Unit 10 – Scheduling and resourcing

Unit 10 - Learning Objectives

To gain an understanding of the following subjects:

- Project scheduling
- What a network diagram is
- What a Gantt chart is
- Use of a baseline
- What a cumulative s-curve is
- Project Resource Management
- What a resource histogram is

Creating and maintaining a schedule

A schedule is a timetable showing the forecast start and finish dates for activities or events within a project (APM BoK).

Scheduling is the process used to determine the overall project duration. This includes identification of activities and their logical dependencies, and estimating activity durations, taking into account requirements and availability of resources (APM BoK).

Schedule Presentation

Schedules may be presented in several ways and most software packages are capable of producing many different formats. The learners should be made aware that users often have preferences about how they like their information to be presented to them.

The most common way is to provide a bar chart (see below) which lists the relevant activities against a timescale. Another is to provide a simple activity listing which lists the activity descriptions, their durations, and their scheduled start and finish dates, and an indication of their criticality or what float is available.

The message is that users should be consulted about their preference and they should be

Milestone Schedules

These are used to record the key events throughout the duration of a project. Milestones (or “Events”) are often used as points of progress measurement, or as payment points – that is, a certain percentage payment may be related to the completion or passing of a milestone.

The way a milestone is defined is very important and you should be aware of the need to ensure that the project has full control over the content of a milestone.

For example, “Delivery of Compressor to Site” is a poorly defined milestone since the delivery is under the control of the supplier, and not the project team. A better definition would be “Final Factory Inspection and Release for Delivery” since the Project Team will carry out the inspection to ensure that the machine has been manufactured to the correct specification, and they will decide whether it can be released from the factory.

A typical Milestone Schedule is shown below.

MILESTONE SCHEDULE – *Example*

PROJECT – *Title*

W.B.S. Activity Code	ACTIVITY DESCRIPTION	Planned Date to Complete	Actual Date Completed	Responsible Authority	COMMENTS
1	Project Approval	Day 1		Project Management Team	
1.20.10	Mobilise Civil Contractor	Day 65		Construction Manager	
1.50	Commence Construction	Day 65		Construction Manager	
1.10	Design Completion	Day 75		Design Manager	
1.50.10	Building Access For Equipment	Day 130		Construction Manager	
1.40	Procurement Complete	Day 135		Equipment Manager	
1.50	Construction Complete	Day 185		Construction Manager	
1.60	Commissioning Complete	Day 205		Commissioning Manager	
1.60	Handover / Sign Off	Day 265		Project Manager	

Enter the Following

Actual Planning Dates: Day XX

Responsible Authority Resource

Client's Name

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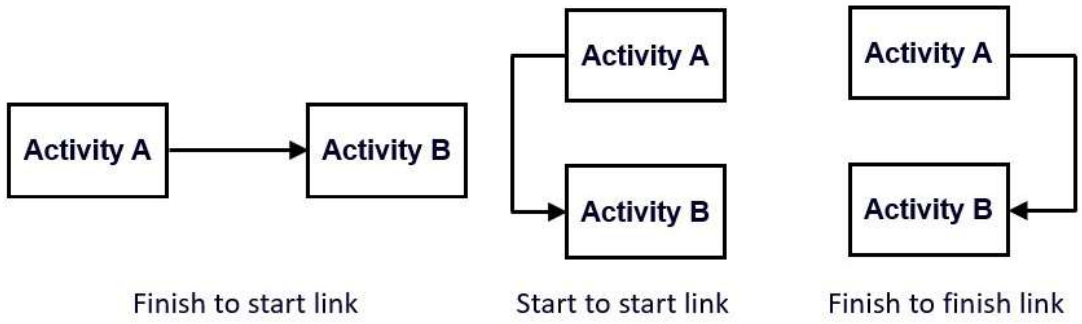
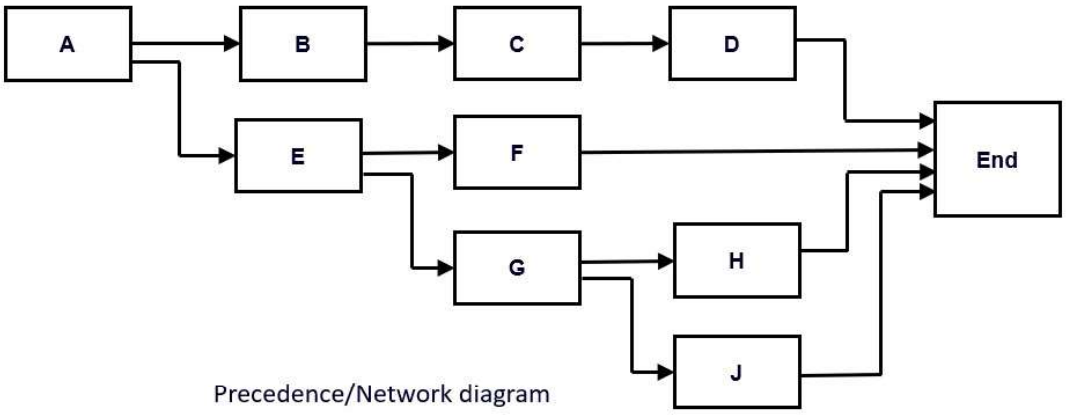
The scheduling process:

Step 1: Create precedence/network diagram

The process starts by taking the activities from the agreed scope (e.g. WBS) and establishes the logic between the activities. This will enable a precedence/network diagram to be created. The following diagram shows the types of links that are generally considered to be best practice:

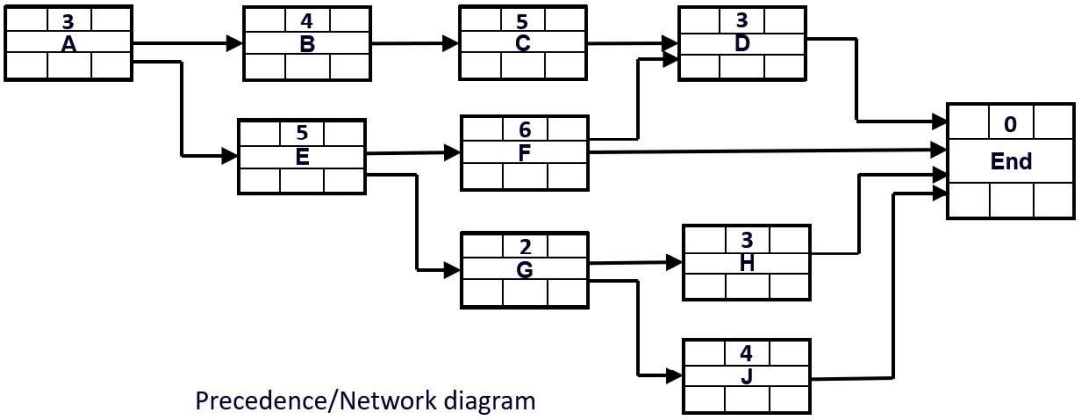




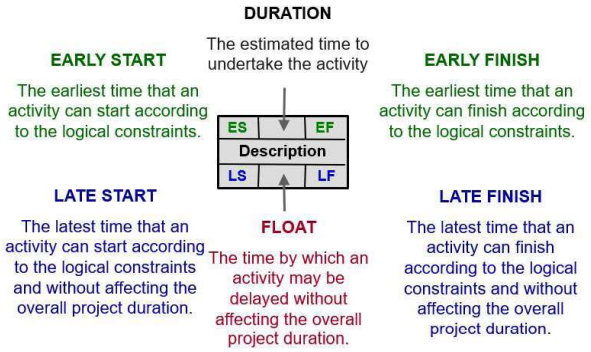
Precedence/Network diagram

Step 2: Estimate activity durations

Once the network diagram has been created, estimates of duration (based on the effort required) can be made for each activity. It is useful to use 3-point estimating for each activity i.e. best and worst cases and the most likely point in that range. It is important that the relevant experts are involved in the estimating process as well as a variety of views to both improve the accuracy of estimates and stakeholder confidence.



Precedence/Network diagram
with estimated durations added



Step 3: calculate overall duration, critical path and floats

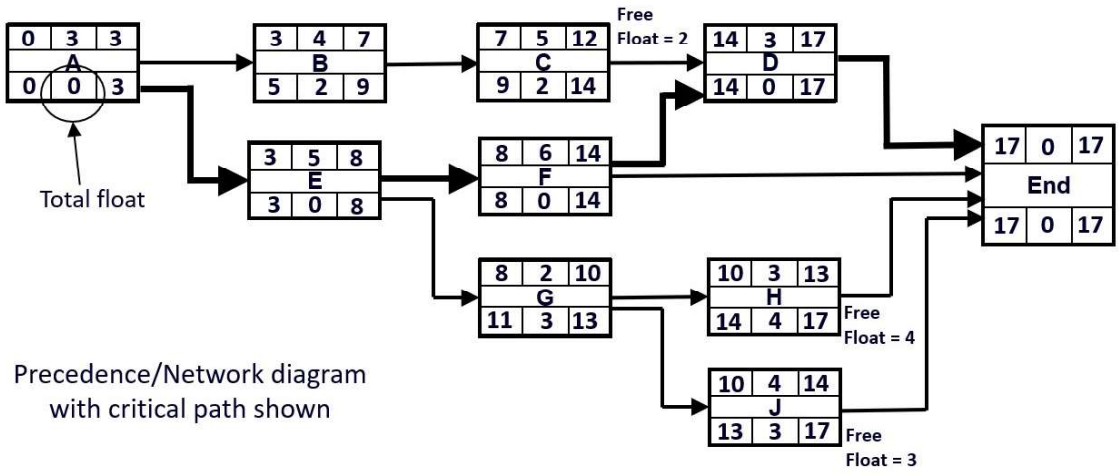
The overall duration of the schedule, total and free float and critical path can now be determined. This is normally performed through the use of dedicated planning software although is important for project professionals to understand how this is done so they can verify that plans are robust and built of defensible logic.

Critical path is a sequence of activities through a precedence network from start to finish, the sum of whose durations determines the overall duration (APM BoK).

Total float is the time by which an activity may be delayed or extended without affecting the overall duration or violating a target finish date (APM BoK).

Free float is the spare time at the end of an activity that can be used without delaying its successor activity (APM BoK).

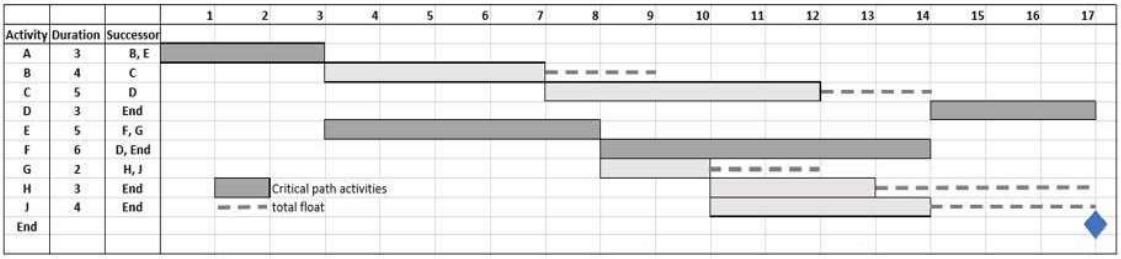
The critical path can now be determined by looking for the continual path which determines the end date. This is the path with zero total float as shown:



For presentation purposes, this diagram can be mapped onto a calendar of time and shown as a Gantt chart.

A Gantt chart is a graphical representation of activity against time (APM BoK).

It is one of the most common ways of presenting a schedule. An example for the previous network is shown below:



A Gantt chart (using the critical path method) is used to:

- Show the project activities, their start and finish times and the logical relationship between them. It shows the critical path and float (total and free) and can be used to develop a resource profile/histogram. It therefore becomes a powerful way of communicating the project timeline to the stakeholders.
- Document actual project progress against the schedule. The original schedule is baselined and the progress (i.e. percentage complete) is added on a regular basis. This will show the difference between the original schedule and the latest schedule status. This can be repeated as every update to show a progress 'narrative'. This will allow a forecast of remaining work to be produced and action to be taken.

Step 4: optimise and baseline

Once a schedule has been created considering the resources available, it needs to be reviewed by the relevant stakeholders, including those who have to complete the activities to ensure that it is realistic and deliverable. There may need to be several iterations before an optimal schedule is produced. Once agreement has been gained, the schedule must be baselined (e.g. v1-0) against which progress and change will be measured.

Step 5: maintain the schedule

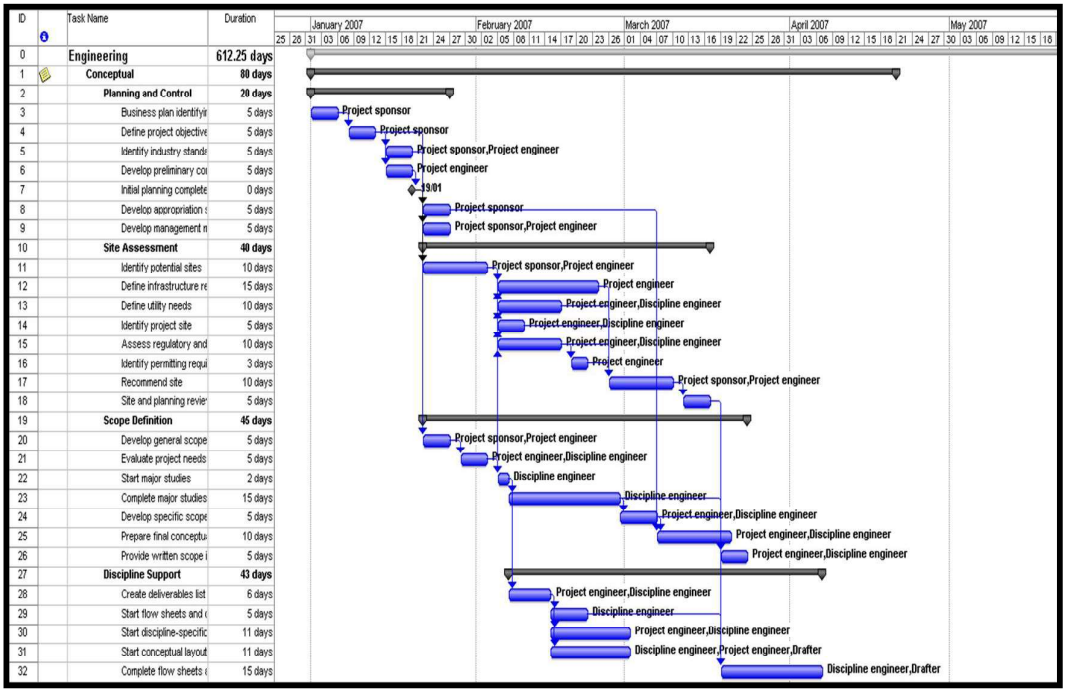
The schedule is a dynamic document that shows not only what was planned to be done, but also what has been done and a forecast of what has yet to be done.

Mechanisms must be in place to gather progress in an agreed and timely way so that the schedule can be updated. Finished tasks should be shown as 100% complete, incomplete tasks (or portions of tasks) should be moved to a date when it is envisaged, they will start.

The effect of delays on subsequent activities, the critical path, free and total float and the end date are essential to forward planning and recovery.

Major changes to the schedule may require re-baselining following agreement with the sponsor.

The following example shows a schedule produced using planning software.



Resource management

Resources are all the labour and non-labour items required to undertake the scope of work to the required quality (APM BoK).

Resources can be categorised into consumable and non-consumable and include:

- People
- Machinery
- Technology
- Property
- Materials
- Facilities
- Cost (covered in later part of this chapter)

Categorising resources makes it easier to understand what a resource is, where it can be obtained from and an input to scheduling and prioritising them.

Resource allocation is the process by which labour and non-labour resources are attributed to activities (APM BoK).

Projects, plans and schedules are almost always constrained by limited resources and therefore, a key part of project management is resource acquisition, allocation and management.

The policies and procedures to be used for acquiring goods and services will be set out in the resource management plan. Mobilising the project involves getting all the resources in place that are needed for the project to begin.

Considerations when allocating and categorising resources in a linear lifecycle.

The characteristics of the different categories of resource should be understood when sourcing and allocating them to project activities.

The considerations for doing this include:

- Time factor in obtaining resources. In order for them to be available when needed, lead times need to be understood and built into schedules and plans. For example, human resources may need to be recruited, inducted and trained in the skills needed, material will need to be procured from suppliers and money obtained from fund holders. All of this will take time and needs to be factored into the project plans. and how they are allocated to meet the requirements of the project following a linear life cycle.
- The amount of resources needed. Using the schedule of work and estimates of effort, resource profiles for each type of resource can be produced to show the levels of resources needed at any point in time. Resources can then be obtained through liaison with line managers and suppliers via contracts. Where resources do not match the planned profile, available float can be used, scope adjusted, or timescales extended.
- Cost of resource. Managing the budget and controlling the cost depends on efficient and effective use of resource. Ensuring that the right quality of resource is important. For example, buying material that is of higher quality or employing people who are overqualified will increase costs. Also, key to this is ensuring the resources are not available before the work is scheduled (e.g. expensive hired plant sitting around when not required) or not returned when no longer needed (e.g. contractors on site after the work is complete).
- Ensuring the right category of people are allocated to the right job. This can be achieved through the use of a RACI chart (responsibility assignment matrix). This helps visualise the activity to person relationship and provides clarity of roles and responsibilities.

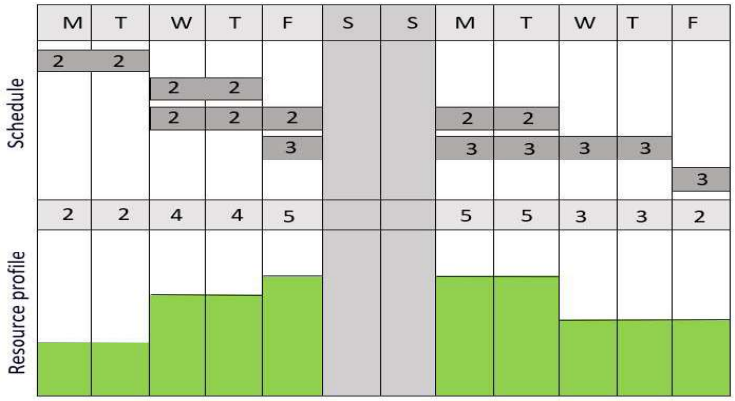
Resource scheduling

Resource scheduling involves the following steps:

- *Allocation* – this involves estimating the amount of effort for each task and the resources required to undertake it. A responsibility matrix can be used.
- *Application* – this involves applying the resources to the schedule and summarising them using a resource histogram to show the amount required for any time period and by resource type or role if necessary.
- *Scheduling* – this involves reviewing resource profiles (histograms) and resolving resource conflicts by either resource smoothing or resource levelling depending whether there is a constraint on time or resource availability.

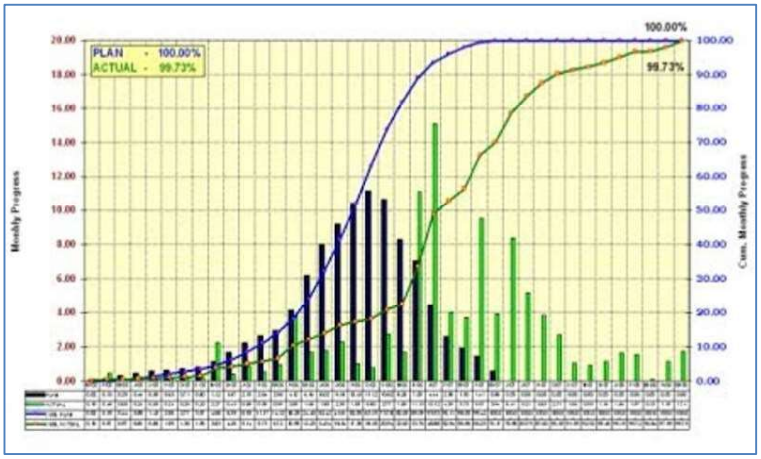
Examples of a resource histogram:

			Day										
Task	**RES**	**WBS**	1	2	3	4	5	6	7	8	9	10	11
Activity A	2 x A	1.1.1											
Activity B	1x A	1.1.2											
Activity C	2 x B	1.1.3											
Activity D	2 x B	1.2.1											
Activity E	3 x B	1.2.2.											
Activity F	1 x A	1.3.1											
Activity G	1 x A	1.3.2											
Activity H	1 x A	1.3.3											
Total Resource A per Day			2	1	1	1	1	0	0	1	1	1	1
Total Resource B per Day			0	2	3	3	0	2	2	1	1	1	1
Resource Histogram for Resource A		2											
		1											
Resource Histogram for Resource B													
		3											
		2											
		1											



When the resource usage as shown in the histogram, is drawn cumulatively, the result is a curve (S-curve) that shows the planned deployment of the resources over time. This can be used as a basis for monitoring actual resources usage against those planned (see earned value management).

Example of an S-curve:



Resource smoothing and resource levelling

There are two basic options available to optimise schedules:

- Resource levelling (resource limited scheduling)
- Resource smoothing (time limited scheduling)

Resource levelling is an approach used during resource optimisation that delays activities such that resource usage is kept below specified limits. Also known as Resource limited scheduling (APM BoK).

The question that this method seeks to answer is: 'given the amount of resource we have available, when will the project finish?'

Resource smoothing is an approach used as part of resource optimisation that involves utilising float or increasing or decreasing the resources required for specific activities, such that any peaks and troughs of resource usage are smoothed out avoiding extension of the duration where possible. Also known as Time limited resource scheduling (APM BoK).

The question that this method seeks to answer is: 'given the fixed deadline we have to meet, how much resource do we need?'

Summary of smoothing and levelling

Smoothing	Levelling
Used when time is more important than cost and where scope and quality are not negotiable. This involves adding resources such as more people, the same people working longer hours or more equipment to meet fixed deadlines.	Used when there are fixed resources available to determine when the work will be finished. This is where cost is more important than time. Where the planned resource profile (using the resource histogram) exceeds the actual resources available, planned completion dates will need to be delayed and the overall duration increased.
Aims to achieve a smooth usage of resources, avoiding peaks and troughs of resource demand. To achieve this, it may be possible to re-order tasks where the logic of interdependencies is not fixed. Examples of this include using available float, splitting tasks and performing tasks in parallel. This may overload resources.	Ensures that resources are used within their capacity (e.g. amount available) and does not overload them in trying to meet unachievable deadlines or increase risk in a project by splitting tasks or trying to complete them in parallel. It ensures that the correct resources are allocated to tasks that are relevant to their knowledge area.
Delays some work to 'smooth' the resource profile. This removes some flexibility from the schedule and its ability to deal with unavoidable delays. The advantage is usually a more efficient and cost effect use of resources.	Retains the flexibility of the schedule and its ability to deal with unavoidable delays. The advantage is that staff have 'breathing space' between tasks before starting the next one. This will improve the probability of achieving the right levels of quality safely. Staff will have time to deal with problems.
It should be noted that there is a finite limit to the resources that can be applied to some tasks due to things such as physical space (e.g. plumbers in a kitchen). If the resource is finite and the hours available limited, then the only option may be to extend duration.	

Learning Objectives

You should now have an understanding of the following:

- Project scheduling
- What a network diagram is
- What a Gantt chart is
- Use of a baseline
- What a cumulative s-curve is
- Project Resource Management
- What a resource histogram is