# PERT Analysis Toolkit

## 1. Overview

Project Evaluation and Review Technique (PERT) is a model for project management designed to analyse and represent the tasks involved in completing a project. It is similar to an **Activity Network** (see separate toolkit) but more complex. It is used to analyse the tasks in a project, especially the time needed to complete each task, and identifying the minimum time needed to complete the total project, allowing you to look at optimistic, pessimistic and expected estimates. In practice you would rarely do a PERT analysis by hand (you'd use a tool like MS Project), but it's important to know the principles so that tools like MS Project can be used properly.

## 2. Why do PERT?

For the same reasons that Activity Networks are useful, PERT is useful. It is a diagram that shows the sequence in which tasks will take place and their inter-dependencies and it includes various estimates of task duration.  A PERT chart defines and makes visible dependencies between the tasks, it helps identify the critical path, plus early start, late start, and slack for each activity. It provides for potentially reduced project duration due to better understanding of dependencies leading to improved overlapping of activities and tasks where feasible.

However it can be complex and for large projects charts can be unwieldy. Luckily modern tools such as MS Project can take much of the legwork out of the analysis, so whilst the principles are explained below, in practice you'd use MS Project to do the job for you.

## 3. What is PERT?

As noted above, it's a diagram that shows activities and their dependencies, somewhat like an activity network. However activity networks only show expected task durations, whilst PERT charts show:

The activity name, expected duration, early start time (ES), early finish time (EF), late start time (LS), late finish time (LF) and slack (the amount of time a task could be delayed without affecting any other tasks).
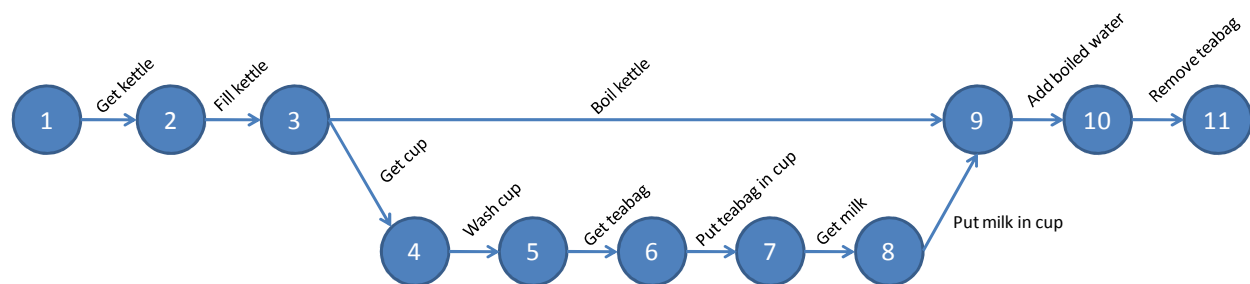


## 4. Calculating PERT

### 4.1 The principles

As previously noted, you won't normally have to do PERT calculations yourself: the purpose of this section is to give you an idea of what's involved.

Normally you complete a simple activity network forst, to establish the task dependencies. You don't bother to add durations. For each task you identify a optimistic duration (OD), an expected duration (ED) and a pessimistic duration (PD). A weighted duration is then claculated using the formula

(OD+4*ED+PD)÷6

The weighted durations can then be used as a more relaistic estimate of task durations than a single estimate figure.

- The first step is to draw the activity network using the 7-cell boxes shown below instead of the circles. Write the task name in the centre in each box.

| Earliest start time | Duration | Earliest finish time |
|---|---|---|
| Task name | | |
| Latest start time | Slack | Latest finish time |

- Next, starting at the far left of the diagram fill in the earliest start time (ES) cell and the duration cell. The first activity is Get kettle and its duration is 5 seconds.
- Assuming a start time of 08:00:00 (your breakfast cup of tea) you then fill in the earliest finish time (EF): this is earliest start plus duration, i.e. 08:00:05.
- Carry on doing this for the rest of the activities, e.g. the next activity will have an ES of 08:00:05 (because that when the preceding task ends), a duration of 10 seconds and an EF of 08:00:15.
- When you get to the task Add boiled water, it has two preceding tasks, one of which has an EF of 08:03:08 (Boil kettle) and one which has 08:01:13 (Put milk in cup). Thus the ES for Add boiled water is the later of the two preceding ES times, i.e. 08:03:08.
- Once all the ES, duration and EF times are entered you'll have the earliest possible finish for the project based on the PERT weighted durations.
- You now start at the left hand end of the diagram and transfer the EF time to the LF time.
- The LS time for the last activity is the LF time minus the duration, in this case 0 seconds as the last task (Tea brewed) is a milestone and these always have zero durations.
- You now work back through the diagram, transferring each LS to its predecessor's LF, and then calculating the LS for that task as above.

Once this is complete you'll have an estimate of the latest the project can start and still achieve the expected finish time.

More importantly, you'll also have information for each task showing the earliest and latest times it can start, i.e. an idea of whether any particular task has any potential slack time and how much that is. Slack time (or float) means that the task can be delayed by that amount of time without impacting the rest of the project.

## 4.2 Using MS Project

In practice you'd use a tool like MS Project to do all the calculations. You'd begin by entering all the tatsks you've identified in a logical order into the default Gantt Chart view. However you don't enter the task durations yet – you have to switch to a PERT Entry Sheet for this.

The next step is to get the weighted durations. This can be entred in MS Project's PERTEntry Sheet as shown opposite for the makeing tea activity network[1]. MS project then calculates the duration using a weighting formula (you can adjust the weighting factors, but usually they're set to the standard 1:4:1). Usually, but not always, the calculated duration is close to the

| | Task Name | Duration | Optimistic Dur. | Expected Dur. | Pessimistic Dur. |
|---|---|---|---|---|---|
| 1 | ⊟ Make a cup of tea | 204 mins | 118 mins | 210 mins | 267 mins |
| 2 | Get kettle | 5 mins | 2 mins | 5 mins | 7 mins |
| 3 | Fill kettle | 10 mins | 6 mins | 10 mins | 15 mins |
| 4 | Boil kettle | 173 mins | 100 mins | 180 mins | 220 mins |
| 5 | Get cup | 6 mins | 4 mins | 5 mins | 10 mins |
| 6 | Wash cup | 15 mins | 10 mins | 15 mins | 20 mins |
| 7 | Get teabag | 10 mins | 5 mins | 10 mins | 15 mins |
| 8 | Put teabag in cup | 4 mins | 3 mins | 3 mins | 10 mins |
| 9 | Get milk | 12 mins | 5 mins | 10 mins | 25 mins |
| 10 | Put milk in cup | 6 mins | 4 mins | 5 mins | 10 mins |
| 11 | Add boiled water | 10 mins | 7 mins | 10 mins | 15 mins |
| 12 | Remove teabag | 6 mins | 3 mins | 5 mins | 10 mins |
| 13 | Tea brewed | 0 mins | 0 mins | 0 mins | 0 mins |

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[1] Note that you would not realistically use MS Project for tasks that last seconds so Project doesn't allow entries of less than one minute. For this example the activities have been entered in units of minutes rather than seconds!

expected, but where the distance between optimistic to expected and pessimistic to epected is very different, the values will vary (e.g. task 4 in the example below). Note that  in this example MS Project has calculated a project timescale that's less than the expected duration, and it also shows the shortest and longest times based on the data provided.

Once this has been completed, and the dependency linkages added (see Activity Network toolkit) you can use MS Project's network view to display the PERT Chart[2]. The example below shows a part of the chart. The critical path is shown in red.
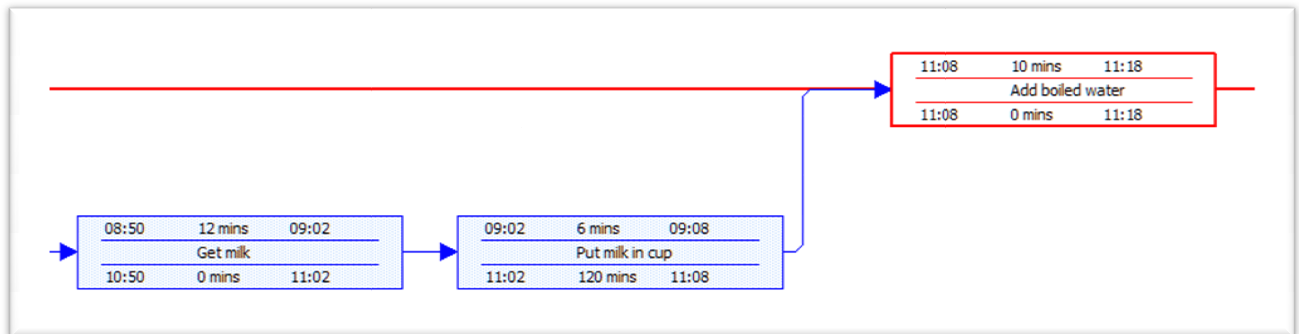


The entire network is shown below (the text in the boxes is too small to read).



## 5. Using PERT

PERT can be used alongside project plan monitoring to assess the impact of delays (slippage). Because each task has an estimate of how much slack there is (if any), you can immediately see the impact on the project if delays do occur. This allows you to both model the new timescales if delays have occurred (and recalculate any slack), and make the project board aware of the affect of delays.

For small and some medium projects it isn't worth the time of maintaining PERT , but for projects with many activities and complex dependencies it's a good tool for getting a feel for the impact of delays.

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[2] Note that MS Project's standard network view doesn't show the task boxes in PERT format but it's easy enough to change the format so that they do.