The Full Monte Duration Confidence Interval

John Owen, *President*
Barbecana, Inc.

Introduction

Full Monte features an input field called the 'Duration Confidence Interval'. This document explains the purpose of the field and why we recommend it should not be used…

It is somewhat confusing that Full Monte has an input field called the 'Duration Confidence Interval' associated with the duration uncertainty fields (Optimistic, Most Likely, and Pessimistic Duration) while customers can require results to be presented at a specific level of confidence, often between 80 and 90 percent.

There is no connection between customers requesting results at say 80% confidence and the setting of any particular value in the Duration Confidence Interval field.

What does the 'Duration Confidence Interval' do?

The purpose of the Duration Confidence Interval is to model the scenario where a subject matter expert (SME) adds a caveat to an estimate they provide. Something along the lines of "I'm 80% confident the duration will fall between 15 and 25 days and the most likely is 18 days". So, the 15d would go in the Optimistic Duration, 18d in the Most Likely, the 25d would go in the pessimistic duration, and the Duration Confidence Interval would be set to 80%. What effect does this have?

Fundamentally, the estimator is saying they are only 80% confident the actual value will fall between 15 and 25 days. Logically this means they expect 20% of the actual values to fall _*outside*_ that range. So, when you set the duration confidence interval to 80%, Full Monte will extend the specified distribution shape in order to model 20% of the simulations with values outside the 15-25 day range. With a Triangular distribution with the duration confidence interval set to 80%, this means the effective optimistic/pessimistic durations will be optimistic 11.62d and pessimistic 29.55 days. Rather different to the original 15-25 days entered. You will see this information displayed in the preview graph on the task edit pane.

The situation gets worse if you use a Beta distribution. With the same data, but using a Beta distribution, the optimistic stays around the same at 12.89 days but the pessimistic moves out to 39.65d (10 days later). Why? Because the tail of the beta is long and thin so in order to achieve the required simulations outside the core 15 to 25 days the software must significantly extend the curve

So, to reiterate, we strongly recommend leaving the Duration Confidence Interval at 100%. Don't accept estimates with caveats. Require the SME to provide an inclusive estimate at 100% confidence. Otherwise the software will start to add in allowances that can be hard to explain/defend.

Result Confidence

Most organizations or customers require the results of an SRA to be presented at a specific Level of confidence. Often this is between 80% and 90%. In practical terms, if the required level of confidence is

80% then 80% of the SRA simulations must indicate a finish on or before the forecast date. This information is available on the finish histogram. Consider the histogram shown in Figure 1.

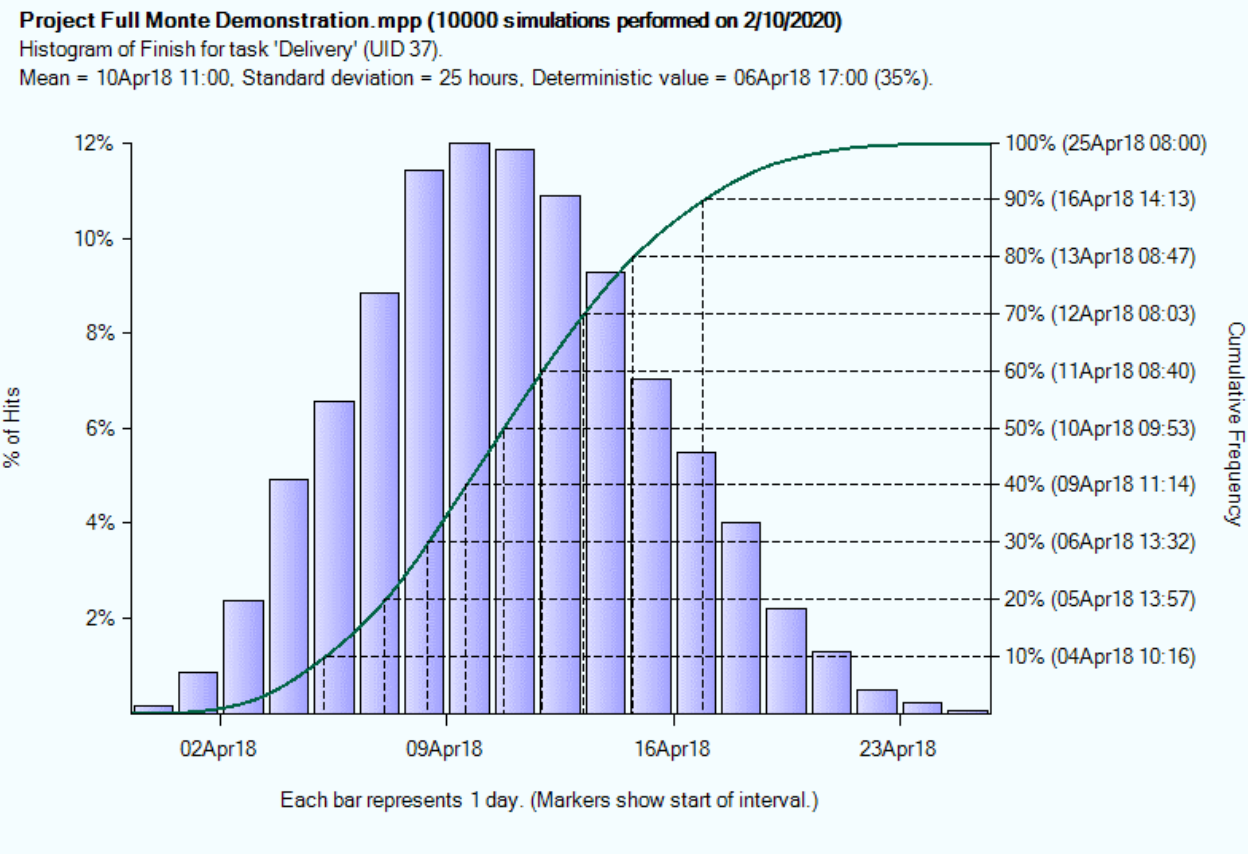

Figure 1.

We can see the deterministic finish date calculated by the scheduling tool is 6Apr18. The tool is indicating that only 36% of the simulations finished on or before that date – only a 36% chance of delivery by 6Apr18.

Using the right-hand Y-Axis, we see the cumulative probability of finishing by various dates. 80% of the simulations finished on or before 13Apr18 so this is the finish date we could publish at 80% confidence, sometimes called a P80 date.

Why not forecast results at 100% Confidence

The problem with forecasting results at 100% confidence is that we are saying 100% of the simulations must show such a completion date is possible.

In the example in Figure 1, the 100% completion date is 25Apr18. This is effectively the date produced when every single task, with uncertainty, finished at its worst-case pessimistic duration in an iteration of the simulation. Because this is actually (hopefully) unlikely, the tail of the probability distribution S-Curve starts to get quite thin/long at these extreme levels of confidence. This means that the 100% date will often be significantly further in the future compared to the 80 or 90 percent dates. In the example above we have 80%=13Apr, 90%=16Apr (3 days after 80%) and then 100%=25Apr (9 days after 90%).

Usually there is an opportunity cost associated with reserving resources to be available, should the worst-case scenario occur. In the above example, if we were committing at 100% confidence, we would have to reserve resources through Apr 25. This means not committing to any other work until after Apr 25. If missing the promised finish date would be catastrophic to the organization (Olympic stadium not ready, missing a unique launch window etc.) then you might forecast at 100% confidence. However, most commercial organizations forecast at some lesser level of confidence, say 80%, as a pragmatic balance between delivering as promised and being able to accept new work. Essentially this is balancing the opportunity cost vs the damages that might be incurred for late delivery.

So why have the Duration Confidence Interval?

There are two reasons the Duration Confidence Interval can be used.

Firstly, some competitive schedule risk analysis software solutions feature a probability distribution type called TriGen. This is essentially a Triangular Distribution with a built in Duration Confidence Interval set to something less than 100. The actual value varies by system. Full Monte's Duration Confidence Interval allows the modelling of the TriGen distribution in a more flexible generic way.

Secondly, the Duration Confidence Interval can be used to ensure some duration samples will be taken from the extreme ends of a highly skewed Beta distribution.

Consider the example shown in Figure 2.

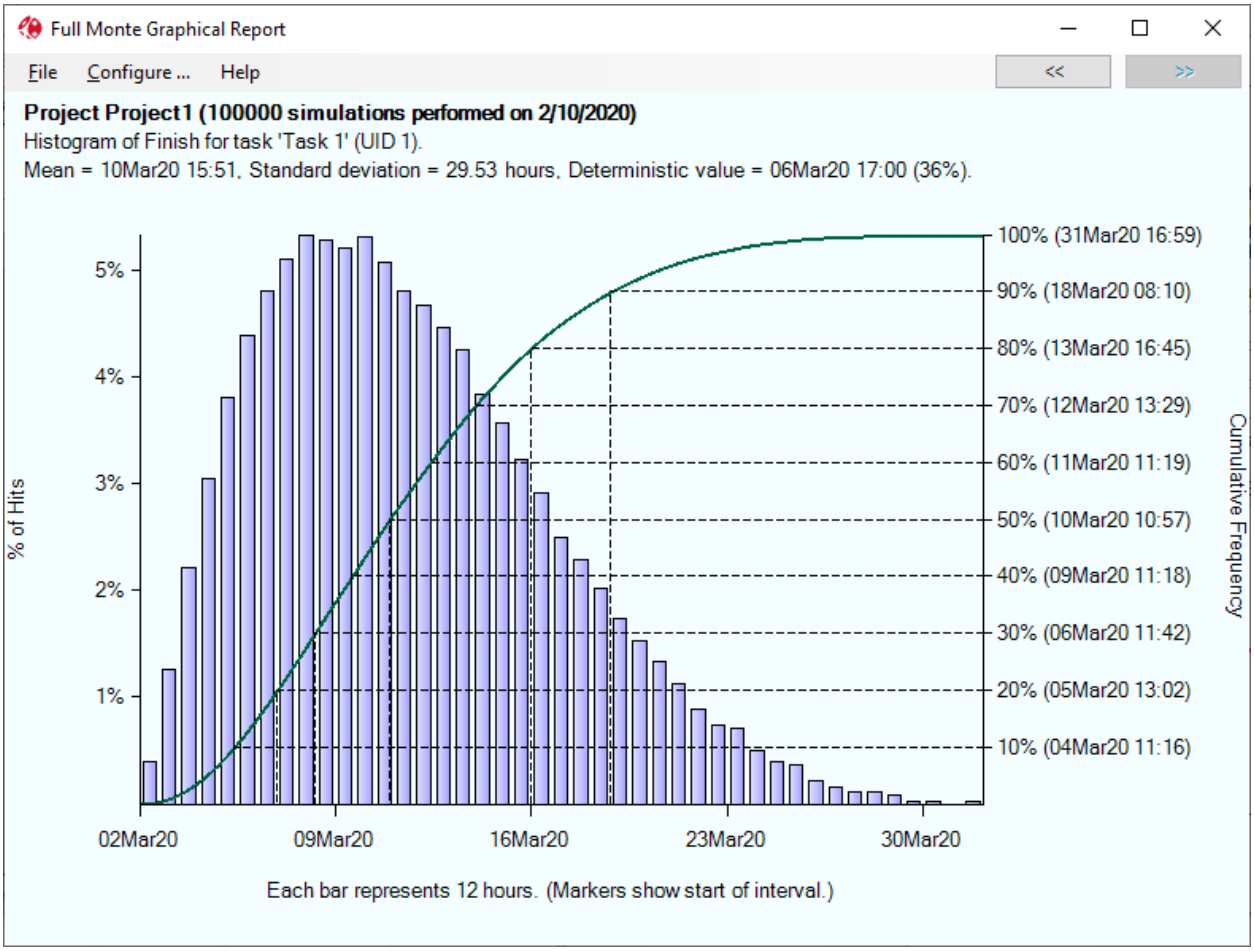

Figure 2.

Task 1 has a duration of 20 days with a pessimistic duration of 40 days. Because the beta distribution is weighted toward the Most Likely duration (20 days in this case), only a small number of samples will be taken close to the worst case 40d pessimistic duration.

In the example shown, less than 0.0% of 100,000 simulations finished in the first 12 hours of 30Mar20. In fact, no simulations finished in the second 12 hours of the same day and the 100% confidence date is shown as 31Mar20. This means 100% of the simulations finished on or before 31Mar20. In fact, the theoretical worst case finish is 3Apr20 (pessimistic duration = 40d).

So, despite performing 100,000 simulations, none of the sampled durations were selected at the theoretical worst case.

Even after running 1,000,000 simulations, the sampled worst case was still only 1Apr20 as shown in Figure 3.

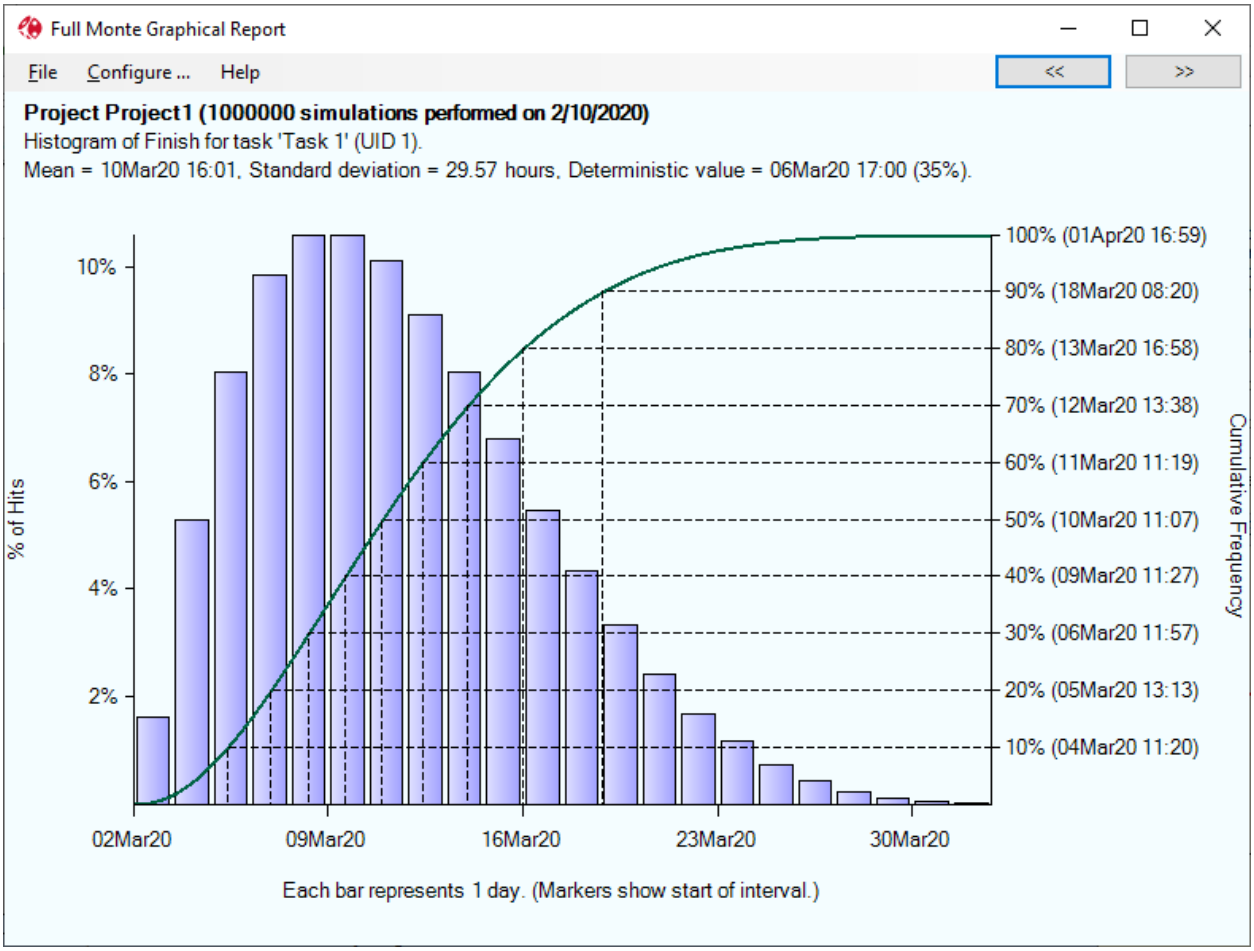

Figure 3.

This is statistically defensible since the Beta is so heavily skewed but what if it was felt essential that the model did indeed occasionally sample the duration at the full 40days?

We can use the Duration Confidence Interval to increase the chance of values being sampled close to the extreme pessimistic value. For the example shown in Figure 4, the Duration Confidence Interval for the task was set to 99%. Note that only 1,000 simulations were performed.

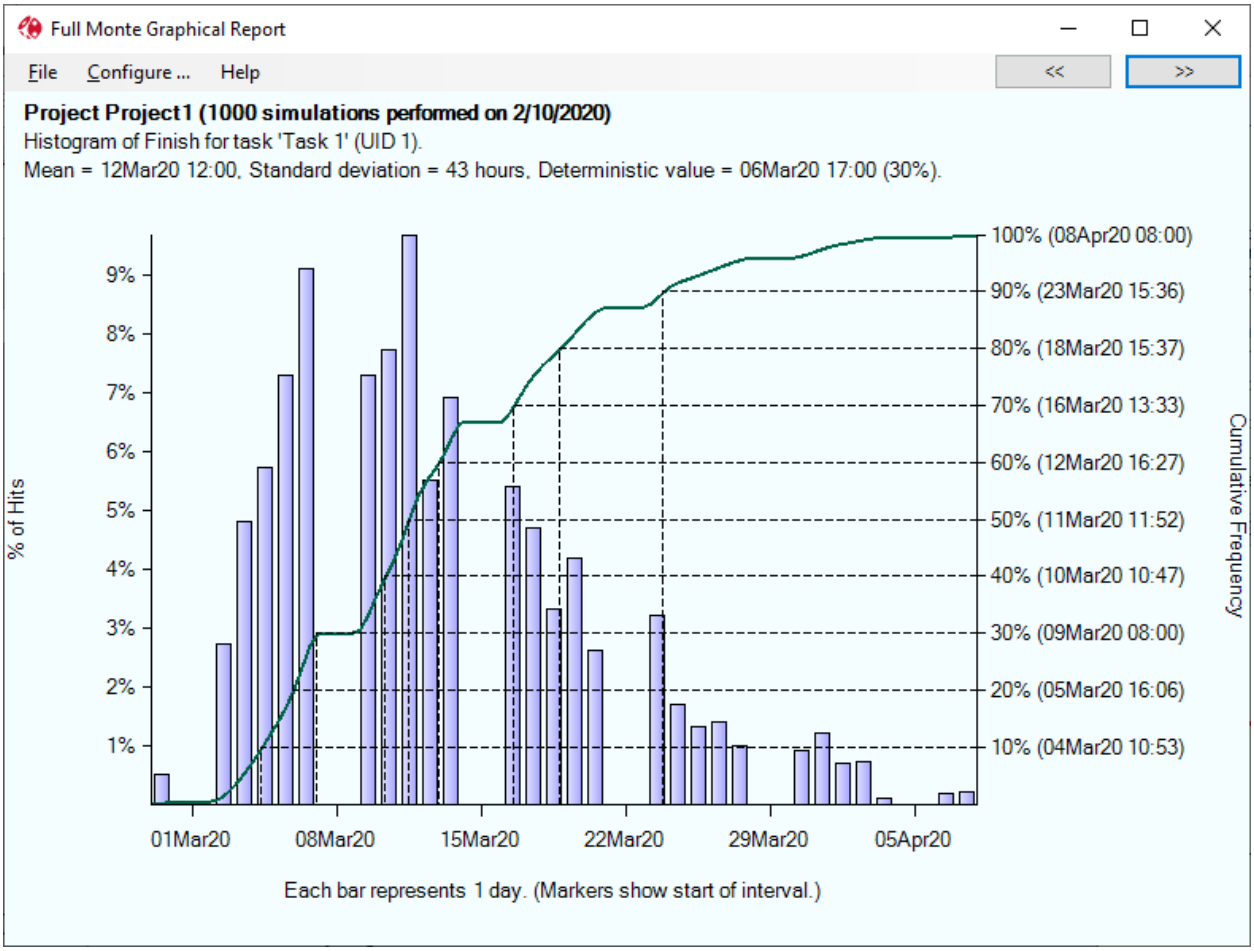

Figure 4.

While the histogram is less smooth because of the small number of simulations, we can see that the 100% confidence date is now 8Apr20 at 8am so the theoretical worst case of 4Apr has now been included in the simulation.

Summary

The Duration Confidence Interval is not related to requesting forecasts at say an 80% level of confidence. The Duration Confidence Interval is used to tell the software to select some sample durations from outside of the optimistic/pessimistic range specified by the estimator.

Barbecana recommends that the Duration Confidence Interval is always left at the default of 100% unless there is a compelling reason to do otherwise.