Project Control & Management

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Lecture 8

Subjects

Project Management in Engineering Environments

1. Process breakdown for **Delivery**
2. Product **Integrity and Reliability**
3. **Cost** factors and management (Cost Control)
4. **Planning and Scheduling**

Recommended Reading

Project Management, A system approach to planning, scheduling and controlling; 11th Edition, **H. R. Herzner**, Wiley, 2013. ISBN: 978-1-118-02227-6

Project Planning

"Planning can be described as the function of selecting the enterprise objectives and establishing the policies, procedures and programmes necessary for achieving them." (Herzner 2013)

Project Managers need to:

- Plan, integrate and execute the plans
- Prioritisation of resources requires detail planning
- Establish course of action within an uncertain environment

Project plans need to be ***Systematic, Flexible, Disciplined*, and** capable of incorporating ***multi-functional inputs.***

The SMART Rule

A project management plan should be:

- Specific [clarity of purpose]
- Measurable [progress measurement]
- Attainable [meet specific targets (product/service features)
- Realistic [understand capability and limitations]
- Tangible within a Time frame [differentiation in time – Controllability]

Statement of Work (SOW)

- Closely coupled with the Work Breakdown Structure(WBS)
- A structured and systematic narrative description of the work to be undertaken and the definitive outcome – based on the contract.
- It is set out by the project management team in direct consultation/interaction with customer(s) and the product engineering department.
- It needs to be well consulted, succinct, clear, detailed and agreed by all (in writing and verbally).

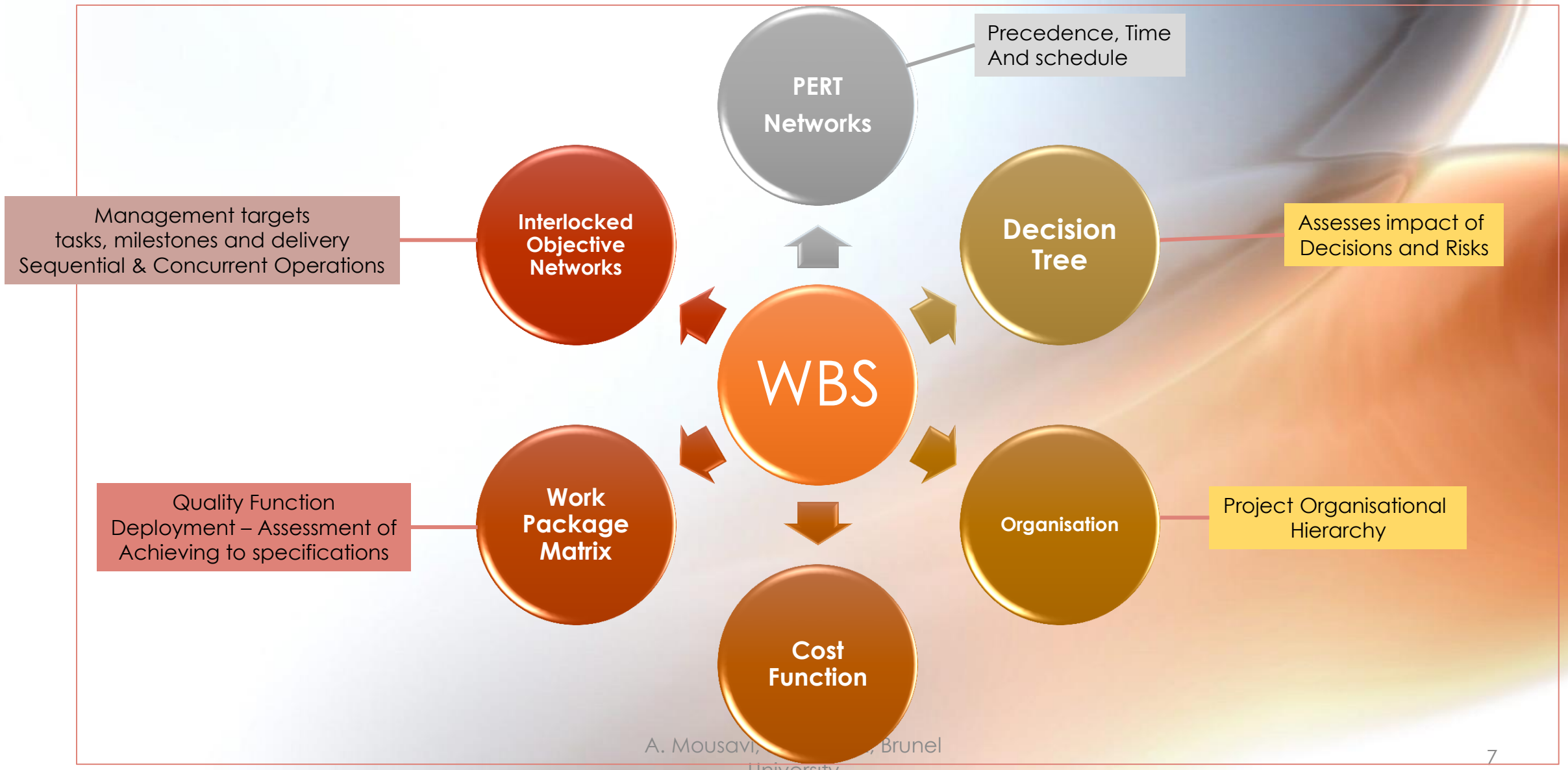
Project Managers' SOW Manuals (NASA)

[Herzner, 2013]

1. The project manager should clearly specify project objectives with the engineering team and agree on achievability
2. A clear Work Breakdown Structure (WBS) and cross relationship with SOW needs to be generated. It should be based on the contract.
3. The project manager appoints the SOW team based on their capabilities.
4. Technical specifications need to be properly interpreted within the SOW, with clear task correlations
5. Creation of a checklist showing the mandatory items
6. The project manager should determine the resources and the material to be used in the project.
7. Cost estimates
8. Establish schedules for submission of coordinated SOW components from each task member

WBS for objective control and evaluation

[also see: Herzner, 2013- pp 529-541]



Project Planning Overview

[also see: Herzner, 2013- pp 561-583]

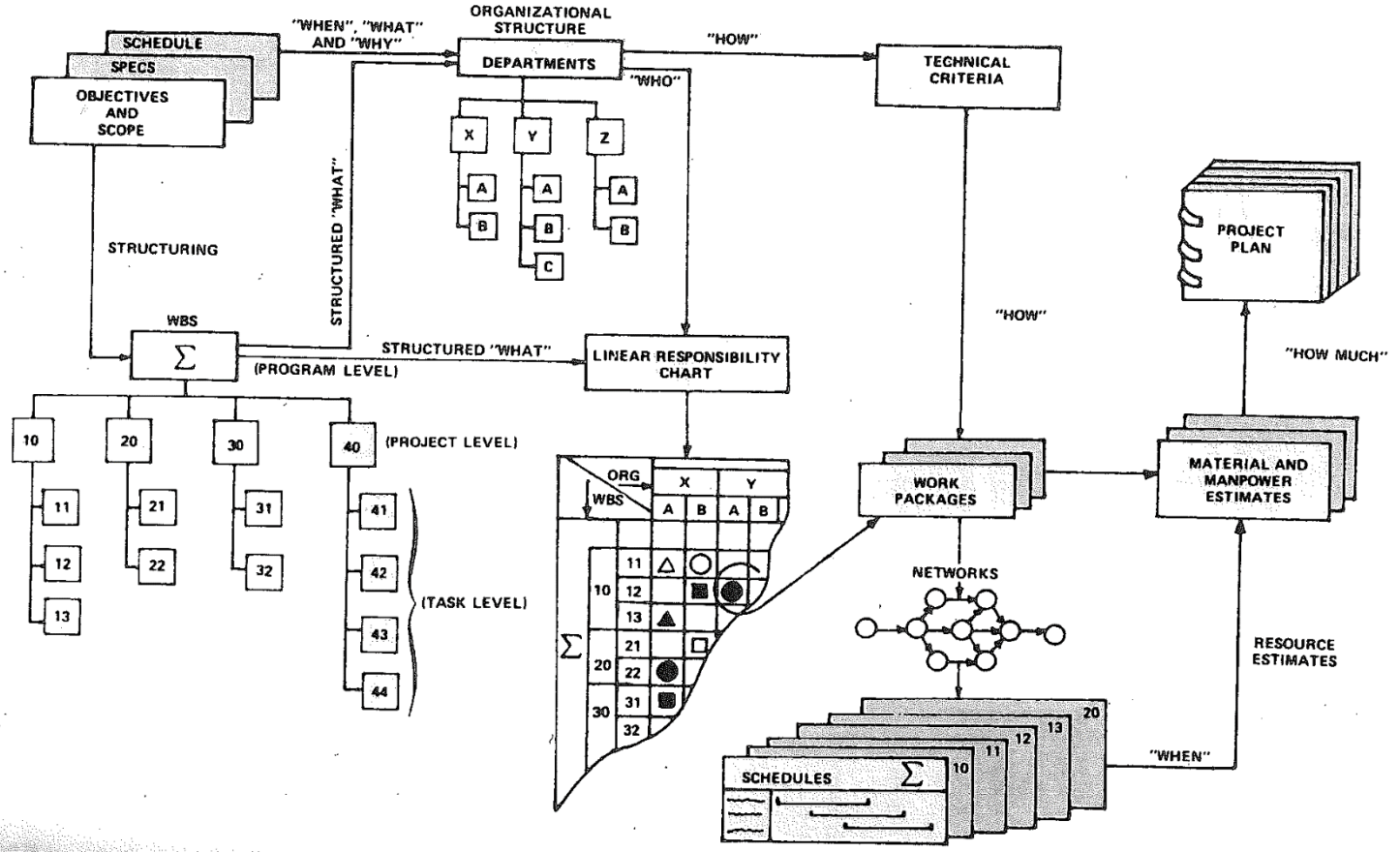
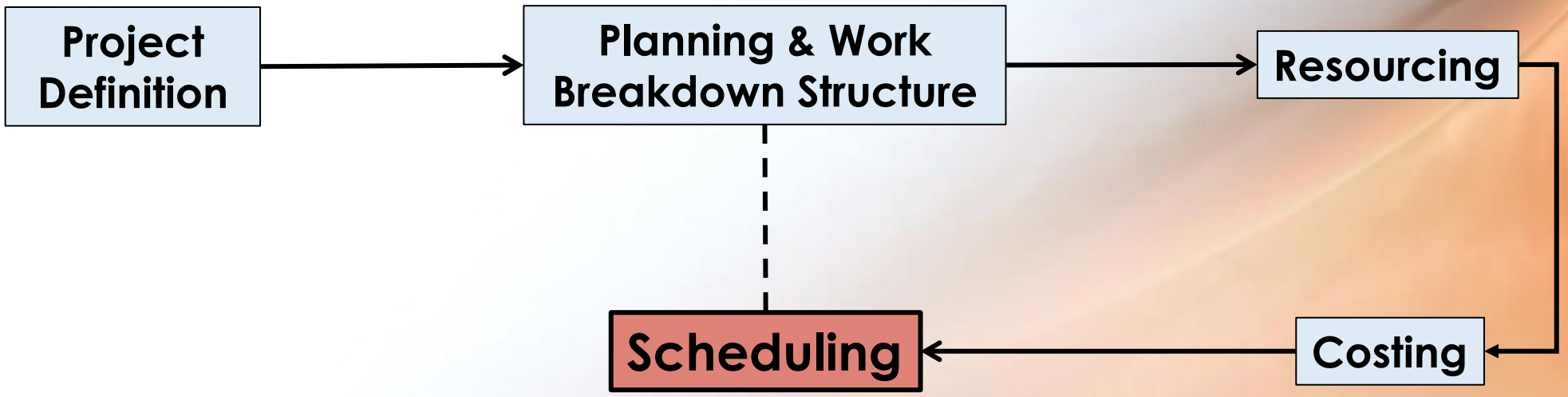


FIGURE 11–15. Project planning.

Planning Steps (Recall)



Project Scheduling

Scheduling technique allows better visualisation and control. Some of the most popular ones are:

- Gantt Charts (provide the sequence and precedence of tasks, milestones within a time scale)
- Milestone Charts
- Production Process Plan (Line Balance) – more relevant to manufacturing
- Decision Trees and Networks
- Programme Evaluation and Review Technique (PERT)
- Critical Path Method (also called Arrow Diagram Method)
- Precedence Diagram Method
- Graphical Evaluation and Review Technique

Advantages of Network Scheduling

- Helps the management to decide how to use resources within the time and cost targets
- Allows a visualisation of the project process
- Allows the evaluation of alternatives and reliability of plans and potential risks to the plans success
- Helps to obtain facts for decision making
- Provide an integrated platform for incorporating sequence of operations, precedence, resourcing, and time
- Helps to show interdependencies of activities
- Provides the basic structure for reporting
- Allows for "what if" scenario analysis
- Identify the critical path

Networks

The main usage of networks is to demonstrate the **interdependencies** of events and activities.

In general they can help project managers and their teams to visualise and assess:

1. The interdependencies of operations
2. Project completion time
3. Impact of lateness
4. Impact of early starts
5. "What if" scenarios
6. Cost of slippage
7. Performance

Some Concepts in Networks

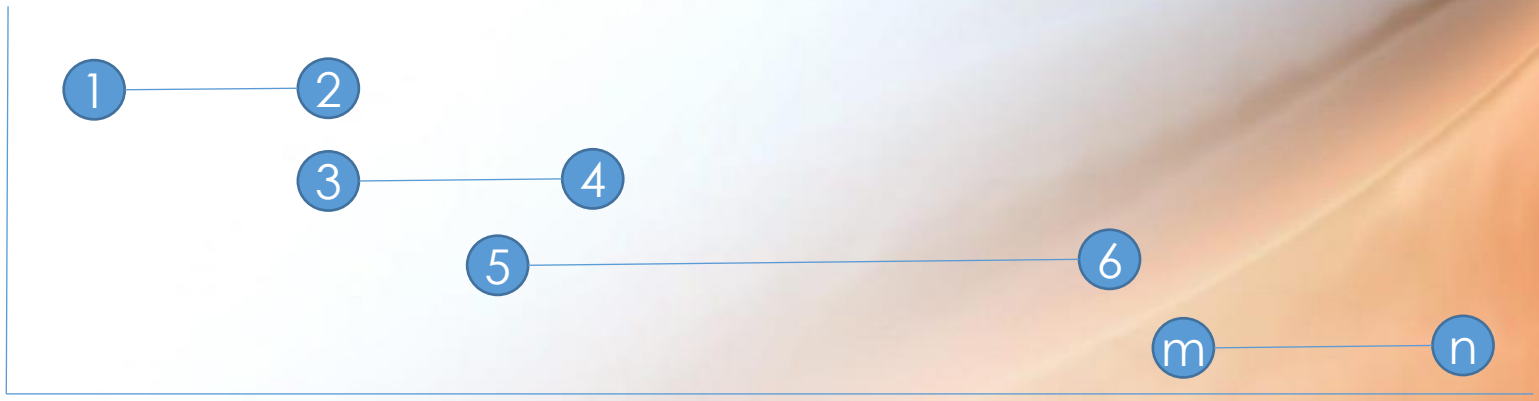
- **Events:** Start and end of an activity marks an event.
- **Activity:** An element of work that needs to be accomplished.
- **Duration:** The time required for an activity to complete.
- **Effort:** The amount of work require in a duration to complete an activity.
- **Critical Path:** The longest path through the network which determines the duration of the project.

Gantt Chart – Milestone Chart – PERT Chart

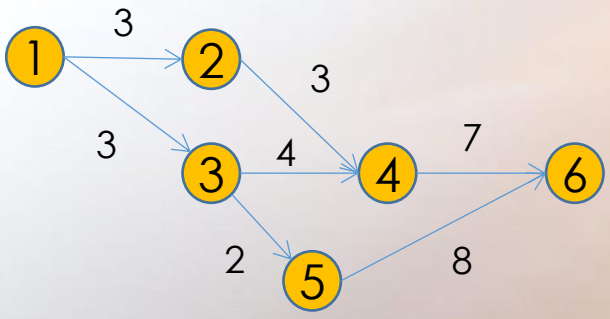
Gantt

Task	Time 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	1		2													
B			3			4										
C					5							6				
…													m			n

Milestone



PERT

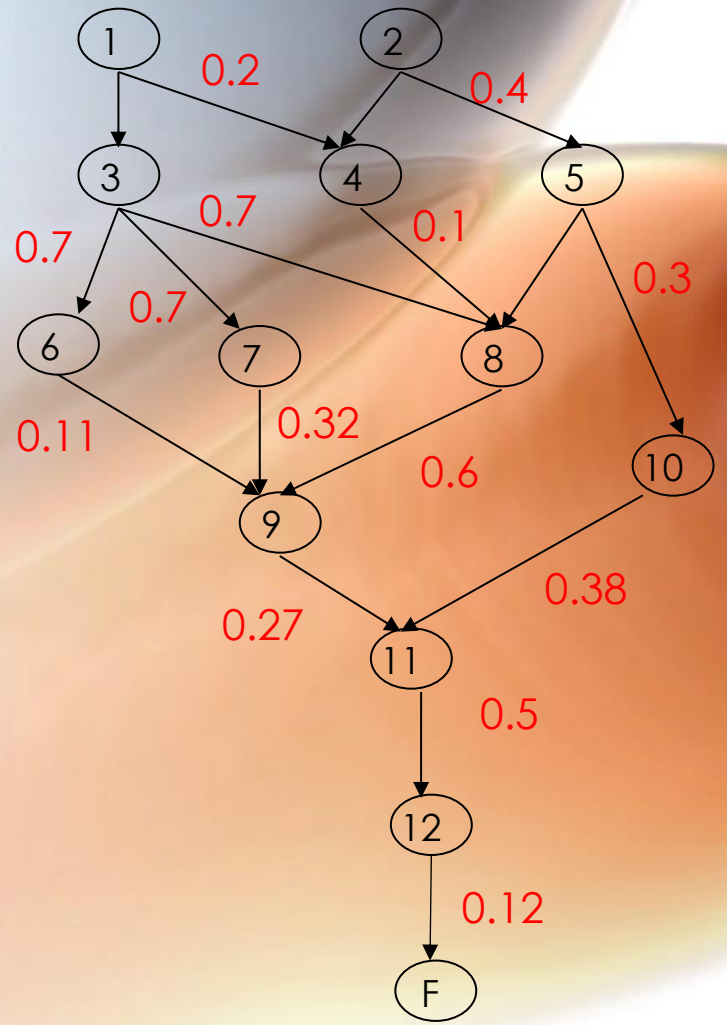


Sequence of Events Example

Table 1

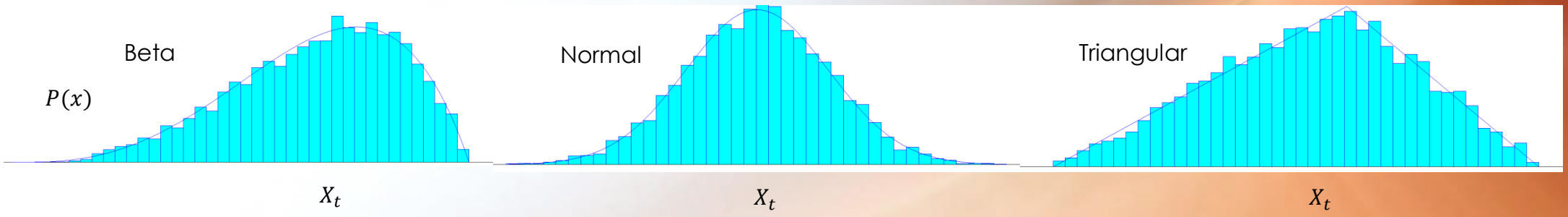
Task No.	Work element Time(min.)	Must be Proceeded
1	0.2	
2	0.4	
3	0.7	1
4	0.1	1,2
5	0.3	2
6	0.11	3
7	0.32	3
8	0.6	3,4
9	0.27	6,7,8
10	0.38	5,8
11	0.5	9,10
12	0.12	11

PERT Chart



PERT & CPM Charts

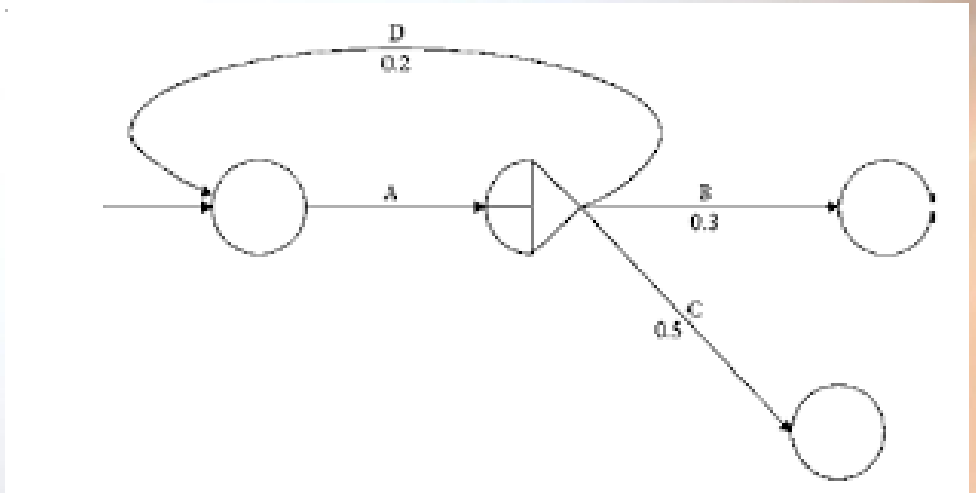
- Can provide three estimates: (optimistic, most likely and pessimistic)
- CPM uses the most likely time
- PERT charts are probabilistic in nature for each distribution they normally use the Beta distribution for activity time and Normal distribution for duration (Triangular is possible as well)



- PERT for projects that calculating time variations are high (e.g. R&D).
- CPM is mainly used for projects that percentage of completion is calculable.
- PERT does not really provide completed percentage. With CPM an accurate estimate of percentage of completion is possible (e.g. construction).

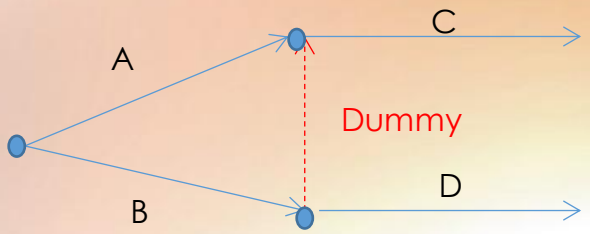
Graphical Evaluation and Review Technique (GERT)

- GERT unlike PERT allows for looping, branching and multiple project outcomes.
- Pert does not show what happens if an activity fails and if there are returns etc.



Dependencies

- **Mandatory Dependencies:** Are hard logic and cannot be changed, e.g. test and validate software functions, the code needs to be completed.
- **Discretionary Dependencies:** these dependencies are normally at the discretion of the project manager and can change pending the conditions faced throughout the project. For example, completing the purchase of all building material before work starts.
- **External Dependencies:** Are type of dependencies that are beyond the control of the project manager, such as 3rd party suppliers, that may affect the critical path.
- **Dummy Activities:** Part of dependencies network to demonstrate a logical flow but not necessarily a mandatory dependency



Slack Time

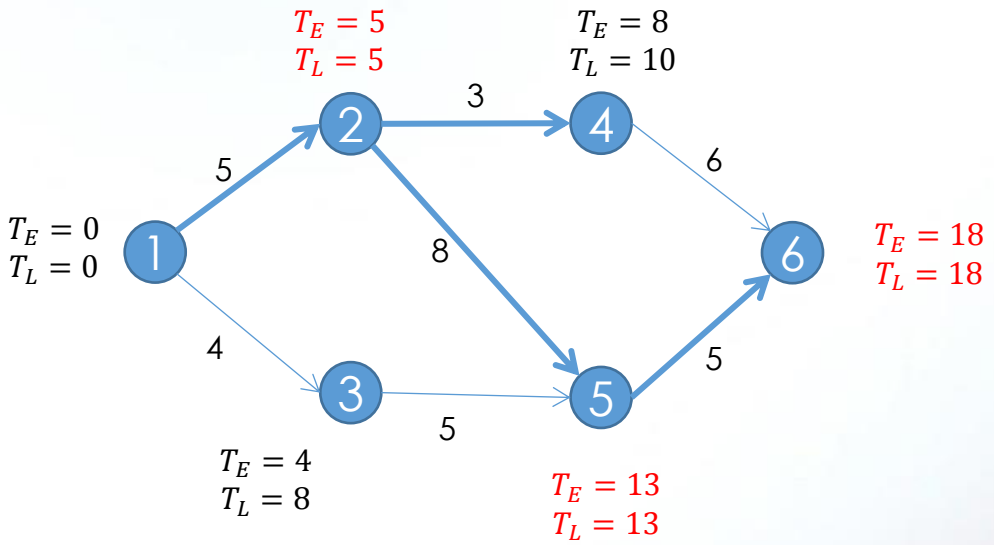
- There is only one path in the network which is the longest. Others are same length or shorter.
- This means that there are activities that can be completed before the time they are actually needed.
- The time difference between the scheduled completion date and the required date to meet the critical path is the ***Slack Time.***

$$Slack\ Time = T_L - T_E$$

T_E: *earliest time which an event is expected to take place*

T_L: *the latest date which an event can take place without extending the project end date.*

Slack Time Example



Event 1, needs to start at day 0.
CP: 1 → 2 → 5 → 6 = 18 time unit
Events 2, 5 and 6 no Slack
Event 3 and 4 on non-critical path therefore:

$$TL_3 = 5 + 8 - 5 = 8$$
$$TL_4 = 13 - 3 = 10$$

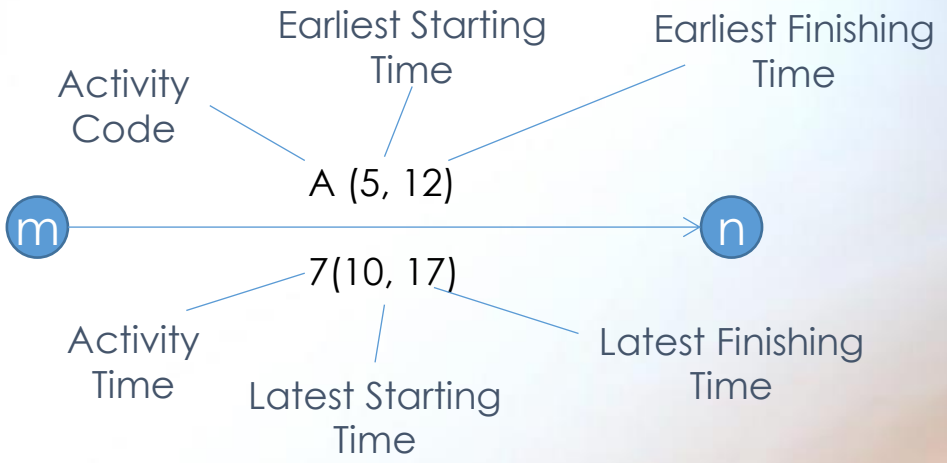
$$ST_3 = 8 - 4 = 4$$
$$ST_4 = 10 - 8 = 2$$

Knowing exactly where slacks are and using the properly can make the success of your project more likely.

PERT Control Table

Event Code	$Earliest\ Time$		$Latest\ Time$		Slack	Original Schedule	Probability of Achieving Schedule	
	$Exp.$	Var	$Exp.$	Var				
A B C …	Make a forward pass through the network (i.e. from right to left). The latest time of a successor activity is the latest of the earliest finish dates of the predecessor activity. The earliest finishing time is the total of the earliest finish starting time plus the activity duration.		Make backward pass through the network (right to left), calculating the *latest finish time*. The latest starting time can be calculated by subtracting the *activity time* from the *latest finishing time*. The latest finishing time for an activity entering a node is the earliest starting time of the activity exiting the node					

Slack time Identification, PERT Charts with Slack



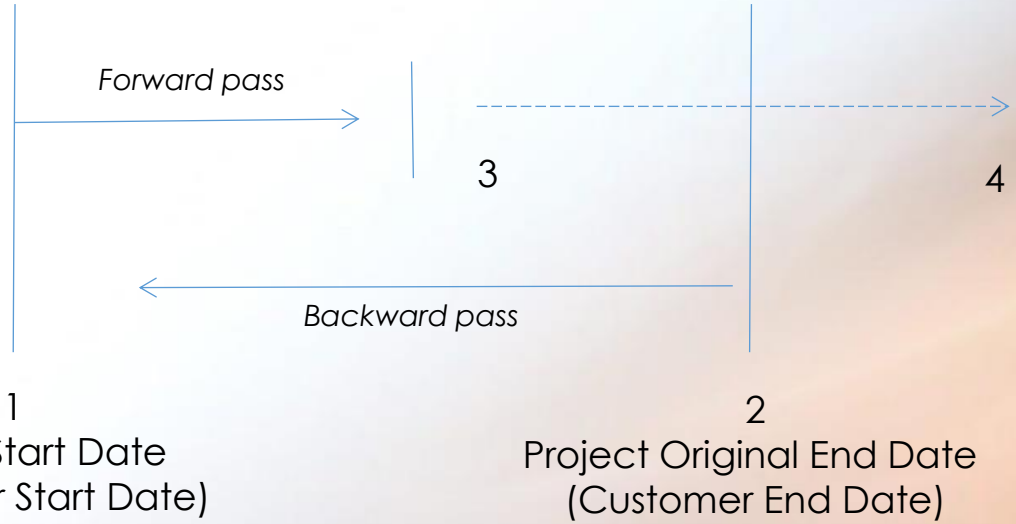
Negative Slack

Imagine this situation:

A (30, 36)

6(25, 31)

Slack Time= -5



Forward pass extends beyond customer end date

indicates that there is not enough time scheduled for the task and is usually caused by constraint dates or task dependencies.

Total PERT/CPM Planning

Six steps for preparing PERT:

1. Creating the full **list of activities.**
2. Placing the activities in **order of precedence** (interdependencies)
3. Ensuring that the project **work flow** (flow diagram) is **approved** by line managers (expert view).
4. **Conversion** of the project work flow in **to PERT** chart (including time durations).
5. Studying the **critical path** and ensuring the **capabilities and resourcing** are well-defined.
6. **Re-planning and adjustment** of activity plans based on availability of resources. Continuous monitoring and scheduling (capacity allocation) and the necessary adjustments to activity times.