

Level of Effort (LOE) Support Tasks

This article applies to Barbecana's Full Monte for Microsoft Project

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Introduction

Any project typically has two types of resources/costs associated with it.

- 1) Resource/Costs directly associated with performing the required work (Labor, Material etc.)
- 2) Overhead Resources/Costs associated with supporting the work (Management, IT Support etc.)

For a complete picture of the resources required to complete a project and their associated costs, we need to model both types of work in the schedule with the caveat that Support work should never appear on the critical path.

In many scheduling tools (Primavera P6, Deltek Open Plan etc.) there are specialized task/activity types to model supporting work, sometimes known as 'Level of Effort' or 'Hammock' tasks/activities.

Unfortunately, Microsoft Project does not feature these types of tasks so how can we model overhead work without affecting the critical path?

Modelling Support Work in Microsoft Project

Consider the schedule in Figure 1

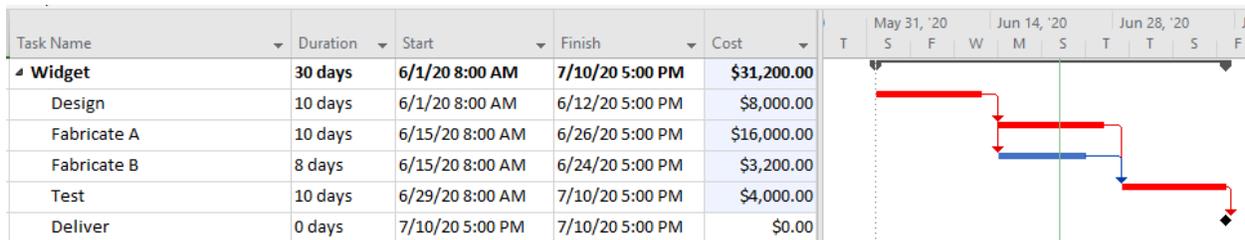


Figure 1

The tasks in the schedule represent the work required to deliver the product 'Widget' and, based on the resources assigned to those tasks, Microsoft Project is forecasting a cost of \$31,200.

However, projects typically also use some shared 'support' resources like Management and IT Support.

Support costs cannot be assigned directly to tasks as 'support' is often constant regardless of the 'work' being performed at any time and we need visibility into the two types of cost.

A typical solution, in Microsoft Project, is to create a task to represent overhead support work as shown in Figure 2.

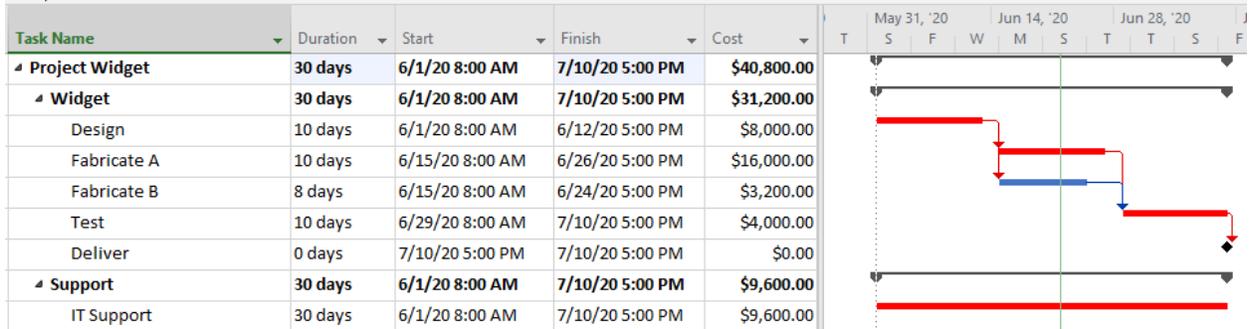


Figure 2

The Duration of the Support task is set to match the summary duration of the work tasks, in this case 30 days. The total 'Project Widget' cost now includes \$31,200 for the 'Work' and \$9,600 in overhead 'Support' costs for a total cost of \$40,800.

Unfortunately, it is a poor practice to have tasks without logical predecessors/successors, so the Support tasks needs to be linked into the schedule as shown in Figure 3.

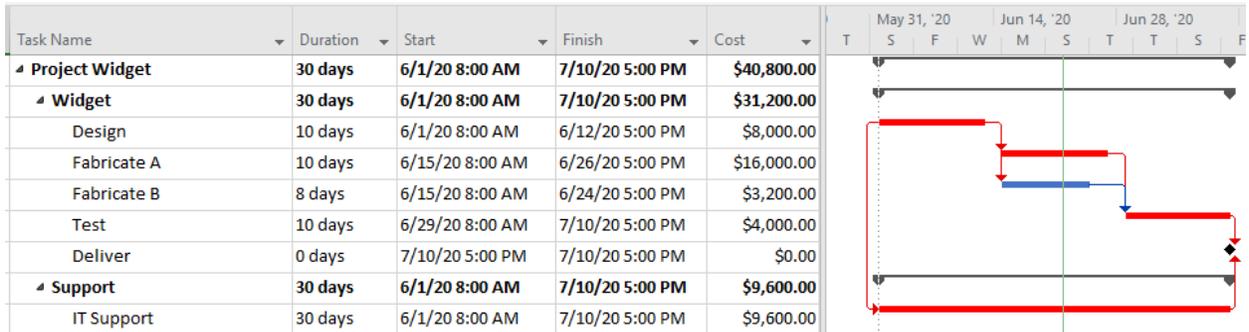


Figure 3

At this point we have a schedule that realistically represents the work to be performed and the overhead support effort and cost that will be required to facilitate the project.

Observe that the 'IT Support' task is being shown on the Critical Path (highlighted in red) by Microsoft Project. Support work should not drive the critical path, so the purpose of the support task needs to be clearly understood by all using this report.

We now wish to perform a schedule risk analysis (SRA) on the project. We will apply duration uncertainty of 80/100/130 to the Widget 'work' tasks.

The probability distribution histogram for the 'Deliver' milestone is shown in Figure 4.

Project LOE Example 1.mpp (10000 simulations performed on 6/22/2020)

Histogram of Finish for task 'Deliver' (UID 41).

Mean = 14Jul20, Standard deviation = 10.87 hours, Deterministic value = 10Jul20 (29%).

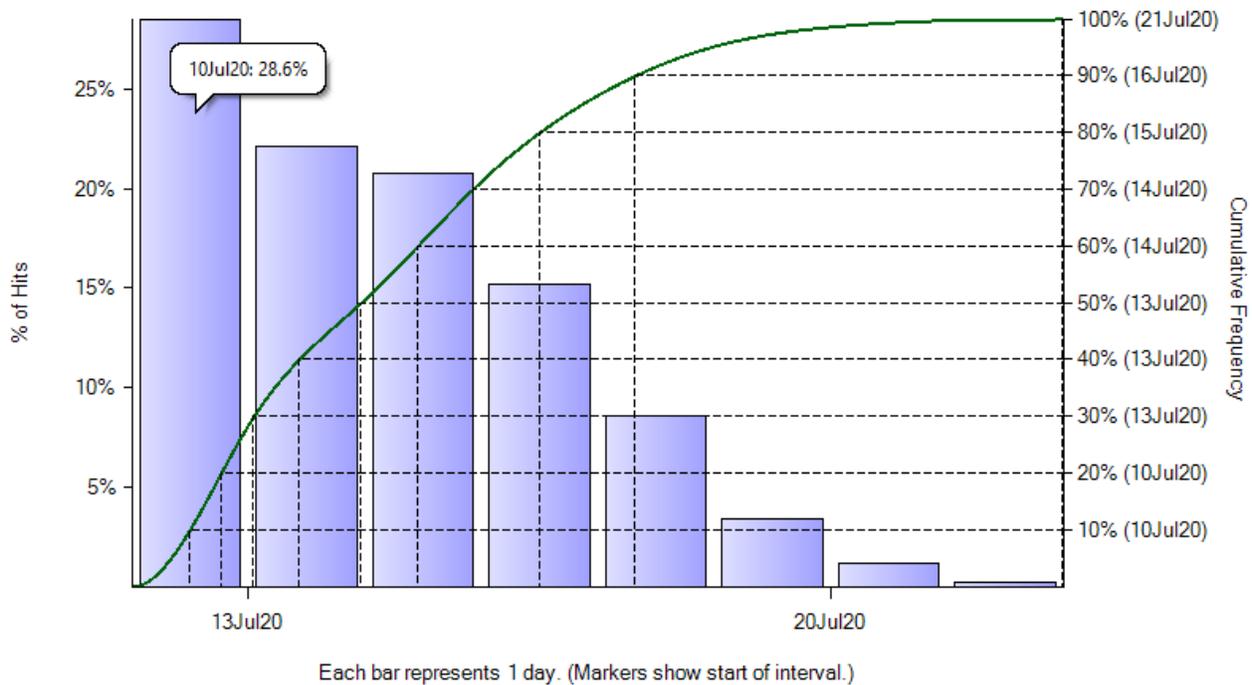


Figure 4

The histogram looks ‘odd’. We typically expect histograms to bear some resemblance to a Normal ‘bell shaped’ distribution and yet this chart starts with a high peak on 10Jul20. 28.6% of the simulations finished on that day and none finished earlier.

The Sensitivity Tornado Chart does not offer much insight into what is going wrong as shown in Figure 5.

| ID | Task Name | Remaining Duration | Percent Critical | Percent Critical (Sensitivity) | Sensitivity Index | Sensitivity Index | Optimistic Finish of Milestone ID 7 | Pessimistic Finish of Milestone ID 7 | 2020 | | | |
|----|-------------|--------------------|------------------|--------------------------------|-------------------|-------------------|-------------------------------------|--------------------------------------|---------|----|----|----|
| | | | | | | | | | Jul | 13 | 14 | 15 |
| 6 | Test | 10 days | 71% | 71% | 54% | [Bar] | 7/13/20 1:49PM | 7/16/20 4:19PM | [Gantt] | | | |
| 3 | Design | 10 days | 100% | 71% | 54% | [Bar] | 7/13/20 1:49PM | 7/16/20 4:19PM | [Gantt] | | | |
| 4 | Fabricate A | 10 days | 68% | 68% | 52% | [Bar] | 7/13/20 2:18PM | 7/16/20 4:04PM | [Gantt] | | | |
| 5 | Fabricate B | 8 days | 3% | 3% | 2% | [Bar] | 7/14/20 10:29AM | 7/14/20 3:53PM | [Gantt] | | | |

Figure 5

The only clue is that nothing is driving the Sensitivity Critical Path 100% of the time. Something else, not shown, is driving the critical path to Delivery in a significant number of the simulations.

The Sensitivity Tornado Chart only shows tasks creating uncertainty in the selected sensitivity target. This means that only tasks that have duration uncertainty and appear on the critical path, in at least some of the simulations, will be shown.

Full Monte also produces a ‘Risk Path’ number that groups tasks into the most probable logical paths driving the selected sensitivity target. A Gantt chart grouped on the Full Monte Risk Path number is shown in figure 6.

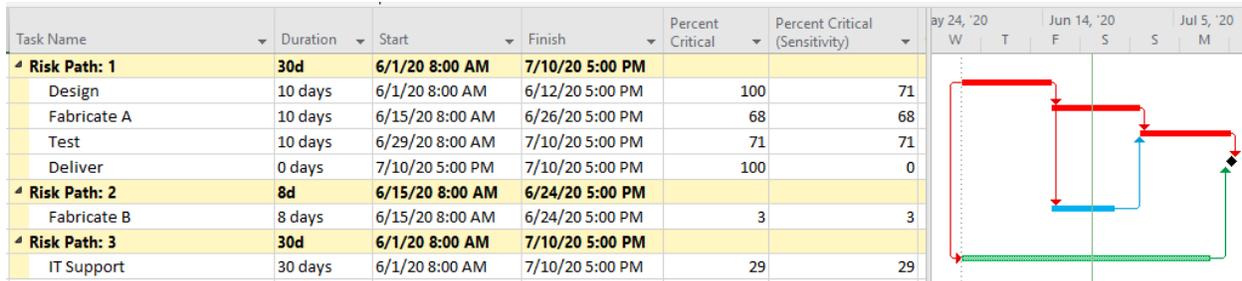


Figure 6

We can clearly see the most likely driving (critical) path to Delivery is Design, Fabricate A, and Test and a secondary path includes Fabricate B. However, a third path has been identified where the IT Support is driving the critical path to Delivery in 29% of the simulations.

Since 'IT Support' ends on 10Jul20, this explains why the histogram in Figure 4 never showed the project finishing before 10Jul20. It was being constrained by 'IT Support'.

Note: This is one reason there is a best practice to apply some uncertainty to all tasks in the schedule. The Tornado chart in Figure 7 shows the result of applying +/- 10% to all remaining tasks in the schedule and now clearly shows the 'IT Support' task is affecting the outcome when clearly it should not.

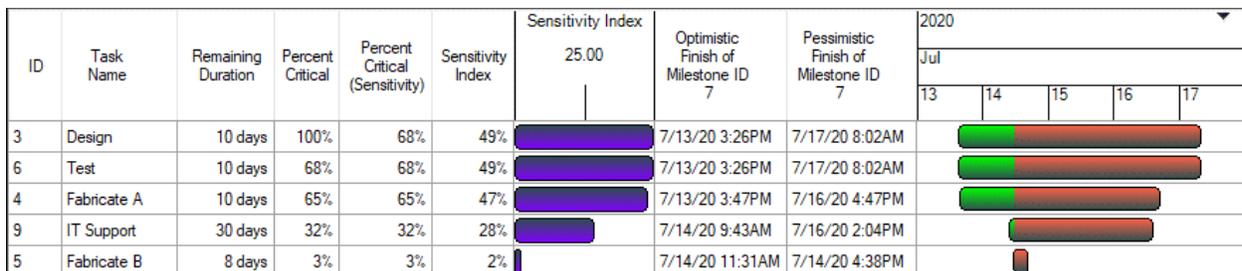


Figure 7

So, how can we model support effort in a Microsoft Project schedule and get correct results from an SRA?

There are three main solutions:

- 1) Zero out the duration of Support tasks prior to performing the SRA. (Okay)
- 2) Assign support resources to Summary tasks. (Better)
- 3) Use the Full Monte Level of Effort special task flag. (Best)

Zero the Duration of Support Tasks prior to the SRA

Our goal is to ensure that support/overhead tasks do not ever appear on the critical path to the deliverable for the purposes of the schedule risk analysis (SRA).

One simple way to achieve this is to set the durations of support tasks to 0 (Zero) before performing the SRA. If you have Microsoft Project Professional and Full Monte 3.4 or later, you can also mark the support tasks as Inactive.

Note: If the 'support' tasks are grouped below a single summary task you can set the Inactive flag on the summary tasks and all 'support' tasks will also be set to inactive.

In the example shown in Figure 8, the support Summary Task has been set to inactive. Although Microsoft Project has not adjusted the Start/Finish dates for the IT Support tasks it has changed the task to non-critical.

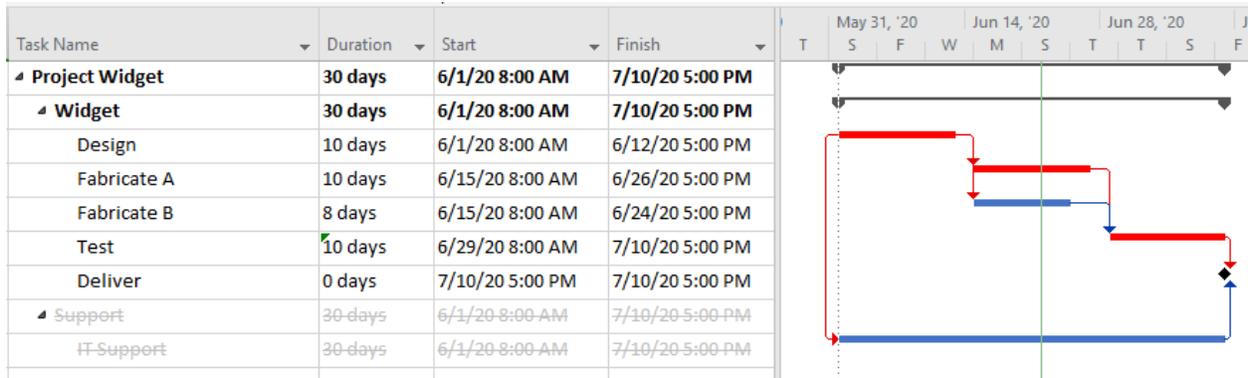


Figure 8

Full Monte 3.4 will automatically set the Probability of Existence to 0% for the Inactive tasks as shown in Figure 9.

| ID | Task Name | Remaining Duration | Duration Distribution Type | Duration Optimistic | Duration Most Likely | Duration Pessimistic | Finish Histogram | Probability of Existence (%) |
|----|----------------|--------------------|----------------------------|---------------------|----------------------|----------------------|------------------|------------------------------|
| 0 | LOE Example 2 | 30 days | Triangular | 80% | 100% | 130% | Graph | 100% |
| 1 | Project Widget | 30 days | Triangular | 80% | 100% | 130% | Graph | 100% |
| 2 | Widget | 30 days | Triangular | 80% | 100% | 130% | Graph | 100% |
| 3 | Design | 10 days | Triangular | 80% | 100% | 130% | Graph | 100% |
| 4 | Fabricate A | 10 days | Triangular | 80% | 100% | 130% | Graph | 100% |
| 5 | Fabricate B | 8 days | Triangular | 80% | 100% | 130% | Graph | 100% |
| 6 | Test | 10 days | Triangular | 80% | 100% | 130% | Graph | 100% |
| 7 | Deliver | 0 | Triangular | | | | Graph | 100% |
| 8 | Support | 30 days | Triangular | 80% | 100% | 130% | Graph | 0% |
| 9 | IT Support | 30 days | Triangular | 90% | 100% | 110% | Graph | 0% |

Figure 9

If the Risk Analysis is now performed, we see the probability distribution histogram for 'Deliver' shown in Figure 10.

Project LOE Example 2.mpp (10000 simulations performed on 6/22/2020)

Histogram of Finish for task 'Deliver' (UID 41).

Mean = 14Jul20, Standard deviation = 14 hours, Deterministic value = 10Jul20 (28%).

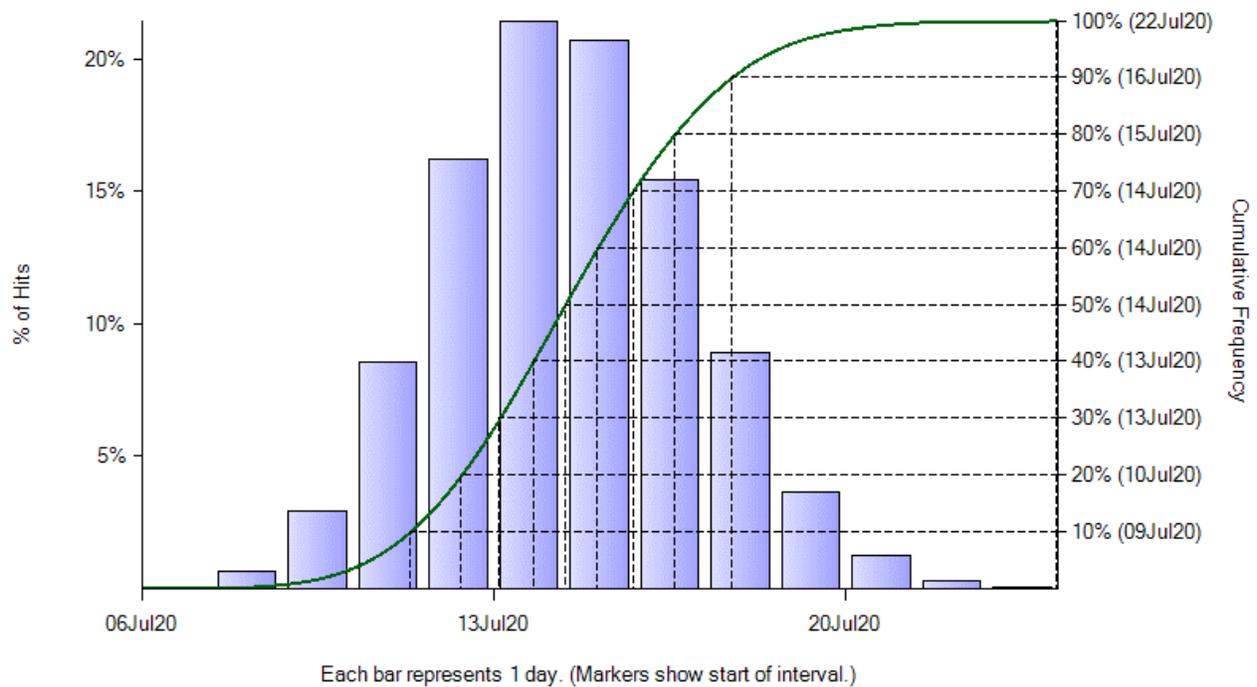


Figure 10

The result now clearly resembles a Normal (bell shaped) distribution and some of the simulations show a Delivery date earlier than 10Jul20.

There are however, two disadvantages with using this technique.

- 1) One must remember to set the support task durations/inactive flag appropriately prior to performing the risk analysis.
- 2) Support costs will not be included in the analysis by Full Monte as the support tasks effectively do not exist for the purposes of the SRA.

The Cost histogram shown in Figure 11 clearly shows that only costs associated with the work required to fulfill deliverables have been included (\$31,200). Support effort has not been included.

Project LOE Example 2.mpp (10000 simulations performed on 6/22/2020)

Histogram of Cost for task 'Project Widget' (UID 46).

Mean = \$32,270. Standard deviation = \$1,910. Deterministic value = \$31,200 (30%).

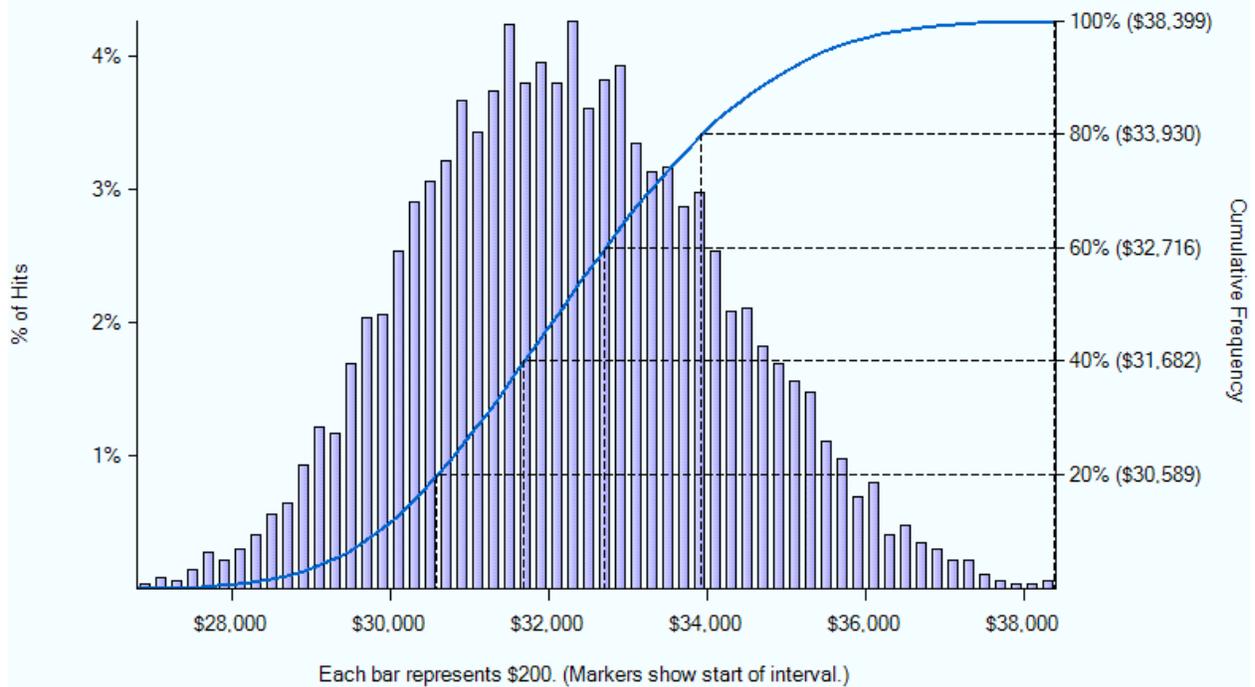


Figure 11

Assign Support Resources to Summary Tasks

The duration of summary tasks is automatically calculated by both Microsoft Project and Full Monte during the risk analysis process, so the summary task duration will expand/contract as the overall duration of the lower level details tasks changes during the simulation.

Note: Some schedule audit agencies frown upon the assignment of resources to summary tasks. You should verify the acceptability of this practice before adopting this technique.

In our simple example schedule, we could assign support resources to the 'Widget' summary task. This would include support work in the overall project cost, but we would again lose sight of the support costs in the overall total cost (as we would if we assigned support resources to individual tasks). In a more complex project, we would also likely end up with double counting for overhead if some summary tasks occurred in parallel.

Fortunately, Microsoft Project does allow us to simulate a hammock task using summary tasks as shown in Figure 12.

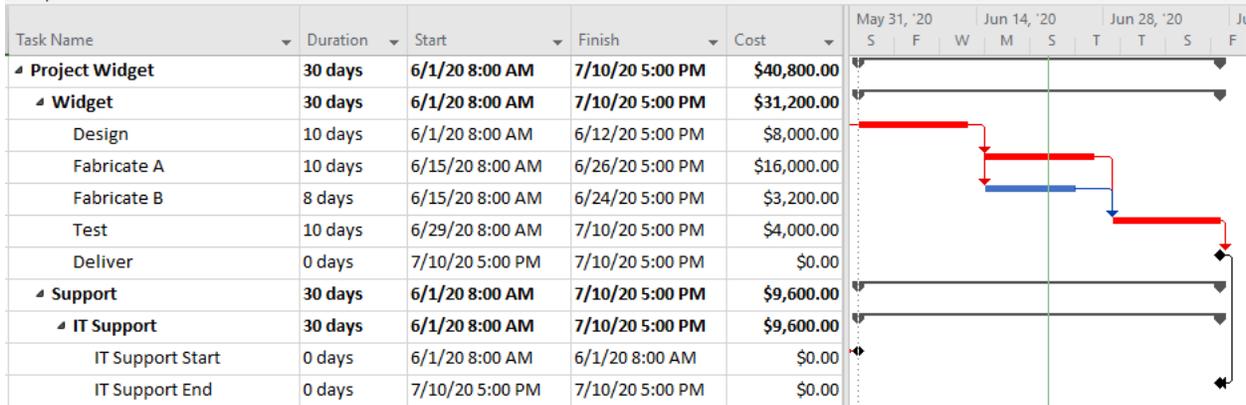


Figure 12

The 'IT Support' task has been changed to a Summary Task spanning two milestones. These milestones are 'IT Support Start' and 'IT Support End'. The 'IT Support Start' milestone has a Start-to-Start predecessors to the task representing the start of work for which IT support is required. The 'IT Support End' milestone has a Finish-to-Finish predecessor of the task representing the end of work for which IT support is required.

The 'IT Support' summary task correctly shows the 30-day elapsed duration between the two milestones.

The cost of the 'IT Support' summary task is shown as \$9,600 as per the original example in Figure 2.

Performing an SRA on this example gives the finish date probability distribution histogram shown in Figure 13.

Project LOE Example 3.mpp (10000 simulations performed on 6/22/2020)

Histogram of Finish for task 'Deliver' (UID 41).

Mean = 13Jul20, Standard deviation = 14 hours, Deterministic value = 10Jul20 (29%).

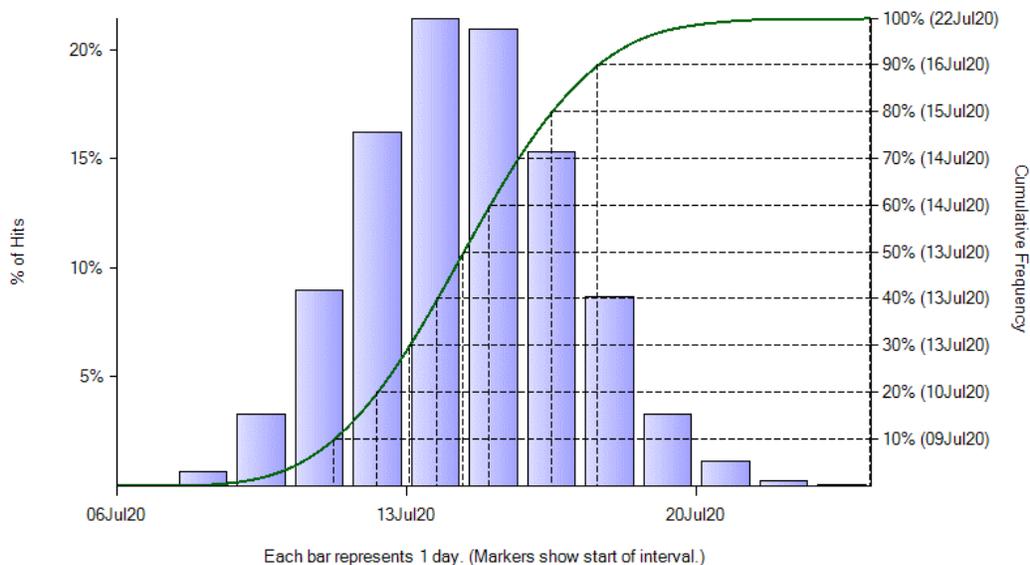


Figure 13

This is the expected result and has not been artificially constrained by the support tasks.

The total project cost now includes both the work effort and support costs as shown in figure 14.

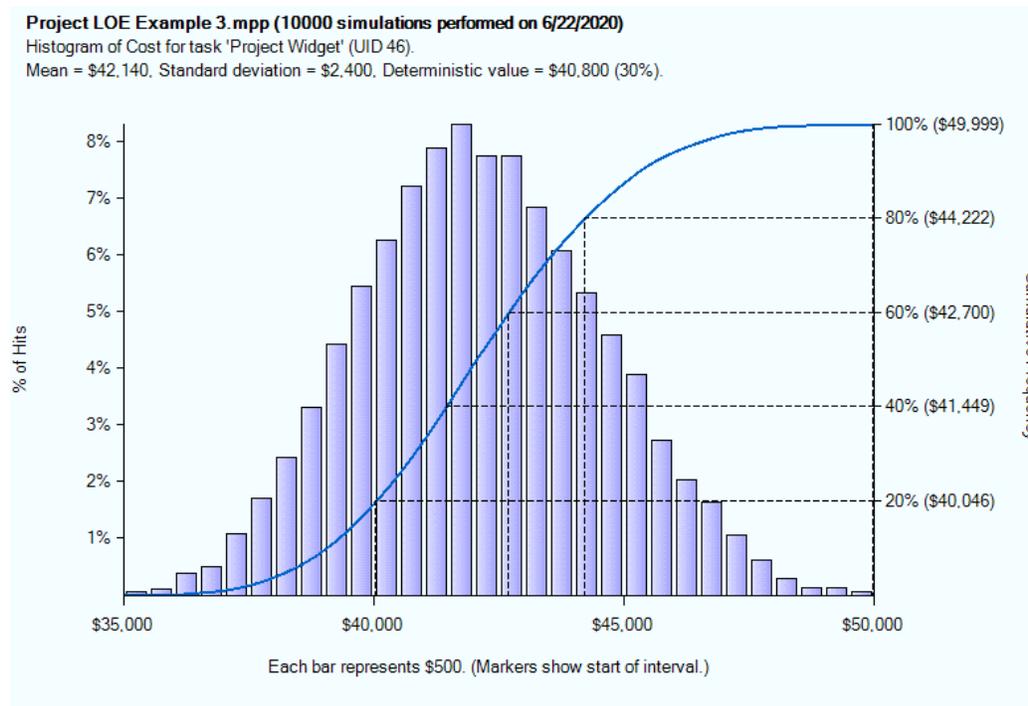


Figure 14

Figure 15 shows an example where Expected (Mean) Cost and Cost at the 80th percentile have been saved to Microsoft Project custom cost fields.

| Task Name | Duration | Start | Finish | Cost | Cost Expected Value | Cost Percentile (80%) |
|------------------|----------|-----------------|-----------------|-------------|---------------------|-----------------------|
| Project Widget | 30 days | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$40,800.00 | \$42,140.00 | \$44,222.00 |
| Widget | 30 days | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$31,200.00 | \$32,220.00 | \$33,896.00 |
| Design | 10 days | 6/1/20 8:00 AM | 6/12/20 5:00 PM | \$8,000.00 | \$8,258.00 | \$9,009.00 |
| Fabricate A | 10 days | 6/15/20 8:00 AM | 6/26/20 5:00 PM | \$16,000.00 | \$16,530.00 | \$18,005.00 |
| Fabricate B | 8 days | 6/15/20 8:00 AM | 6/24/20 5:00 PM | \$3,200.00 | \$3,303.00 | \$3,595.00 |
| Test | 10 days | 6/29/20 8:00 AM | 7/10/20 5:00 PM | \$4,000.00 | \$4,129.00 | \$4,502.00 |
| Deliver | 0 days | 7/10/20 5:00 PM | 7/10/20 5:00 PM | \$0.00 | \$0.00 | \$0.00 |
| Support | 30 days | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$9,600.00 | \$9,920.00 | \$10,396.00 |
| IT Support | 30 days | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$9,600.00 | \$9,920.00 | \$10,396.00 |
| IT Support Start | 0 days | 6/1/20 8:00 AM | 6/1/20 8:00 AM | \$0.00 | \$0.00 | \$0.00 |
| IT Support End | 0 days | 7/10/20 5:00 PM | 7/10/20 5:00 PM | \$0.00 | \$0.00 | \$0.00 |

Figure 15

Based on this analysis, we have an 80% chance that the total project cost will not exceed \$44,222 including direct costs of \$33,896 and overhead of \$10,393.

The Full Monte Level of Effort Flag

For situations where assigning resources to summary tasks is not acceptable, Barbecana has added a feature to Full Monte to allow customers to designate tasks that should be treated as Level of Effort (LOE) in a similar way to Hammocks in other scheduling tools.

The LOE support task is created in the same way as the original example in Figure 2. If the LOE support task is to span the entire project no further logic is required. Full Monte will calculate the duration of the task between Project Start (or Status Date) and the Project Finish calculated during the simulations.

However, the LOE support task may be linked with a Start-to-Start predecessor to any task in the schedule and either a Finish-to-Start to a successor or a Finish-to-Finish to a predecessor task. This will allow the calculated duration of the LOE support task to span specific portions of the schedule.

In the example shown in Figure 16, the 'IT Support' task has been linked with a Start-to-Start to 'Design' and has a successor Finish-to-Start link to 'Deliver'.

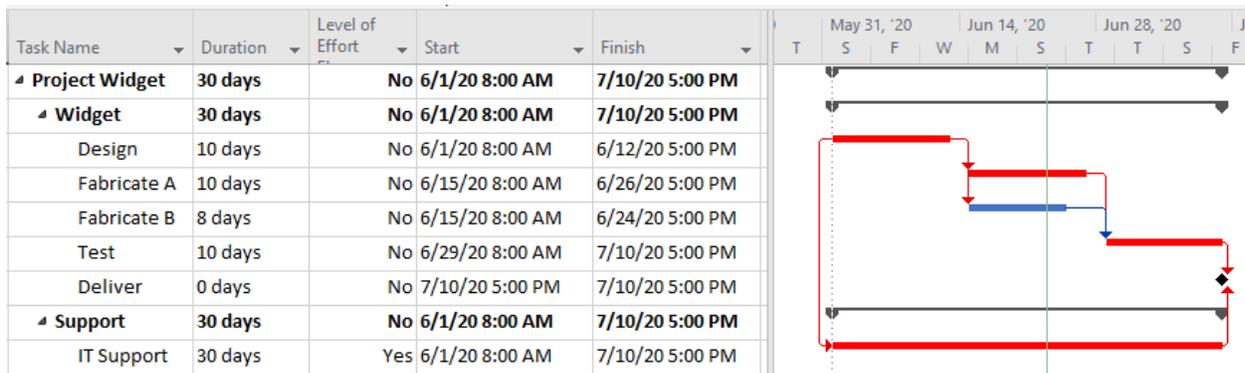


Figure 16

In the example, the task duration has been set to 30 days, representing the planned span from the start of Design through Delivery. This initial duration value is only used by Microsoft Project and will be ignored by Full Monte as the task Duration will be calculated during the simulations based on the dates of the linked tasks.

In Figure 17 we can see that a Custom Flag Field, in this case Flag10, has been renamed to 'Level of Effort' and set to 'Yes' for the 'IT Support' task.

| Task Name | Duration | Level of Effort | Start | Finish | Cost |
|----------------|----------|-----------------|-----------------|-----------------|-------------|
| Project Widget | 30 days | No | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$40,800.00 |
| Widget | 30 days | No | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$31,200.00 |
| Design | 10 days | No | 6/1/20 8:00 AM | 6/12/20 5:00 PM | \$8,000.00 |
| Fabricate A | 10 days | No | 6/15/20 8:00 AM | 6/26/20 5:00 PM | \$16,000.00 |
| Fabricate B | 8 days | No | 6/15/20 8:00 AM | 6/24/20 5:00 PM | \$3,200.00 |
| Test | 10 days | No | 6/29/20 8:00 AM | 7/10/20 5:00 PM | \$4,000.00 |
| Deliver | 0 days | No | 7/10/20 5:00 PM | 7/10/20 5:00 PM | \$0.00 |
| Support | 30 days | No | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$9,600.00 |
| IT Support | 30 days | Yes | 6/1/20 8:00 AM | 7/10/20 5:00 PM | \$9,600.00 |

Figure 17

This will be used to instruct Full Monte to automatically adjust the duration of the support task to span the simulated dates of the linked tasks.

This is achieved using the Full Monte Field Mapping shown in Figure 18. A field mapping entry has been added to link the Full Monte field 'Level of Effort Flag' with the Microsoft Project Custom Flag field, 'Flag10'.

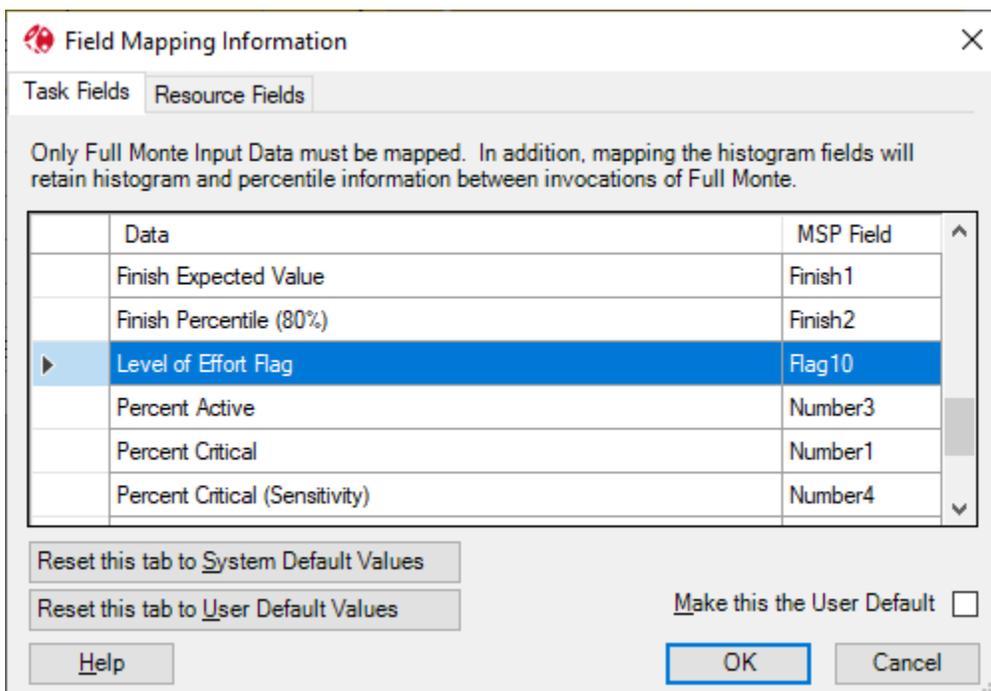


Figure 18

The results of a subsequent Risk Analysis again show the expected Normal (Bell Shaped) distribution for the Deliver finish date as shown in Figure 19. The duration of the 'IT Support' task is being automatically adjusted by Full Monte during the simulation, to reflect the span duration of the 'Design' through 'Deliver' tasks, and never affects the critical path.

Project LOE Example 4.mpp (10000 simulations performed on 6/22/2020)
 Histogram of Finish for task 'Deliver' (UID 41).
 Mean = 14Jul20, Standard deviation = 14.2 hours, Deterministic value = 10Jul20 (29%).

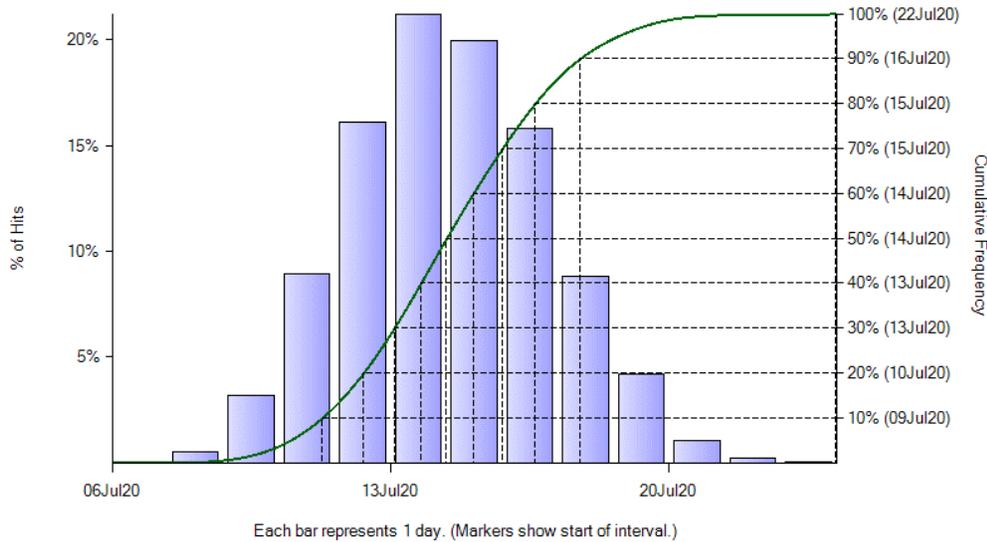


Figure 19

The project costs are also being correctly calculated and summed as shown in Figure 20.

Project LOE Example 4.mpp (10000 simulations performed on 6/22/2020)
 Histogram of Cost for task 'Project Widget' (UID 46).
 Mean = \$42,200, Standard deviation = \$2,430, Deterministic value = \$40,800 (30%).

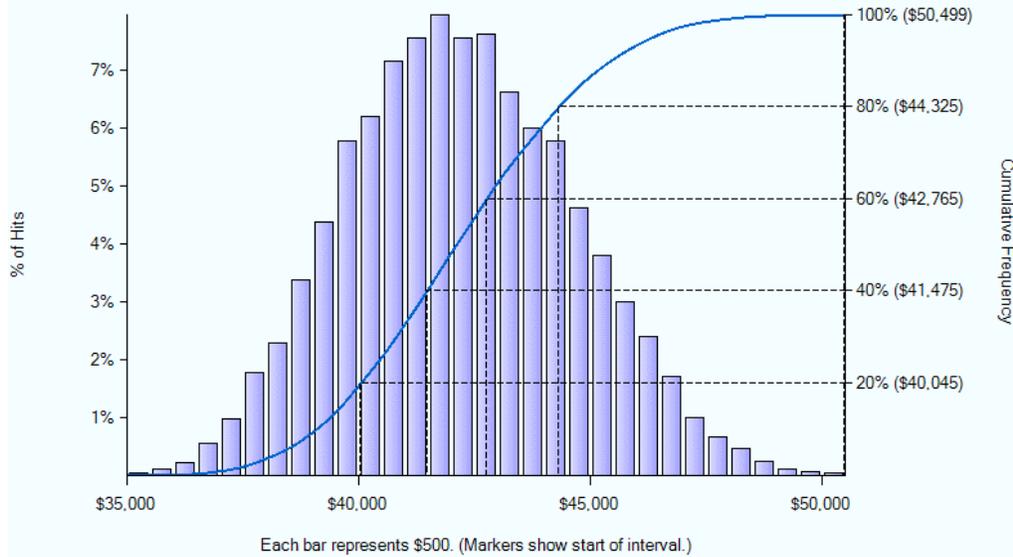


Figure 20

Note: The slight variation between Figure 14 and 20 are due to the 'random' nature of the samples used during the simulation. Increasing the number of simulations would reduce the variation.

Finally, the results can be saved back to Microsoft Project as shown in Figure 21. Observe that Full Monte has correctly set the 'Percent Critical' of the IT Support task to 0 (zero) as LOE Support tasks

should never appear on the Critical Path. The Green bar in the Gantt chart is showing the span of the LOE support task calculated by Full Monte at 80% confidence. The green bar spans the bars representing the 80th percentile confidence dates for the 'work' tasks and the support costs at 80% confidence have been displayed.

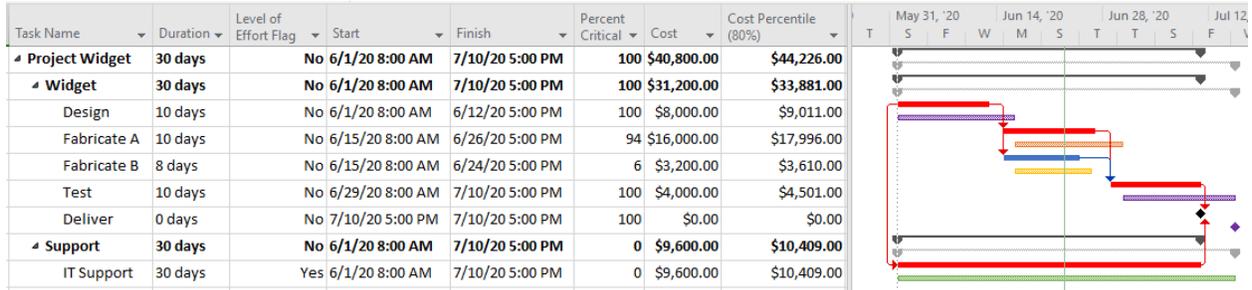


Figure 21

Conclusion

For resource loaded schedules, Full Monte supports two mechanisms to ensure that support work never ends up driving the critical path, using features integral to the base Microsoft Project scheduling tool for ease of implementation and maintenance.