Managing the Project Schedule

Project Skills

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MANAGING THE PROJECT SCHEDULE

PROJECT SKILLS

Managing the Project Schedule: Project Skills
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PREFACE

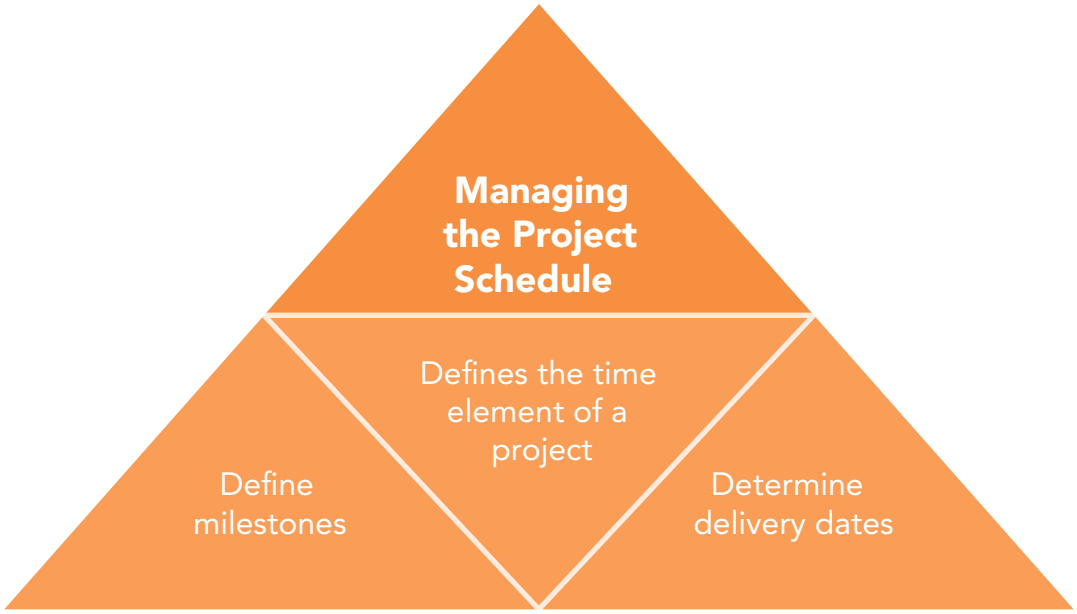
This free eBook describes the process of managing the project schedule. Most project management software programs will help you with managing the time line of the project schedule but they are no substitute for being able to identify activities, sequence them and estimate the time and resources required to complete them.

You will learn:

- The six steps required to manage a project schedule.
- How to draw a network diagram.
- The principle of rolling wave planning.
- How to estimate the resources and duration of your project.
- The principles of float and resource levelling.

INTRODUCTION

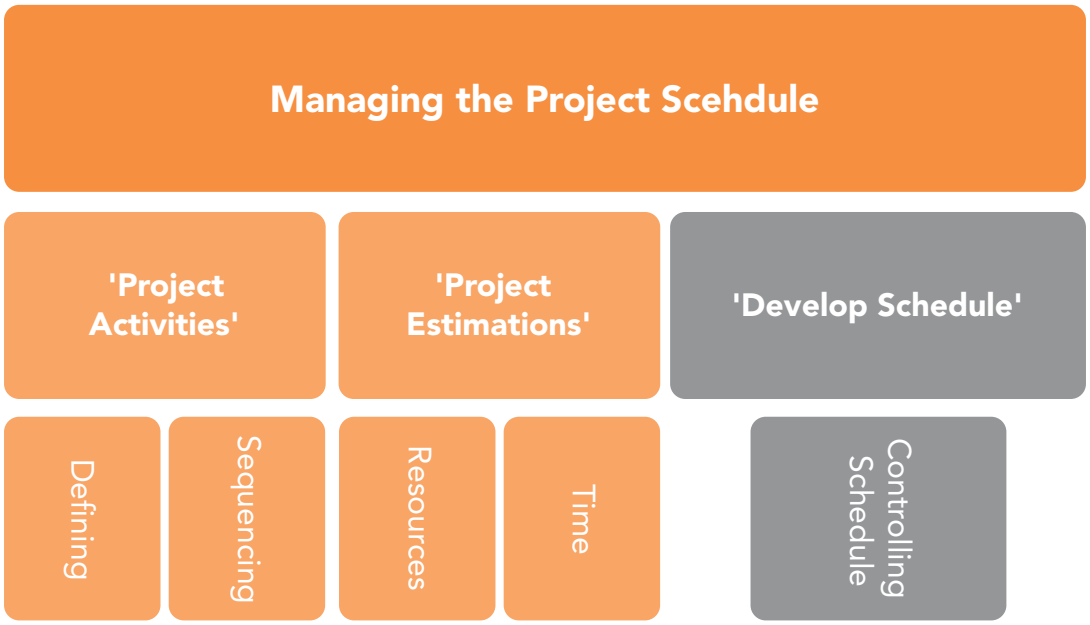
Costs are not the only things that need to be estimated and managed during a project – time is just as important, if not more so. When getting started on a project, it is crucial to set an accurate time line for the upcoming work so that progress can be made and goals can be met successfully. When too much time is allocated for a project, things might not get done as quickly as they could have otherwise. If not enough time is permitted, the team may get frustrated by constantly falling behind and the work could suffer.



The ability to accurately forecast the project schedule is something that is developed with experience and through trial and error. It should be rather obvious why schedule management is so important when it comes to running any kind of project within your organization. If you don't manage time successfully, resources or opportunities are sure to be wasted. The more time that employees are spending on a specific project, the more expensive that project becomes. When a one-month project ends up taking two, the costs in some areas of the budget are likely to be doubled – potentially turning a successful endeavor into a failure.

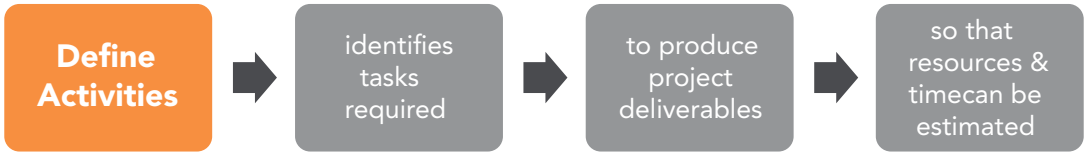
It isn't good enough in most cases to just get a project finished. Rather, it needs to be finished and kept on time and on budget in order to be deemed a success.

While each individual project will undergo a slightly different scheduling process depending on the specific elements involved, there are generally two facets that a project manager will go through with respect to time.



Planning the Work

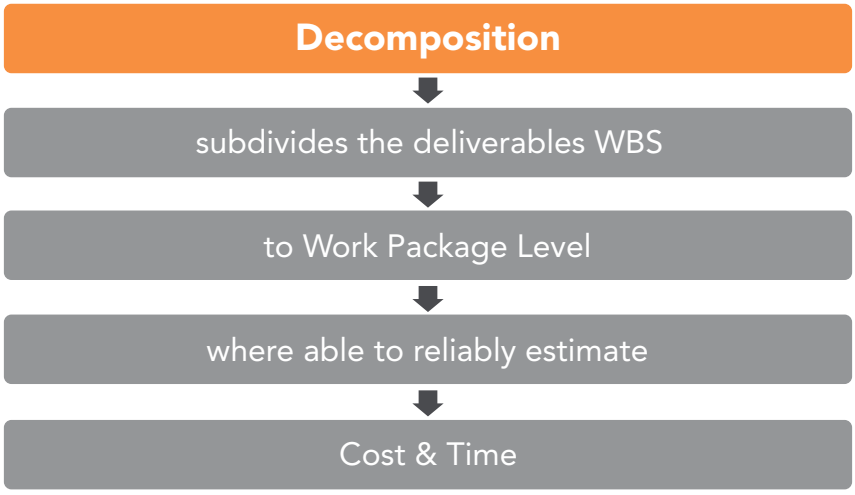
These are the activities that occur before the project even gets started. The manager and other members of the team will work together to break the overall project down into smaller segments and allocate a certain period of time for each. At this point, it is also important that the various steps of the project are organized in a sequence that will be most time-effective for everyone on the team. For example, if one department can't get started on their portion of the project until another department is finished, this sequencing will need to be taken into account.



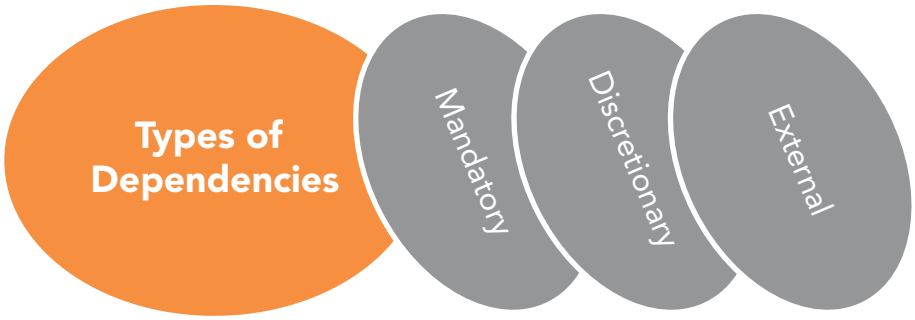
One of the vital elements that needs to be considered during the planning process is experience with the various tasks that will be conducted. This is why it is so helpful to involve team members who may have worked on similar types of projects previously.

As a project manager, you might not have the relevant experience with some of the specific tasks that is needed to accurately allot time for them to be finished. By working with a

member of your team who is an expert in that particular task, they should be able to tell you what a reasonable amount of time is for the work that will be done.



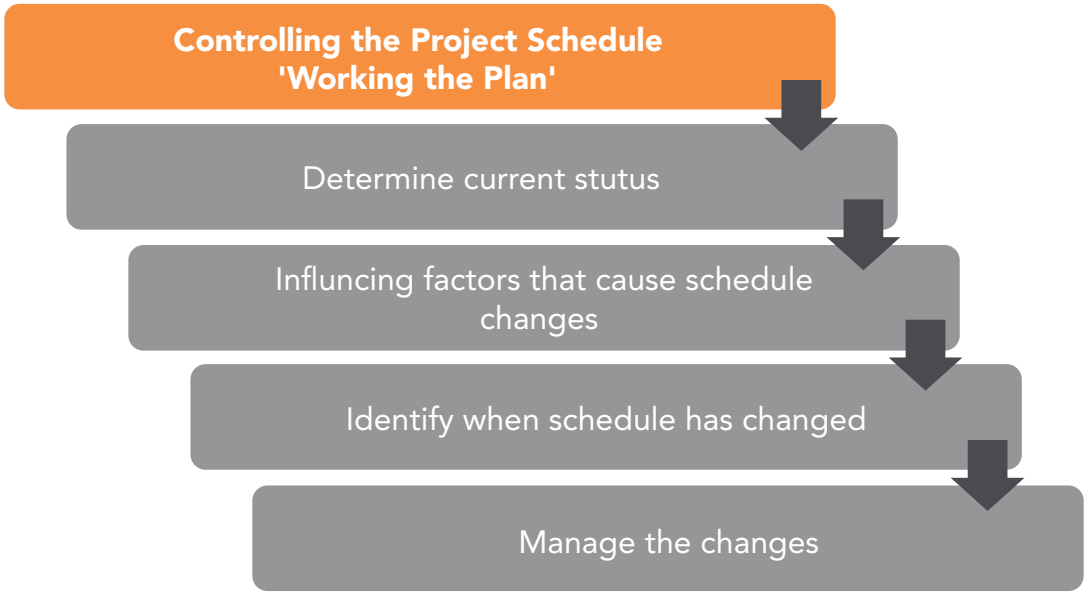
Bringing in experience is a valuable benefit that should be taken advantage of whenever possible. A significant part of this work involves the process of decomposition and taking the work packages down to its lowest level in the work breakdown structure (WBS). Having identified each work package theses must then be put into a sequential order to develop the project schedule and to discern the type of dependencies that exist between them.



Then the amount of resources required and time needed to perform each activity must be estimated and developed into a final project schedule. Now having planned how the project will be performed in terms of its activities as project manager you need to ensure that it runs according to the time plan that has been agreed.

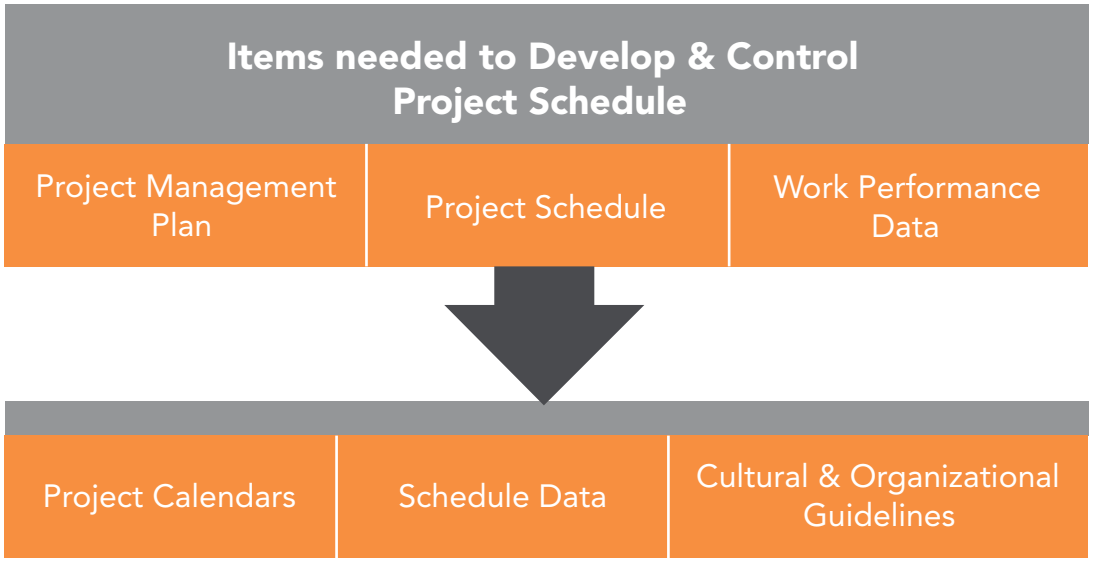
Controlling the Work

Once the project gets underway, the scheduling portion of the job is still very much in play. Now that the timeline has been planned, it needs to be carefully monitored along the way to ensure that it is accurate and reasonable. If certain tasks are taking longer or less time than expected, for example, those changes should quickly be made to the overall timeline.



It is generally inevitable that there will be adjustments to your schedule along the way, but those adjustments will be easier to deal with if they are made early on the process. Accurate reporting is another crucial piece of the time puzzle. Having specific checkpoints along the way that are pre-determined will make it easier for you to track the progress of the project as a whole – and the progress of individual team members within the project.

There are certain key documents that are shown in the diagram below that are needed as inputs to controlling the project schedule.



Without accurate and reliable reporting, it will be basically impossible to follow along with the progress of the project and make amendments to the schedule as needed. A good project manager will be consistent about tracking progress and will require the same of all the team members involved.

Closing the Process

As mentioned earlier, experience is a big part of being able to accurately time a project from start to finish. So, when a given project is finishing up, that is a great time to review what has taken place – and how long it has taken. While it might be too late to adjust the timeline for the current project, this information can be incredibly valuable for future work.

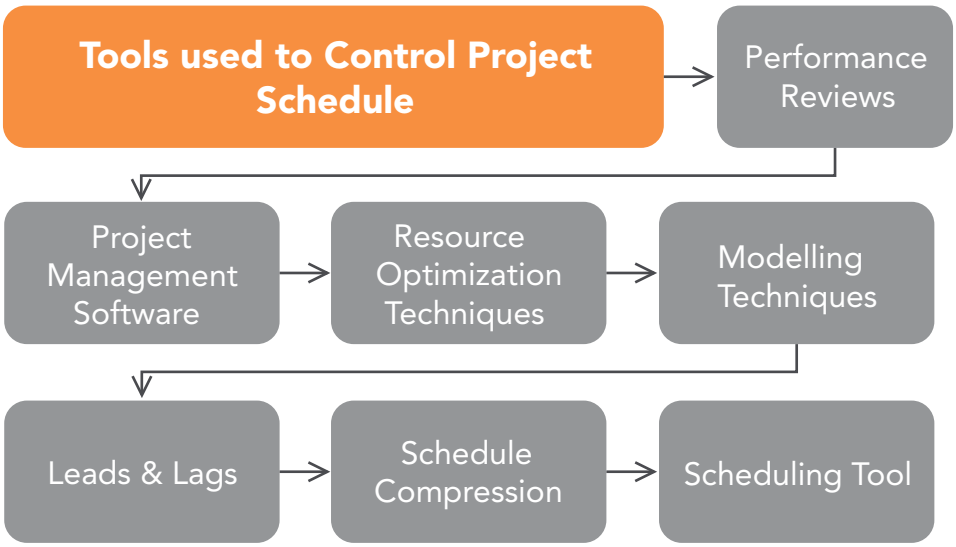
- Which parts of the job took longer than was planned?
- Which parts went fast?
- What kind of steps could be taken in future projects to streamline the process and lower the overall time needed to reach completion?

There are many questions that can be asked during the closing process, and much valuable information to be gained.

Discipline is required when the project is nearing a close because it is tempting to just be done with the project and move on to the next. The is especially true when you have been working on the same project for months or even years – you may be tired of dealing with

it and hoping to work on something new. However, having the discipline to go through the closing process and analyze your time management successes and failures will help make you a better project manager down the line.

Projects are all about time. Getting them done on time means they are more likely to stay on budget, and they are more likely to meet the needs of those above you. There are several modeling techniques that you can use to assess different scenarios and the element of risk attached to each one. These schedule scenarios are then compared to the schedule baseline and the project management plan for alignment and the one with the 'best fit' will be selected.

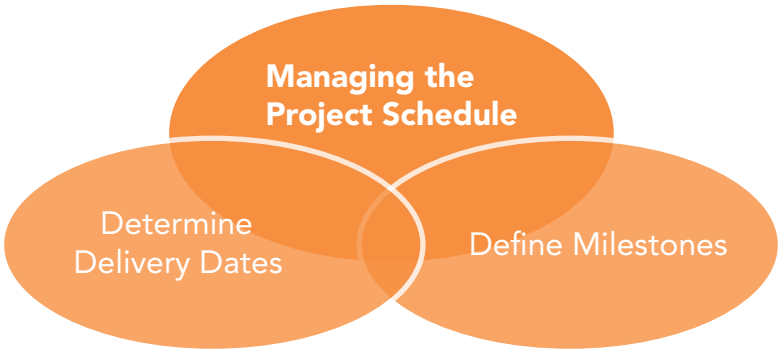


Good time planning is a skill that can be developed with experience, but even a new project manager can have some success simply by asking the right questions and relying on the right people. Going into a project with an open-ended deadline is just asking for trouble, and is a sure way to waste resources as well. Learn how to stay on time and you will be a big step closer to leading productive projects.

1 MANAGING THE PROJECT SCHEDULE

Managing the project schedule includes all of the steps required to ensure the timely completion of the project. It involves determining the delivery dates and milestones whilst taking all of the known constraints into account.

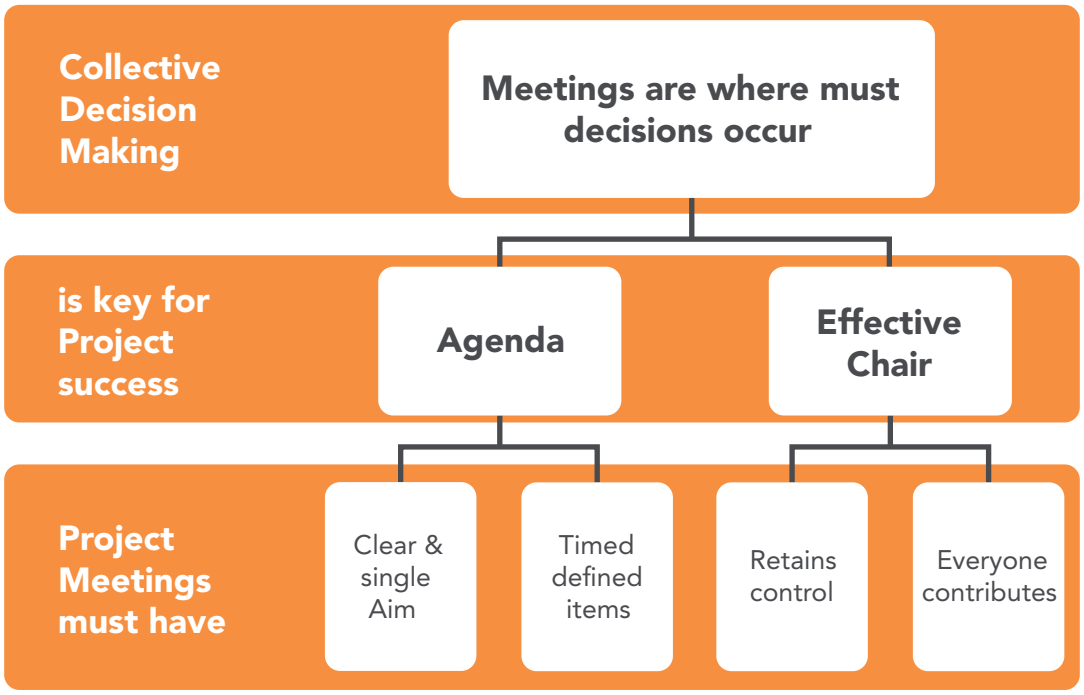
Generally speaking the level of detail needed is proportional to the level of risk and uncertainty associated with the activity. For this reason schedule planning should be carried out with the input of the project team that is going to actually do the work.



This ensures that the sequencing and activity duration estimates are as realistic as possible as just as importantly, that the team feel as though have some ownership of them rather than seeing them as something that has been imposed on them.

Managing the schedule is sometimes seen as the core discipline of project management and some software tools focus almost exclusively on this aspect. It is a logical way of taking the project plan and creating a sequence and schedule for producing the project deliverables.

It is required through all phases of the project lifecycle and is normally derived at a high level during the initiation process in order to provide a framework in which the project plan can evolve as the project iterates between planning, execution and monitoring.



Collective decision-making is very important area of project management that can make or break this part of the project. Almost all of the project processes that form part of project schedule management will involve meetings between the project manager, the team and other stakeholders in order to make decisions about the activity definitions and associated estimates. How well these meetings are conducted will have a major impact on how smoothly the project runs.

These meetings need to have a clear agenda and a chairman who can keep them running on schedule. If you do not take steps to make this happen then these meetings can easily become bogged down and fail to produce the required outputs when they are needed.

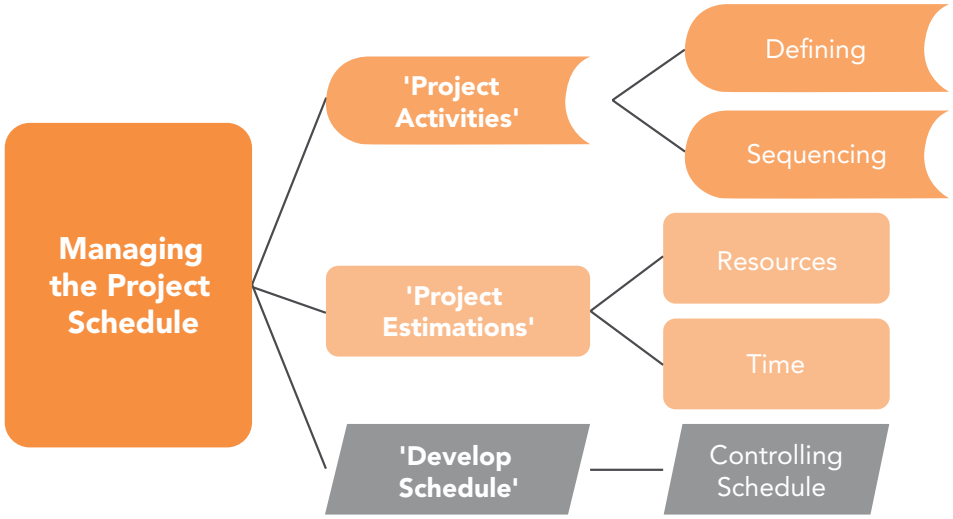
When estimating work it is inevitable that there will be disagreements about the time required and the resources needed. People will have different opinions of how much effort is involved to complete an activity based on similar work they have undertaken in the past. This type of disagreement is to be expected and only becomes a problem when discussions are allowed to drag on beyond the point when a 'reasonable' estimate could be made.

For example, early on in this process it really does not matter if an estimate for an activity duration is 5 days or 8 days. This is something that will become clear once the work starts.

A good chairman working to a properly timed agenda can ensure that 'good enough' decisions are made in a timely manner and that project team members are not left idle because the planning process is overrunning.

If you feel as though your project meetings could be improved then you can download the 'Meeting Skills' eBooks from this website. These free eBooks cover all aspects of meetings including how to set an agenda that will ensure that the meeting achieves it's aims and how to chair a meeting so that it is as productive as possible.

Managing the project schedule involves planning the work and working the plan as follows:



Defining the Activities – the high-level requirements are broken down into high-level tasks or deliverables. These are then broken down into activities and presented in the form of WBS (Work Breakdown Structure).

Sequencing the Activities – the activities identified in the previous step should be sequenced based on the order in which they need to be done depending on their interdependencies.

Estimating the Resources Required – the estimation of the amount and the types of resources required for activities is done in this step. The project management team will need a clear understanding of resource availability and capability.

Estimating the Time Required – this is a key step in the project planning process and there are a number of tools that can also be utilized to help you to estimate the required activity resources. Most of the organizations follow either Work Breakdown Structure (WBS) based estimating or Function Points based estimates in this step. Once the activity estimates are completed, the critical path of the project should be identified in order to determine the total project duration. This is one of the key inputs for the project schedule management.

Developing the Schedule – in order to create an accurate schedule, several parameters from the previous steps are required including: the activity sequence, duration of each activity, and the resource requirements. Software packages, like as Microsoft Project, can help you to develop a project schedule including planning diagrams that can help to present the relevant information in a way that makes it easy to understand.

Controlling the Schedule is sometimes referred to as 'working the plan' in contrast with the earlier processes which are all to do with 'planning the work'. No project can be executed without changes to the original plans and schedules and this process will run throughout the project.

On some projects, especially those of smaller scope, defining activities, sequencing activities, estimating activity resources, estimating activity durations, and developing the schedule are so tightly linked that they are viewed as a single process that can be performed by a person over a relatively short period of time.

All of the activities detailed above must be preceded by a planning effort by the project management team. This planning effort produces a schedule plan that selects a scheduling methodology, a scheduling tool, and sets the format and establishes criteria for developing and controlling the project schedule.

A scheduling methodology defines the rules and approaches for the scheduling process. Some of the better-known methodologies include critical path method (CPM) and critical chain.

The finalized and approved schedule is the baseline that will be used to developing and control the schedule. As the project activities are being performed, the majority of effort will occur in this process to ensure completion of project work in a timely manner.

Key Points

- Managing the project schedule involves determining the delivery dates and milestones whilst taking all of the known constraints into account.
- It is sometimes seen as the core discipline of project management and some software tools focus almost exclusively on this aspect.
- It is required through all phases of the project lifecycle and is normally derived at a high level during the initiation process in order to provide a framework in which the project plan can evolve as the project iterates between planning, execution and monitoring.
- High-level requirements are first broken down into high-level tasks or deliverables, which are than decomposed into activities and presented in the form of a work breakdown structure.
- The activities identified should be sequenced based on the order in which they need to be done depending on their interdependencies.
- Estimates are then made of the resources required allowing for resource availability and capability. This allows estimates to be made of the time required.
- In order to create an accurate schedule, several parameters from the previous steps are required including: the activity sequence, duration of each activity, and the resource requirements.
- Software packages, like as Microsoft Project, can help you to develop a project schedule including planning diagrams that can help to present the relevant information in a way that makes it easy to understand.
- Controlling the schedule is sometimes referred to as 'working the plan' in contrast with the earlier processes which are all to do with 'planning the work'. No project can be executed without changes to the original plans and schedules and this process will run throughout the project.

2 DEFINING THE PROJECT ACTIVITIES

The purpose of this process is to identify the specific tasks needed to be done in order to produce the project's deliverables. This needs to be done in sufficient detail to estimate what resources and time will be required to complete them. The main inputs are the scope baseline consisting of the approved project scope statement, the work breakdown structure, and the WBS dictionary.

This process uses decomposition to take the work packages identified in the WBS, which are nouns, and to identify the activities (which are verbs) required in order to complete them. It is essentially the bridge between the planning involved in scope management, and the planning involved in time or schedule management.

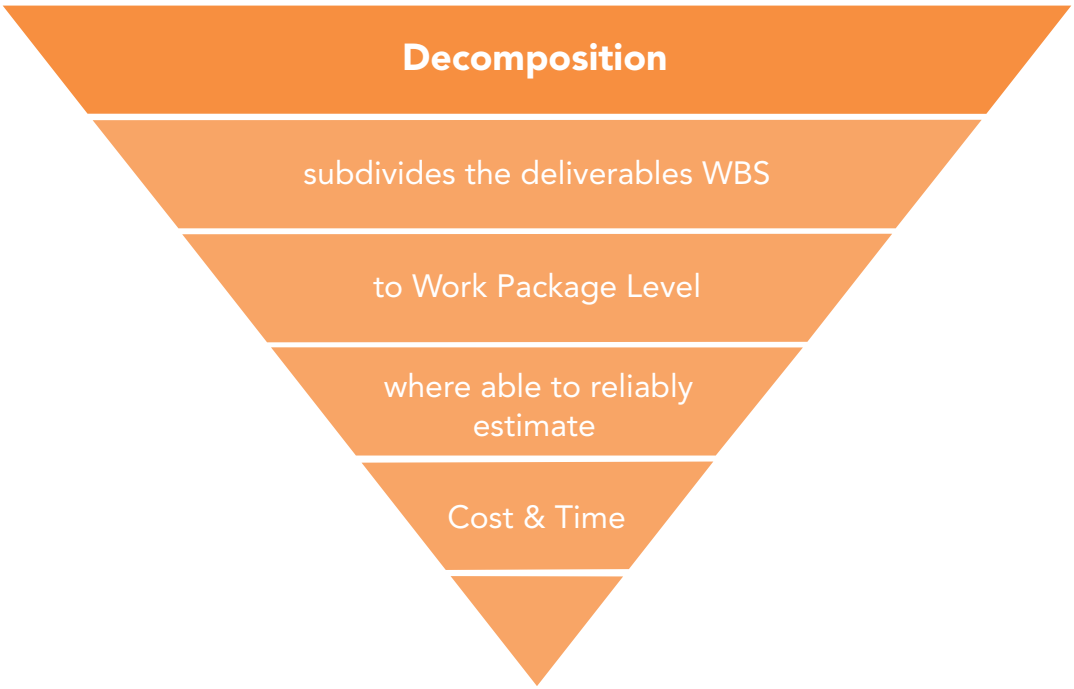
The scope baseline is a component of the project plan. It is made up of:

- The *scope statement*, which includes the products scope description of the project deliverables and defines the product user acceptance criteria.
- The *work breakdown structure* (*WBS*), which defines each deliverable and the decomposition of the deliverable into work packages.
- The *WBS dictionary*, which contains a detailed description of work and technical documentation for each WBS element.

The scope baseline is used as a starting point to breakdown the documented deliverables, as well as a guide to assure that the entire scope of the project is covered, but that the activities do not extend beyond the agreed boundaries.

It is described in the eBook 'Managing the Project Scope' which can be downloaded free from this website and comprises three things – the work breakdown structure, WBS dictionary and the project scope statement. There are three interrelated techniques that can be used in this process.

In order to produce the activity list it is necessary to examine each work package and break it down into individual work schedule activities. As the name suggests the activity list, is a list of all the activities that must be performed within the project and each one should be linked back to just one work package (although each work package may have several activities within it).

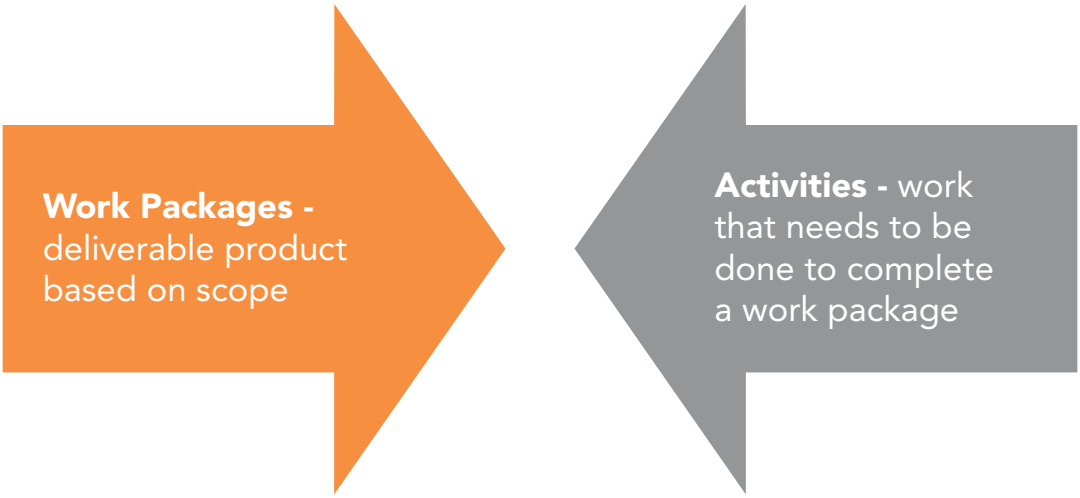


The work package is the lowest level of the WBS is achieved when the work can be accurately estimated (both cost and duration) and can be managed by one individual. The key word here is 'managed', although the work package can be managed by one person, the actual work within the work package may be completed by several people.

For example, One individual could manage work package 'Select and Appoint Contractor'. However, the work package could be decomposed into the following activities each of which could be undertaken by a different person:

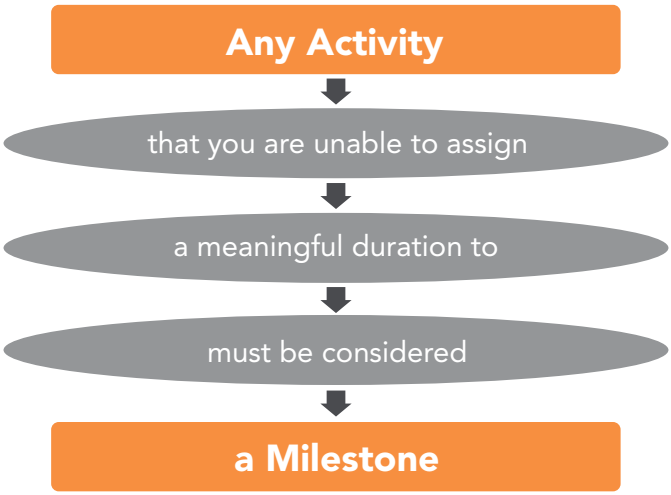
1. Specify Task Requirements.
2. Identify Potential Contractors.
3. Send Invitation to Tender.
4. Review Tenders.
5. Interview Contractors.
6. Choose Contractor.
7. Check References.
8. Agree Contract Terms.
9. Appoint Contractor.

Each activity must be complete and accurate, because it will be used to develop the project schedule. An activity is typically described using a noun and verbs such as 'Specify Task Requirements'.



As you can see, when the work packages are decomposed into activities in this way the result is to create an activity list, which can then be used to develop the project schedule. Remember that work packages are product or deliverable based to deliver the scope of the project, whereas activities' focus on the work that needs to be carried out in order to execute such work packages.

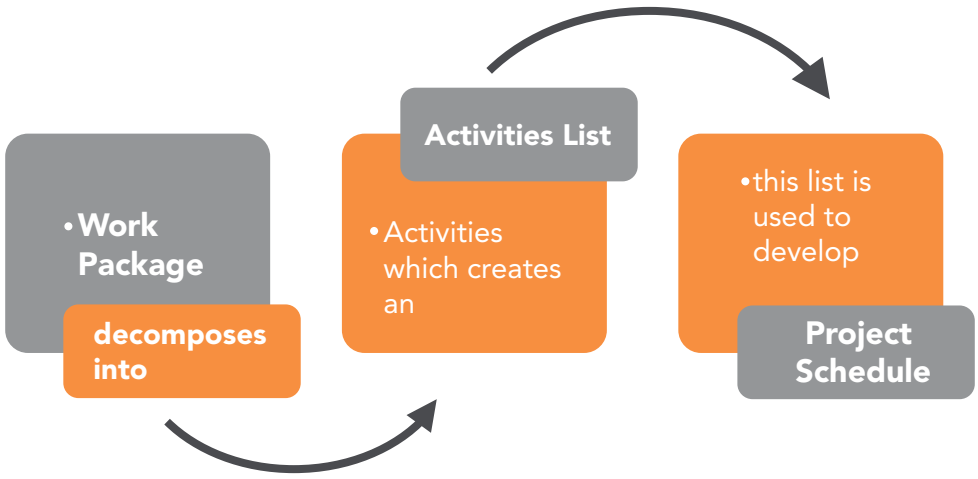
An activity has an expected duration and consumes resources in terms of manpower and/or budget. If duration cannot be meaningfully assigned to it then it should be considered a milestone.



In the example above steps 3 and 9 would be considered a milestone rather than an activity:

'Step 3 – Send Invitations to Tender' and
'Step 9 – Appoint Contractor'

The technique of decomposition, as applied to defining activities, involves subdividing the project work packages into smaller, more manageable components called activities. Activities represent the effort needed to complete a work package.



The activity list, work breakdown structure, and WBS dictionary can be developed either sequentially or concurrently, with the WBS and WBS dictionary as the basis for development of the final activity list. Each work package within the WBS is decomposed into the activities required to produce the work package deliverables. Involving team members in the decomposition can lead to better and more accurate results.

This decomposition will usually be carried out as part of a planning workshop involving as much expertise as necessary to ensure that the activities are accurately identified and it should be of sufficient detail to create a realistic and feasible schedule. This list would also have extra information about each activity such as constraints, assumptions, logical relationships, etc.

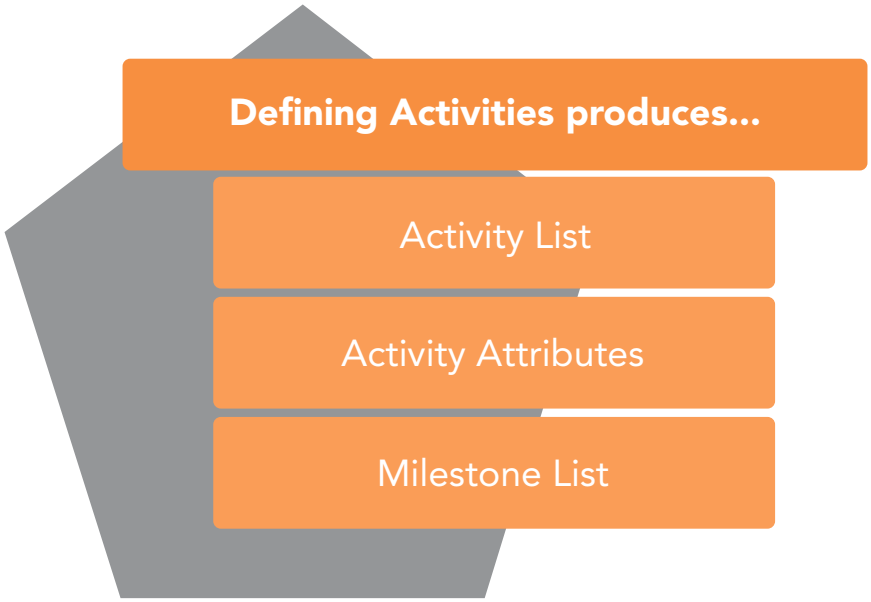
As well as decomposing the WBS work packages, there is another technique that can help with defining the activities. Rolling wave planning (RWP) is the process of project planning in waves as the project proceeds and later details become clearer. It involves progressive elaboration and is based on the fact that activities required in the immediate future will be known in greater detail than those further into the future. This means that WBS components will exist in different level of detail in the structure.

Progressive elaboration means that the work packages are refined in greater detail over time. RWP is particularly useful in projects of high uncertainty like software development or R&D projects, where the project goal is known, but the final deliverable may change somewhat as the project progresses.

Attempting to create detailed task-oriented plans for project teams in these types of environments is likely to lead to plans that are abandoned soon after being published and a great deal of project management time spent endlessly re-planning rather than actually managing the project.

Rolling wave planning is more often used within IT type projects but less so within the construction industry where lack of detail in initial plans may cause huge expense later. Unfortunately many IT projects undertake the bulk of their planning too early in the lifecycle, when little concrete data is known about the problem domain, business environment, or how the team will work together.

The activity list is a comprehensive list including all schedule activities required by the project. The activity list includes the activity identifier and a scope of work description for each activity in sufficient detail to ensure the project team members understand what work is required to be completed.



Activity attributes extend the description of the activity by identifying the components associated with each one. The components for each activity evolve over time. Activity attributes can be used to identify the person responsible for executing the work, where the work will be performed and the activity type. They are used for schedule development and for selecting, ordering and sorting the planned scheduled activities in various ways within reports.

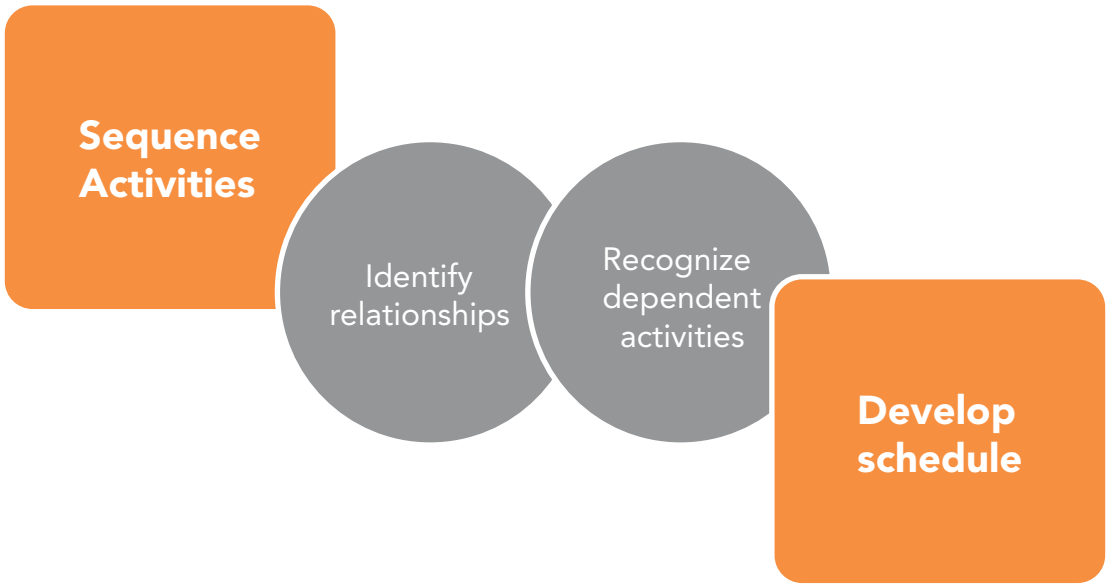
A milestone is a significant point or event in the project. A milestone list identifies all milestones and indicates whether it is mandatory such as those required by contract or optional.

Key Points

- Defining the project activities involves identifying the specific tasks needed to be done in order to produce the project's deliverables.
- This process uses decomposition to take the work packages identified in the work breakdown structure, which are nouns, and to identify the activities (which are verbs) required in order to complete them.
- This represents the bridge between the planning involved in scope management, and the planning involved in time or schedule management.
- A work package is the lowest level of the work breakdown structure, and is achieved when the work can be accurately estimated (both cost and duration) and can be managed by one individual.
- Although the work package can be managed by one person, the actual work within the work package may be completed by several people.
- An activity has an expected duration and consumes resources in terms of manpower and/or budget. If duration cannot be meaningfully assigned to it then it should be considered a milestone.
- Decomposition involves subdividing the project work packages into smaller, more manageable components called activities, which represent the effort needed to complete a work package.
- Rolling wave planning is the process of project planning in waves as the project proceeds and later details become clearer.

3 SEQUENCING THE PROJECT ACTIVITIES

Once the activities have been identified the next stage is to sequence them according to their dependencies. In other words, any relationships between activities need to be identified so that dependent activities can be scheduled to follow those that they are dependent upon.



It is important to classify any dependencies properly because they indicate the sequence in which activities must occur. There are four types of dependency relationships.

*A **finish-to-start** relationship exists if one activity must finish before another activity starts.*

*A **start-to-start** relationship exists if one activity cannot start until another activity starts.*

*A **finish-to-finish** relationship exists if the one activity cannot finish until another activity finishes.*

*A **start-to-finish** relationship exists if one activity must start before another can finish.*

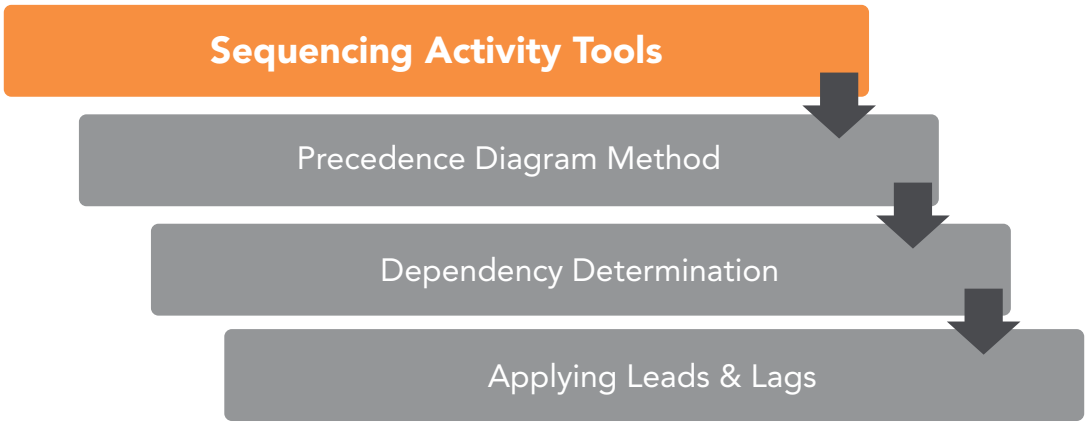
Dependencies may be external or internal. For example, an organization may subcontract the production of some deliverable from a supplier organization and the delivery of this

would represent an external dependency, one that involves some relationship outside of the project and its control.

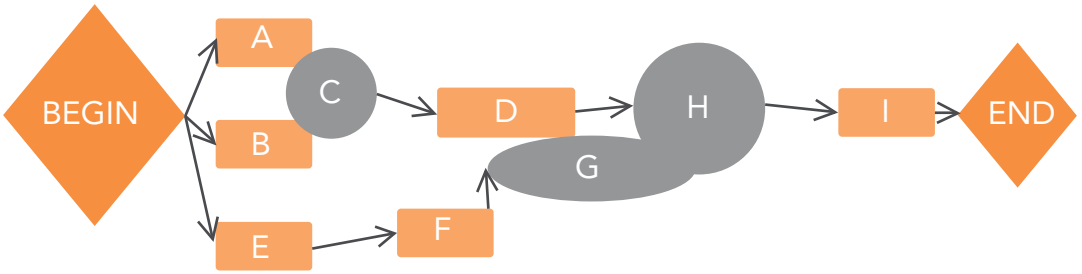
Some dependencies may exist within the project. For example, an engineer may only be able to contribute half of his time to a project, although his skills could potentially be used full time. You can check out the complete range of project management eBooks free from this website.

The principal output from this process is a network diagram showing the sequence of activities and their relationships. Always bear in mind that the purpose of this process is simply to find and illustrate dependencies, there are assumed to be no resource constraints.

The diagram below shows the three interrelated techniques that can be used to sequence activities.



The precedence diagram is a graphical tool for scheduling activities in a project plan. It uses boxes or rectangles, referred to as nodes to represent activities and connects them with arrows to show the logical relationships that exist between them. This technique is also called Activity On Node (AON) and is the method used by most software project management packages.



In this example,

- 'Begin' and 'End' are both milestones.
- Activities A and B are not dependent on each other.
- Activity C is dependent on both A and B (shown as a circle).

Many of the project planning software packages available use this method, which simply plots the tasks to be completed and connects them with arrows that show the dependencies. Note that each activity has an input arrow and an output arrow.

The only two elements that do not are the 'Begin' and 'End' milestones (which are not really activities). If an activity within a diagram has only one arrow then this is represents an error and needs to be corrected.

Three types of dependencies are used to define the sequence among the activities:

1) Mandatory.
2) Discretionary.
3) External.

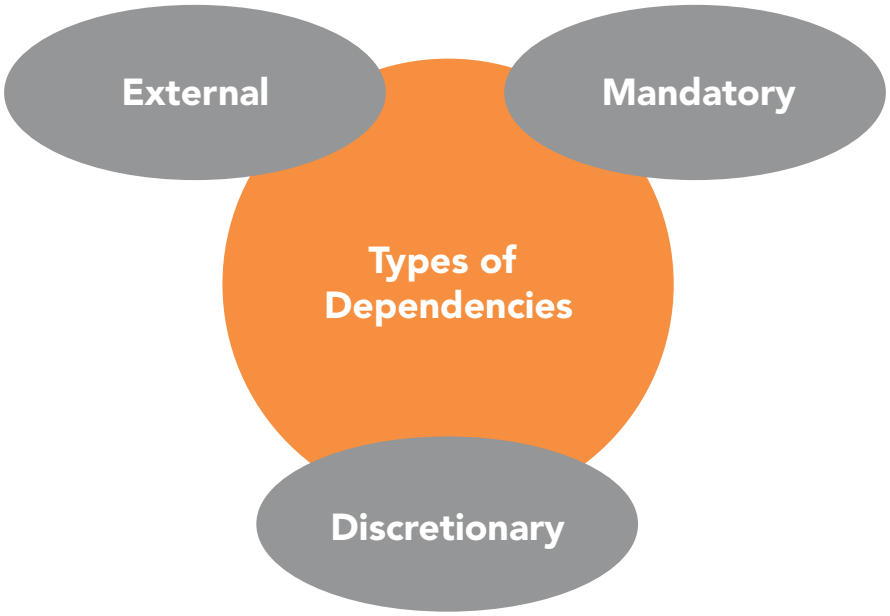
The table below shows the dependency and gives an explanation for this.

Category	Dependency	Explanation
Mandatory vs. Discretionary	Mandatory (hard logic)	Involves physical limitations Contractual or legal obligations.
	Discretionary (soft logic)	Based on knowledge of best practices.
External vs. Internal	External	*Outside of project team's control.* Based on relationship of project activities and activities outside project.
	Internal	*Within project team's control.* Based on relationship between project activities.

Mandatory dependencies are inherent in the work or process e.g. when constructing a new building, building the walls is dependent on laying the foundations. The project team determines which dependencies are mandatory to reach during the process of sequencing the activities. They are also sometimes referred to as hard logic.

Discretionary dependencies are those defined by the project manager and their team. They should be defined based on best practice or previous experience within the particular area. Discretionary dependencies are sometimes referred to as preferred logic and based on knowledge of best practices within a particular application area or some unusual aspect of the project where a specific sequence is desired even though there may be other acceptable sequences.

Discretionary dependencies should be fully documented since they can create arbitrary total float values and can limit later share dealing options.



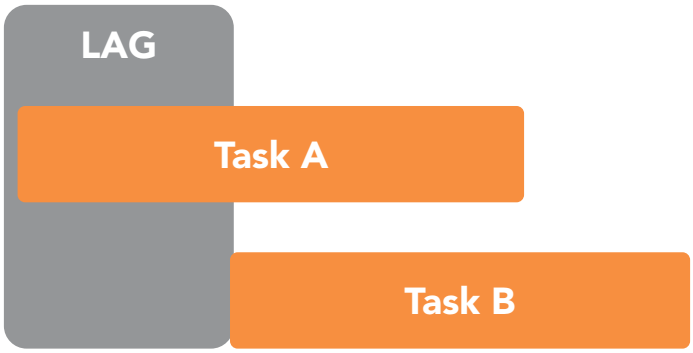
External dependencies involve a relationship between project activities and non-project activities. These dependencies are usually outside the project teams control. For example the testing activity in a software project can be dependent on the delivery of hardware from an external source.

Once the dependencies are agreed they can be mapped into a precedence diagram (on PC, on paper, or using post-it notes). When drawing the precedence diagram the project team needs to decide which tasks:

- Can only be completed after another task.
- Can be done at the same time.
- Don't depend on other tasks at all (e.g. project review meetings).

It can be useful to work backwards when compiling the precedence diagram and ask yourself what do we need to have done immediately before this task?

You will then need to apply leads and lags. A lag directs a delay in the successor activity. For example, an IT project requires two different but similar user interfaces to be designed, interfaces A and B. Each task is scheduled to take 5 days. There is no reason why these tasks cannot be started at the same time, but it makes sense to design A first and obtain user agreement before starting work on interface B which can then be largely based on A.



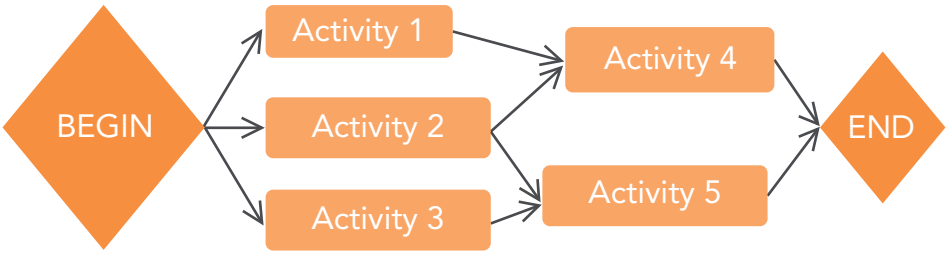
Therefore, the time between the start dates of the two tasks can be defined as a lag (The project manager has specified two days in this case). It is important to note that task B does not need to be completed before task A can begin but because some of the lessons learned in the design stage of task A can be directly applied to task B it will reduce the overall amount of work required if this lag is specified.

Lead refers to a relationship whereby the successor activity begins before the predecessor activity has completed. Lead is only found activities with finish-to-start relationships: A must finish before B can start. In order to leverage a lead, which will compress the total combined duration of both activities, the dependency must be discretionary, meaning that there is no physical limitation on completing A before B begins.

Standardized schedule network diagram templates can be used to expedite the preparation of networks of project activities. They can include an entire project or only a portion of it. Portions of a project schedule network diagram are often referred to as a sub-network or a fragment network.

Sub-network templates are especially useful when a project includes several identical or nearly identical deliverables, such as floors on a high-rise office building, clinical trials on a pharmaceutical research project, coding program modules on a software project, or the start-up phase of a development project.

These give rise to project schedule network diagrams, which are schematic displays of the project's schedule activities and the logical relationships among them, also referred to as dependencies.



A project schedule network diagram can be produced manually or by using project management software. It can include full project details, or have one or more summary activities. A summary narrative can accompany the diagram and describe the basic approach used to sequence the activities. Any unusual activity sequences within the network should be fully described within the narrative.

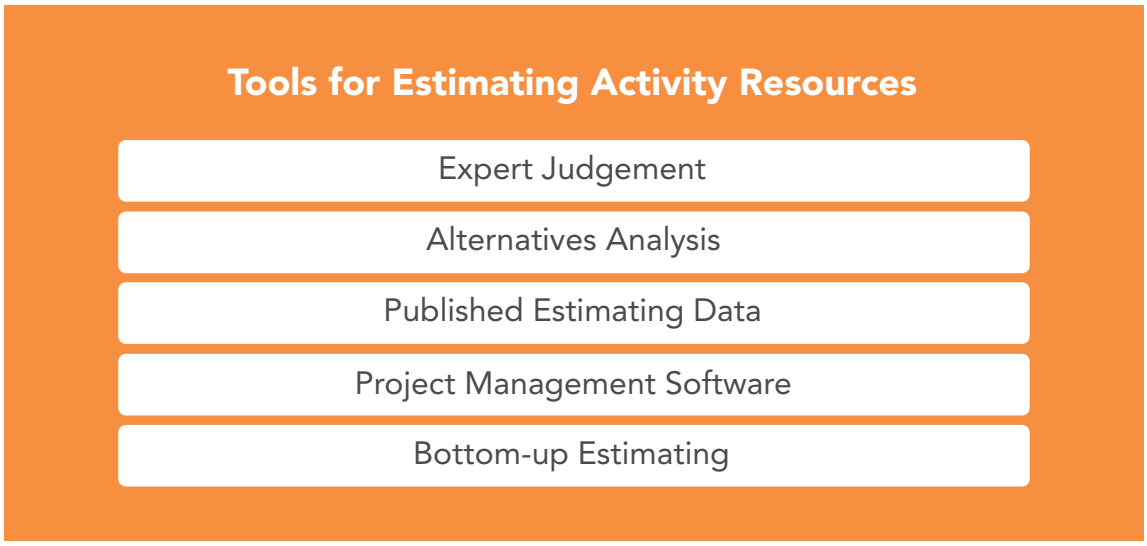
Key Points

- The relationships between activities need to be identified so that dependent activities can be scheduled to follow those that they are dependent upon.
- There are three interrelated techniques that can be used to sequence activities: precedence diagrams, dependency determination, and sequencing leads and lags.
- Three types of dependencies are used to define the sequence among the activities: mandatory, discretionary, and external.

4 ESTIMATING THE RESOURCES REQUIRED

This step involves making an estimate of the resources required to complete each activity. The previous processes described what is to be done and in what order. This process describes who will do the work.

Don't spend too much time worrying about factors that you simply don't know. Remember, the key word here is 'estimate', whilst you should try to be as accurate as you can, remember that any figures you come up with can and will be revised during later processes. There are a number of tools that can be used to estimate the required activity resources.



Expert judgment can be provided by members of the project team or by a team leader. However, it often requires an expertise that is not present within the project team and an external group or person with a specific skill set or knowledge is brought in.

You may be able to make use of estimating data published by other organizations, which can provide regularly updated unit costs of a wide range of human and material resources. In this technique, the activity is compared to the activities for which data exists and the actual cost or durations of the closest comparable activity is selected from the data and used as the estimate.

The advantage of this technique is that it is accurate when the project conditions match the conditions under which the published data was generated.

The disadvantages are that data does not exist for many activities and that the published data that does exist is based upon the characteristics of the organizations that compiled and published it, which may not correspond to your own.

Bottom-up estimating involves further decomposition of the component tasks can be individually resourced. It is basically an iteration of defining and sequencing the activities in which each task is broken down into smaller components. Then, individual estimates are developed to determine what specifically is needed to meet the requirements of each of these smaller components.

The estimates for the smaller individual components are then aggregated to develop a larger estimate for the entire task as a whole. As a general rule, the smaller the scope of a task, the more accurately you can estimate it. The disadvantages of this technique is that it is very time consuming, and it may be impossible to decompose activities that cannot be easily defined.

The main purpose of the activity resource estimating process is to determine the resource requirements for each activity, and therefore this is the major output item from this process.

You identify the types of resources required to perform each activity and estimate the required quantity of each identified resource. If a work package in the WBS has multiple

activities, the resource estimates for those activities can be aggregated to estimate the resource requirements for the work package.

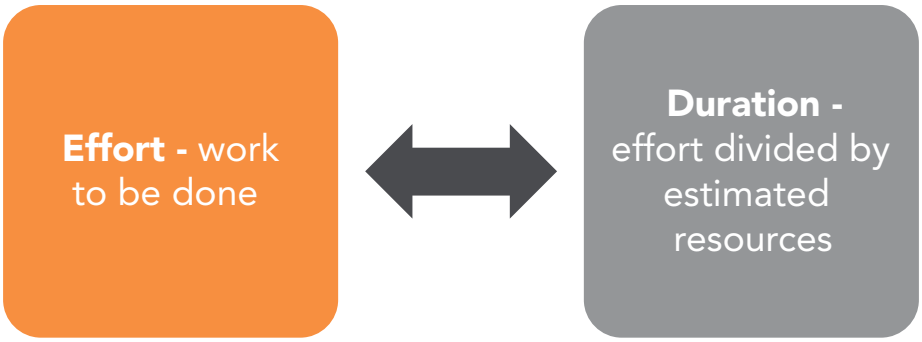
The requirement documents may also include information such as the basis for each estimate, the assumptions made for the estimate, and the availability of the resources.

Key Points

- Estimating the resources required aims to describe who will do the work.
- There are five tools that can be used including: expert judgment, alternative analysis, published estimating data, software and bottom-up estimating.

5 ESTIMATING THE TIME REQUIRED

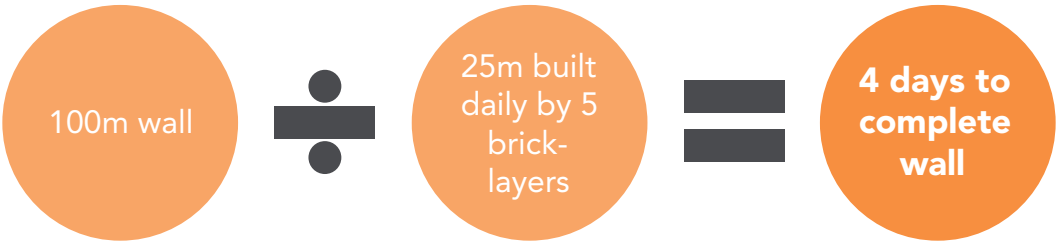
This step involves estimating the amount of effort required for each activity and then calculating the total duration. Effort is the work to be done whereas duration is this figure divided by estimated resources.



For example,

> *If there is a requirement to build one hundred meters of wall and a bricklayer can build 5 meters of wall in a day.*

The duration of the task can be calculated by dividing the length of the wall by the number of bricklayers that will be assigned to the task. Then five bricklayers could be expected to complete the task in 4 days.



All estimates, are to some extent uncertain at the beginning of a project and need to be progressively updated as you gain a better idea of how efficiently work is being done and exactly what resources you have available. You can check out the complete range of Project Management PDF eBooks free from this website.

The time required to complete an activity depends on the resources assigned to it but there are some limitations to this. For example,

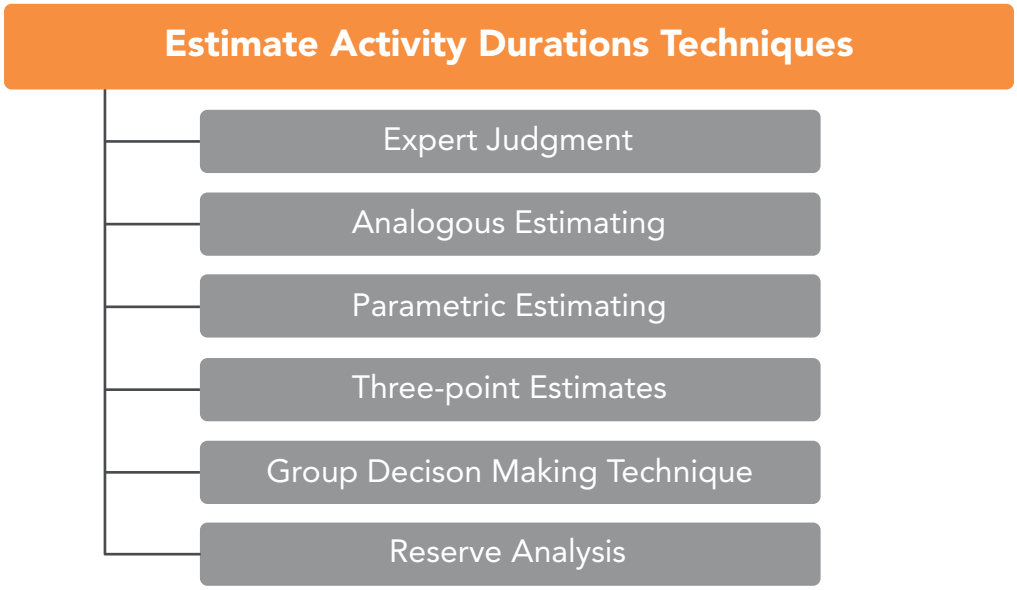
> *Suppose it will take one operator with an earthmover four days to dig the foundations of a building. It is tempting to believe that two operators with an earthmover each could do it in two days.*

However, this assumption does not take account of the fact that they would need to spend time coordinating their efforts and would probably keep getting in each other's way, greatly reducing their individual efficiency.

When assigning additional resources to an activity, always consider the possibility that it might reduce the overall efficiency and productivity. Most activities have a threshold beyond which assigning additional resources does not reduce the duration because of the additional overhead of communication and coordination.

The resource calendar, finalized (or modified) during activity resource estimating, contains the type, quantity, availability, and capability of each resource, including the skills of a human resource, which must be considered during activity duration estimating.

Capability and quantity of available resources, both human and material, can affect the activity duration estimate.



Expert judgment using historical information from similar projects can provide duration estimates. It can also be used to reconcile different estimating methods, and to estimate the whole duration of an activity when not enough information is available.

This technique can be used to estimate some parameters to be used in other methods. For example, what percentage of the original activity duration estimate should be used as a contingency reserve, and in comparing an activity to a similar activity in a previous project during analogous estimation?

Analogous estimating techniques estimate the duration of an activity based on the duration of a similar activity in a previous project. The accuracy of the estimate depends upon how similar the activities are and whether the team member who will perform the activity has the same level of expertise and experience as the team member from the previous project.

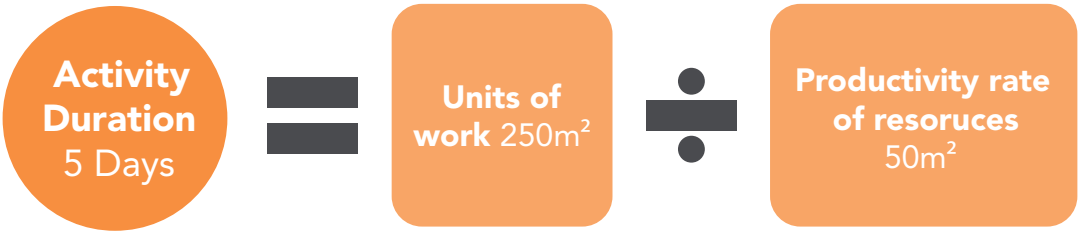
Analogous estimating is typically a form of expert judgment that is most reliable when the previous activities are similar to the current activity and when the team members preparing the estimates have the necessary experience.

This is a simple technique used to calculate the activity duration when the productivity rate of the resource performing the activity is available. You can use the following formula:

Activity duration = Units of work in the activity / Productivity rate of the resources.

For example,

If a groundwork gang consisting of six operatives plus their equipment can lay 50 square meters of reinforced concrete in a day, the duration calculation can be performed as follows: Activity duration = 250 square meters / (50 square meters/day) = 5 days



This technique relies on the statistical relationship that exists between a series of historical data and the variables in question. When this data is being drawn from a large body of historical data taken from similar projects, then it can yield accurate estimates.

It provides several advantages as an estimating technique for example they:

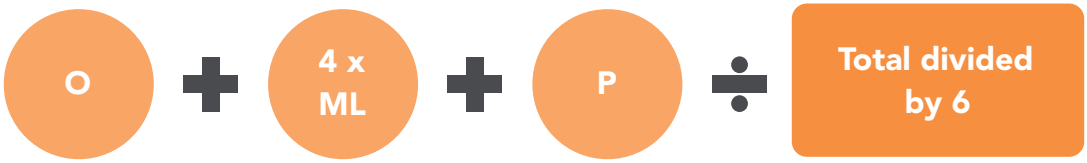
- Allow estimates to be prepared in much less time than required by more detailed techniques.
- Require quantitative inputs that are linked to algorithms providing quantitative outputs. All costs are traceable.
- If two estimators input the same values for parameters, they will get the same resulting cost.
- Provide a consistent estimate format and estimate documentation.
- Provide costs for a range of input values, extrapolating to derive costs for projects of a different size or nature.
- Highlights the design parameters used.
- Able to provide key statistical relationships and metrics for comparison with other projects.

The disadvantages of this method are:

1) Models will not exist for activities until there is a sufficiently large experience base for the activity. Basing estimates on work that is only vaguely comparable will yield inaccurate estimates.
2) Physical parameters, for example 'number of bricks laid', 'area of trees cleared' or 'number of widgets produced' are far more meaningful than non-physical parameters for example, the 'number of lines of code' in a software project.
3) There may be changes in technology or working practices. For example, an electrician's productivity is constrained by the speed at which he can 'chase out' channels in the walls in which to lay cables, a job that used to be done with a hammer and chisel. The invention of an affordable power tool to do this job resulted in a significant increase in the amount of cable that could be laid per day.

Three point estimates address the issue of uncertainty in estimating the activity duration. This uncertainty can be calculated by making a three-point estimate in which each point corresponds to one of the following estimate types:

1) ***Most Likely Scenario (ML)*** *– the activity duration is calculated in most practical terms by factoring in resources likely to be assigned, realistic expectations of the resources, dependencies, and interruptions.*
2) ***Optimistic Scenario (O)*** *– is the best-case version of the situation described in the most likely scenario.*
3) ***Pessimistic Scenario (P)*** *– is the worst-case version of the situation described in the most likely scenario.*



We then find the average, but we first weight the Most Likely estimate by 4. The formula is (O + (4*ML) + P) / 6. We must divide by six because we in effect have six different estimates (although four of these estimates are the same number). This is because we are averaging (O + ML + ML + ML + ML + P) / 6.

Here's an example.

> *A roofing contractor is replacing all of the tiles on the roof of a house. He estimates that the job will take his team 10 hours based on the expectation that they will need to replace some of the underlying timbers. This is his* ***Most Likely estimate****.*
>
> *If none of the timbers need replacing then the job will take 7 hours, this represents* ***his Optimistic estimate****.*
>
> *If most of the timbers need replacing then the job will take 16 hours, this represents* ***his Pessimistic estimate****.*

This formula is most useful in estimating time or cost of activities for projects that are especially unique, such as in research and development where there are many unknowns.

This step should include incorporating a time cushion into your schedule; this cushion is usually called a contingency reserve, time reserve, or time buffer. It's purpose is to accommodate the possibility of schedule risks. One method of calculating the contingency reserve is to take a percentage of the original activity duration estimate, although it can also be estimated by using quantitative analysis methods.

When more information about the project becomes available, the contingency reserve can be reduced or eliminated. Usually, while estimating for large projects, managers would like

to keep a buffer of 5% or so of the total estimate for the project to account for project schedule risks, like delays in procuring hardware or unexpected personnel problems.

Key Points

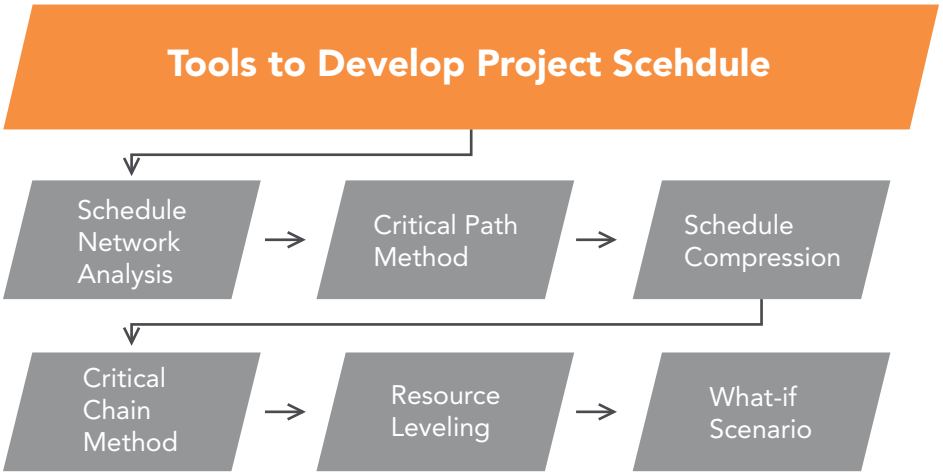
- Estimating the time required involves estimating the amount of effort required for each activity and then calculating the total duration. Effort is the work to be done whereas duration is this figure divided by estimated resources.
- Expert judgment using historical information from similar projects can provide duration estimates, and can also be used to reconcile different estimating methods.
- Analogous estimating techniques estimate the duration of an activity based on the duration of a similar activity in a previous project.
- Three point estimates address the issue of uncertainty by combining three different types of estimate the:
  - *Most Likely Scenario* the activity duration is calculated in most practical terms by factoring in resources likely to be assigned, realistic expectations of the resources, dependencies, and interruptions,
  - *Optimistic Scenario* is the best-case version of the situation described in the most likely scenario, and
  - *Pessimistic Scenario* is the worst-case version of the situation described in the most likely scenario.

6 DEVELOPING THE SCHEDULE

By this stage, you should have all of the data you need to develop the project schedule. The process itself is invariably done using a scheduling tool, which can immediately produce a preliminary result based on:

- Defined activities.
- Estimate of resources available.
- Estimates of duration.
- Logical relationships between activities.

There are several different tools and techniques that can be used to develop the project schedule. Most organizations have a preferred method or methods and these can vary depending on the project and the individual project manager. These methods are described briefly below:



Schedule network analysis

Schedule network analysis is a technique that generates the project schedule. It employs a schedule model and various analytical techniques, such as critical path method, critical chain method, what-if analysis, and resource levelling to calculate the early and late start and finish dates, and scheduled start and finish dates for the uncompleted portions of project schedule activities.

Activity networks are made up of a series of activity boxes, each of which depicts a discrete activity or task. Each activity box may contain up to 7 items of information.

Earliest Start	**Duration**	**Earliest Finish**
Activity Description & Identifier		
Latest Start	**Float**	**Latest Finish**

The top line of the box reflects the earliest point at which the activity could start and finish. The centerline should contain descriptive information about the activity and the bottom line should be used to reflect the latest start and finish times. For example,

> *Activity A must be completed before activity C can begin (indicated by the line that joins the two activity boxes).*
>
> *Activity A requires 5 days and Activity C requires 4 days (this part of the project will therefore last 9 days).*
>
> *The earliest start time for activities right at the beginning of the network are set to zero (shown in bold).*

The earliest finish time for whichever input activity is the latest is used to establish the earliest start time for the dependent activity.

In this example, Activity A is scheduled to be completed on day 5. *Only then* can activity C begin.

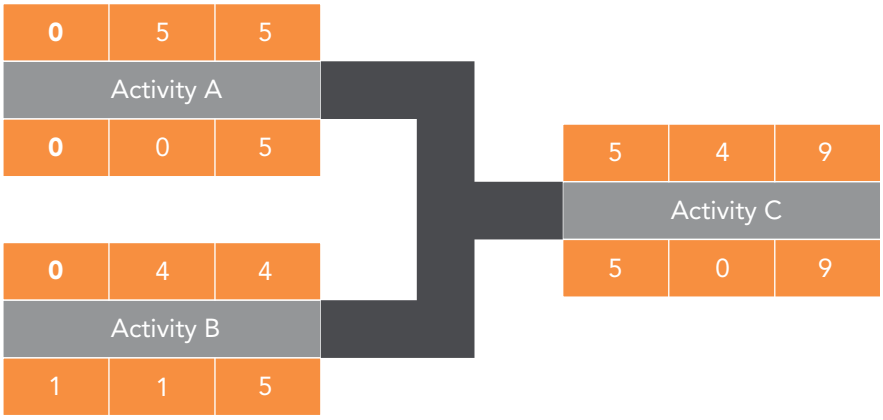
In many cases an activity will be dependent on the completion of more than one preceding activity. In the example shown:

Activities A & B must both be completed before activity C can begin.

A requires 5 days,
B requires 4 days and
C requires 4 days.

Activities A and B can be carried out in parallel as they are not dependent upon each other.

In this example this part of the project will also last 9 days.



Determining the relationships between activities can be a complicated process and may require a substantial amount of discussion involving numerous personnel across the various departments that may be involved in the project.

The process of identifying relationships between the activities should only be concerned with logical requirements, in other words it should be assumed that there are no resource constraints when drawing the activity network. This issue has then to be addressed and appropriate adjustments made. Resolving resource shortfalls and conflicts is the scope of resource planning and scheduling.

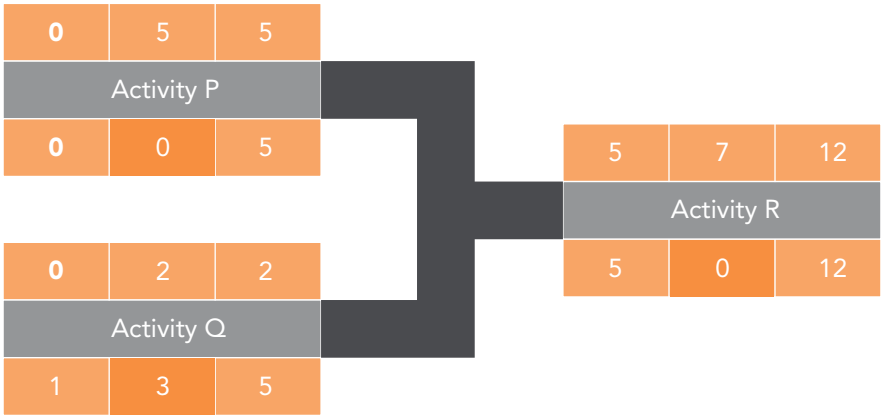
You may find it useful to produce sub-diagrams and use these to conduct a brainstorming approach to identifying all possible relationships, prior to building the final network. The project will need to be monitored at various points to ensure that its business and technical integrity is being maintained – the activity network should also reflect these activities.

Use of Float

Float is a measure of the amount of time an activity can be delayed without affecting subsequent activities. The amount of float indicates the extent of time that the activity can be delayed without putting back the end date of the overall project.

Activities that have an associated float are natural candidates to be delayed when other activities are suffering from problems or overruns.

Reading through the activity network from left to right gives the total duration of the plan. Reading back through the network, subtracting each duration, shows those activities that have any spare time. This spare time, known as float (shown in red below), is a very useful concept in relation to resource scheduling and smoothing.



In the example shown: Activity R is dependent upon the completion of both of the activities P and Q. However activity P is scheduled to take 5 days whilst Q should be completed in 2 days. The area of work represented by this part of the network should last 12 days.

Activity Q has a float of 3 days so: Q could start up to 3 days late or Q can take an extra 3 days to complete without delaying the start of the subsequent activity R.

Once the resources required to complete each product have been identified and the activity network updated to reflect these, then the start and finish dates can be added. With the

shape and size of the project now visible, the total cost of the resources for each planning period can be calculated.

Critical Path

The activity network also clearly identifies the critical path, which is the sequence of related activities that will take the longest time. The critical path is an invaluable concept in project planning – as it defines that sequence of activities that should take the longest time.

The critical path is defined as the series of activities that have zero float. There will always be a critical path running through a project from the first activity to the last.

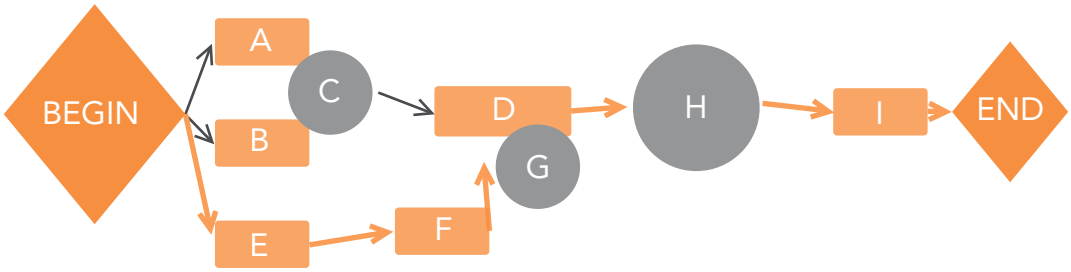
However, any task, if subjected to sufficient delay; may itself become critical. This occurs at the point when its float has been entirely consumed by the passage of time. In larger projects, particularly as the project nears completion a number of the arms of the network may contain zero float i.e. the project may contain numerous critical paths.

The critical path is an important feature in project planning and control and is usually highlighted on the network in some manner – e.g. bold print, red or a different style of line. It is important to remember that the critical path is not defined at the initial planning stage and then set in stone.

As the project progresses and planned activities overrun the network should be frequently updated to ensure that it continues to reflect the true status of the project. The failure to do this is a common reason for projects going out of control and ultimately failing.

The critical path method calculates the longest path of planned activities to the end of the project – the 'critical path' – and the earliest and latest date that each activity can start and finish without extending the project. Any activity delay on the critical path impacts the planned project completion date.

A network diagram visually conveys the critical path. This visibility into the critical path allows project managers to prioritize activities and take appropriate corrective actions to meet schedule deadlines.



An understanding of the critical path also allows project managers visibility as to which schedule activities are flexible – that is, those activities that are not on the critical path. By looking at a network diagram, project managers can determine when they have float or slack, which is the amount of time that any given schedule activity can be delayed without causing a delay to the start date of subsequent activities (free float) or to the project completion date (total float).

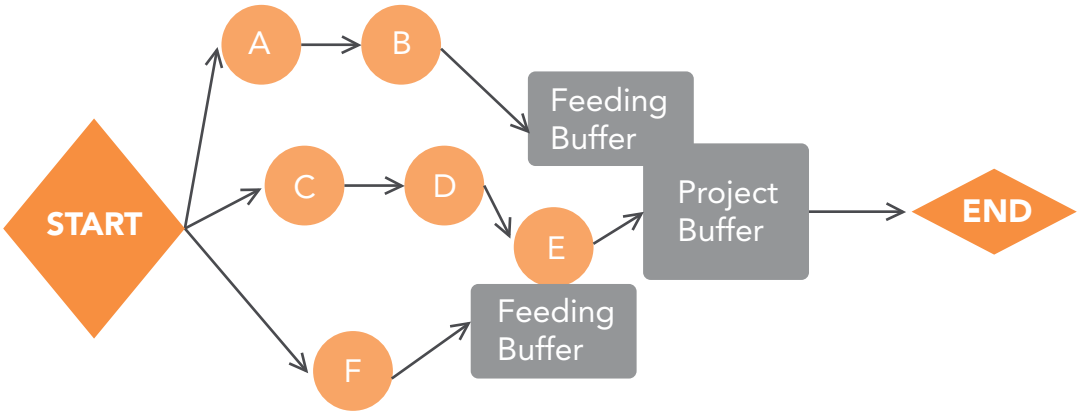
Knowing when a project has float allows a project manager to understand what tasks may slip and by how much before they have an impact on the project schedule.

A final point worth noting in the area of resource planning, especially in relation to resource smoothing concerns the critical path. Some planners tend to see the critical path as a sacred sequence of activities that should be left untouched whilst other activities are 'smoothed'.

An alternative point of view is that the critical path results from a series of activities which have suffered from a lack of resources being allocated to them and therefore should be seen as the first line of attack. The correct interpretation will vary, depending on the characteristics of each project.

Critical Chain

The basis for the critical chain method is the same as the basis for the critical path method but with one key difference; the critical chain method accounts for resource limitations.



By adding resource limits to the analysis, the result is that critical path is generally longer. The resource-constrained critical path is known as the critical chain. If resources are allocated in the scheduling tool, the network diagram will display the critical chain.

Using the critical chain method involves adding duration buffers to project schedules to protect the targeted finish date from slippage. Duration buffers are added to the schedule as non-work schedule activities – one at the end of the critical chain and others at the end of each sequence of tasks that feeds into the critical chain.

As a result, 'buffer' time is integrated throughout the project schedule to account for duration uncertainty. Later in the project, project teams monitor project progress by reviewing the consumption rate of the buffers.

Resource Levelling

Resource levelling is the process of changing schedule resource allocation to resolve over-allocations or conflicts. It is applied to a schedule that has already been analyzed by the critical path method. This technique is used to adjust a project schedule if shared resources are only available at certain times, or in limited quantities, or if a project manager wants to maintain resource usage at a constant level.

Resource levelling is necessary when resources have been over-allocated, such as when a resource has been assigned to two or more activities during the same time period, when shared or critical required resources are only available at certain times or are only available in limited quantities. The network diagram should be recreated after resource levelling to assess the updated critical path.

What-if Analysis

This examines the schedule impact of various scenarios, such as the delayed delivery of a major deliverable. What-if scenario analysis may include simulation that calculates multiple project durations with different sets of activity assumptions.

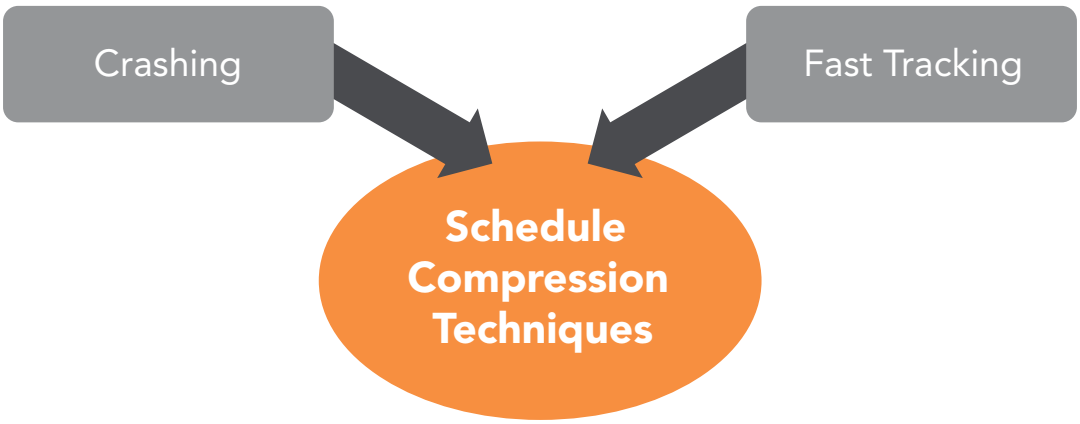
Multiple network diagrams may be generated to visually convey the impact of varying scenarios. Project managers can use the results of this analysis to determine schedule feasibility under adverse conditions and prepare relevant contingency plans.

The outcome of the what-if scenario analysis can be used to assess the feasibility of the project schedule under adverse conditions, and in preparing contingency and response plans to overcome or mitigate the impact of unexpected situations.

Leads and Lags

Leads and Lags are used to develop a viable schedule by adjusting the start time of successor activities. Leads are used in limited circumstances to advance a successor activity with respect to the predecessor activity, and lags are used in limited circumstances where processes require a set period of time to elapse between the predecessors and successors without work or resource impact.

As a result of network diagram analysis, project teams may identify a need to compress the schedule. Schedule compression shortens the project schedule in order to meet schedule deadlines without reducing the project scope.



Schedule compression techniques include crashing and fast tracking. If utilized, project teams should recreate and reassess the network diagram to ensure that no new schedule issues have emerged.

Crashing

Crashing involves either adding resources or increasing work hours (overtime, weekends) to shorten task duration. Shorter task durations typically result in higher task costs, so project teams must determine, prior to crashing, whether the total costs savings is enough to justify the higher costs. Crashing almost always requires cost increases because it usually necessitates new tasks.

This is a controversial technique because adding project resources can increase project complexity or risk and may ultimately have a negative impact on the schedule. Crashing does not involve reducing project scope or eliminating project tasks.

Fast Tracking

Fast tracking is a schedule compression technique in which project phases or activities usually conducted sequentially are performed in parallel to reduce duration. Care must be taken to ensure that parallel work does not create additional work or increase risk. Fast tracking frequently results in increased complexities in task dependencies, so additional project controls must be implemented to ensure ongoing and accurate insight into schedule performance.

Project Management Scheduling Software

There are dozens of project management software packages available and most will include some or all of the following features:

1) Planning, tracking and monitoring – these most common features provide for planning and tracking of the projects tasks, resources and costs. Usually the software also provides impact assessments of planned deviations and resource and schedule projections.
2) Management reports supported by Gantt charts, network diagrams, tabular summaries and other business graphics.

3) A project calendar that enables the specification of non-working periods such as weekends and holidays. These calendars usually become the basis for all computer assisted resource scheduling.
4) A what-if analysis facility. Some packages can perform a comparative analysis and display the new against the old project plan, enabling easy management review of the options.
5) A multi-project analysis facility. Some of the more sophisticated packages feature a single, comprehensive database enabling cross-project analysis and reporting.

The project schedule includes a planned start date and planned finish date for each activity. If resource planning is done at an early stage than the project schedule would remain preliminary until resource assignments have been confirmed and schedule start and finish dates are established. This process usually happens no later than completion of the project plan.

A project target schedule may also be developed with a defined target start and target finish for each activity. The project schedule may be presented in summary form sometimes referred to as the master schedule or milestones schedule or it may be presented in detail. It is usually presented graphically using one or more of the following formats:

1) Milestone charts are similar to bar charts but only identify the schedule start or completion of major deliverables and key external interfaces.
2) Bar charts use bars representing activities to show activity start and end date as well as expected durations.
3) The logical bar-chart shows the logical relationships between the activities. Whilst this technique is useful, be aware that on larger projects the volume of activities may result in a cluttered presentation.
4) Many variations of Gantt chart can be used to represent a broad spectrum of project information and in spite of its limitations the Gantt chart remains the most common presentation format for senior management.

Project management staff need to calculate how many resources a specific activity will require. They also need to establish the overall resource requirements of the project, for any given period – possibly including the resources needed on a daily basis. The type of diagram that facilitates this is called a histogram (or bar chart) and is another widely used project planning aid.

Histograms enable this information to be portrayed clearly. They can be derived from the Gantt chart representing the period in question. The only additional information that may be required is the type of specialist resource required for each activity.

Project schedule network diagrams show both the project network logic and the projects critical path schedule activities. These diagrams can be presented in the activity on no diagram formats or presented in the times you'll schedule network diagram format that is sometimes called a logical bar chart.

Whilst the activity network is one of the most useful aids to effective project management, senior managers will not usually want to see this level of detail. When project management staff need to communicate information to senior management; Gantt charts, histograms and other graphical techniques are the preferred presentation format.

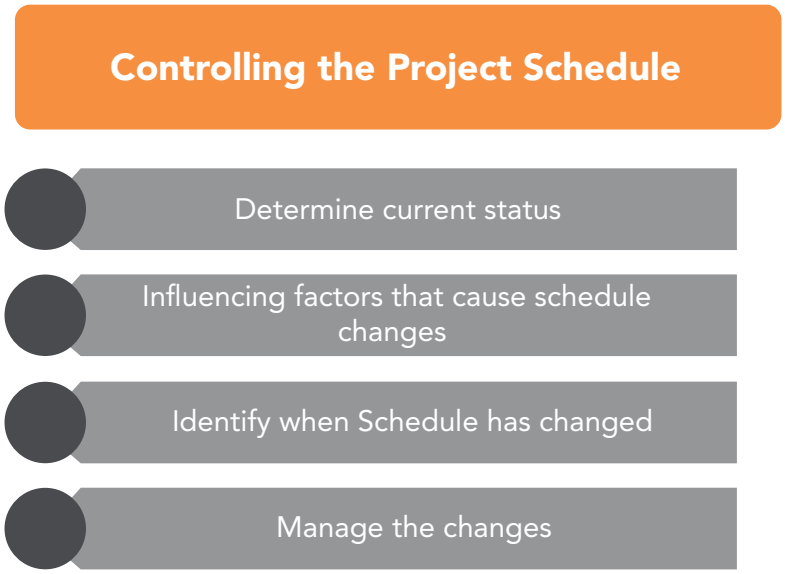
Any plan, schedule or specification that will be circulated should be represented in a clear and unambiguous format. The notation used should be clear to both an in-house and an external audience. In order to do this, the three vital planning and control parameters – time, cost and performance should be summarized at an appropriate level of detail.

Key Points

- There are several different tools and techniques that can be used to develop the project schedule. Most organizations have a preferred method.
- These methods include: schedule network analysis, critical path method, schedule compression, critical chain method, resource levelling and what-if scenarios.

7 CONTROLLING THE SCHEDULE

A schedule baseline is needed if the schedule is going to be controlled and this baseline must be maintained so that it reflects the current status of the project.



This process is part of monitoring and controlling and is sometimes referred to as 'working the plan' in contrast with the previous processes which are all to do with 'planning the work'. Controlling the schedule involves:

1) Determining the current status.
2) Influencing factors that could cause schedule changes.
3) Identifying if the schedule has changed.
4) Managing changes as they occur.

There are several different techniques that can be used to control the project schedule.

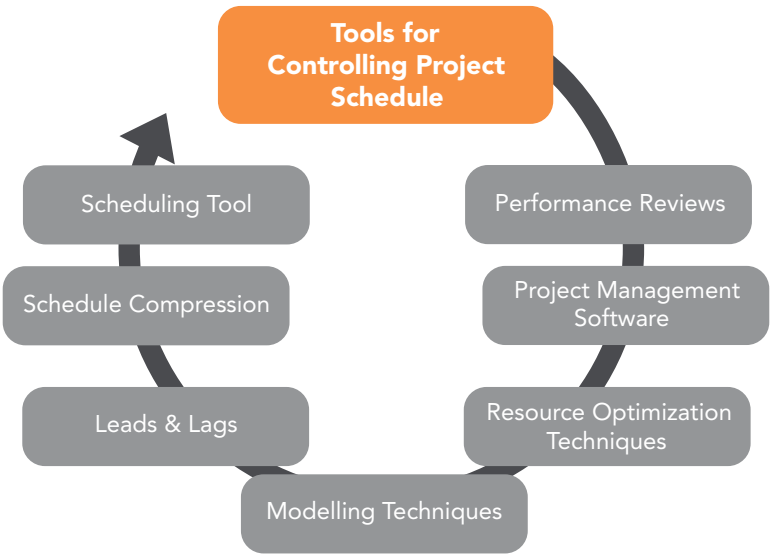
Performance reviews measure, compare, and analyze schedule performance such as actual start and finish dates, percent complete, and the remaining duration for work in progress. If earned value management (EVM) is utilized the schedule variance and schedule performance index are used to assess the magnitude of schedule variations.

An important part of schedule control is to decide if the schedule variation requires corrective action. For example, a major delay on any activity not on the critical path may have little

effect on the overall project schedule, while a much shorter delay on a critical or near-critical activity may require immediate action.

If using the critical chain scheduling method, comparing the amount of buffer remaining to the amount of buffer needed to protect the delivery date can help determine schedule status. The difference between the buffer needed and the buffer remaining can determine whether corrective action is appropriate.

Schedule performance measurements are used to assess the magnitude of variation to the original schedule baseline. The total float variance is also an essential planning component to evaluate project time performance.



Important aspects of project schedule control include determining the cause and degree of variance relative to the schedule baseline and deciding whether corrective or preventive action is required.

Adjusting leads and lags is used to find ways to bring project activities that are behind into alignment with plan.

The schedule compression techniques described earlier are used to find ways to bring project activities that are behind into alignment with the plan. It includes crashing, which adds resources and fast-tracking, in which activities normally done in sequence are now performed in parallel for part of their duration.

Schedule data is updated and compiled into the schedule to reflect actual progress of the project and remaining work to be completed. The scheduling tool and the supporting schedule data are used in conjunction with manual methods or other project management software to perform schedule network analysis to generate an updated project schedule.

The most crucial outputs are the work performance information in the form of: Schedule variance (SV) and Schedule performance index (SPI).

These can be used to forecast future performance of the project based on the performance to date. If this information indicates that there is a significant variance of the performance of the project as compared to the performance baseline, then this may suggest changes to either the project itself in the form of corrective action or preventive action, or changes to the schedule baseline itself if it is determined that the original baseline was unrealistic.

Any of these change requests are then fed as inputs into the change control process. If there is an eventual change to the schedule baseline, then that will generate a new project schedule. If schedule compression techniques are used, this may create changes in other management areas: cost (in the case of crashing) and risk (in the case of fast-tracking).

Finally, if the reason for the variances is uncovered, this is noted in the lessons learned so that further scrutiny can be given to this throughout the rest of the project. The following represent outputs from this process:

> Measurements can include planned vs. actual technical performance or other scope performance measurements. This information is documented and communicated to stakeholders.

These are estimates of the future conditions of the project based on the work performance information provided.

Schedule variance analysis, along with review of progress reports, results of performance measures, and modifications to the project schedule can result in change requests to the schedule baseline and/or to other components of the project plan.

Change requests are processed for review and disposition through the change control process. Preventive actions may include recommended changes to reduce the probability of negative schedule variances.

Elements of the project plan that may be updated when variance occurs include:

1) The schedule baseline changes are incorporated in response to approved change requests related to project scope changes, activity resources, or activity duration estimates.
2) The schedule plan may be updated to reflect a change in the way the schedule is managed.
3) The cost baseline may be updated to reflect changes caused by compression or crashing techniques.

Project documents that may be updated when variance occurs include:

- New project schedule network diagrams may be developed to display approved remaining durations and modifications to the work plan. In some cases, project schedule delays can be so severe that development of a new target schedule with forecasted start and finish dates is needed to provide realistic data for directing the work, and for measuring performance and progress.
- An updated project schedule will be generated from the updated schedule data to reflect the schedule changes and manage the project.
- Schedule compression or fast-tracking may generate new risks that should be documented in the risk register.

The importance of the project schedule cannot be under-estimated, its management plan is one of the key documents for any project manager. He or she will need to be vigilant in observing the communication of the latest version of the project schedule to ensure the executing phase runs as smoothly as possible.

Key Points

- Controlling the schedule is sometimes referred to as 'working the plan'.
- It is concerned with: determining the current status, influencing factors that could cause schedule changes, identifying if the schedule has changed, and managing changes as they occur.

SUMMARY

Project management is a complex activity that requires a structure, procedures and processes that are appropriate to your project. This will enable you to manage the inevitable changes that occur throughout a project's lifespan in a professional manner to ensure success. Each project function describes the expertise, skills and tools needed for your project.

So much work is now run as projects and so few people have the necessary skills to manage them properly that there is a huge demand for good project managers and that demand is increasing all the time.

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