



# Schedule Risk Analysis

## What is it and Why Is It Worth Doing?

Microsoft Project Users Group (MPUG) – August 2023



### Presenter Info: John Owen

[John Owen](#) – joined Barbecana as Chief Operating Officer in 2014 and assumed the role of President and CEO in 2019. He has extensive experience of both project management and software development. Previous positions have included Senior Director for Product Management at Deltek, VP Development for Welcom, and Manager for Computerized Project Management at Worley Engineering. John's interests include Land Rovers, Smart Homes, and DIY projects around the house.





## Learning Objectives

- Learn what Schedule Risk Analysis means
- Understand the difference between Uncertainty and Risk
- Find out how to quantify Uncertainty and Risk
- See how to apply Uncertainty and Risk to CPM schedules
- Interpret the results to create more achievable outcomes
- Use Schedule Margin to protect contract deliverables

# What problem are we trying to solve?



An unfortunate truth is that many projects are delivered later than expected, and often cost more than budgeted.

Sometimes this is blamed on poor estimating and/or execution.

A major reason is often poor management of scope changes.

But what part do Risks and Uncertainty play?

# Schedule Risk Analysis is...



A technique to enhance Critical Path Method (CPM) models to consider the impact of risks and uncertainty.

All projects have some exposure to risk/uncertainty. Schedule Risk Analysis uses a technique called Monte Carlo Simulation to model the effects of risk/uncertainty.

Don't confuse an SRA using Monte Carlo with other techniques like PERT that also capture estimate ranges. PERT still produces a single deterministic answer that doesn't consider how uncertainty on the various paths through the project interact and affect the outcome.

**Risks** are potential events that May, or May Not occur. To all intents and purposes, they are **Random**.

Technical name: Aleatoric (depending on Chance)

**Uncertainty** is caused by a lack of Precise Knowledge about the future. We cannot know, **with absolute certainty**, exactly how long a task will take to complete until it is actually complete.

Technical name: Epistemic (relating to Knowledge)

# The Effect of Risk and Uncertainty



If a **Risk** occurs, it will likely change the flow of the project logic and add time and/or cost to the project tasks. Usually this means extra work to be performed to complete the project.

**Uncertainty** will affect the time and/or cost that will be required to complete individual planned tasks. Tasks may take more (or less) time to complete compared to their original estimates.

The impact of Risk(s) can be obvious, but **Uncertainty** can cause more **surprising delays** to the schedule.

# What about Opportunities?



Many project management authorities (like the Project Management Institute – PMI) consider both **Threats** and **Opportunities** as subsets of **Risks**.

However, in practice, they are very different, and Barbecana recommends using the term ‘risk’ to only refer to ‘threats’.

**Threats are random.** They may be mitigated but if they happen, they will impact the schedule and are **not under your control**.

**Opportunities are typically a choice.** You do not have to implement an opportunity. **Any impact to the schedule is because you chose it.**

Risk Management is the **Identification** of threats (risks) and planning the subsequent **Response** to those threats.

Risks have two attributes: The **Probability** they will occur, and the **Impact** should they occur.

Not all risks will affect the schedule and not all schedule risks will necessarily be modelled as tasks in the schedule.

Remember, information (in this case knowledge of a risk) is only useful if you take action based on that knowledge!



Risk Identification is a process that detects, describes, and catalogs potential threats (or opportunities) that could impact business or project outcomes in terms of performance (schedule), cost, quality, damage, or reputation.

Sources include:

- Project Scope Review
- Lessons Learned
- Subject Matter Experts, Interviewing Staff
- Brainstorming / SWOT analysis

Identified Risks are cataloged/captured in a **Risk Register**

For each Risk in the Risk Register, a response is identified. The response to a risk can take several forms including:

- Avoidance Eliminate the conditions that create the risk.
- Mitigation Reduce the chance of a risk occurring and/or reduce its impact should it occur.
- Transfer Shift the impact/responsibility to a third party
- Acceptance Acknowledge the risk but take no action.

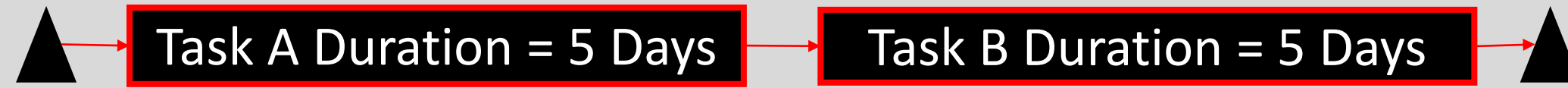
For Mitigation and Acceptance response types, it **may** be appropriate to include tasks in the schedule to represent the (residual) potential impact to the schedule.

While Risk Management (Risk Identification and Response planning) is crucial to project success, modelling **Uncertainty** in a schedule, for the purposes of a Schedule Risk Analysis, is arguably **far more important**.

The impact of risks is easy to comprehend. If Risk A occurs and it affects a task on the critical path, then it will delay the project by x...

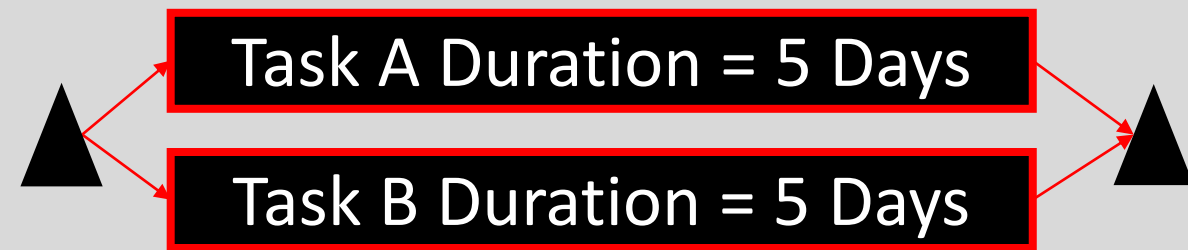
However, the potential for delay to the project due to estimate uncertainty is not so obvious.

# The Surprising Effect of Duration Uncertainty



In this 'serial' example, if Task A is delayed, we can potentially make up the time while executing Task B, so the successor milestone can still start on day 11 as planned

Assume each task is just as likely to finish a little early, as a little late.



In this 'parallel' example, if Task A is delayed, then the start of the successor milestone is delayed, regardless of how well we perform on Task B.

Task A	Task B	Milestone Start
Early/On-Time	Early/On-Time	Early/On-Time
Late	Early/On-Time	Late
Early/On-Time	Late	Late
Late	Late	Late

In this simple example there is a **75% chance** the successor will **not start on time!**

This effect is called **Merge Bias**.

Merge Bias occurs when a task has more than one predecessor that could potentially drive the start of the successor. The result is **Merge Delay**.

In its simplest form, assuming all task durations are subject to some uncertainty, a task that has more than one potential driving predecessor will be less likely to start on time. It gets worse as you increase the number of predecessors.

What this means is that the planned project completion, shown by a Critical Path Method (CPM) model, is unlikely to be realistic for complex projects with multiple parallel logic paths.

Risks typically don't create Merge Delay. Duration Uncertainty does.

Duration estimates are a key component of any project schedule.

They can be based on historical information or detailed estimates of the work content.

Some estimates will be more accurate than others. For example, the time taken to lay 250 bricks can often be estimated with some confidence while the estimated time to develop a new software program will likely be less reliable.

A task duration estimate should provide a 50/50 chance of completing the work in the time estimated.

# Padding Duration Estimates – Don't do it!



On the previous slide we suggested that a task duration estimate should give workers a 50/50 chance of completing the work in the time estimated.

Isn't that planning to fail 50% of the time?

From the perspective of a single task Yes, but projects have hundreds or thousands of tasks. Unless we are really bad at estimating, some tasks will finish earlier and some later.

Also, if we pad duration estimates to ensure the work can be completed in the estimated time, the project finish date will likely be unacceptable to stakeholders and don't forget Parkinson's Law.

A **Three-Point Estimate** is used to capture our assessment of uncertainty for individual tasks.

**Optimistic** (Best case) – The shortest duration we believe the work can be completed in.

**Most Likely** – Usually the same as the original duration estimate and representing the time where we have a 50/50 chance of completing the work.

**Pessimistic** (Worst case) – The longest duration we believe the work could take to complete.



# Obtaining Three-Point Estimates



**Range Assessments** – A simple assessment of confidence in the estimate. E.g. High, Medium, Low or numeric bands.

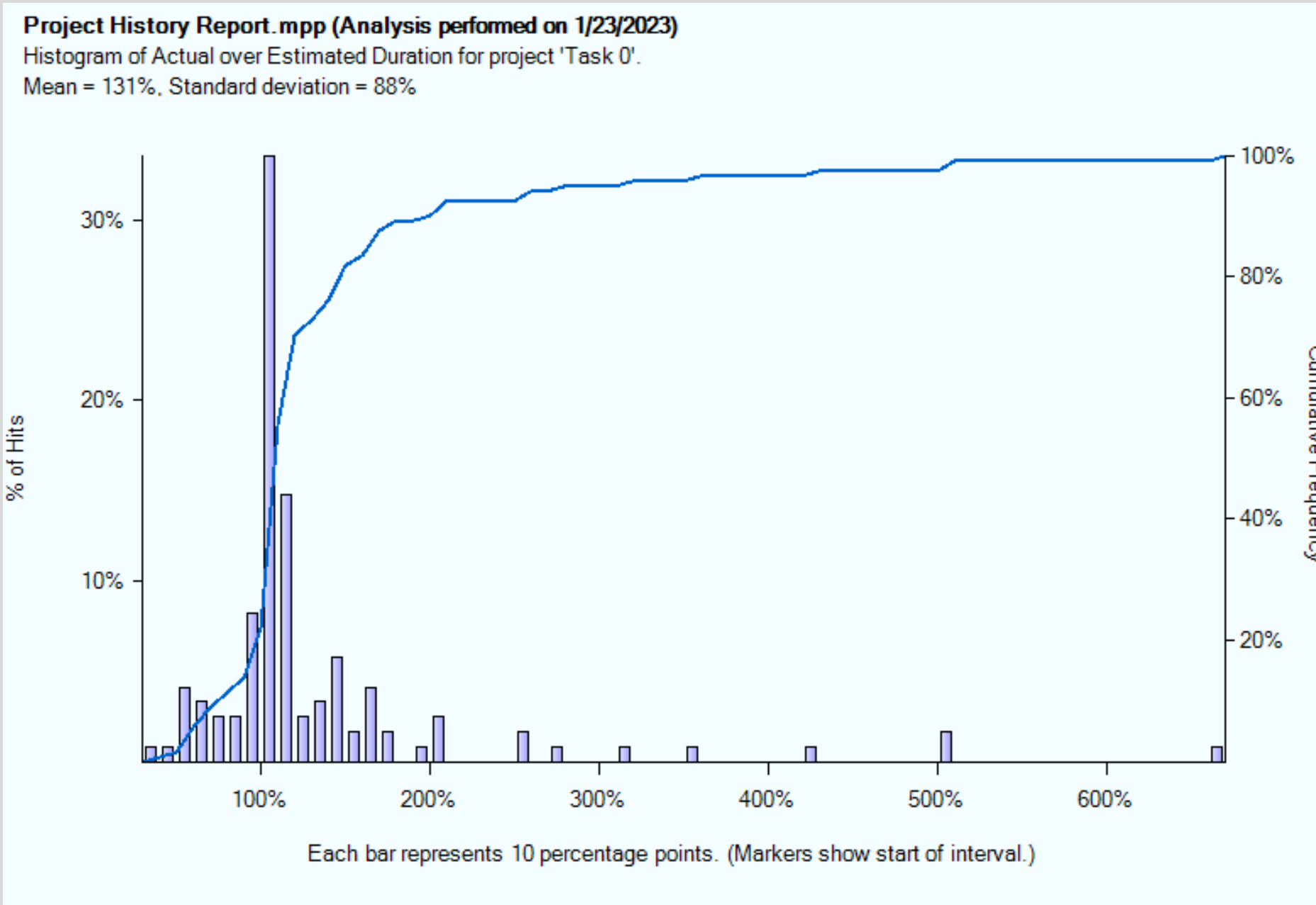
**Subject Matter Expert (SME)** – Can provide discrete duration estimates for the three points. (8 days, 10 days, 14 days)

**Historical Analysis** – Can provide insight into past performance against estimates in the form of percentages (e.g. 80%, 100%, 140%) for similar work.

**Not all tasks** need detailed three-point estimates. **Focus on critical, near-critical and known high risk/uncertainty tasks.**

That said, applying some 'background' uncertainty to all tasks can enhance the value of sensitivity analysis later in the process.

# Historical Analysis



The chart shows an analysis of actual vs estimated durations for completed tasks.

For similar future tasks we could use this information to justify uncertainty estimates of:

Optimistic = 50%

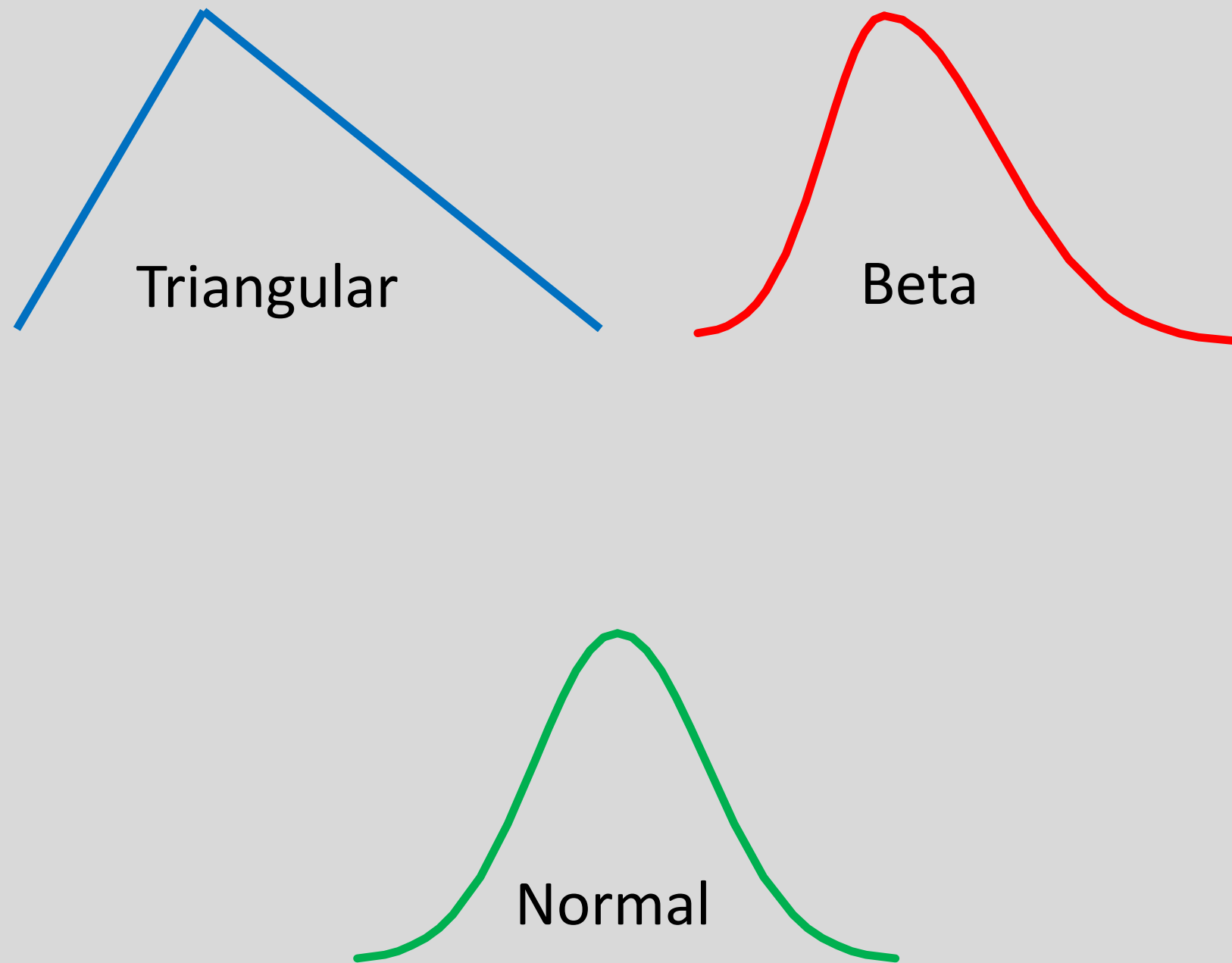
Most Likely = 100%

Pessimistic = 200%

With a Beta Distribution.

The outliers above 200% should be investigated for data entry errors or lessons to be learned regarding threats that occurred.

# Duration Distributions



Along with three-point duration estimates, we can specify how likely we think the actual value is to be closer to any of the three points using a Distribution Type. The most used are Triangular, Beta and Normal.

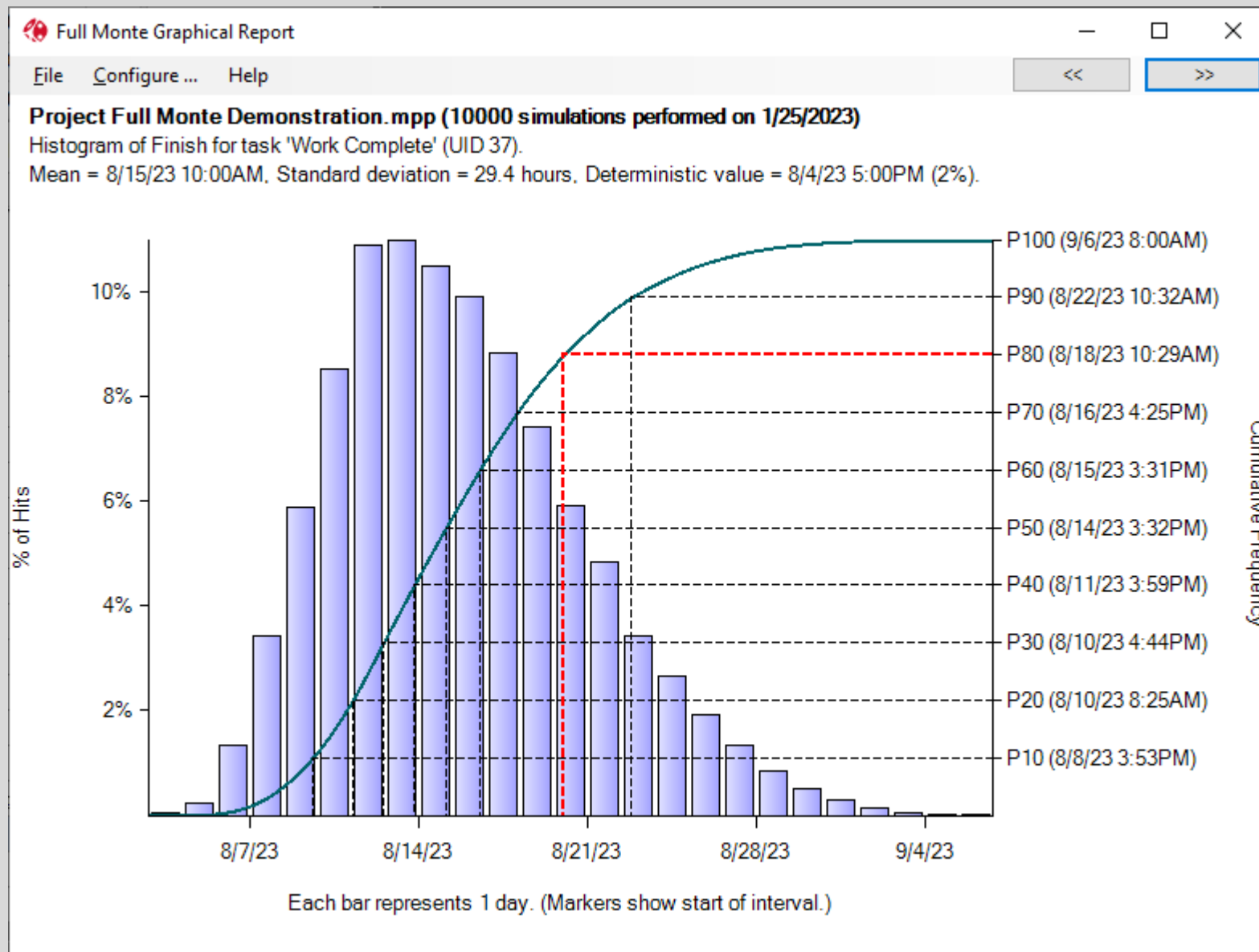
Ultimately what we want to know is how likely we are to meet contract delivery dates and costs.

The SRA process involves running many simulations using different task durations selected from the specified Three-Point estimates.

This will create a frequency distribution histogram showing the range of possible finish dates. We can use the information to suggest how likely we are to finish by a specified date.

Most commercial projects aim for between 80% and 90% confidence that the project will finish by the contract delivery date.

# Result Confidence



The bars show the number of times the project completed on specific days during the simulation.

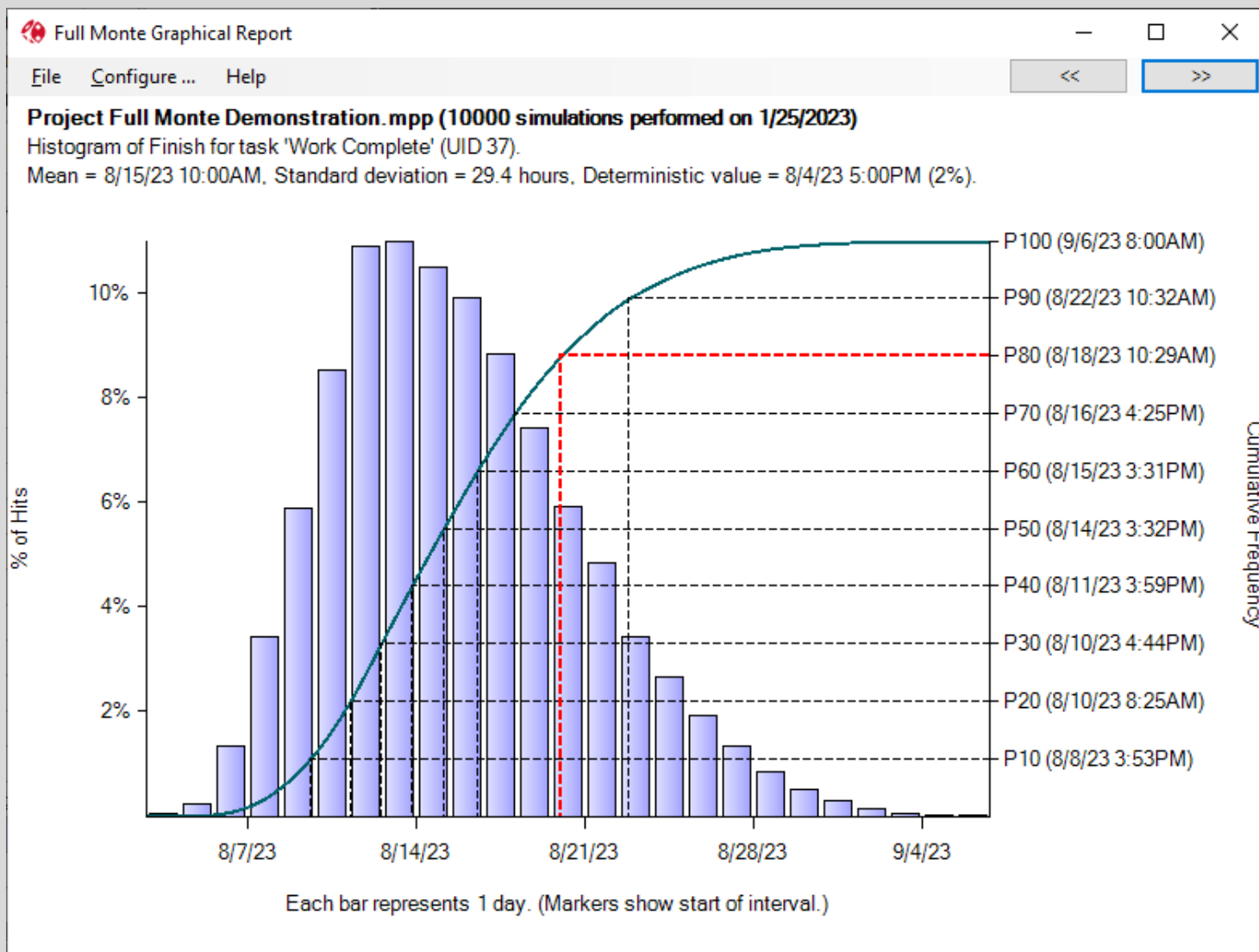
80% of the simulations show a finish on or before 8/18 (highlighted in red).

The software is predicting just a 2% chance of completion by 8/4 (the date calculated by the scheduling tool).

# Why not use 100% Confidence?



We said earlier that most commercial projects forecast at 80-90% confidence. In the example graph below, we can see the 80% confidence finish is August 18. There's a 20% chance we won't achieve that, and the worst case simulated result was September 6.



Some projects will forecast at 100% confidence (Olympic Stadium, Space Probe) but for most projects, provided the penalty for late delivery isn't catastrophic, a lesser value gives you the opportunity to bid for new work sooner, giving the opportunity to be more profitable.

# What if we don't like the answer?



It is an unfortunate truth that a schedule risk analysis often gives an uncomfortably low probability of meeting contract deadlines.

Schedule Sensitivity Analysis, displayed as a 'Tornado' Chart, can identify opportunities for schedule compression to meet contract requirements.

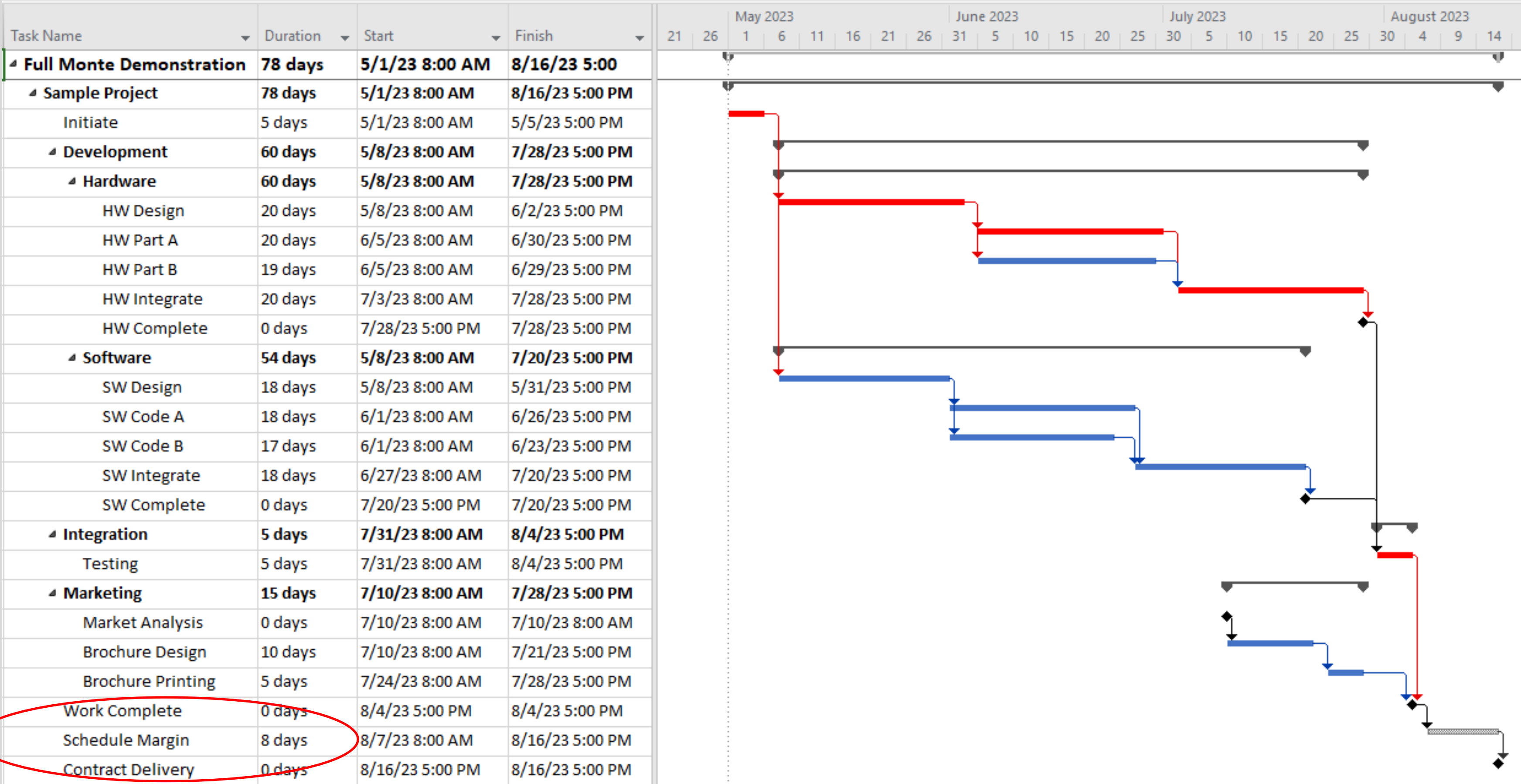
ID	Task Name	Remaining Duration	Percent Critical	Percent Critical (Sensitivity)	Sensitivity Index	Sensitivity Index		Optimistic Mean Finish of Project	Pessimistic Mean Finish of Project	Project Mean Finish 14Aug23 08:05			Schedule Sensitivity Bar Basis
						20.0	40.0			2023	Aug		
										06	13	20	
11	SW Design	18 days	80%	80%	53%			10Aug23 09:02	21Aug23 14:41				Estimated
14	SW Integrate	18 days	80%	80%	53%			10Aug23 09:02	21Aug23 14:41				Estimated
12	SW Code A	18 days	53%	53%	35%			11Aug23 08:30	21Aug23 09:35				Estimated
13	SW Code B	17 days	27%	27%	17%			11Aug23 14:27	17Aug23 15:40				Estimated
17	Testing	5 days	100%	100%	16%			10Aug23 15:13	15Aug23 10:05				Estimated
2	Initiate	5 days	100%	100%	16%			10Aug23 15:13	15Aug23 10:05				Estimated
8	HW Integrate	20 days	20%	20%	7%			11Aug23 16:16	15Aug23 14:11				Estimated
5	HW Design	20 days	20%	20%	7%			11Aug23 16:16	15Aug23 14:11				Estimated
6	HW Part A	20 days	16%	16%	5%			11Aug23 16:31	15Aug23 11:49				Estimated
7	HW Part B	19 days	4%	4%	1%			11Aug23 17:00	14Aug23 15:13				Estimated

Using our assessment of uncertainty, the probability (chance) of achieving the 'work complete' milestone by the date shown in the schedule is almost certainly less than 50% (due to uncertainty, risks and merge bias).

However, the 'work complete' date should not be the delivery date promised to the customer. We can introduce a second 'contract deliverable' milestone after the 'work complete' and protect it with a **Schedule Margin** buffer.



# Example Schedule with Schedule Margin

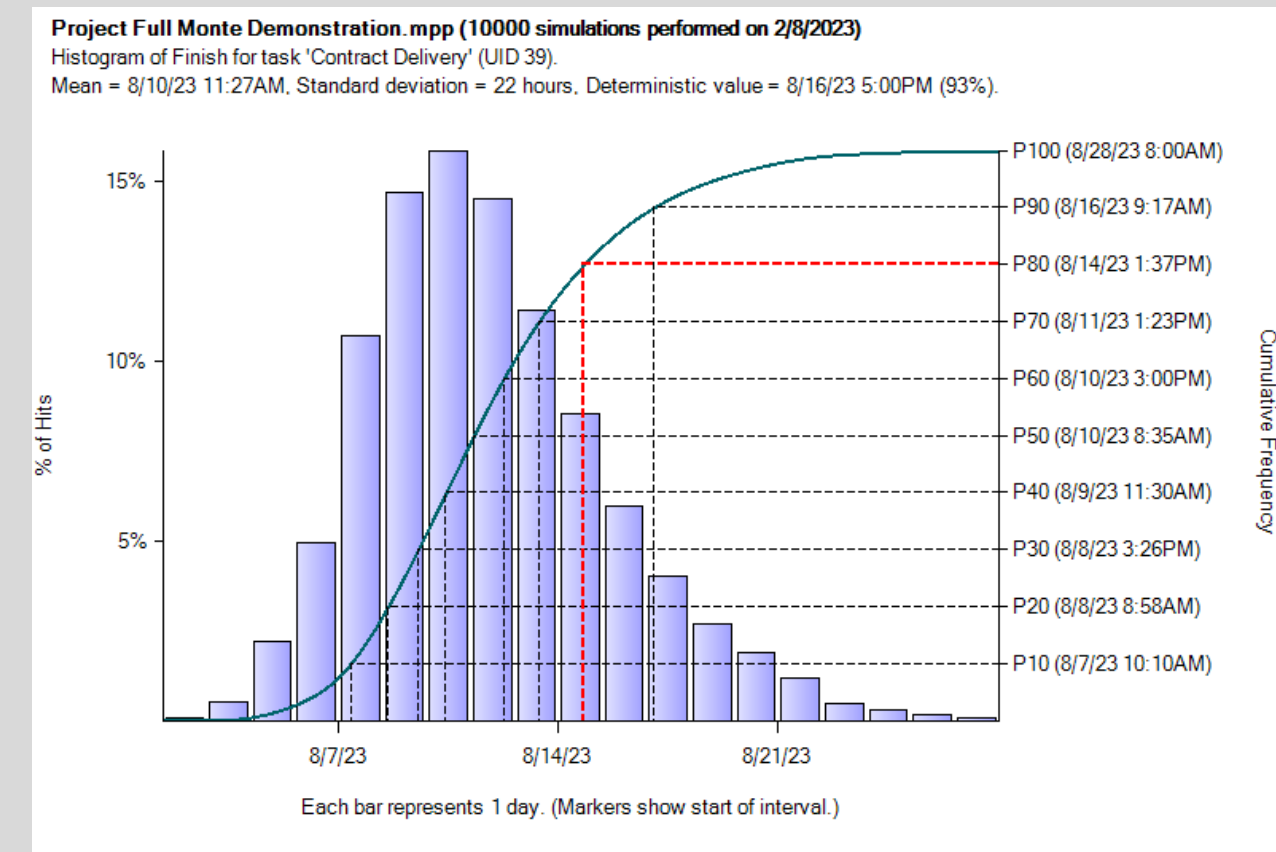
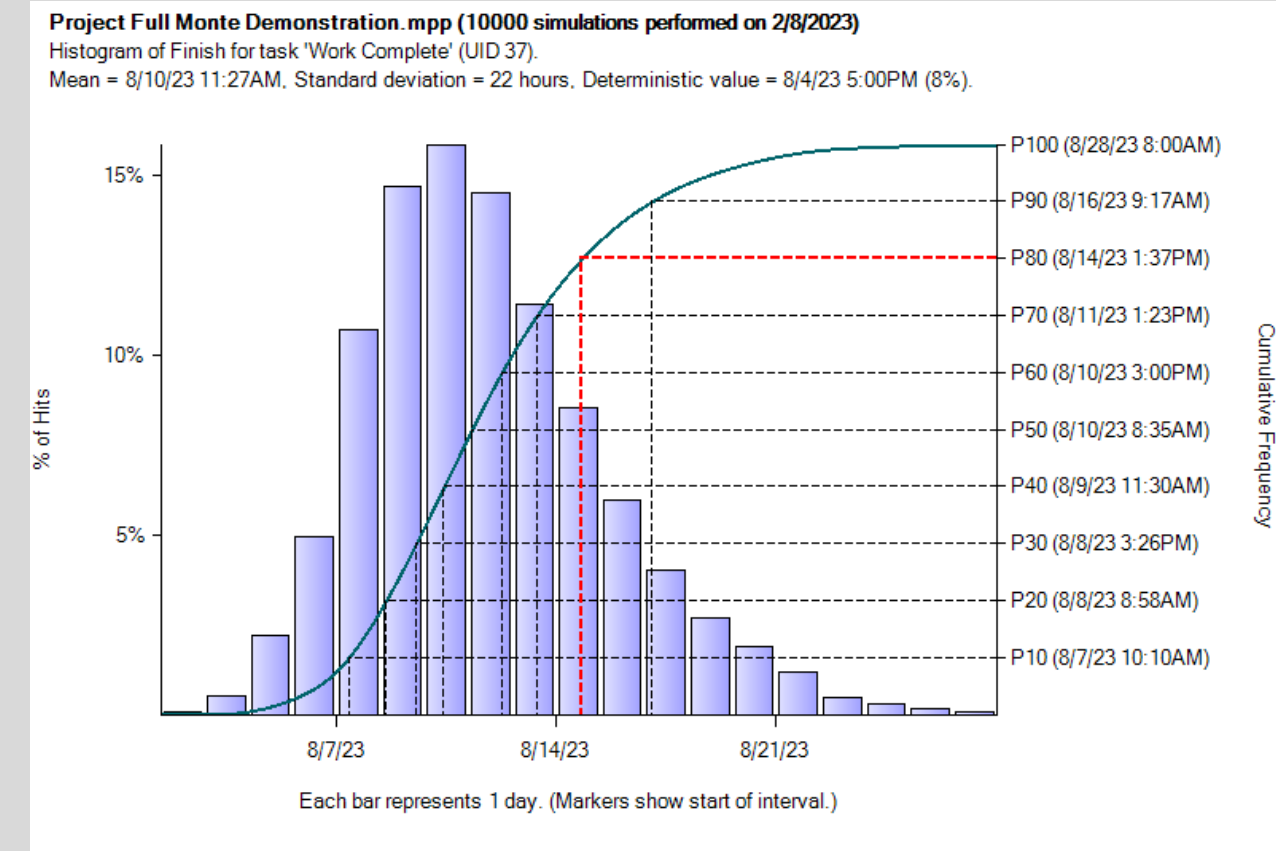


# Is 8 days Schedule Margin enough?



The committed contract delivery is August 16. Is 8 days schedule margin enough to protect that date from uncertainty and risk in the schedule at the required level of confidence?

The top histogram is 'Work Complete'. The analysis shows just an 8% chance of work being complete on August 4. The bottom histogram shows 'Contract Delivery'. It is showing a 93% chance of August 16 being achieved. In fact, it is showing an 80% chance we could deliver early on August 14.



# Schedule Risk Analysis – is it worth doing?



Absolutely YES!

In the following demonstration you will see that capturing risk/uncertainty information doesn't have to be onerous and the impacts can quickly be determined.

Sensitivity Analysis can help identify opportunities for schedule compression.

By making realistic commitments, customers reward with repeat business, and managers and staff can work more effectively with reduced overheads due to avoidance of surprises.

For more information...



Risk Free trial software

**[www.barbecana.com](http://www.barbecana.com)**

Questions about the presentation or Schedule Risk Analysis

**John Owen**

**[jowen@barbecana.com](mailto:jowen@barbecana.com)**



# Thank you!



Email [sales@barbecana.com](mailto:sales@barbecana.com), and mention this webinar, to receive a 25% discount on Full Monte SRA for Microsoft Project and a free copy of the Schedule Inspector project health check software during August 2023.

John Owen

[jowen@barbecana.com](mailto:jowen@barbecana.com)

[www.barbecana.com](http://www.barbecana.com)

