100,000 \$25,000

Retainage

0 \$3,750 \$8,750 0 0

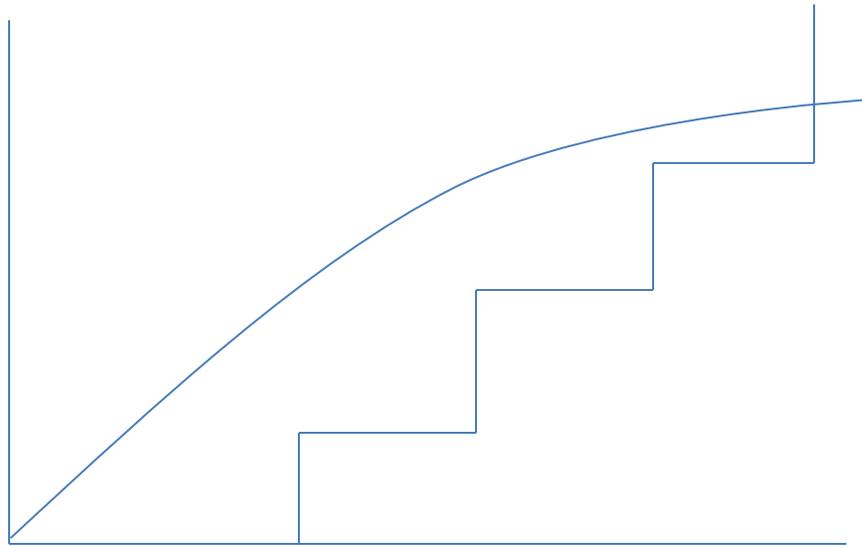
Payment Received

0 0 \$33,750 \$78,750 \$100,000 \$37,500

Contractor's Cash Flow

Draw the income (progress payment) on S curve

The difference between Expenses and income (revenue) is overdraft (necessary for contractor to obtain financing)



Contractor's Cash Flow

- Expenses vs. Income profiles can be plotted on S curve to enable estimate of overdraft
- Two very useful pieces of information for financial planning
- Maximum overdraft level (either for a given project or for multiple projects)
- Cost of overdraft – need to be added to project cost or will erode profit

Amounts of Overdraft depends on

- Amount of Markup (or profit) applied to contractor's bid
- Amount of Retainage withheld by owner
- Delay between billing and payment
- Payment arrangements with subcontractors and suppliers

Contractor's Financing

- Contractor needs to cover overdraft (by borrowing from banks)
- Bank charges interest (typically high)
- Good policy to try to minimize the overdraft
- Some contractors offset the overdraft borrowing requirement by
 1. Unbalance bid
 2. Requesting mobilization money from owner

Mobilization Advance Payment

- Some owners issue up to 20% of the advance payment at the inception against a bank guaranteed submitted by contractors
- The advance payment recovered in each progress payment at a rate of the advance payment
- Transfer the interim financing from contractor to owner
- Overall cost saving to owner and the contractor

HOW THE S CURVE WILL LOOK LOKE IN CASE OF MOBILIZATION
ADVANCE PAYMENT

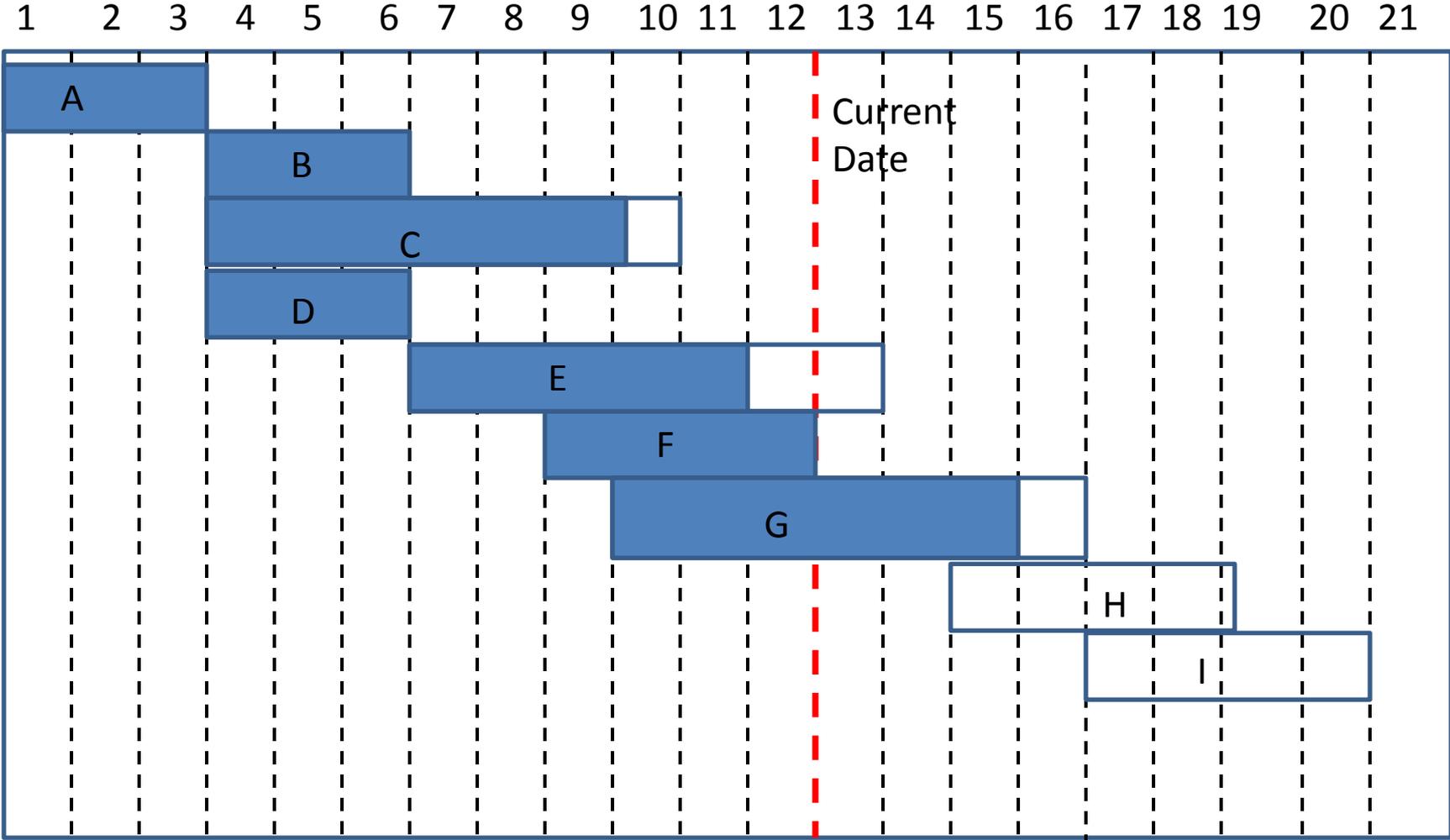
Bar Chart

Based on previous example, some definitions can be established:

Critical Path CP: It is the longest time path and it is the shortest time to complete the project activities.

The CP consists of critical activities in which any change in time will result in change of the duration of the project

Bar Chart



Reading the chart

- Activities B, C, and D appear to begin as soon as A completed
- What about Activity F? is it linked with B or D or both?
- What about G, H and I?
- Activity F is on schedule, Activity C is behind the schedule and Activity G is a head of schedule
- What about the schedule of the entire project? Is it a head or on or behind???

These uncertainties are called shortcomings or bar Chart

Network Analysis Method

It is a scheduling method and it has more details than the bar chart. It provides accurate numbers about start, finish, float, critical path and much information that may help in cost estimation, resources and others. There are two types of Network Methods:

1. Activity On Arrow AOA
2. Activity On Nodes AON

Activity On Arrow AOA

Arrow diagrams were widely used in construction industry in the 1960s and 1970s.

In Arrow Diagrams, the Activities are denoted as Arrows

Ex/ Activity A is represented as



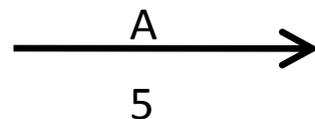
Activity “foundation” is



Activity is anything that must be accomplished (whether by owner, contractor, subcontractor, supplier or any other party) in order to complete the project.

Remember: *Activity consumes time. Time can be written below*

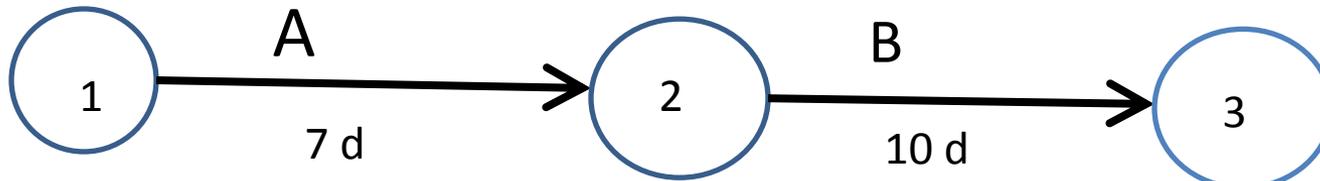
the arrow



“Activity A consumes 5 days”

AOA

Nodes, termed **events**, are typically drawn as small circles represent a point in time. They are used to signify the start and finish of the Activity. Nodes consume no times



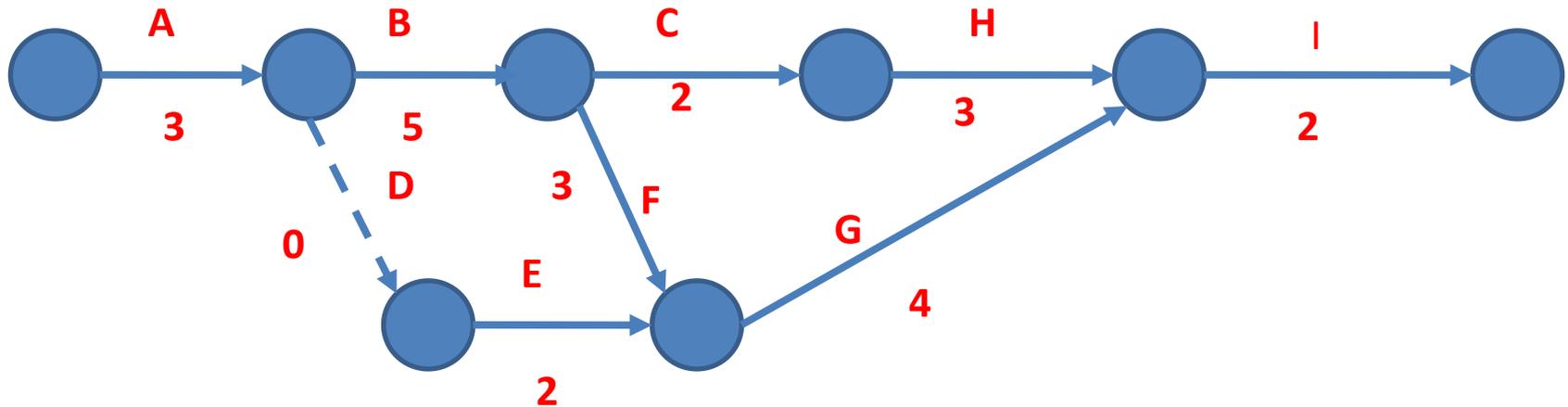
Activity A has a duration of 7 day is followed by B . Activity B which is preceded by A has a 10 days duration. Activity A is Preceding A and B is following activity.

Even 1-2 start at ... and finish at

Calculations

Calculate the start and finish of activities in the following diagram?

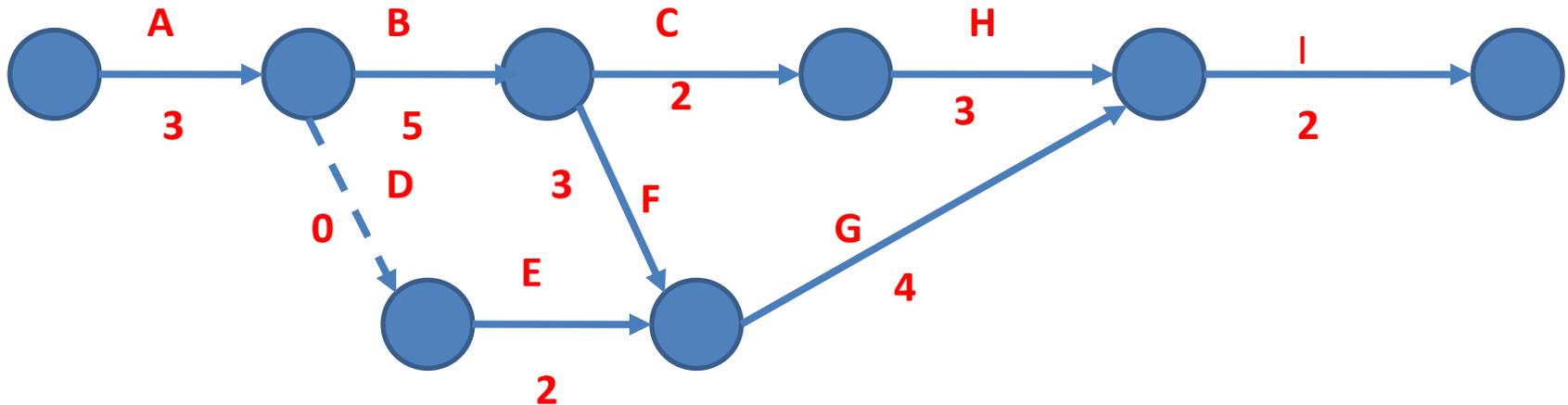
Forward Pass Calculations = *Early Start of Preceding + duration*
= *Early Start of following*
= *Early finish of preceding*



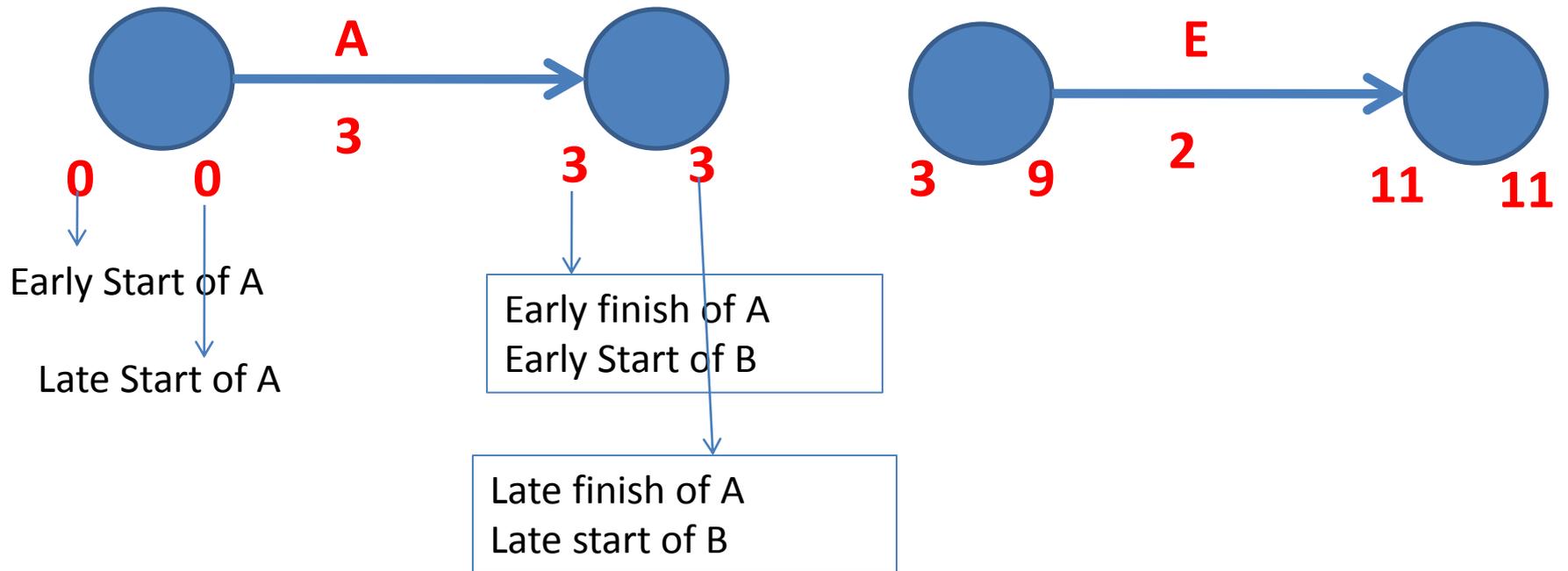
Calculations

Backward Pass Calculations:

- The early finish of the last activity is equal to the late finish of the last activity
- *Late finish of the activity – duration = late start of the activity*



Calculations



AOA

Ex/ A

project consists of 7 activities as shown below. Draw network of the project using AOA, determine ES, EF, LS and LF for each activity, determine the critical path of the project, and calculate the free and total floats of each activity.

Activity	Duration (days)	Preceded by
A	2	
B	6	A
C	6	B
D	1	B
E	3	A
F	3	D, E
G	2	C, F

Engineering Management

What is the Management:

The **God** creates the Humanity in two days and four days for what?????

Definition of Management.....more than 100 definition in text book.

“how to satisfy requirements using the most economic and best tools”

For discussion what is Best??

Engineering Management

Project Management **IS NOT** Construction Management

Project is not necessary to be a **construction**

Execution of Engineering Building in Al Muthanna University is a Project (**construction Project**)

Opening a new department in College of Engineering is a Project (**but not a construction project**)

SO

**WHAT IS THE PROJECT, PROJECT MANAGEMENT,
CONSTRUCTION, CONSTRUCTION MANAGEMENT.**

What is the PROJECT ???

- A project is a **temporary** endeavor undertaken to accomplish a **unique product** or service with a **defined start and end point** and **specific objectives** that, when attained, signify completion.
- **PMBOK definition**
- المشروع عبارة عن مسعى او جهد مؤقت متخذ لإنجاز منتج خدمة أو
- فريدة من نوعها ضمن فترة زمنية محددة وأهداف محددة ، والتي يدل
- تحققها على اكتمال المشروع.

Examples of projects



Project Management

- Project management is the application of knowledge, skills, tools, and techniques applied to project activities in order to meet or exceed stakeholder needs and expectations from a project.
- **PMBOK definition**
- إدارة المشروع هو تطبيق المعارف والمهارات والأدوات والتقنيات
- على فعاليات المشروع من أجل تلبية احتياجات أصحاب المصلحة
- وتوقعاتهم من المشروع.

Construction

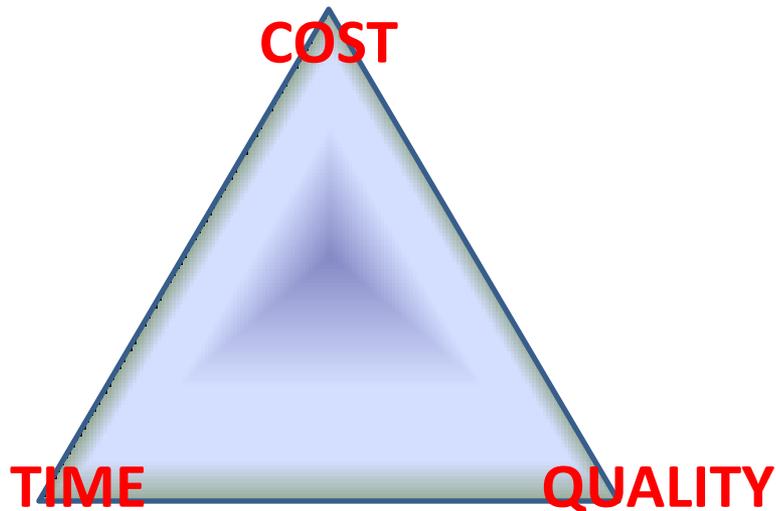
Construction: it is the group of services through which the drawings and specifications prepared by engineers are transferred to a completed physical structure.

Construction Management: A career of dealing with people involved in the project (contractors, subcontractors, suppliers) using the best and available techniques and tools to perform the project within pre-defined **time, cost and quality**.

Elements of Construction Management

There are three main targets for Construction Managements

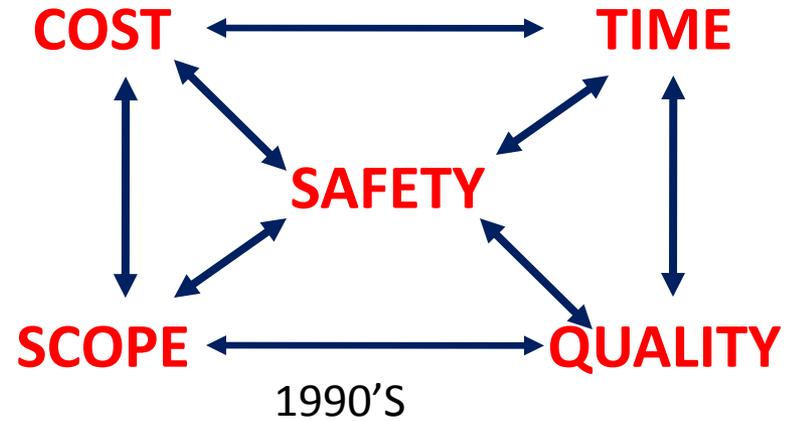
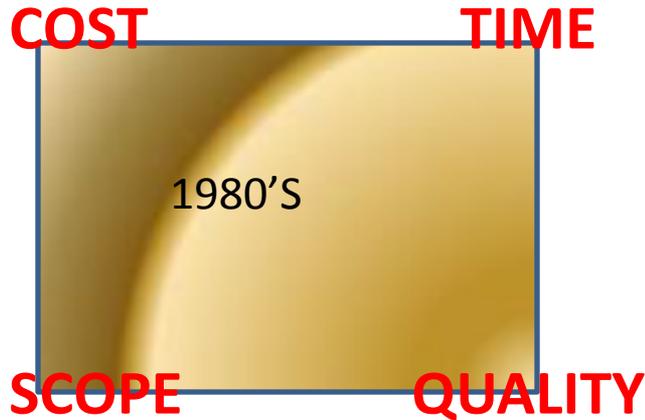
TIME, COST, AND QUALITY



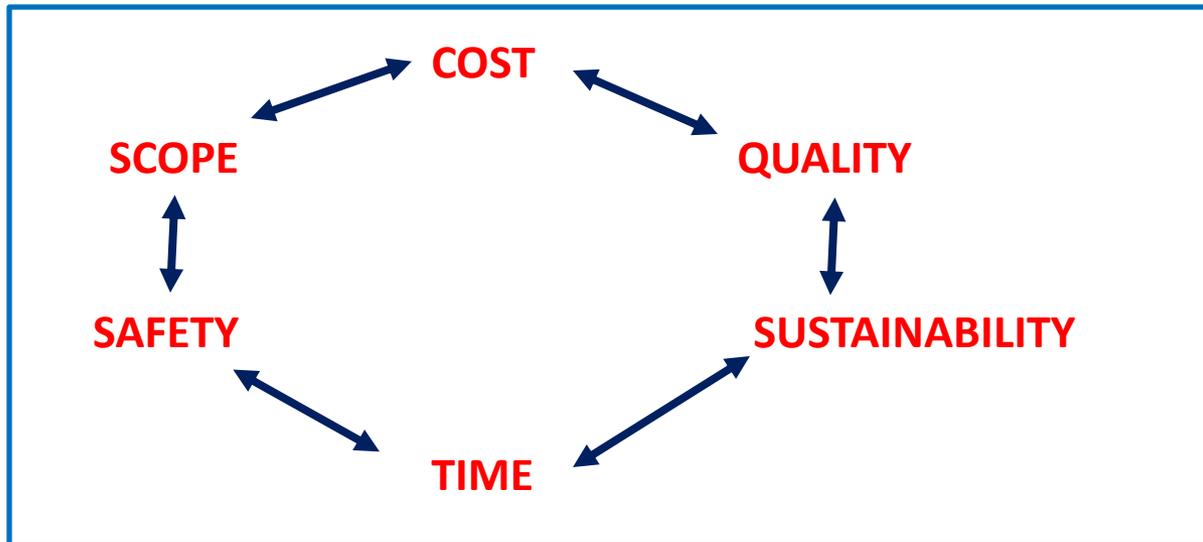
Cost is the base and the other two elements can affect in different ways. Discuss??????

Believe or not: this is an old understanding of Construction Management (Esam Hewayde)

What is the New



NOW
2004



TIME

Time of Project: It is the pre-defined duration to perform the activities of the project:

Time of Activity can be calculated based on productivity:

Ex/ if the productivity of tiles crew is 50 sq. m per day, how many days are needed to perform 325 sq.m if a) one crew is used, b) two crews are used? Discuss the accuracy of productivity method?

Do you Know

There are other methods to estimate time

This is just for your information

- Guess
- Analogous Estimating = same as
- Parametric Estimating = last time we did A it took us X to complete. So now we need 5A therefore it will take $5 * X$
- Multiple estimators: you ask 2 or 3 estimators to develop estimate for these WBS elements and then compare and rationalize and develop good estimate from the result of those 2 or 3 estimator.

Programme Evaluation and Review Technique (PERT):

It uses the principles of multiple estimator. It does the following

- **Most likely.** The duration of the schedule activity, given the resources likely to be assigned, their productivity, realistic expectations of availability for the schedule activity, dependencies on other participants ,and interruptions.
- **Optimistic.** The activity duration is based on a best-case scenario of what is described in the most likely estimate.
- **Pessimistic.** The activity duration is based on a worst-case scenario of what is described in the most likely estimate.
- **Actual estimate= $(P+4M+O)/6$**

Planning and Scheduling

It is about time

Planning: can be thought of as determining “what”, “how”, “where” and by “whom”. In scheduling, this information is needed in order to determine “when”

In construction projects, the drawings and specification (plan) generally define the end product and general time frame to complete the project.

However, they normally do not specifically identify the individual steps, their order, and the timing followed to achieve the project.

Planning and Scheduling

In summary, planning relates to develop the logic of how a project will be constructed, while scheduling consists of integrating that plan with a calendar or specific time frame.

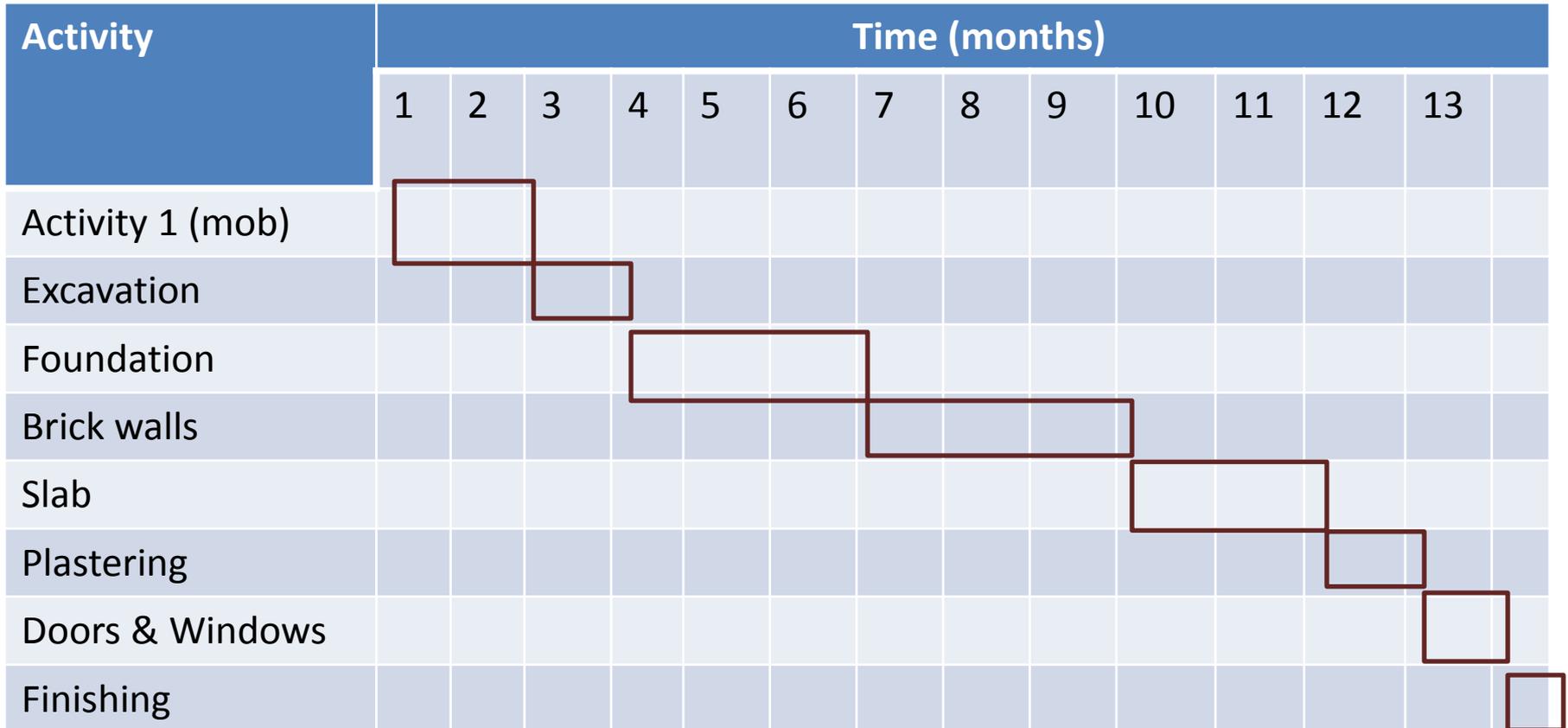
We all do planning and scheduling on a regular, albeit informal basis. We mentally determine a plan and schedule, such as what will do in the next half-hour and how and when we will accomplish that task, such as homework assignments.

Bar (Gantt) Chart

one of the scheduling method. Now it is considered as planning and scheduling method.

- In 1917 Henry Gantt developed a method of relating a list of activities to a time scale in a very effective manner, by drawing a bar(or Gantt) chart.
- Activities are represented as bars on the chart, while across the top or bottom of the chart is a time line.
- For each activity, a bar is drawn from starting time until its ending time

Bar (Gantt) Chart



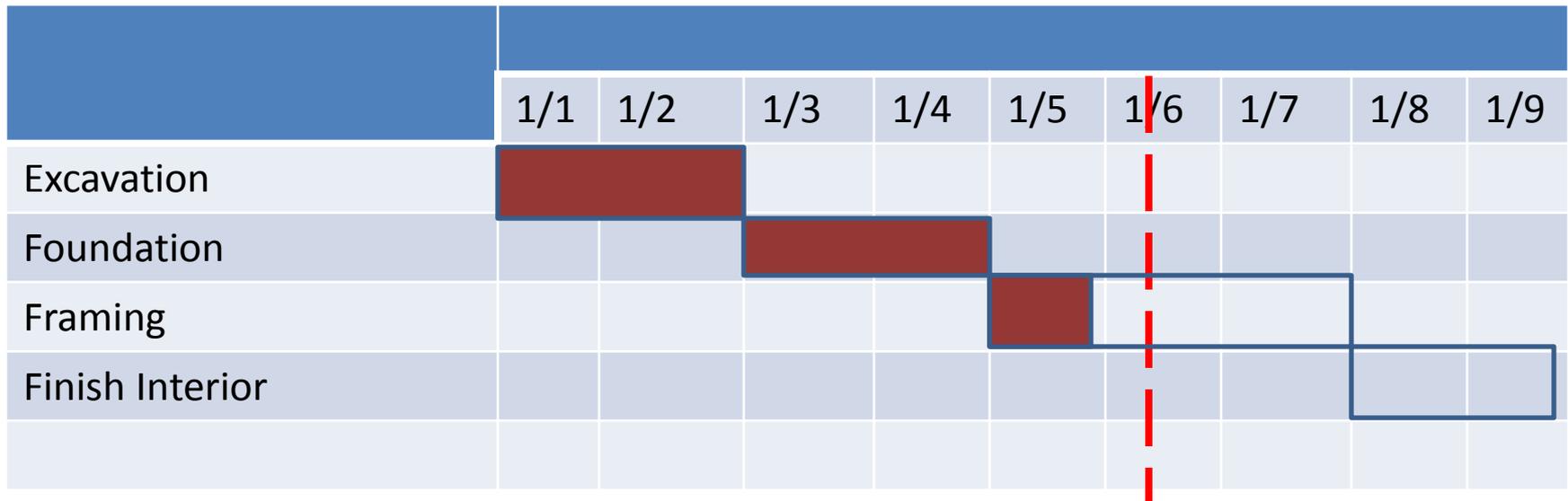
Bar (Gantt) Chart

Its primary advantage is that it is simple graphic representation allows one to grasp schedule information quickly and easily.

- Bar charts are simple presentations that show how major work activities are scheduled.
- They are easily prepared as time-scaled presentations
- It can be understood with only a cursory examination
- The activity sequencing is apparent and one can surmise easily when each activity is to began and when it is to be completed.

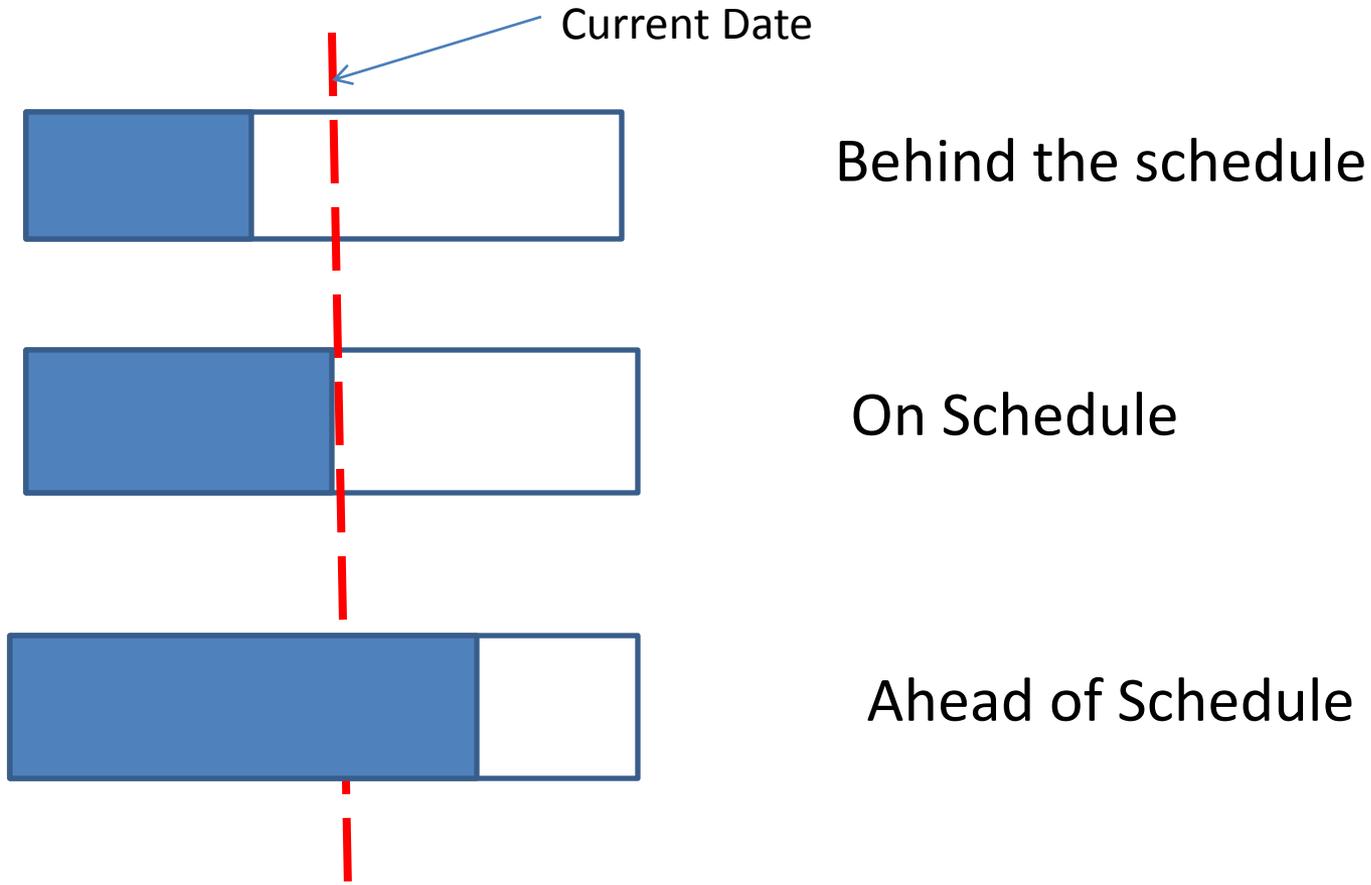
IT CAN SHOW THE SCHEDULED VERSUS ACTUAL PROGRESS

Bar (Gantt) Chart



- The heavy dashed line represents the current date
- The shaded portion of activity indicates the amount of work has been completed by current date

Bar (Gantt) Chart



Bar (Gantt) Chart

Ex/Draw Gantt chart of the following project.

<u>Activity</u>	<u>Duration</u>	<u>Preceded by</u>
A	2 months	start
B	6 months	A
C	6 months	B
D	1 month	B
E	3 months	A
F	3 months	D
G	2 months	C, F

Contractors Income Profile

For same example (assume markup is 25%)



Billed by Contractor

0 \$37,500 \$87,500 \$100,000 \$25,000

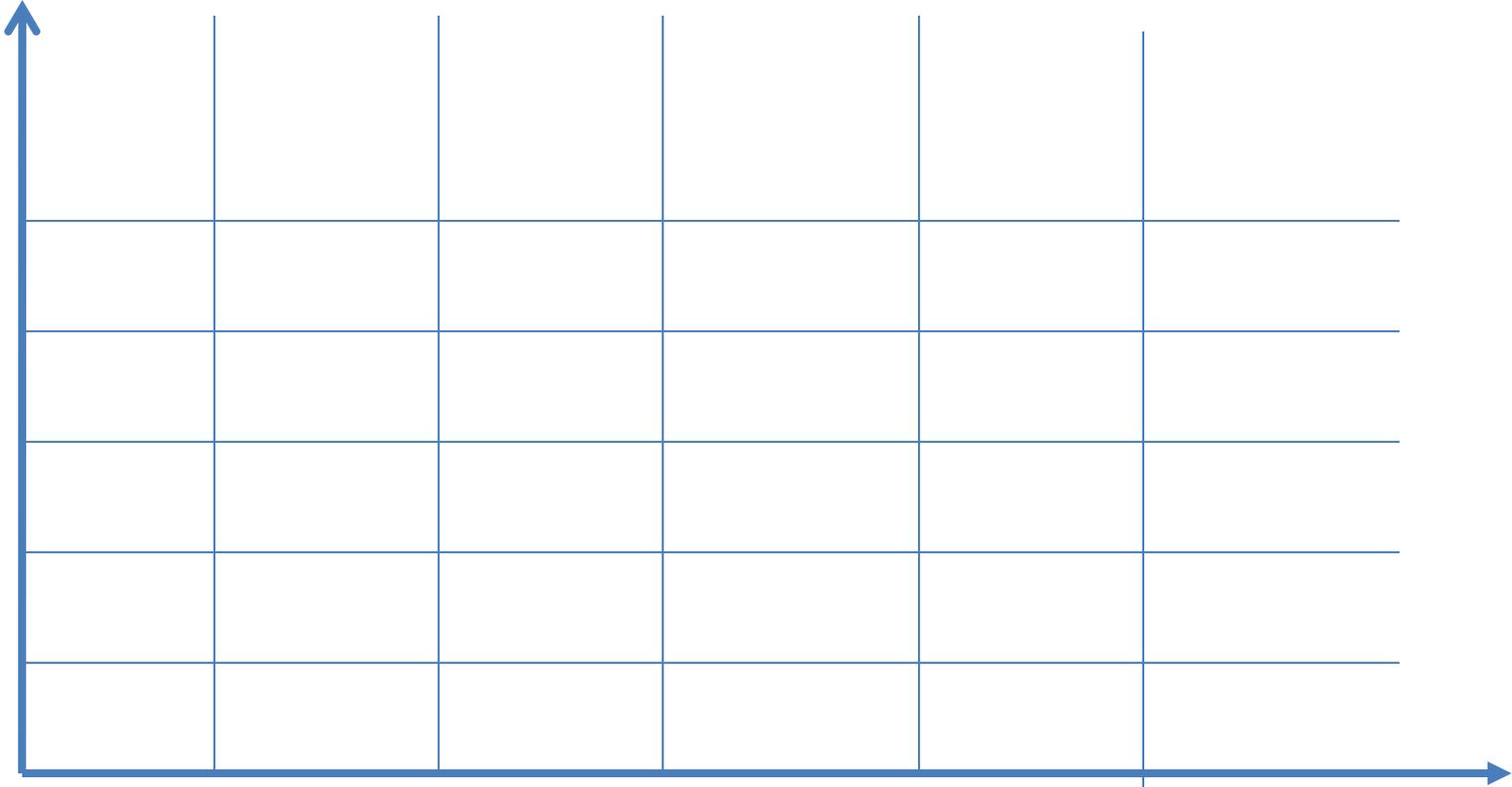
Retainage

0 \$3,750 \$8,750 0 0

Payment Received

0 0 \$33,750 \$78,750 \$100,000 \$37,500

Expenses Vs. Income profile

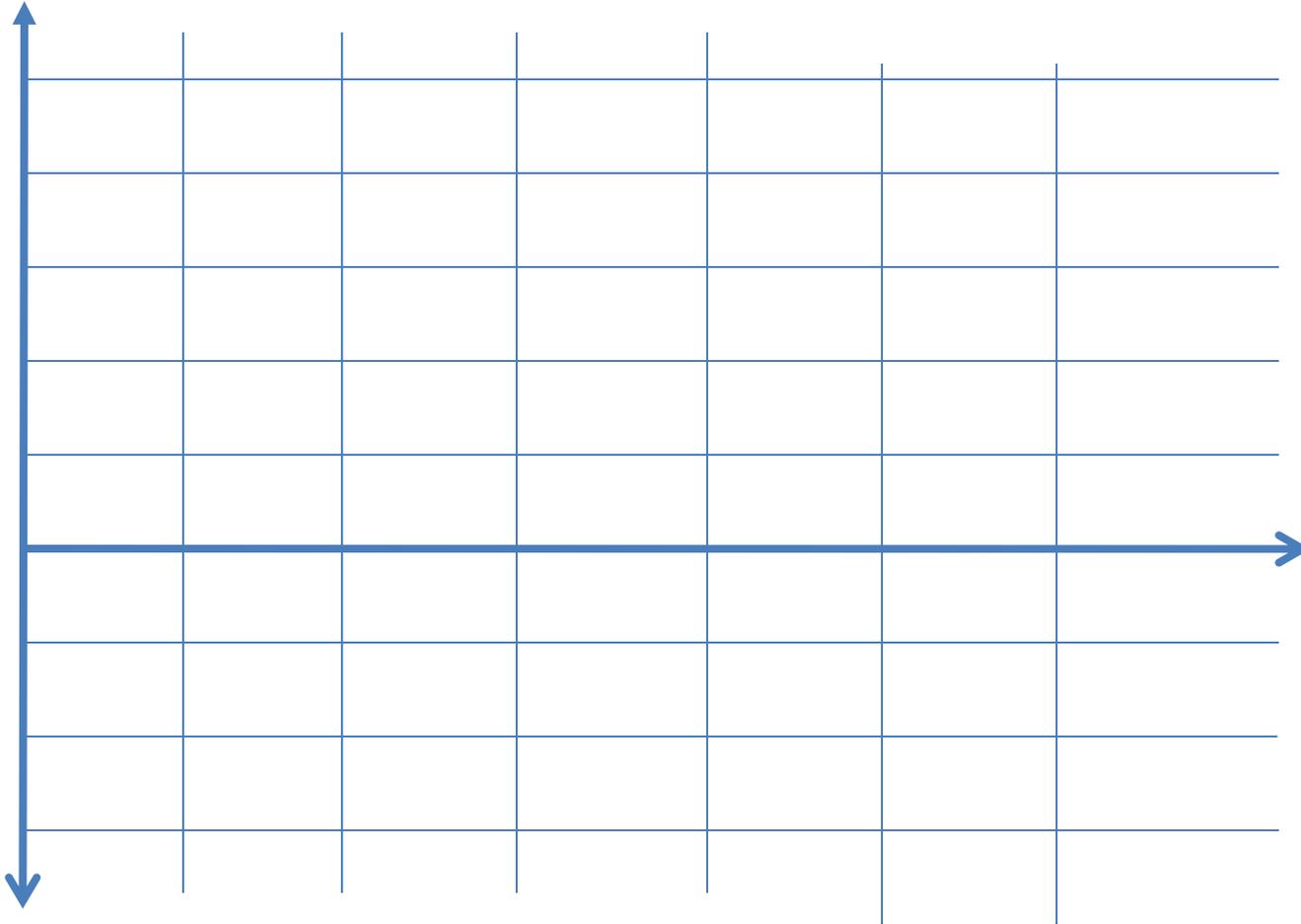


Cost of Financing = Area under curve x Interest Area

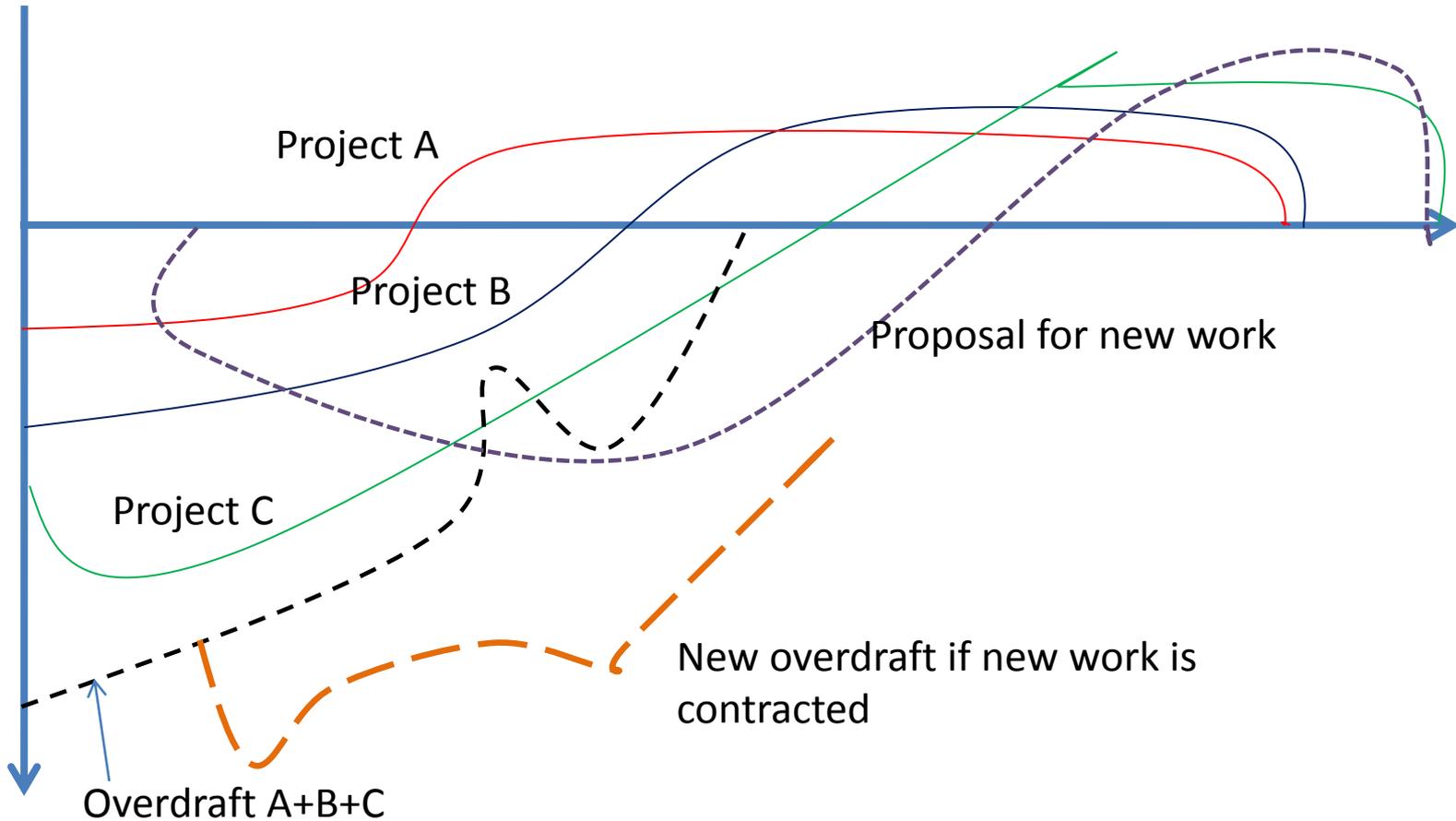
Calculating the Cost of Financing

	1	2	Month 3	4	5	
Direct Cost	25,000	65,000	75,000	15,000		
Indirect Cost	5,000	5,000	5,000	5,000		
Subtotal	30,000	70,000	80,000	20,000		
Markup	7,500	17,500	20,000	5,000		
Total billed	37,500	87,500	100,000	25,000		
Retainage	3,750	8,750	0	0		
Payment received			33,750	78,750	100,000	37,500
Total cost to date	30,000	100,000	180,000	200,000	200,000	
Total amount billed	37,500	125,000	225,000	250,000	250,000	
Total paid to Cont.			33,750	112,500	212,500	250,000
Overdraft end	30,000	100,300	147,553	90,927	(8,818)	(46,318)
Interest	300	1,003	1,476	903	0	0
Total amount financed	30,300	101,303	149,029	91,182		

Overdraft profile



Multi Project Overdraft



Advanced payment

For the previous example. Assume that the owner will make advance payment (20% of contract price). The contractor has to repay the advanced payment as 25% in each progress payment

Cost

Cost of Project: Amount of money spent to perform a project

Cost of Project = Σ cost of activities

Remember Time of project is **NOT** Σ time of activities

Types of Cost:

1. **Direct Costs:** refers to the salary costs for the team, costs of the materials and the sub-contractor and other labors required.
2. **Indirect Costs:** the insurance premium, the space allocated for their desks, charges from the telephone or any other cost that are not considered to be a direct cost.

COST

Types of Cost (according to PMbook)

1. **Direct Costs:** refers to the salary costs for the team, costs of the materials and the sub-contractor and other labors required.
2. **Indirect Costs:** the insurance premium, the space allocated for their desks, charges from the telephone or any other cost that are not considered to be a direct cost.
3. **Fixed Costs:** costs that are not changed with time (rental, travel, requirements of project).
4. **Variable Costs:** costs that are changed with time, electricity, phones, expense.

How to Calculate Cost

Cost of Activity = cost of resources including (team, materials, equipments, management, and any other resources)

Indirect Cost can be added as a percentage (may be 5% to 20% depends on nature of work)

Example/ Cost of 1 cubic meter of concrete

- ✓ *Cost of cement, sand, gravel, water*
- ✓ *Cost of reinforcement*
- ✓ *Cost of carpenter, casting crew*
- ✓ *Cost of curing*
- ✓ *Cost of technical staff*
- ✓ *Think what else????????????????????*

Quality

Quality is “the degree to which a set of inherent characteristics fulfill requirements”

It means how we can check that the product complies the requirements

- **Quality Control QC:** monitoring specific project results to determine whether they comply with relevant quality standards (such as testing sand, cement, concrete.....)
- **Quality Assurance QA:** applying the planned, systematic quality activities to ensure that the project employs all processes needed to meet requirements (such as what specifications will be used, what kind of test...)

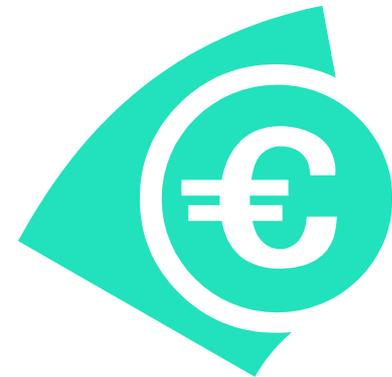
Major Contract Types-Traditional

1. Lump Sum (Stipulated Sum)
2. Unit Price (Schedule for Rates)
3. Cost Plus (Negotiated)



Lump Sum

- 1) One price for the whole contract
- 2) Includes cost plus overheads and profits
- 3) High risk for Contractor
- 4) Payments based on schedule percentage scheme
- 5) Change orders....hassle
- 6) Suitable for building construction



Unit Price

- 1) Prices by Units
- 2) No total final price
- 3) Re-negotiate rate if works considerably exceeds initial quantity
- 4) Payments are based on the measure
- 5) High risk to Owner-low risk to Contractor



Cost Plus

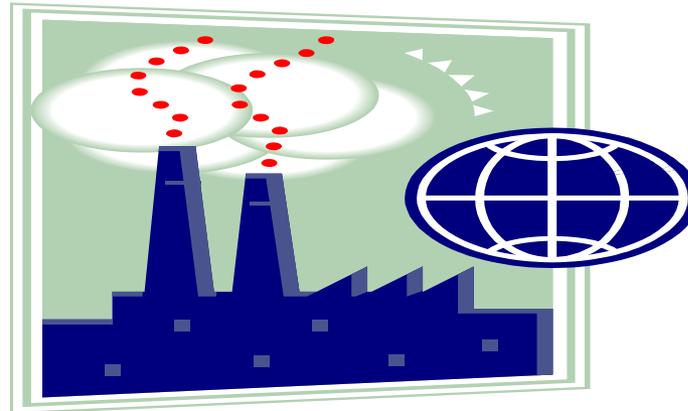
- 1) Actual cost plus a negotiable reimbursements to cover overhead and profits
- 2) Risk shared between Owner and Contractor
- 3) Fast track
- 4) Complex
- 5) Can be
 - a. Cost + Percentage
 - b. Cost + fixed fees
 - c. Cost + fixing fees + sharing clause
 - d. Cost + sliding fees



Special Types of Contracts

1. Design Build

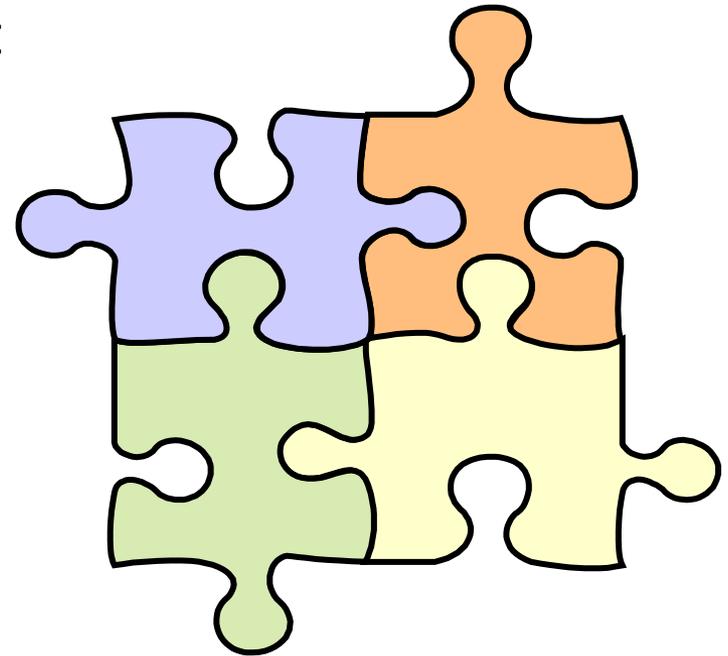
- ✓ Single contract package for both design and construction
- ✓ Reduces the deputes among parties involved
- ✓ Higher coordination
- ✓ Time Saving – design and construction concurrently
- ✓ Mainly used for large and complex industrial projects



Special Types of Contracts

2. Construction Management

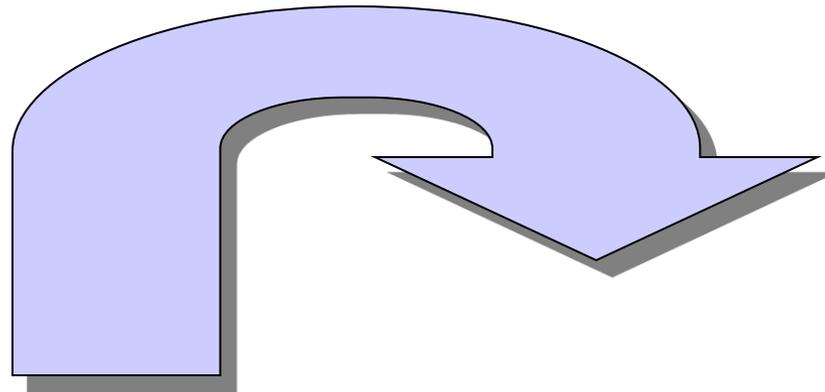
- One firm manages the project
- The firm represents the Owner
- Involves at both design and construction phases
- Ideal for large and complex project



Special Types of Contracts

3. Design, Build, Own, Operate and Transfer

- ❖ Owner defines the project
- ❖ Contractor designs, builds and finances the project
- ❖ Contractor owns and operates the projects to recover its cost
- ❖ The project is then transferred to Owner at some later specified date



Special Types of Contracts

4. Turnkey Contract

- Contractor are responsible for designing, building and supplying of mechanical and electrical equipment
- Can be one or two contractors
- High efficiency during implementation (details are well known to Contractors)
- Less control of Owner
- Ideal for special projects (refinery, nuclear plant)



Owner-Contractor

Owner Desires

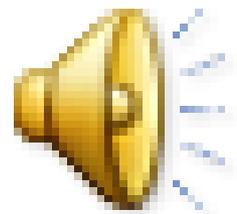
Better Operational Features

Lower Cost

Quicker Schedule

Less Risk

Less Hassle



Contractor Desires

More Work

More Profit

Less Risk

Less Hassle



Who Can Contract?

Capacity to Contract

Individuals
Governments
Companies
Joint Ventures
Societies/club
Agencies

Can NOT Contract

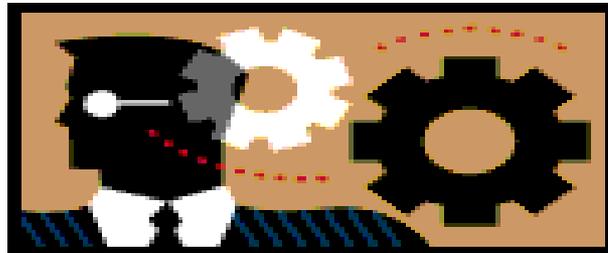
Minors
Mentally Incompetent
Bankrupt organizations
Intoxicated Persons
Non-existing parties



Elements for a Legally Binding Contract

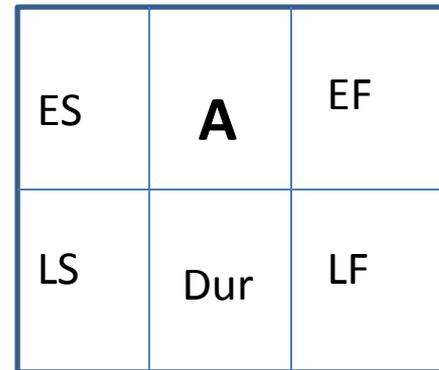
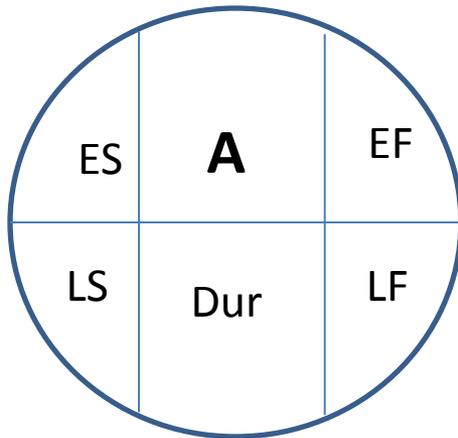
1. An offer must be made and accepted
2. Mutual intent to enter the contract
3. Consideration
4. Lawful Purpose
5. Capacity to Contract

Contract = offer + Acceptance + Consideration



Activity On Node AON

- Activity is represented as Node NOT Arrow
- The Node can be circle or square or Rectangle
- No dummy activity in AON
- Can show Lag

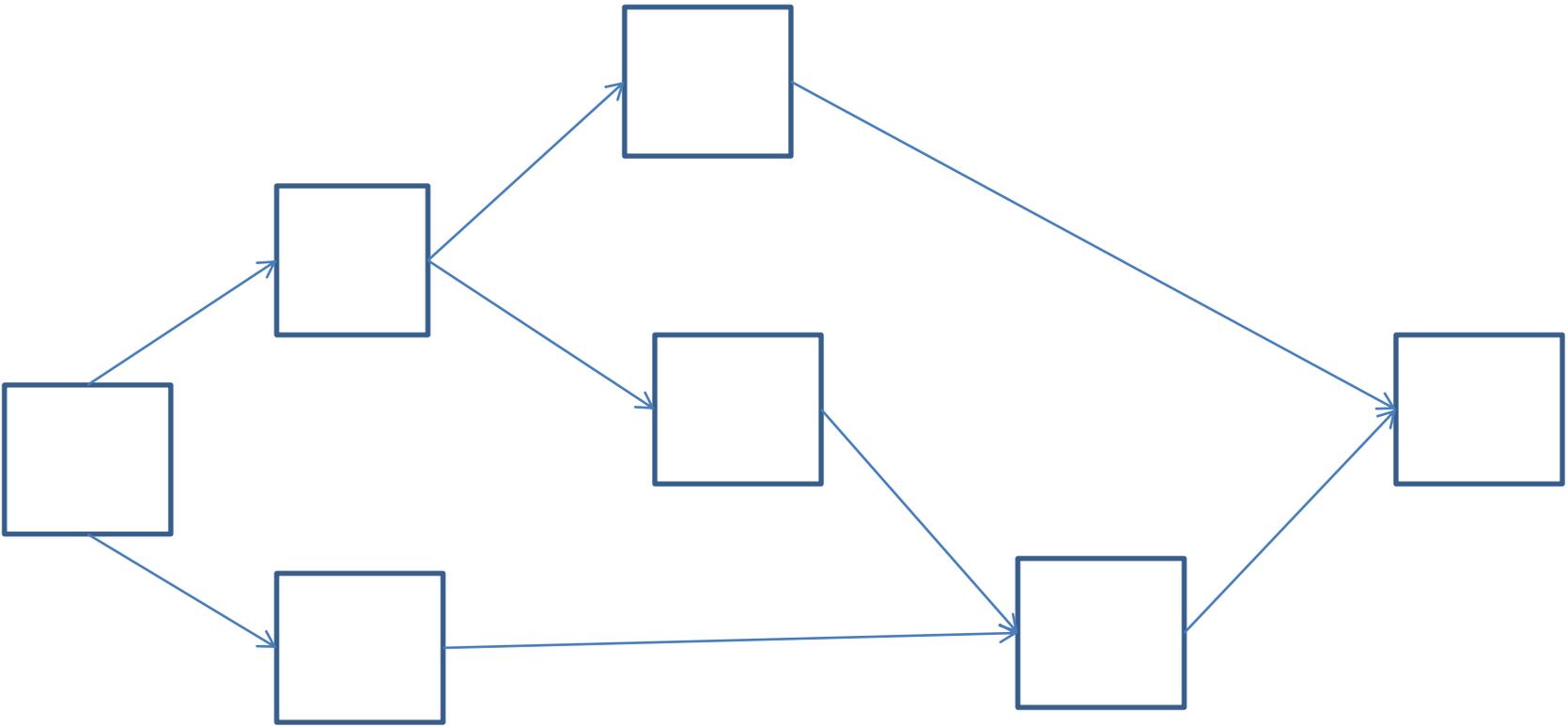


AON

Ex/Draw AON of listed activities and determine ES, LS,EF, LF, TF, and FF and show the Critical Path of the project?

Activity	Duration WK	Preceded by
A	2	-
B	6	A
C	6	B
D	1	B
E	3	A
F	3	D, E
G	2	C, F

AON



AON

LAG: The amount of time that exists between the early finish of an activity and the early start of a specified succeeding activity.

$$\text{Lag (between Act. A and Act. B)} = ES_B - EF_A$$

Activity			
ES	Duration		LS
EF	FF	TF	LF

AON

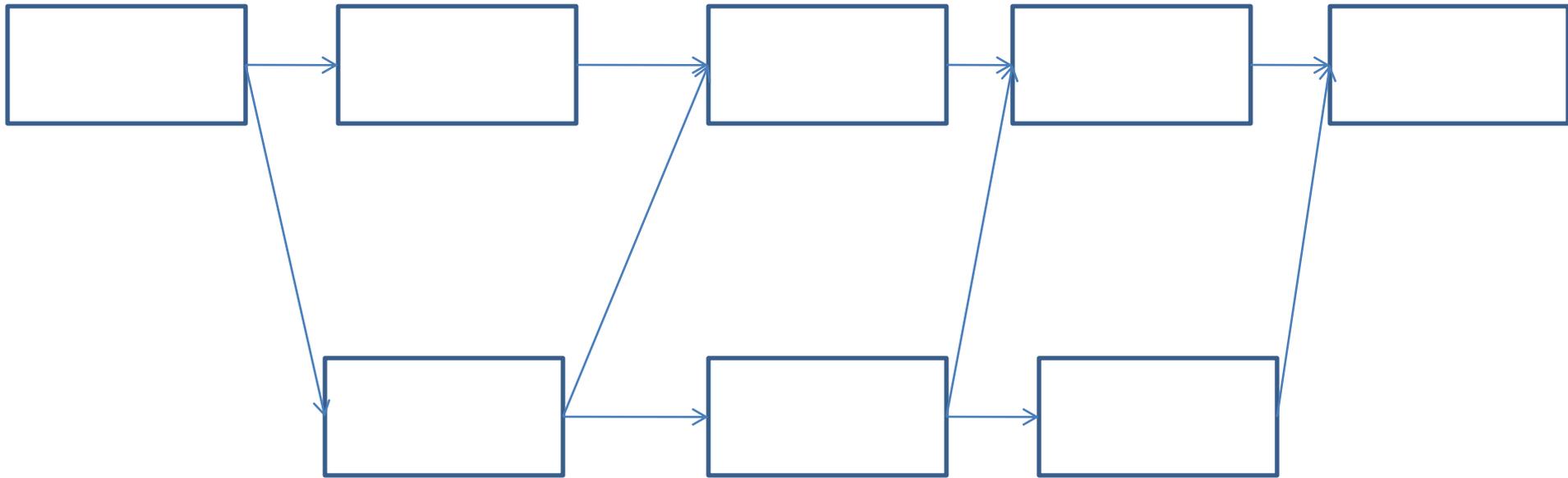
Ex/ Draw AON of listed activities and determine lag, ES, LS, EF, LF, FF, and TF

Activity	Duration MTHS	Depends on
A	1	-
B	9	A
C	5	A
D	5	B, C
E	4	C
F	4	D, E
G	6	E
h	1	F, G

AON

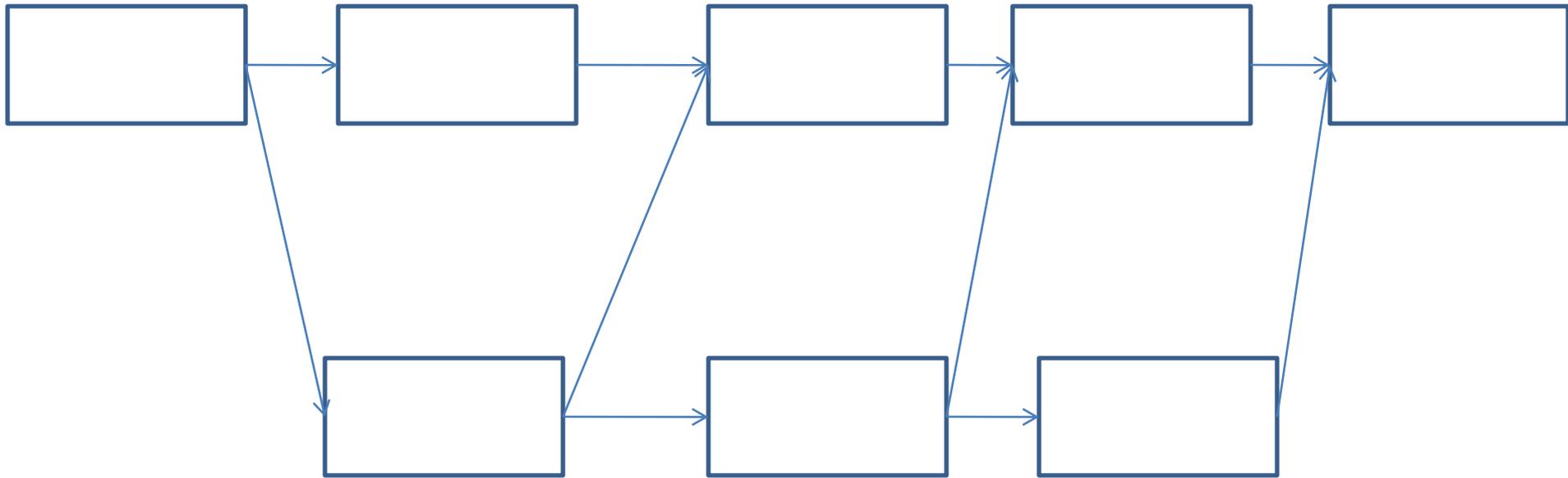
$$EF = ES + D$$

$$\text{Lag } AB = ES_B - EF_A$$



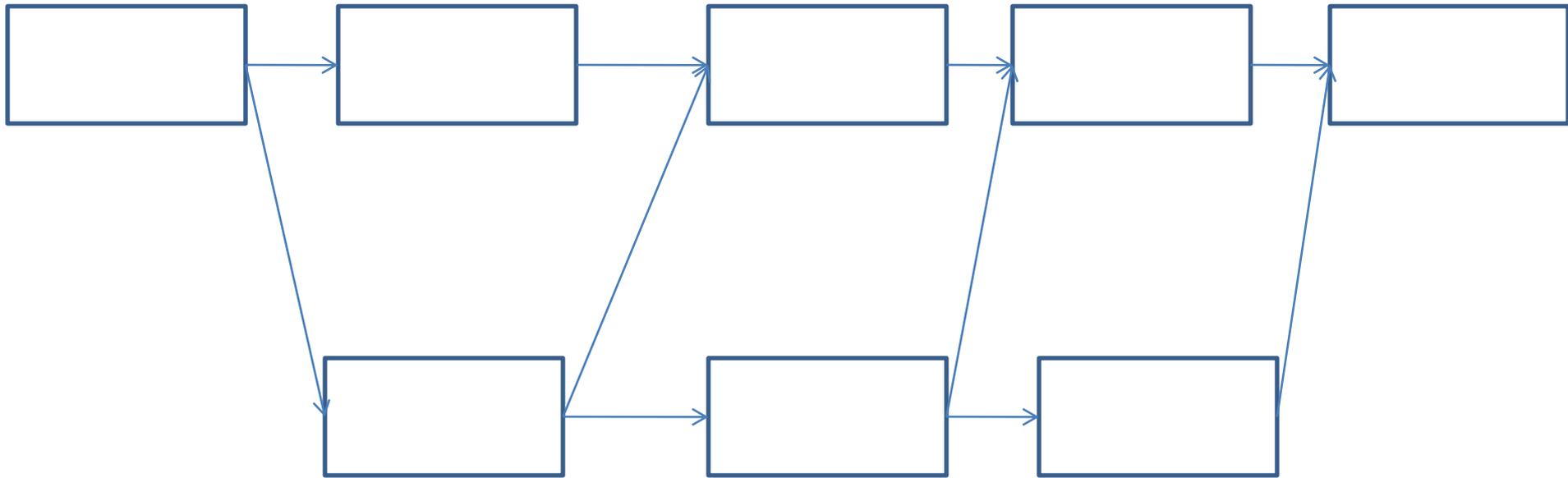
AON

FF = smallest lag of lines following activity



AON

TF of last activity = 0

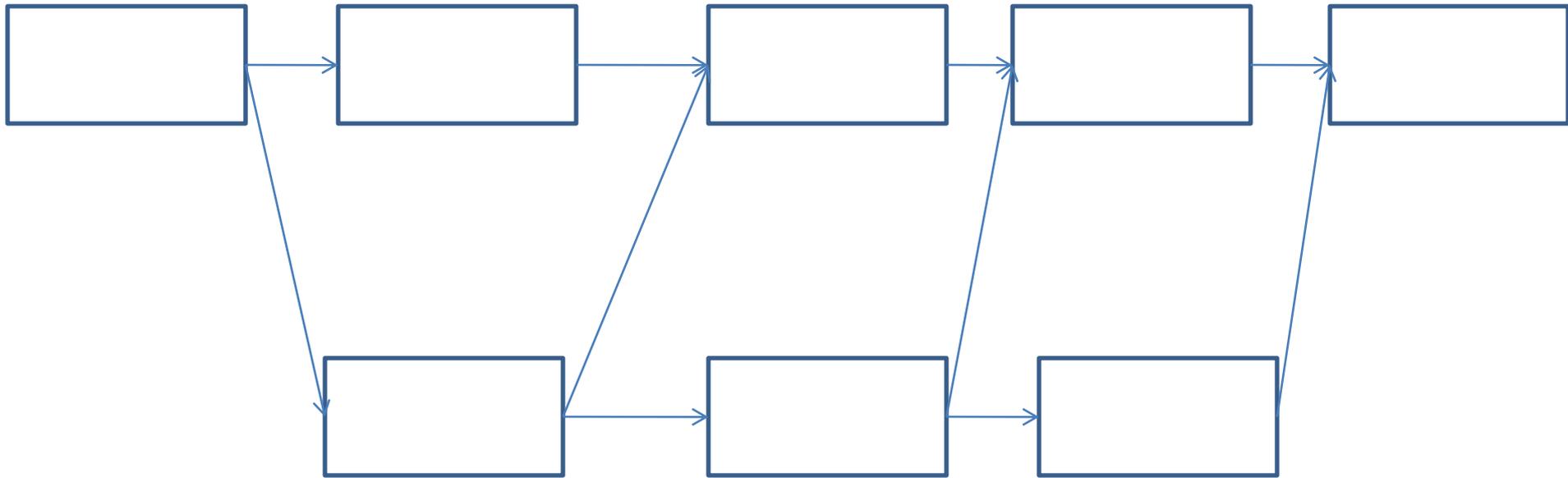


TF of activity = TF of following activity + lag (choose smallest)

AON

$$LS = ES + TF$$

$$LF = EF + TF$$



Independent and Interfering Floats

Independent Float (Safe Float): is the float that is owned by one activity. It means that the float of an activity is independent of the late finish of preceding activities and of the early times of succeeding activities. It is the flexibility that is ascribed to the specific use by one activity.

Independent Float $A = ES_{\text{successor}} - LF_{\text{predecessor}} - \text{Duration } A$

Interfering Float (Shared Float) of an activity is the amount of time that its early start can be delayed without delaying the project completion but will delay at least one other succeeding activity.

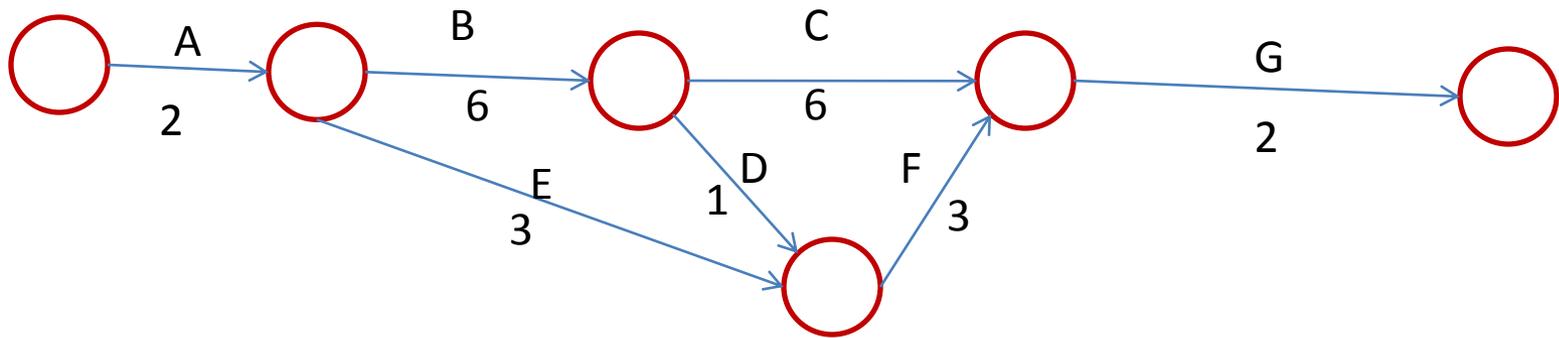
Interfering Float $A = TF_A - FF_A$

AOA

Ex/ A

project consists of 7 activities as shown below. Draw network of the project using AOA, determine ES, EF, LS and LF for each activity, determine the critical path of the project, and calculate the free and total floats of each activity.

Activity	Duration (days)	Preceded by
A	2	
B	6	A
C	6	B
D	1	B
E	3	A
F	3	D, E
G	2	C, F



Total and Free Float

Total Float (Total Slack) T.F: The maximum amount of time that an activity can be delayed (beyond its designated Early start) without delaying the project time. It is the difference between an activity's early finish and its late finish or the difference between the early start and late start,

Free Float (F.F): the maximum amount of time that an activity can be delayed (beyond its designated early start time) without delaying the early start of any other activity, specifically those activities immediately following that activity

Total and Free Floats

Act.	Dur	E.S	E.F	L.F	L.S	T.F	F.F	C.P
A	2	0	2	2	0	0	0	Y
B	6	2	8	8	2	0	0	Y
C	6	8	14	14	8	0	0	Y
D	1	8	9	11	10	2	0	N
E	3	2	5	11	8	6	4	N
F	3	9	12	14	11	2	2	N
G	2	14	16	16	14	0	0	Y

ES from network

$$EF = ES + D$$

LF from network

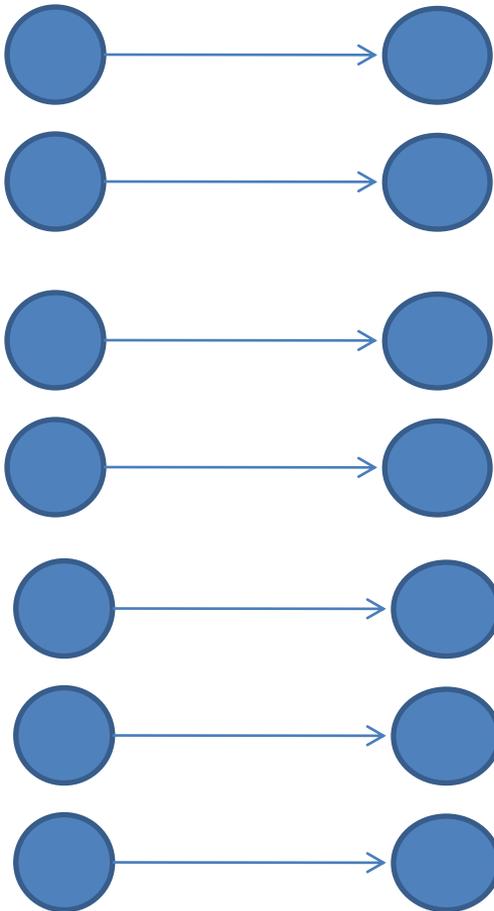
$$LS = LF - D$$

$$T.F = LF - EF \text{ or } LS - ES$$

$$F.F = ES_{\text{next}} - ES_{\text{act}} - D \text{ from network}$$

Total and Free Float

Break the network into activities and find $F.F = ES_j - ES_i - D$



AOA

Sketch the network AOA) of listed activities and find ES, LS, EF, LF of each activity and determine the critical path

Activity	Duration
1-2	2
2-3	3
2-4	5
3-5	4
3-6	1
4-6	6
4-7	2
5-8	8
6-8	7
7-8	4

Sketch

	Activity	Duration (WK)	Preceding Act.	Following Act.
	A	3		C,E,F
	B	3		G,E,F
A	C	2	A	M,N
B	D	7		
C	E	8	A,B	M,N
D	F	5	A,B	J
E	G	6	B	H
F	H	4	G	
G	M	6	C,E,J	
H	N	4	C,E,J	
M	j	3	F	M,N
N	4	C,E,J		
j	3	F	M,N	

- Activity A requires 2M and 1H for one day
- At completion A, activities B&C are eligible for scheduling
- Both B&C can be schedules as resources are not exceeded
- When C completed, F, G, and H became eligible
- G has the earliest LS but resources are not allowed as helpers will exceed
- F will be the priority (not exceeding limitations)
- H can not be schedule as exceeding the resources
- D&E are eligible for scheduling as B completed
- E is the priority but will exceed the limitations
- D can be scheduled
- G can be scheduled now
- And so on

Ac	Res	Du	TF	LS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A					■																					
B						■	■	■	■	■																
C							■																			
D										■																
E											■	■	■	■	■											
F								■	■	■	■															
G										■	■	■	■													
H																■	■									
J														■	■											
K																■	■	■	■	■	■					
L																						■	■			
M																								■		
Masons					2	4	4	5	5	5	4	4	4	5	2	3	3	2	2	2	2	3	3	2		
Helpers					1	2	2	1	1	2	2	2	2	2	2	2	2	1	1	1	1	2	2	1		

Stages of Projects

- After identifying needs, each project has to pass through process group or (stages)
- These stages can be applied for construction projects or any other projects
- Stages are
 - 1. *Initiating***
 - 2. *Planning***
 - 3. *Executing***
 - 4. *Monitoring and Controlling***
 - 5. *Closing***

1. Initiating

Initiating Process defines and authorizes the projects.

During the initiating stages, the following shall be performed,

1. **Define the project** and boundaries of project (cost, time, scope)
2. **Develop Project Charter** – authorize the project, prepare the documents, and get the required acceptance
3. **Develop Preliminary Project Scope Statement** – define the scope of work and deliverables required

Planning

The Planning Process Group helps gather information from many sources with each having varying levels of completeness and confidence.

The planning processes develop the project management plan. These processes also identify, define, and mature the project scope, project cost, and schedule the project activities that occur within the project. As new project information is discovered, additional dependencies, requirements, risks, opportunities, assumptions, and constraints will be identified or resolved.

Planning

Planning process prepare

1. **Develop Project Management Plan** - defining, preparing, integrating and coordinating all subsidiary plans into a project management plan
2. **Scope Planning** - creating a project scope management plan that documents how the project scope will be defined, verified and controlled, and how the work breakdown structure will be created and defined
3. **Scope Definition** - developing a detailed project scope statement as the basis for future project decisions

Planning

4. **Create WBS (Work Breakdown Structure)**: subdividing the major project deliverables and project work into smaller, more manageable components
5. **Activity Definition**: identifying the specific activities that need to be performed to produce the various project deliverables
6. **Activity Sequencing**: identifying and documenting dependencies among schedule activities
- 7 **Resource Estimating**: estimating the type and quantities of resources req. Activity required to perform each schedule activity

Planning

8. **Activity Duration Estimating**: estimating the number of work periods that will be needed to complete individual schedule activities
9. **Schedule Development**: analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule
10. **Cost Estimating**: developing an approximation of the costs of the resources needed to complete project activities
11. **Cost Budgeting**: aggregating the estimated costs of individual activities or work packages to establish a cost baseline

Planning

12. **Quality Planning**: identifying which quality standards are relevant to the project and determining how to satisfy them
13. **Human Resource Planning**: identifying and documenting project roles, responsibilities and reporting relationships, as well as creating the staffing management plan
14. **Communication Plan**: determining the information and communication needs of the project stakeholders
15. **Risk Management Plan**: deciding how to approach, plan and execute the risk management activities for a project
16. **Risk Identification**: determining which risks might affect the project and documenting their characteristics

Planning

15. **Plan Purchases and acquisition**: determining what to purchase or acquire, and determining when and how
16. **Plan Contracting**: documenting products, services, and results requirements and identifying potential sellers

Executing

consists of the processes used to complete the work defined in the project management plan to accomplish the project's requirements

The Executing Process Group includes the following project management processes:

1. **Direct and Manage Project Execution**: directing the various technical and organizational interfaces that exist in the project to execute the work defined in the project management plan
2. **Perform Quality Assurance**: applying the planned, systematic quality activities to ensure that the project employs all processes needed to meet requirements

Executing

3. Acquire Project Team: obtaining the human resources needed to complete the project.
4. Develop Project Team: improving the competencies and interaction of team members to enhance project performance
5. Information Distribution: making information available to project stakeholders in a timely manner
6. Select Sellers: reviewing offers, choosing from among potential sellers, and negotiating a written contract with the seller

Monitoring and Controlling

consists of those processes performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken

The Monitoring and Controlling Process Group includes the following project management processes

1. **Monitor and Control Project Work**: collecting, measuring, and disseminating performance information, and assessing measurements and trends to effect process improvements.
2. **Change Control**: controlling factors that create changes to make sure those changes are beneficial, determining whether a change has occurred, and managing the approved changes, including when they occur.

Monitoring and Controlling

3. **Scope Verification**: formalizing acceptance of the completed project deliverables
4. **Scope Control**: controlling changes to the project scope
5. **Schedule Control**: controlling changes to the project schedule
6. **Cost Control**: influencing the factors that create variances, and controlling changes to the project budget
7. **Perform Quality Control**: monitoring specific project results to determine whether they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance

Monitoring and Controlling

8. **Manage Project Team**: tracking team member performance, providing feedback, resolving issues, and coordinating changes to enhance project performance
9. **Performance Reporting**: collecting and distributing performance information. This includes status reporting, progress measurement, and forecasting
10. **Contract Administration**: managing the contract and relationship between the buyer and seller, reviewing and documenting how a seller is performing or has performed and, when appropriate, managing the contractual relationship with the outside buyer of the project

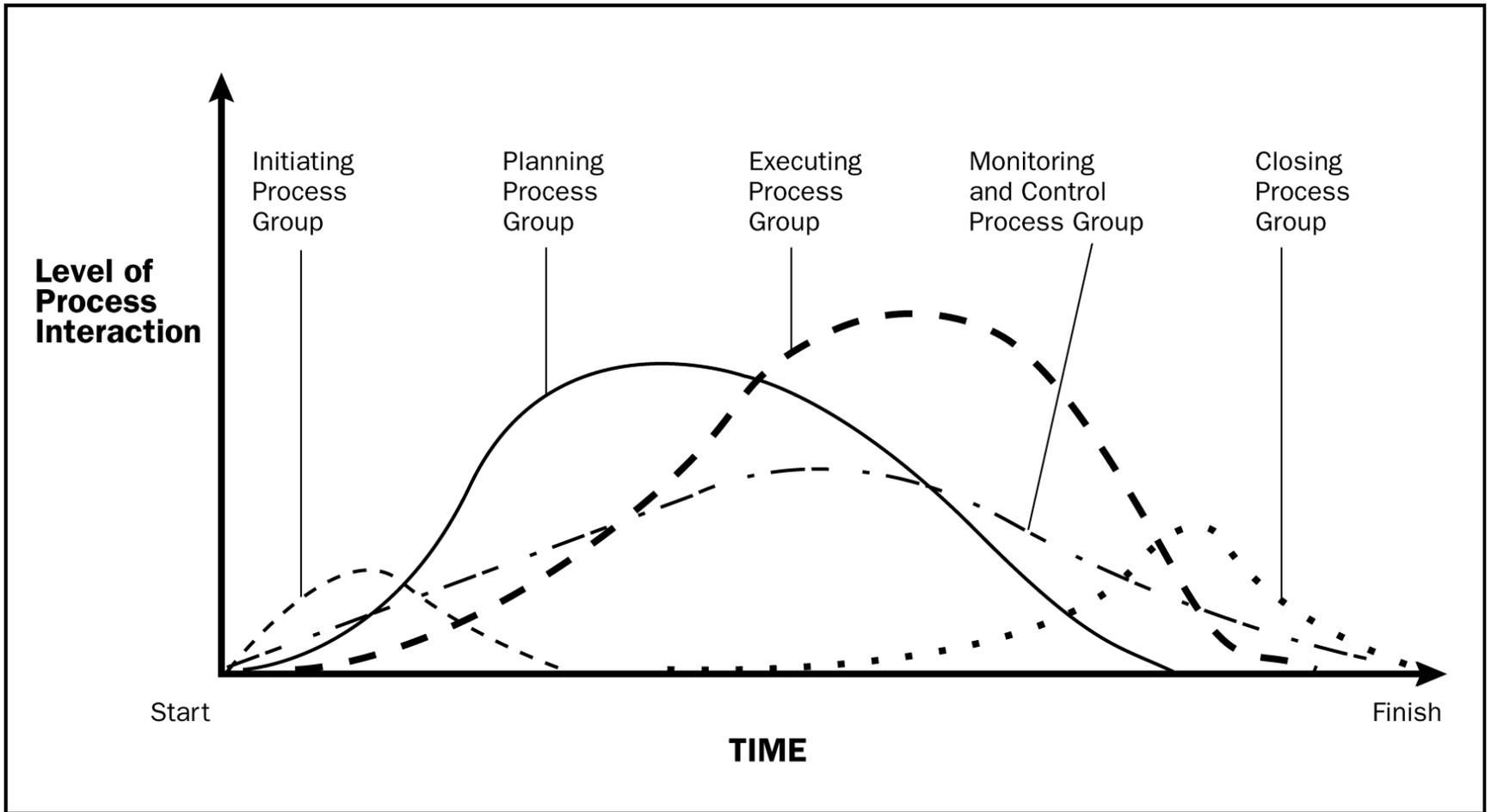
Closing

includes the processes used to formally terminate all activities of a project or a project phase, hand off the completed product to others or close a cancelled project.

The Closing Process Group includes the following project management processes

1. **Close Project**: finalizing all activities across all of the Process Groups to formally close the project or a project phase
2. **Contract Closure**: completing and settling each contract, including the resolution of any open items, and closing each contract applicable to the project or a project phase

Process Interaction



Project Management Knowledge Areas

