INT 3 Schedule Risk Analysis

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and Training Workshop
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Agenda

- Add uncertainty to the schedule, correlation
- Demonstrate the Merge Bias
- Install reference ranges of Uncertainty
- Adding discrete risk events as Risk Drivers
- Probabilistic Branching
- Probabilistic Calendars
- Inflation
- Risk Prioritization

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Introduction

USAF Approach to Schedule Risk

"A Most Probable Schedule (MPS) will be prepared by assessing the durations presented in the offeror's MIPS (this means estimating the longest, the shortest, and the most likely duration for each task, activity, event, and milestone) and preparing a network-based Monte Carlo simulation in order to determine a schedule that has a 90% probable completion date."

Integrated Risk Management Guide,
Aeronautical Systems Center (ASC), draft, 9 April 1994

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Purpose of a Risk Analysis

- Promote the language of probability and use of its mathematics in risk analysis
  - Why do schedules overrun? Things do not go "according to plan"
- Examine elements of a project in detail, determining relationships and formulating a model
- Most people are less able to comprehend the whole of the problem than risk of the elements individually

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Purpose of a Risk Analysis (continued)

- Risk analysis strategy
  - Describe the risks at the level of the activity
  - Use the schedule and Monte Carlo simulation to find the overall project schedule risk
- The essence is a statement of the probability of program outcomes

Source: *Risk Assessment Techniques*,

Defense Systems Management College 1983

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Overrun Risk is Not a New Issue

"Initial cost and schedule estimates for major projects have invariably been over-optimistic. The risk that cost and schedule constraints will not be met cannot be determined if cost and schedule estimates are given in terms of single points rather than distributions"

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Overrun Risk is Not a New Issue
(continued)

"A formal risk analysis is putting on the table those problems and fears which heretofore were recognized but intentionally hidden."

Source: "*Final Report*,"
US Air Force Academy
Risk Analysis Study Team 1973

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Some Reasons for Schedule Risk

- Fundamental uncertainty in the work
- Unrealistic baseline schedule
- Natural, geological causes
- Project complexity
- Scheduling abuses
- Relying on participants outside the organization
- Subcontractor late

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Some Reasons for Schedule Risk

(continued)

- Design changes
- Staffing Manufacturing problems
- Contracting problems
- Customer (government) not supportive
- Cannot get subcontractor under contract

William Cashman, *"Why Schedules Slip…"*

Air Force Institute of Technology (AFIT) Master's Thesis, 1995

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Pitfalls in Relying on CPM

- CPM network scheduling is static, not dynamic
- Single-point activity durations known with certainty
- OK only if everything goes *according to plan*
- CPM durations are really probabilistic assessments

There are no "facts" about the future

Lincoln Moses, Statistician and Administrator of Energy Information in the US DOE

1977 Annual Report to Congress

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Risk Analysis Answers Many Questions that CPM cannot

- Since the inputs are uncertain, the results are uncertain and we need to make statistical statements
- Can address questions CPM cannot
- The 3 promises
  1. What is the likelihood of meeting schedule?
  2. How much schedule contingency do we need to provide?
  3. Where is there risk to the project schedule?

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Why Conduct Monte Carlo Simulation

- It would help estimate our project if we had data on 5,000 projects exactly like our, just with different risks occurring
- We never have such databases
- Monte Carlo simulation creates this database
  - Uses our schedule
  - Uses our risks
  - Risks occur in different combinations, 5,000 times, recording the results

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Simplified Progression of Capabilities

- Initially, just applied probability distributions to the activity durations (e.g., PERT) to represent all duration risk
- Within the last 10 years have integrated discrete risk events commonly found in Risk Registers
  - Relegated 3-point estimates to represent only inherent uncertainty, estimating error / bias
- Added capabilities such as probabilistic branching, probabilistic calendars and prioritization

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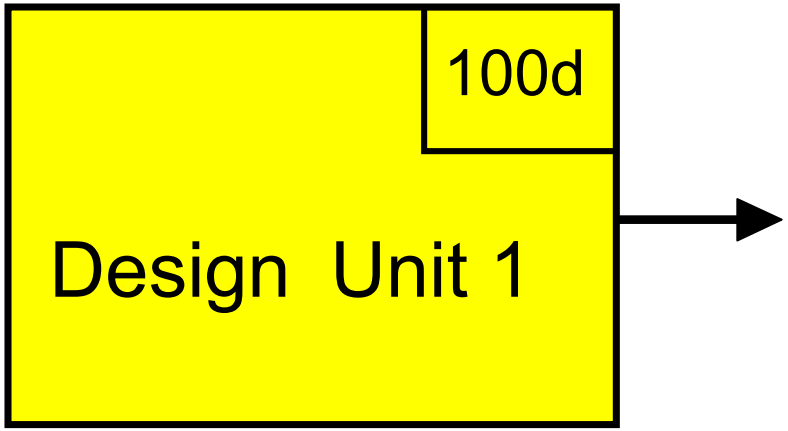
Risk of an Individual Activity

- Simple activity duration estimates are risky



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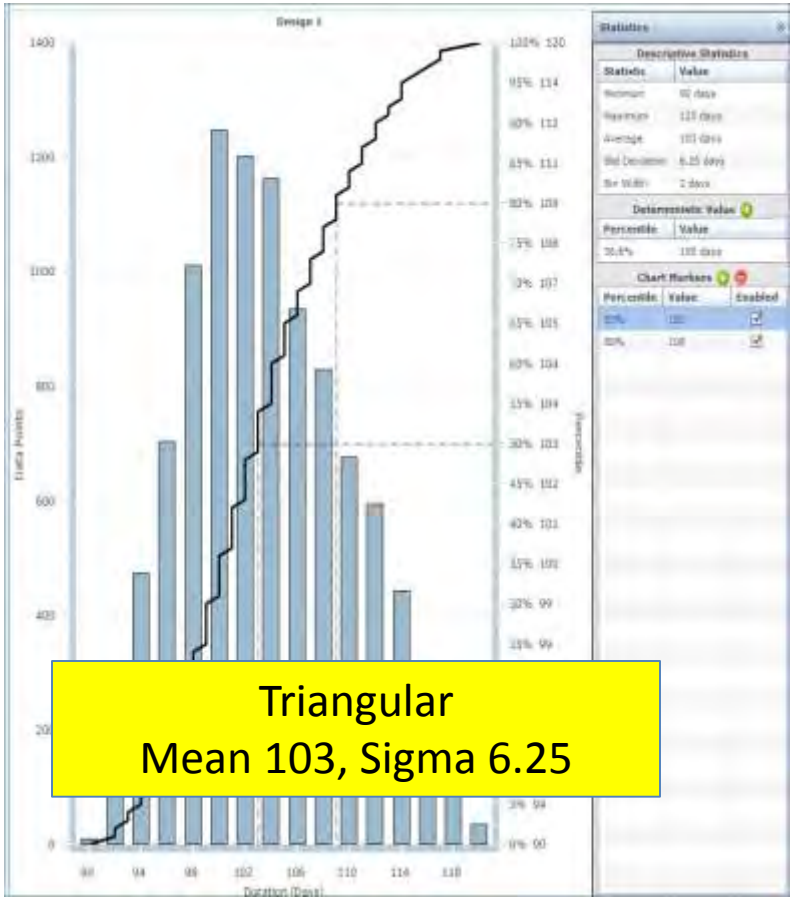
Uniform and Triangular Distributions
Uncertainty Range .9, 1.0, 1.2



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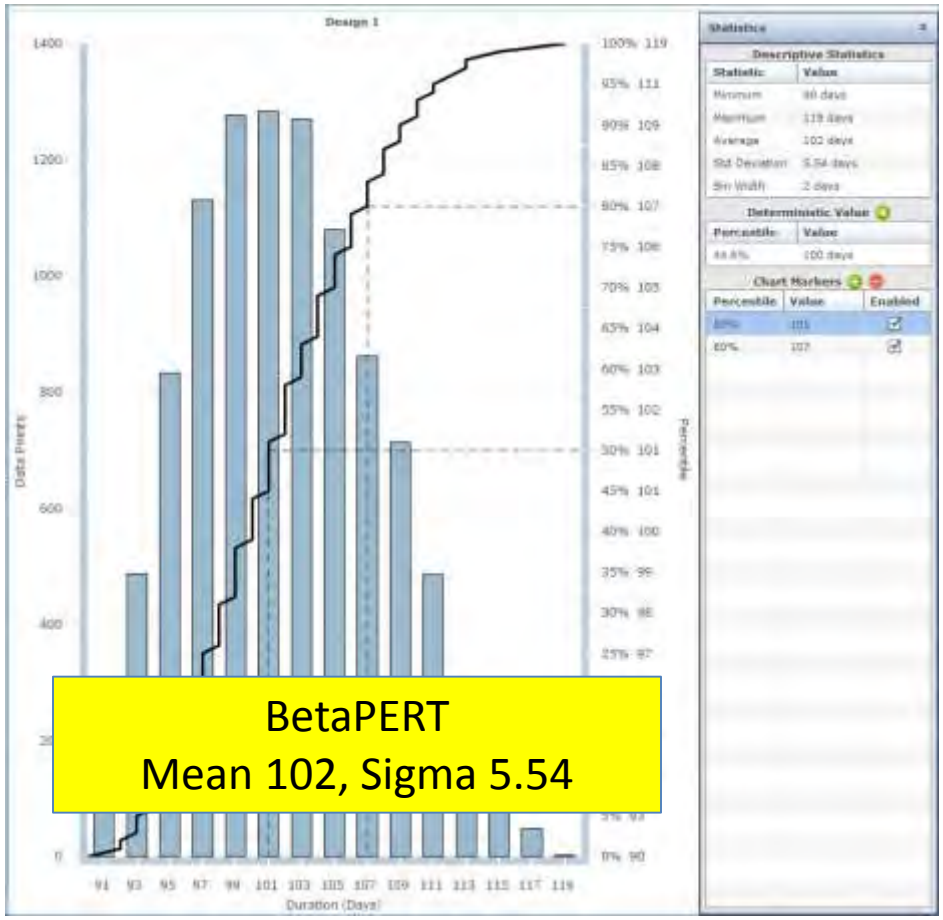
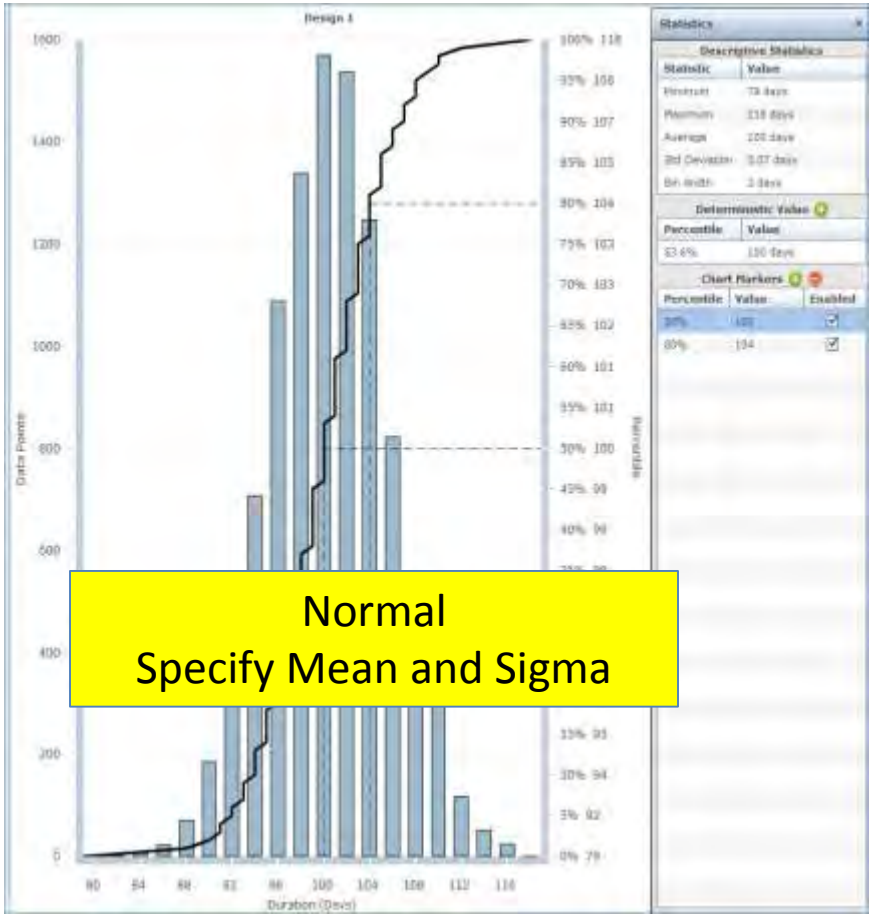
BetaPERT and Normal Distributions Uncertainty Range .9, 1.0, 1.2





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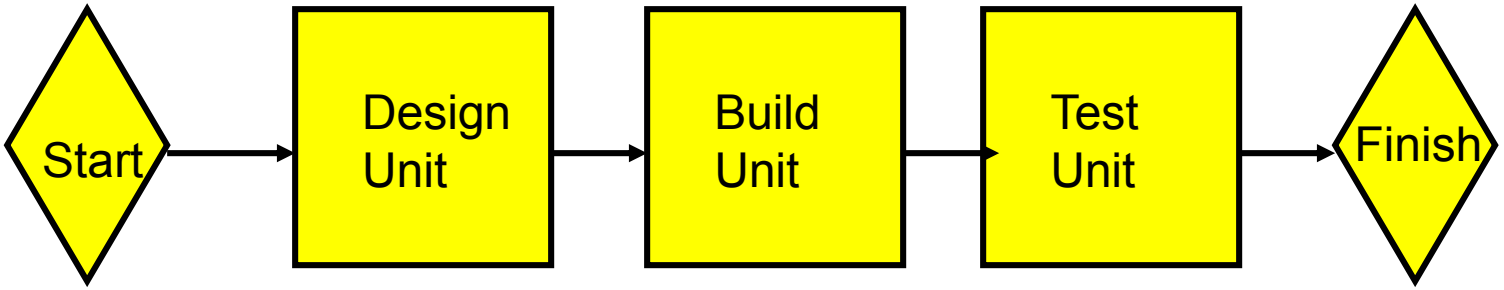
Risk Along a Contiguous Schedule Path

- Path risk is the combination of the risks of its activities



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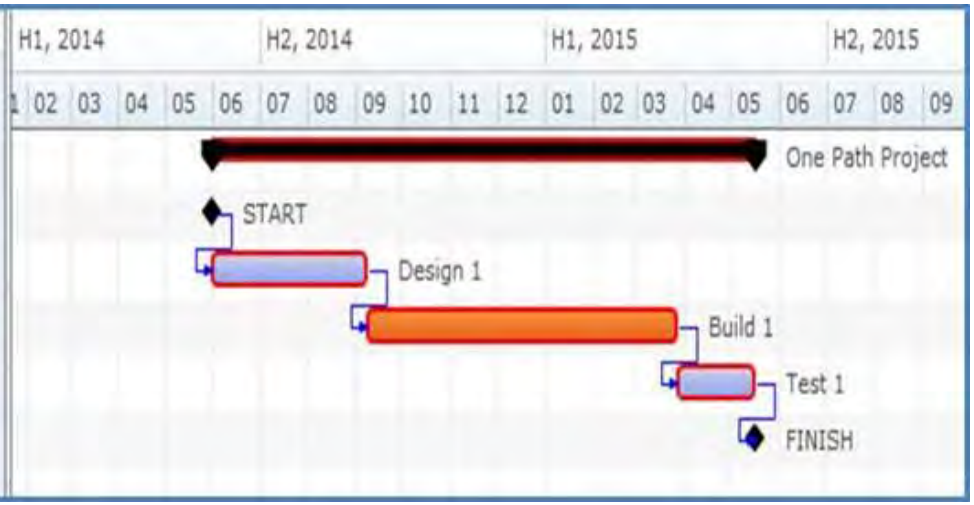
Really Simple Schedule

- This schedule finishes on September 3
  - 7-day weeks, like a model changeover, refinery turnaround

UID	Task	Start Date	End Date	Duration
One Pa	One Path Project	6/1/2014	5/16/2015	350
A1000	START	6/1/2014		0
A1010	Design 1	6/1/2014	9/8/2014	100
A1020	Build 1	9/9/2014	3/27/2015	200
A1030	Test 1	3/28/2015	5/16/2015	50
A1040	FINISH		5/16/2015	0



- If we can get into trouble with this simple schedule, we can get into trouble with real project schedules

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Add Duration Risk to the Schedule using Triangular Distributions

Duration Ranges Used				
Task	Scheduled	Min	Most Likely	Max
Design 1	100	90	100	120
Build 1	200	170	200	250
Test 1	50	40	50	90

This section features Polaris by Booz Allen Hamilton

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What is a Simulation?

- How do you find total project results?
  - Cannot add distributions
  - Must combine distributions
- Combining distributions using Monte Carlo simulation
  - Almost all possible combinations of durations
  - “Perform” the project many times with activity durations varying randomly each iteration
  - Each iteration is a possible project, but we do not know which is ours

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Risk Analysis Tools

- Monte Carlo Simulation of the schedule - 70-year old method
  - A simulation is made up of many (thousands) iterations – represent a synthetic database of projects
  - Each iteration uses a new set of activity durations chosen at random from the probability distributions
  - Iteration is just a CPM analysis using those durations
  - Iterate many times to reflect uncertainty in duration estimates
  - Collect the data, make probability distribution of results
- CPM is not even the most likely completion date and may not be very likely, given risks

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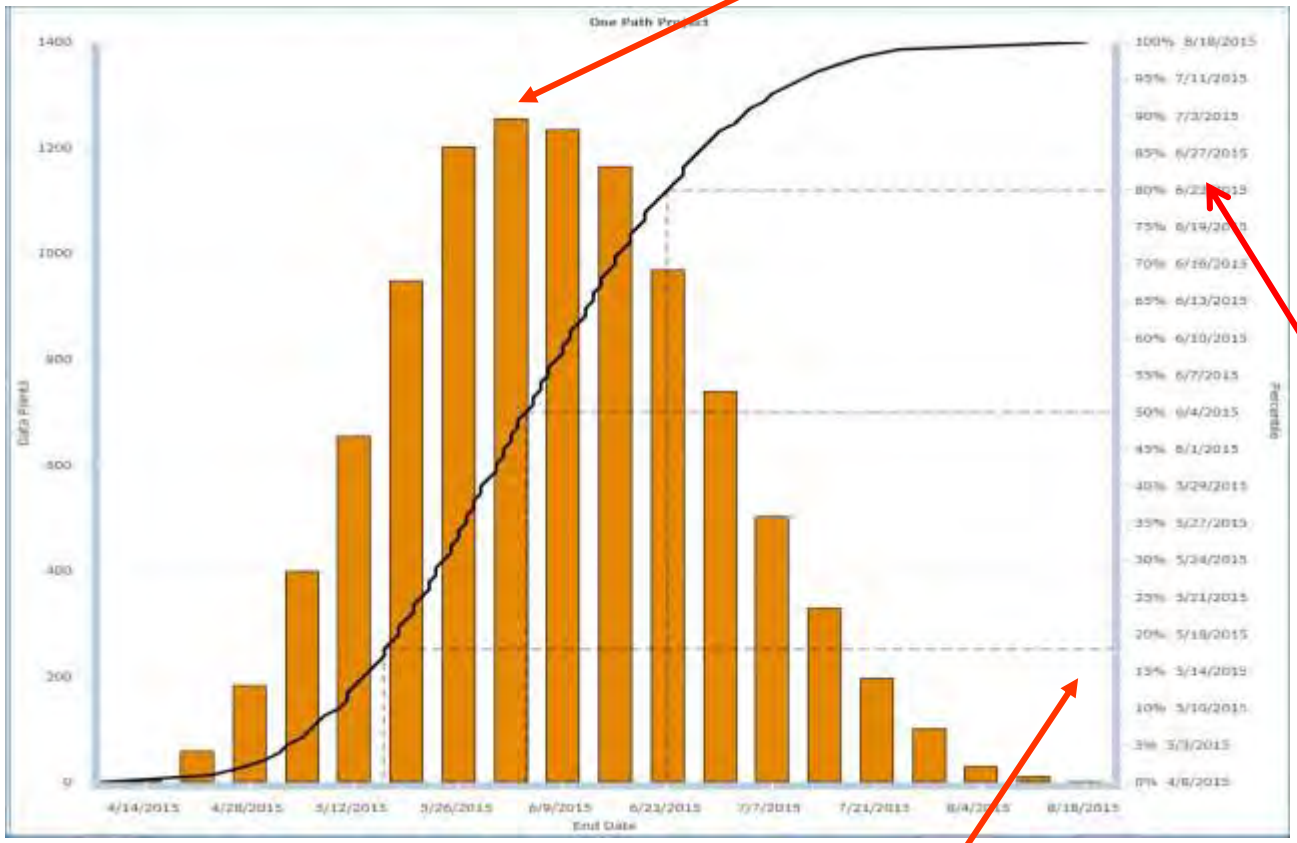
Monte Carlo Simulation Results for Really Simple Schedule

CPM date is not even the most likely – That's about 6/2



80% Target is 6/23 implying a schedule contingency of 38 days

CPM date is about 18% Likely to be met

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Offsetting Underestimation of Duration Risk – the Trigen Function

- Often risk workshops or even risk interviews will result in Minimum and Maximum ranges that are too narrow
  - People tend to anchor on the schedule duration and adjust the extremes insufficiently
  - Some are just inexperienced and / or timid
- Use their ranges but adjust them to the percentage of total probability they really represent
  - Turn the Triangular distribution into a Trigen distribution

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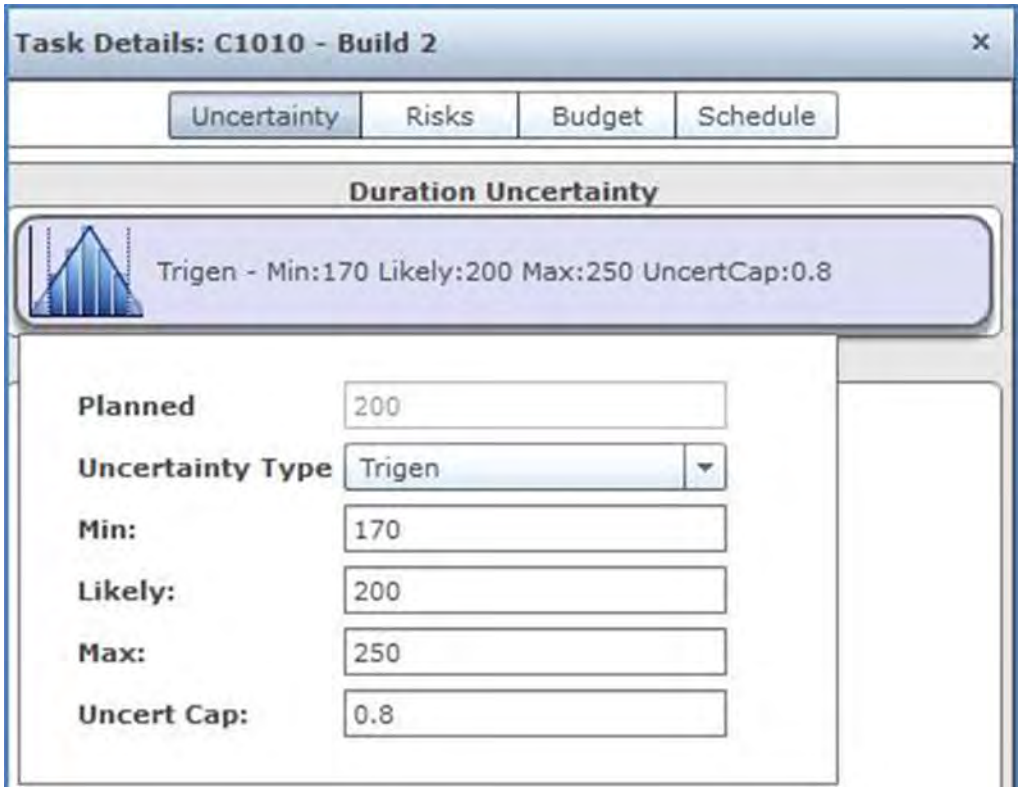
Compare the Raw Input Distributions with Distributions Corrected for Underestimation



The ranges on Build 2 are the same as before, but the Trigen specification is that the range from 170d to 250d covers only 80% of the total. To cover 100% of the probability the Min and Max have to be wider

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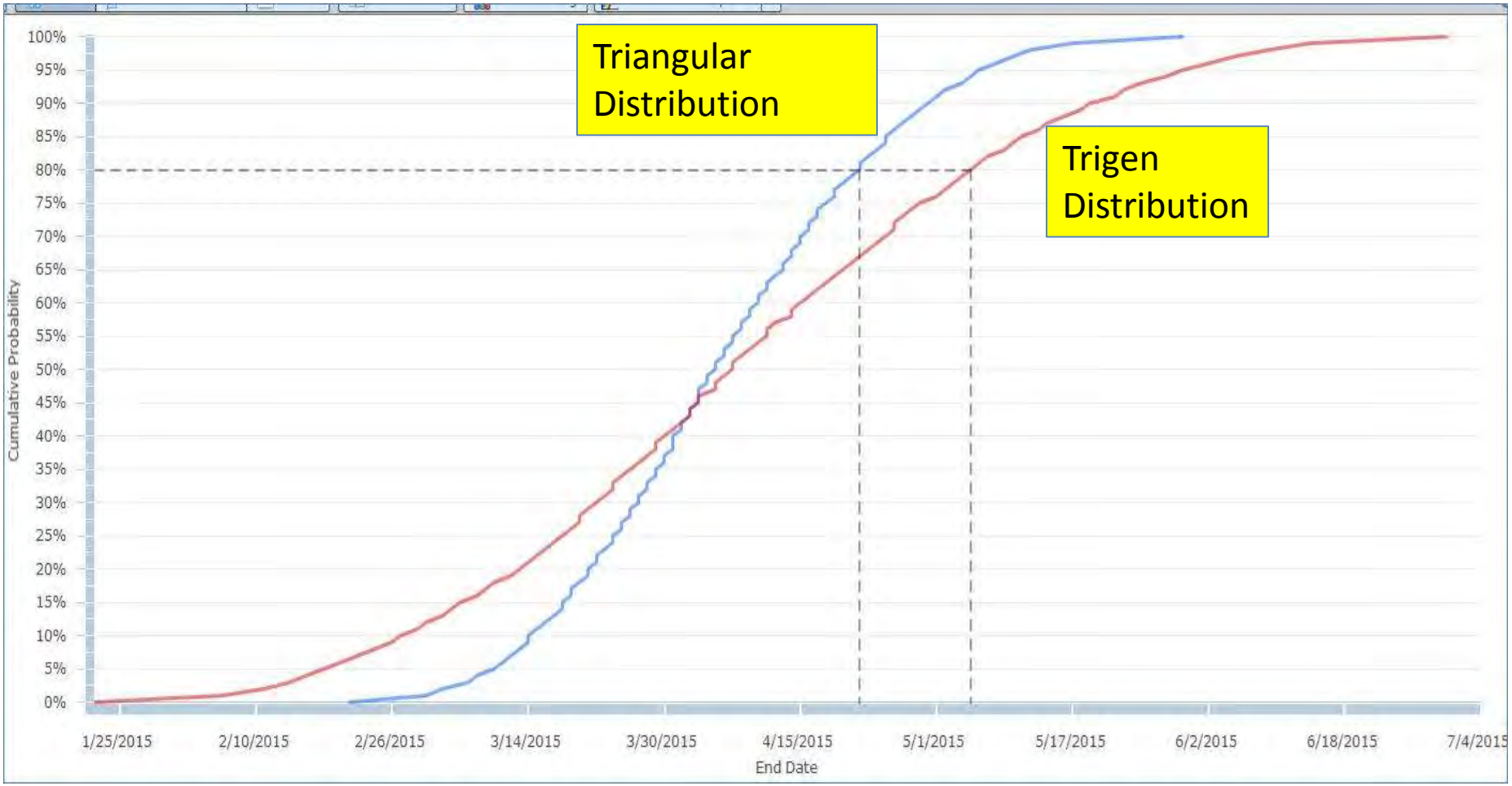
Using the Trigen Function Spreads the Tails of the Triangular Distribution



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Presence of Estimating Bias

- Often the project team members do not believe the scheduled durations
  - These were once called “magic numbers” or “everything has to go right” for the schedule to work
- The “Most Likely” duration does not need to be the duration in the schedule
- Often happens when the finish date is specified in advance of knowing project data
  - Management, the customer or competition often impose to optimistic duration estimates
  - Schedule risk analysis can compensate, bring reality

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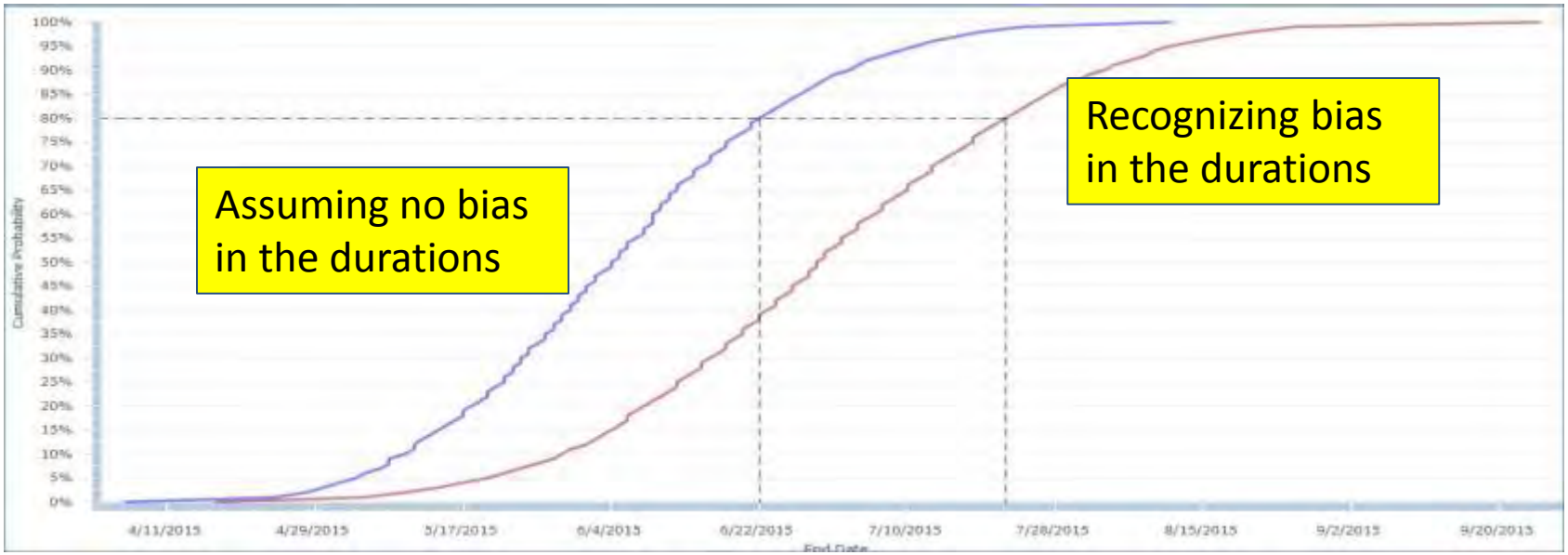
Effect of Correcting for Optimistically-Biased Durations



Duration Ranges Used				
Task	Scheduled	Min	Most Likely	Max
Path 1 Unbiased Estimates				
Design 1	100	90	100	120
Build 1	200	170	200	250
Test 1	50	40	50	90
Path 2 Correcting for Optimistic Estimates				
Design 2	100	90	110	130
Build 2	200	170	215	270
Test 2	50	40	60	100

Uncorrelated Uncertainty

- Independent duration ranges applied to the activities on the same path will exhibit some cancelling out – some will be long in their distributions in the same iterations while others may be short or middling duration
- If someone says that the range for the path is, say, “+ 10% and – 5%”, applying these ranges to the activities will result in a much narrower total path uncertainty

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Correlated Uncertainty

- To cause the "+ 10% and = 5%" range for the entire path we need to specify a correlation between the activities' durations of 100% (perfect positive correlation) between each pair of durations

Schedule Correlation Blanket Value: 0.00 **Entries** Add Re

Task	Task	Correlation
B1000 - Design 1	B1010 - Build 1	1.0
B1000 - Design 1	C1020 - Test 2	1.0
B1010 - Build 1	C1020 - Test 2	1.0

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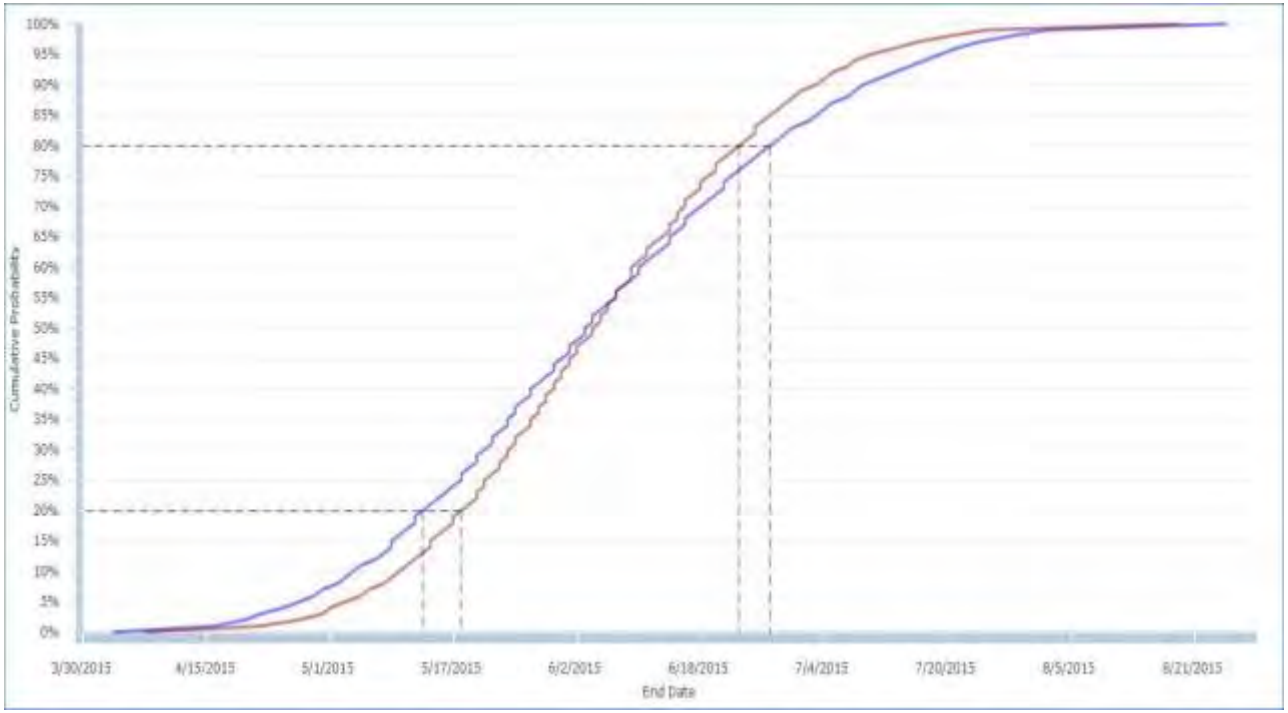
Comparison with and without Correlation = 1.0



Schedule Risk Results Correlation		
Schedule	20%	80%
NO Correlation	18-May-15	23-Jun-15
100% Correlation	13-May-15	27-Jun-15

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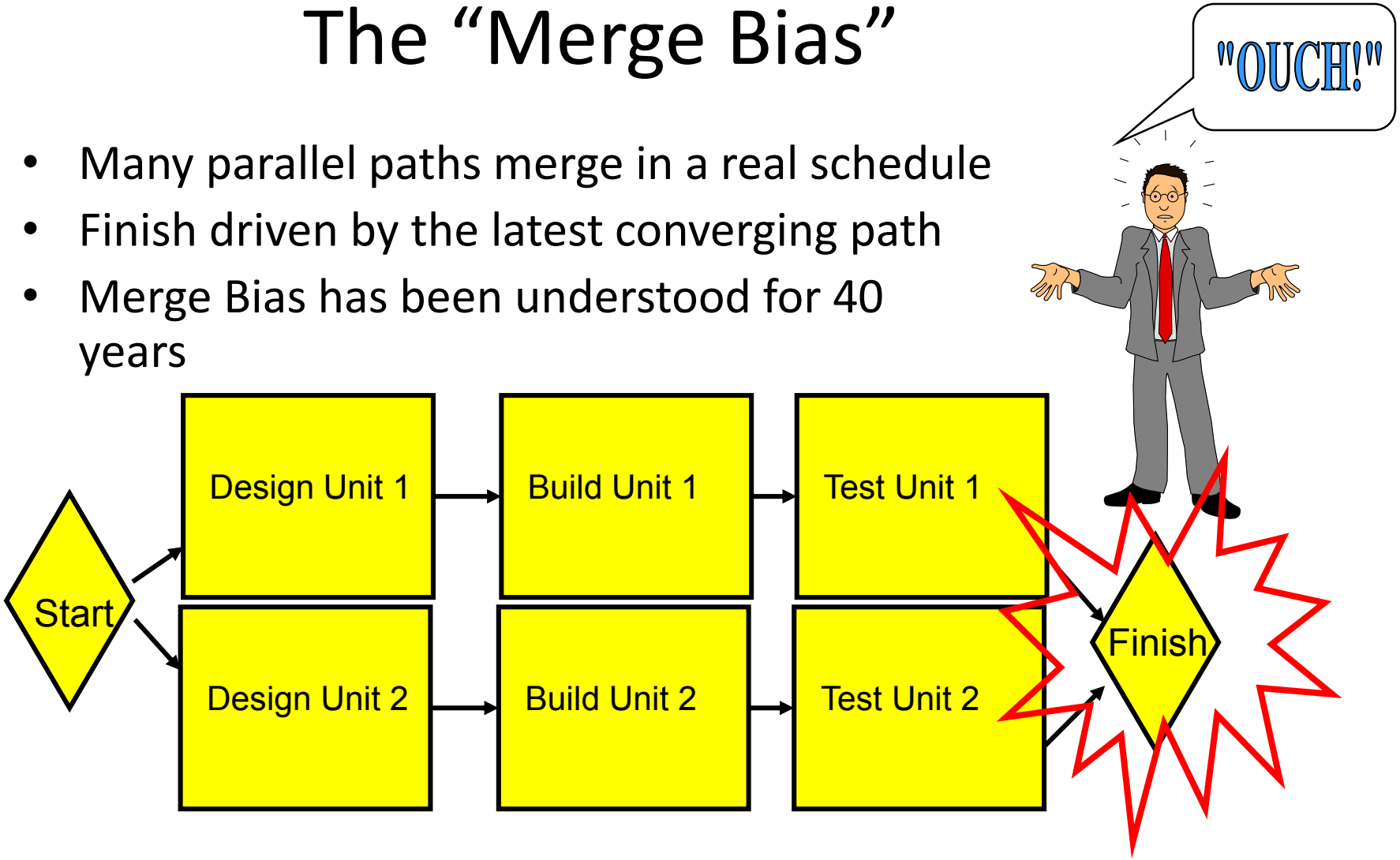
Risk at Merge Points: The "Merge Bias"

- Many parallel paths merge in a real schedule
- Finish driven by the latest converging path
- Merge Bias has been understood for 40 years



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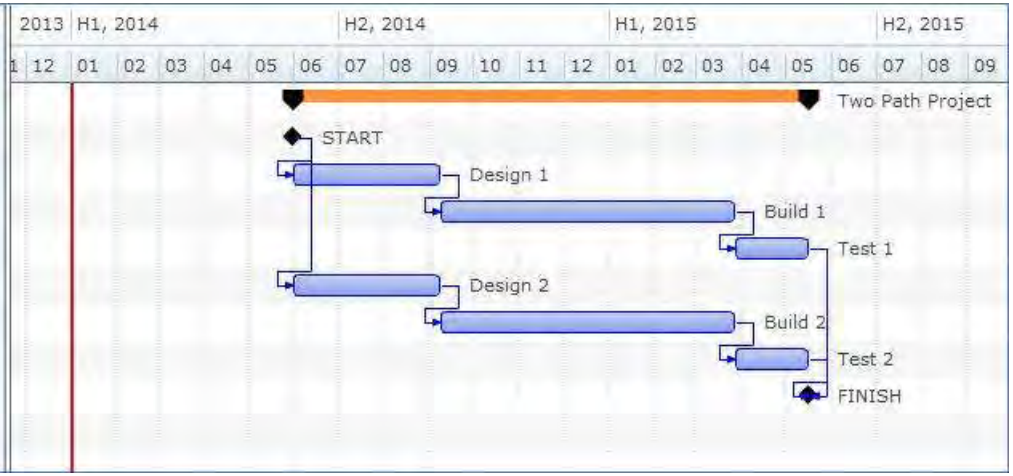
Inserting Uncertainty in the Schedule

UID	Task	Start Date	End Date	Duration
TwoPat	Two Path Project	6/1/2014	5/16/2015	350
A1000	START	6/1/2014		0
B1000	Design 1	6/1/2014	9/8/2014	100
B1010	Build 1	9/9/2014	3/27/2015	200
B1020	Test 1	3/28/2015	5/16/2015	50
C1000	Design 2	6/1/2014	9/8/2014	100
C1010	Build 2	9/9/2014	3/27/2015	200
C1020	Test 2	3/28/2015	5/16/2015	50
Z1000	FINISH		5/16/2015	0



Duration Ranges Used				
Task	Scheduled	Min	Most Likely	Max
Design 1	100	90	100	120
Build 1	200	170	200	250
Test 1	50	40	50	90
Design 2	100	90	100	120
Build 2	200	170	200	250
Test 2	50	40	50	90

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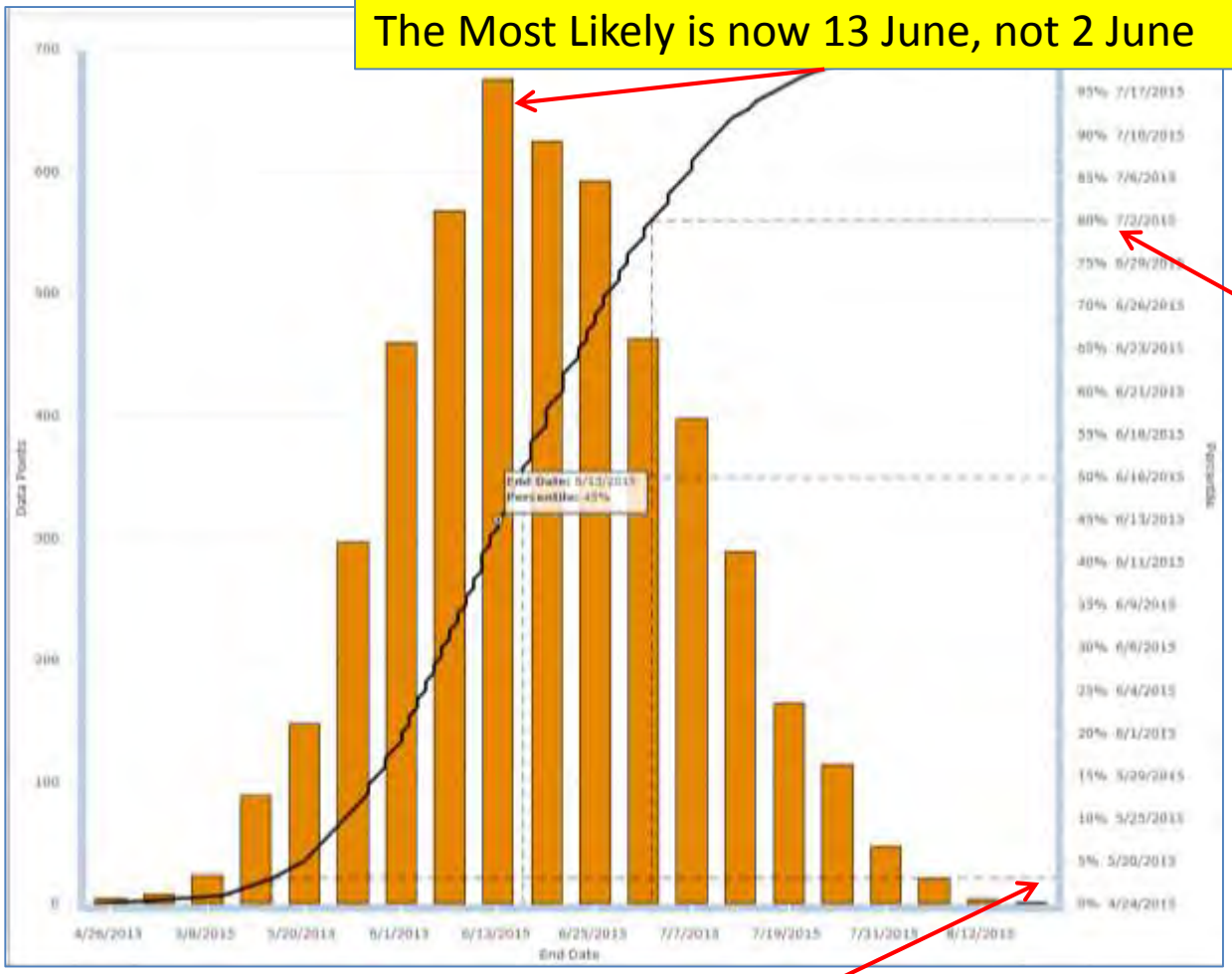
Results for One Schedule with Two Paths – The Merge Bias

The Most Likely is now 13 June, not 2 June



The P-80 is now 2 July not 23 June

The likelihood of meeting 16 May is now 3.3%, was 18.3%

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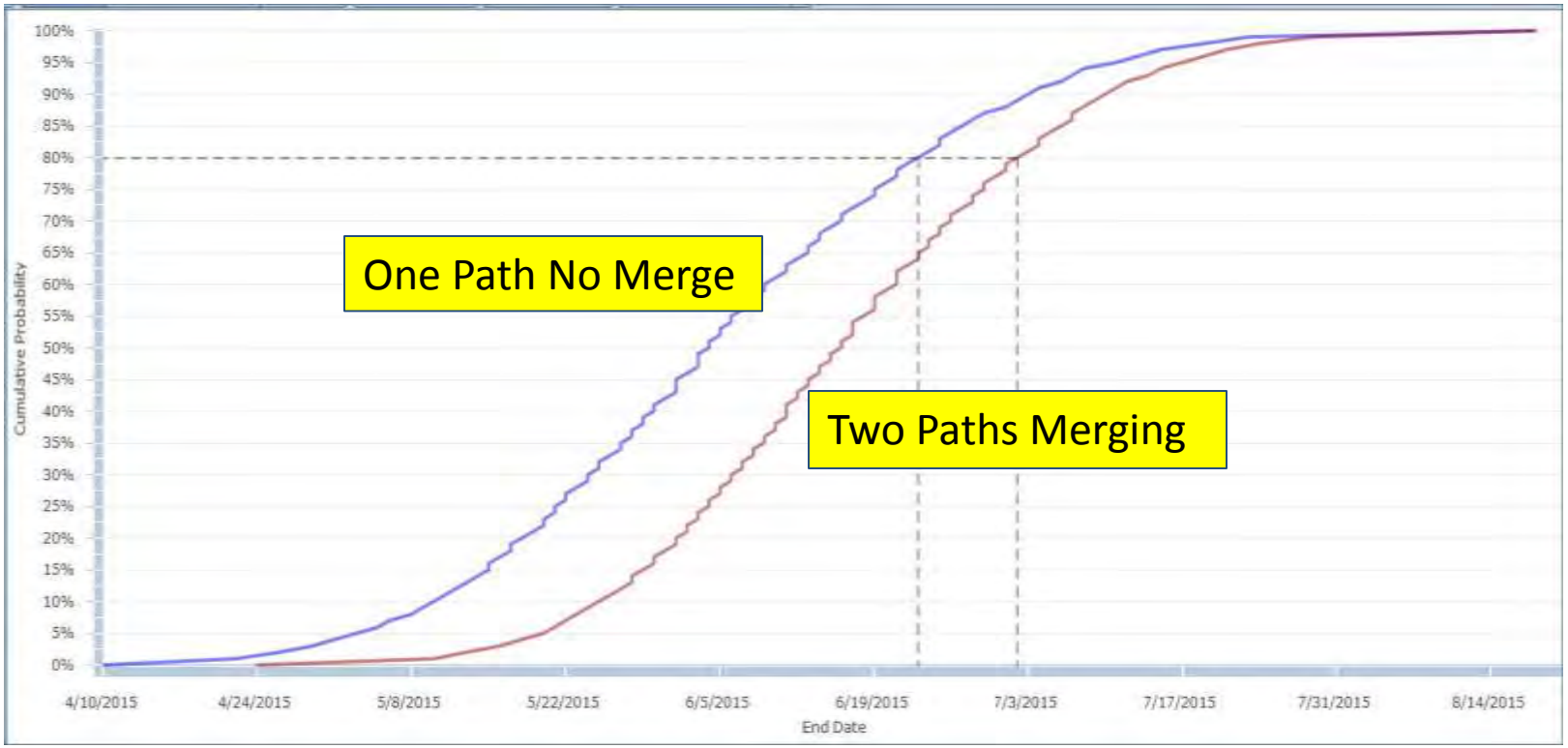
Modeling The Merge Bias



Schedule Risk Results						
Schedule	Scheduled date	Pr (date)	5%	50%	80%	95%
One Path	16-May-15	18%	3-May-15	4-Jun-15	23-Jun-15	11-Jul-25
Two Path Merge	16-May-15	3%	20-May-15	16-Jun-15	2-Jul-15	17-Jul-15

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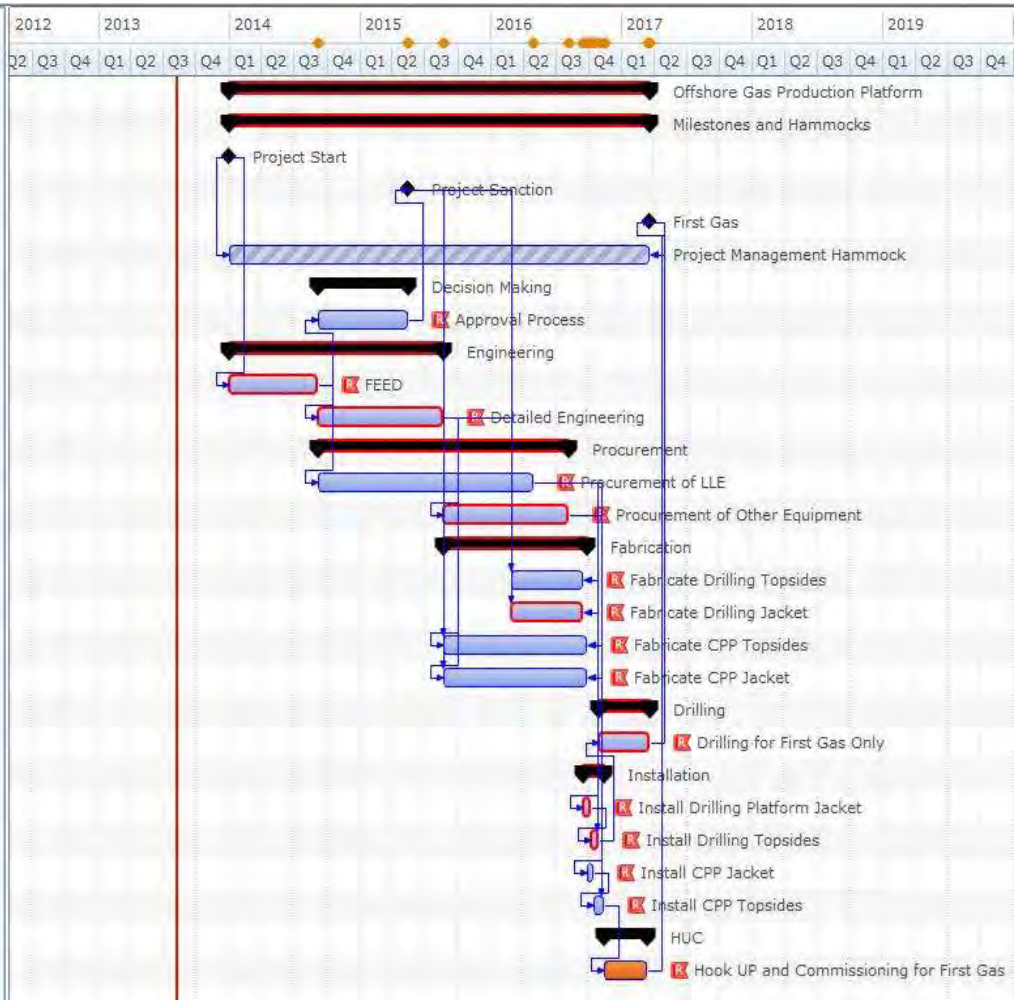
Introducing the Gas Production Platform Schedule

UID	Task	Start Date	End Date	Duration
Gas Pla	▼ Offshore Gas Production Platfor	1/1/2014	3/20/2017	1,175
Gas Pla	▼ Milestones and Hammocks	1/1/2014	3/20/2017	1,175
A1000	Project Start	1/1/2014		0
A1010	Project Sanction		5/15/2015	0
A1020	First Gas		3/20/2017	0
A1030	Project Management Ham	1/1/2014	3/20/2017	1,175
Gas Pla	▼ Decision Making	9/8/2014	5/15/2015	250
B1000	Approval Process	9/8/2014	5/15/2015	250
Gas Pla	▼ Engineering	1/1/2014	8/23/2015	600
C1000	FEED	1/1/2014	9/7/2014	250
C1010	Detailed Engineering	9/8/2014	8/23/2015	350
Gas Pla	▼ Procurement	9/8/2014	8/7/2016	700
D1000	Procurement of LLE	9/8/2014	4/29/2016	600
D1010	Procurement of Other Equ	8/24/2015	8/7/2016	350
Gas Pla	▼ Fabrication	8/24/2015	9/26/2016	400
E1000	Fabricate Drilling Topsides	3/1/2016	9/16/2016	200
E1010	Fabricate Drilling Jacket	3/1/2016	9/16/2016	200
E1020	Fabricate CPP Topsides	8/24/2015	9/26/2016	400
E1030	Fabricate CPP Jacket	8/24/2015	9/26/2016	400
Gas Pla	▼ Drilling	11/1/2016	3/20/2017	140
F1000	Drilling for First Gas Only	11/1/2016	3/20/2017	140
Gas Pla	▼ Installation	9/17/2016	11/15/2016	60
G1000	Install Drilling Platform Ja	9/17/2016	10/6/2016	20
G1010	Install Drilling Topsides	10/7/2016	10/31/2016	25
G1020	Install CPP Jacket	9/27/2016	10/16/2016	20
G1030	Install CPP Topsides	10/17/2016	11/15/2016	30
Gas Pla	▼ HUC	11/16/2016	3/15/2017	120
H1000	Hook UP and Commission	11/16/2016	3/15/2017	120



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Applying Different Uncertainty to Categories of Tasks as Reference Ranges

Templated Uncertainty Editor Apply ☑ Replace Existing Distribution

Templates Add Remove Edit Filters

Priority	Filter	Schedule Uncertainty
1	Approval	Triangular - Min:0.9 Likely:1.1 Max:1.3
2	Engineering	Triangular - Min:0.85 Likely:1.05 Max:1.3
3	Procurement	Triangular - Min:0.95 Likely:1.05 Max:1.2
4	Fabrication	Triangular - Min:0.9 Likely:1.05 Max:1.2
5	Drilling	Triangular - Min:0.8 Likely:1.05 Max:1.4
6	Installation	Triangular - Min:0.95 Likely:1.1 Max:1.3
7	HUC	Triangular - Min:0.85 Likely:1.1 Max:1.5

Each category of activity may have different levels of uncertainty, called "reference ranges"

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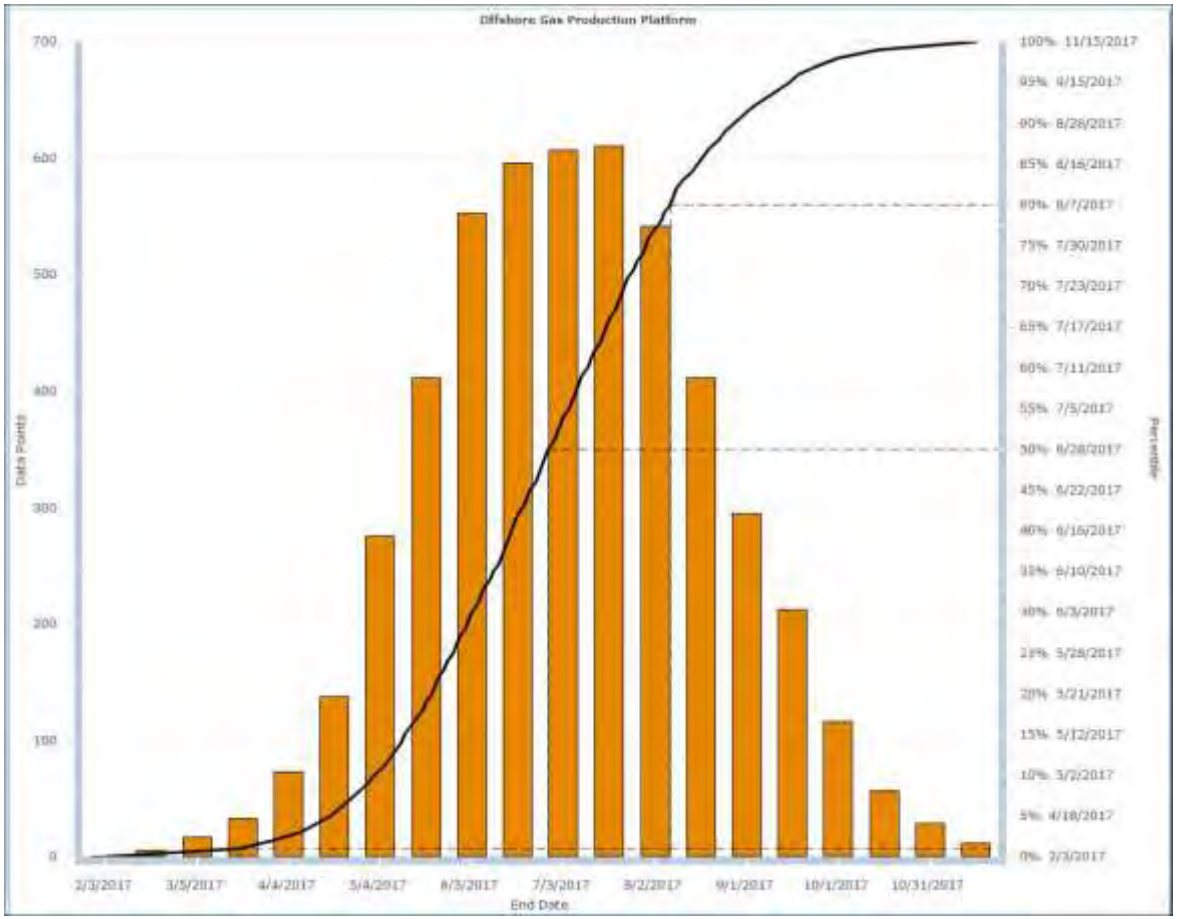
Risk on the Offshore Gas Production Platform - Reference Range Uncertainties



With Uncertainty by category of task representing:

- Inherent variability
- Estimating error
- Estimating bias

The CPM date is 20 March 2017

The P-80 date is 7 August 2017 for a contingency just with Uncertainty of 4 ½ months

This is very likely irreducible.

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Introducing the Risk Driver Method for Causing Additional Variation in the Simulation

Discrete | Driver

Risk Driver Editor

Enabled	UID	Risk Driver Name	Probability	Description	Notes
☑	1	Engineering company productivity may differ from planned	100%		
☑	2	Construction Contractor may or may not be familiar with the technology	40%		
☑	3	Testing may reveal issues that need to be resolved	65%		
☐	4	Organization's quality controls may not be sufficient to avoid issues in Delivered Product	50%		

Risk Driver Impact Editor

Tasks: Add | Remove

Task	In Parallel
B1000 - Design 1	☐
C1000 - Design 2	☐

Duration Factor

Triangular - Min:0.9 Likely:1.05 Max:1.3

Cost Factor

None - Original Value: 1

Using the simple 2-path schedule. Four risks are specified. The first is a general risk about engineering productivity, which may be under- or over-estimated, with 100% probability. It is applied to the two Design activities

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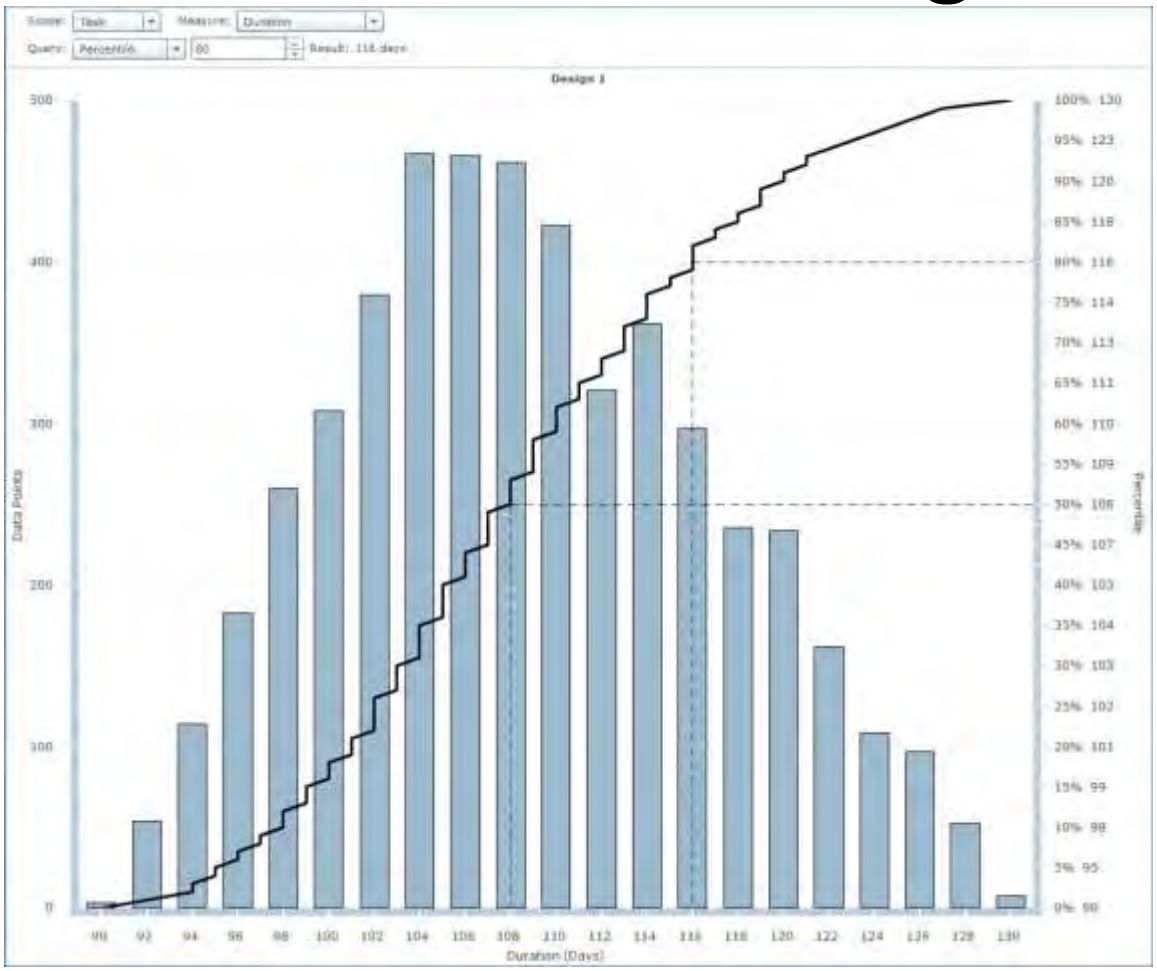
100% Likely Risk Driver's Effect on Design Duration



With a 100% likely risk the probability distribution of the activity's duration looks like a triangle. Not any different from placing a triangle directly on the activity

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Risk Driver with Risk at < 100% likelihood

Risk Driver Editor

Enabled	UID	Risk Driver Name	Probability	Description	Notes
☑	1	Engineering company productivity may differ from planned	100%		
☑	2	Construction Contractor may or may not be familiar with the technology	40%		
☑	3	Testing may reveal issues that need to be resolved	65%		
☐	4	Organization's quality controls may not be sufficient to avoid issues in Delivered Product	50%		

Risk Driver Impact Editor

Tasks Add Remove

Task	In Parallel
B1010 - Build 1	☐
C1010 - Build 2	☐

Duration Factor

Triangular - Min:0.9 Likely:1.1 Max:1.4

Cost Factor

None - Original Value: 1

With this risk, the Construction Contractor may or may not be familiar with the technology, the probability is 40% and the risk impact if it happens is .9, 1.1 and 1.4. It is applied to the two Build activities

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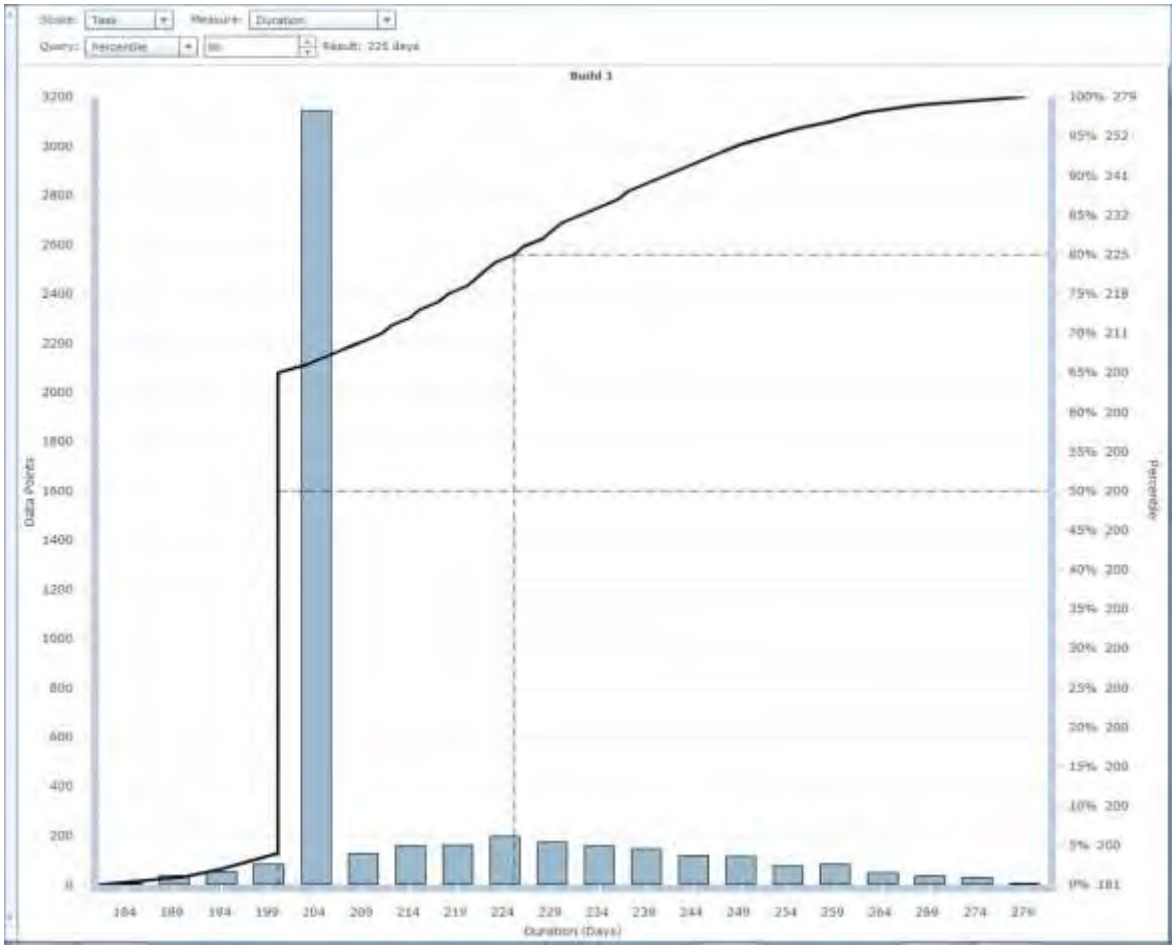
With a 40% Likelihood, the "Spike" in the Distribution Contains 60% of the Probability



Here is where the Risk Driver method gets interesting. It can create distributions that reflect:

- Probability of occurring
- Impact if it does occur

Cannot represent these two factors with simple triangular distributions applied to the durations directly

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Risk Drivers Models how Correlation Occurs

- Correlation can be caused by identifiable risks that are assigned to two different activities
  - If the risk occurs it occurs for each activity
  - If the risk impact multiplier is X% it is X% for each activity
- We are not very good at estimating correlation coefficients, so generating them within the simulation is a better approach
- There still may be correlations among uncertainty (3-point estimates)

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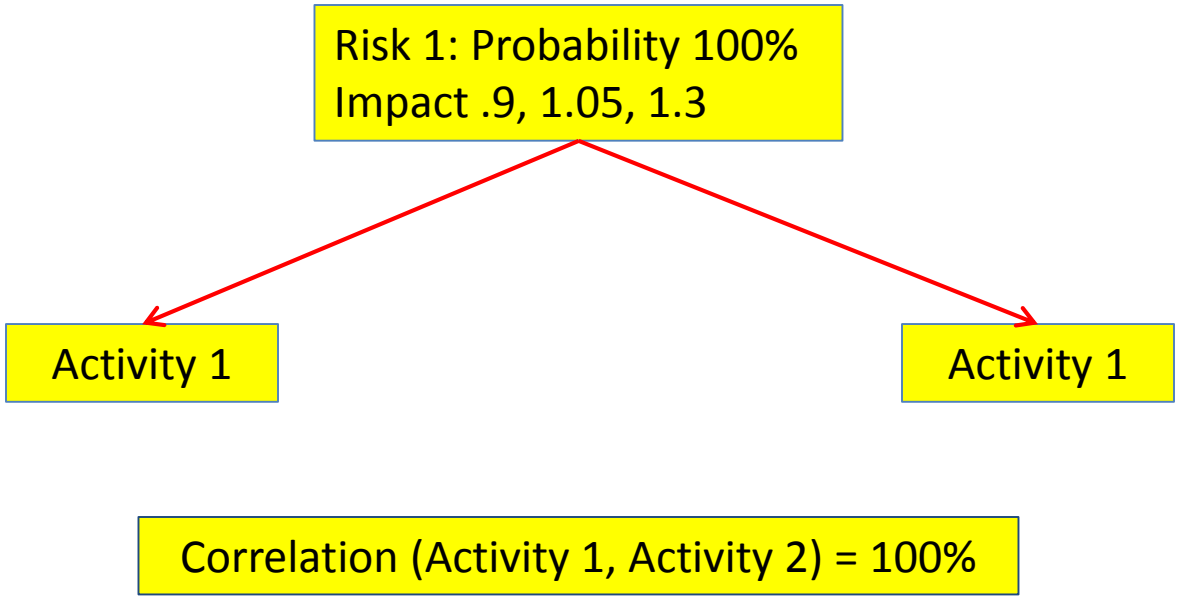
Risk Drivers Generate Correlation between Activities (1)



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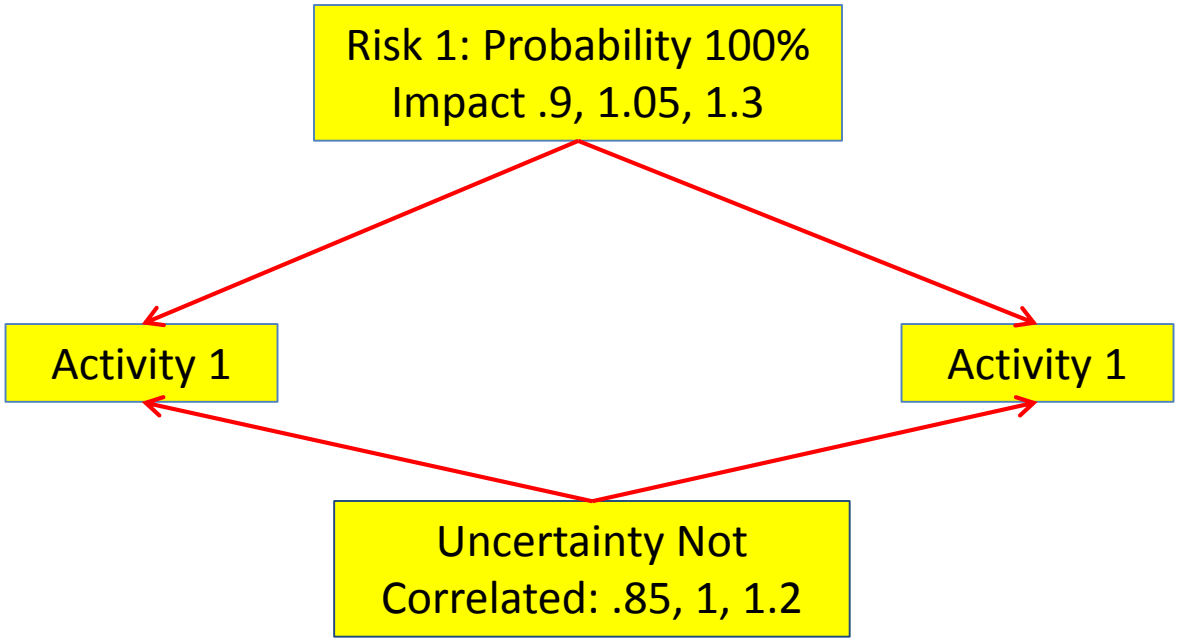
Risk Drivers Generate Correlation between Activities (2)

But there is no such thing as 100% correlation



Adding uncorrelated uncertainty reduces correlation (Activity 1, Activity 2) to 86%

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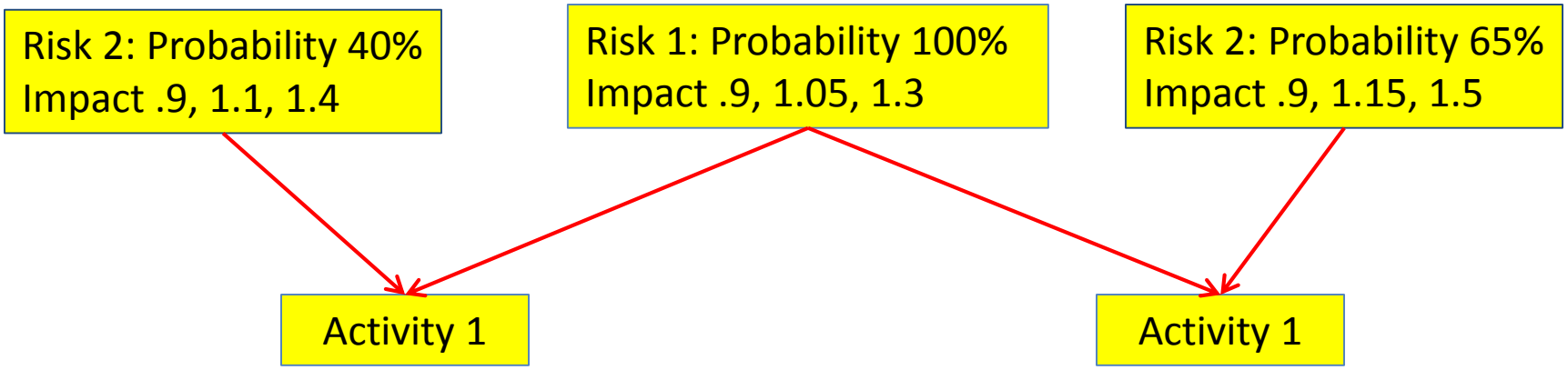
Risk Drivers Generate Correlation between Activities (3)



Correlation (Activity 1, Activity 2) = 64%
(without uncertainty)

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Activities Can be Influenced by More than One Risk Driver

Risk Driver Editor

Enabled	UID	Risk Driver Name	Probability	Description	Notes
☑	1	Approval Risk Driver	60%		
☑	2	Engineering Risk Driver	40%		
☑	3	Procurement Risk Driver	30%		
☑	4	Fabrication Risk Driver	60%		
☑	5	Drilling Risk Driver	75%		
☑	6	Installation Risk Driver	80%		
☑	7	HUC Risk Driver	65%		
☑	8	Organizational Risk	95%		

Risk Driver Impact Editor

Tasks: Add | Remove

Task	In Parallel
[illegible] - Approval Process	☐
[illegible] - FEED	☐
C1010 - Detailed Engineering	☐
D1000 - Procurement of LLE	☐
D1010 - Procurement of Other Equipment	☐
E1000 - Fabricate Drilling Topsides	☐
E1010 - Fabricate Drilling Jacket	☐
E1020 - Fabricate CPP Topsides	☐
E1030 - Fabricate CPP Jacket	☐
F1000 - Drilling for First Gas Only	☐
G1000 - Install Drilling Platform Jacket	☐
G1010 - Install Drilling Topsides	☐
G1020 - Install CPP Jacket	☐
G1030 - Install CPP Topsides	☐
[illegible] - Hook UP and Commissioning for First Gas	☐

Duration

Triangular - Min:0.95 Likely:1.05 Max:1.25

Cost

None - Original Value: 1

An Organizational Risk has been added to the mix, assigned to all activities in the Offshore Gas Production Platform schedule

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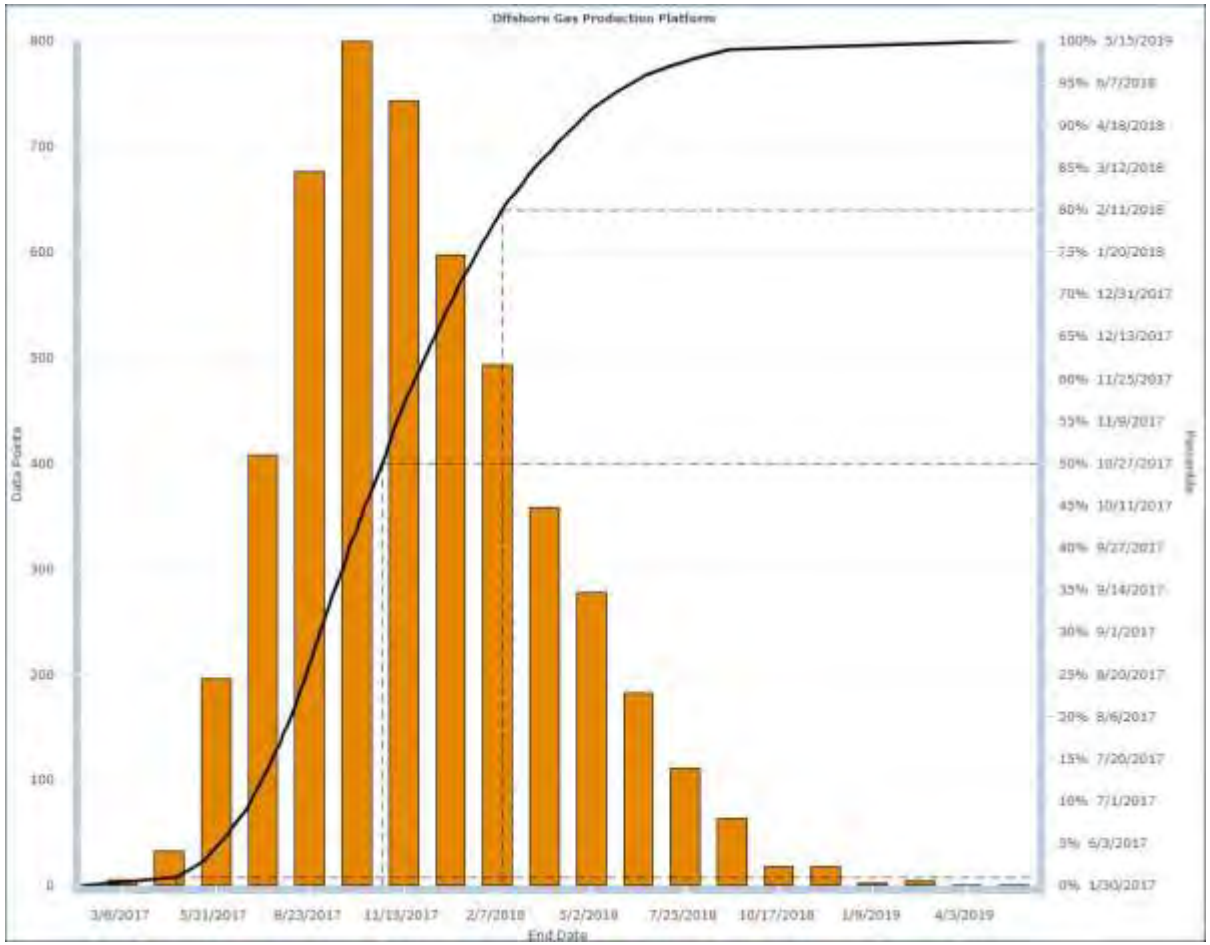
Adding Organizational Risk to Every Activity



With all risk Drivers including the Organizational Risk the P-80 result is 11 February 2018

With Uncertainty the P-80 was 7 August, 2017

The scheduled date is 20 March 2017

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Risk Drivers can be Applied In Series or In Parallel

- Two or more risks can be applied to the same activities. If they occur together in an iteration they may be in parallel or in series
- We are talking about the impacts of a risk that has occurred
  - Risk takes most resources or is so important to be addressed that recovering from others must wait are entered in series (we have been assuming this)
  - Risks can be recovered from simultaneously can be entered in parallel

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Parallel and Series Risks Multiplicative with Risk Drivers

If these two risks cannot be recovered from simultaneously, they are entered ***in series***

Risk 1 1.2 factor

Risk 2 1.05 factor

Use (1.2 x 1.05 = 1.26) Factor, multiply the two

If recovery from two risks can be accomplished simultaneously, they are entered ***in parallel***

Risk 1 1.2 factor

Risk 2 1.05 factor

Use 1.2 Factor, the largest factor, only

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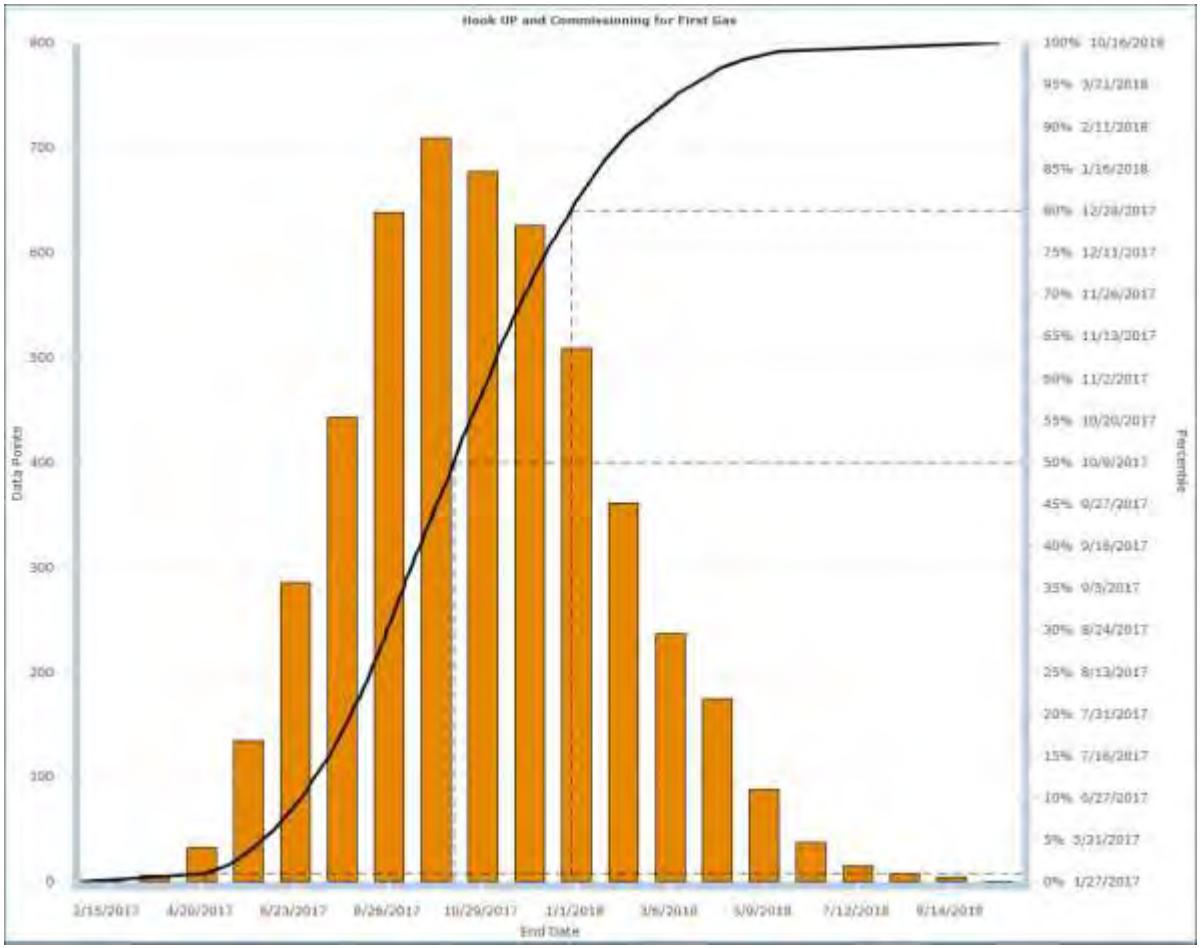
Changing the Risks to In Parallel Reduces the Schedule Risk



Putting the Risk Drivers in Parallel results in an earlier P-80 of 28 December 2017

Had been 11 February 2018 with Risk Drivers in series

In this model it puts the Organizational risk in parallel with all the others when it occurs (65% likely)

This capability is more important if more risks are assigned to the same activities

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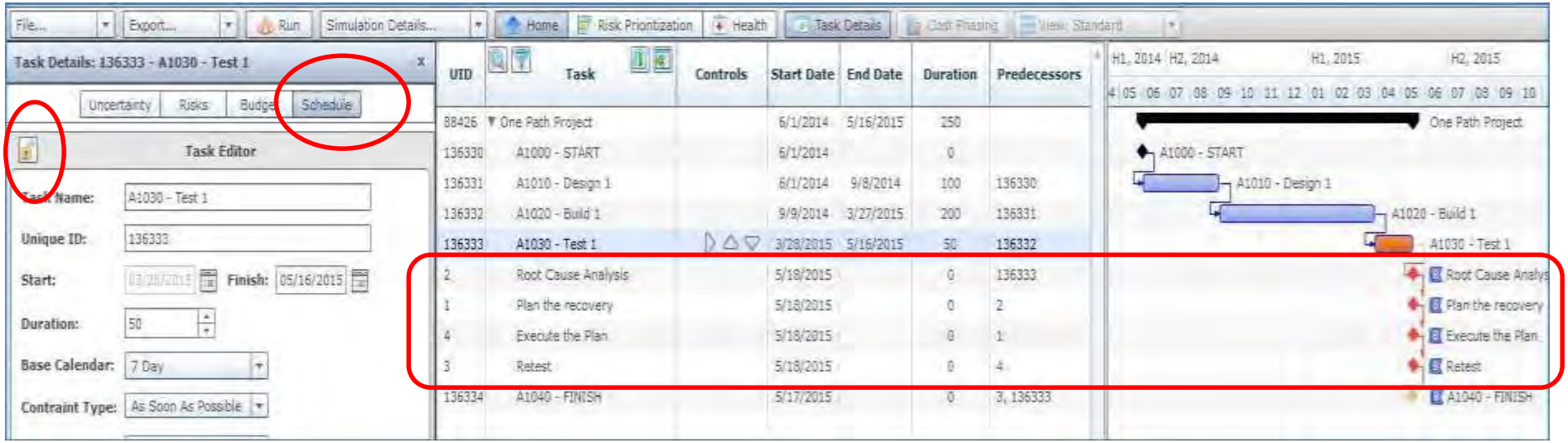
Failing the Test may lead to Multiple Activities that are Not In the Schedule

- If the test fails we may need to do:
  - Examine the Root Cause of the failure
  - Determine what to do next
  - Do what is needed to be done to recover
  - Re-test the article
- All of these activities need to be done, or none is needed
  - These 4 activities constitute a probabilistic branch, since the possibility of doing them is probabilistic

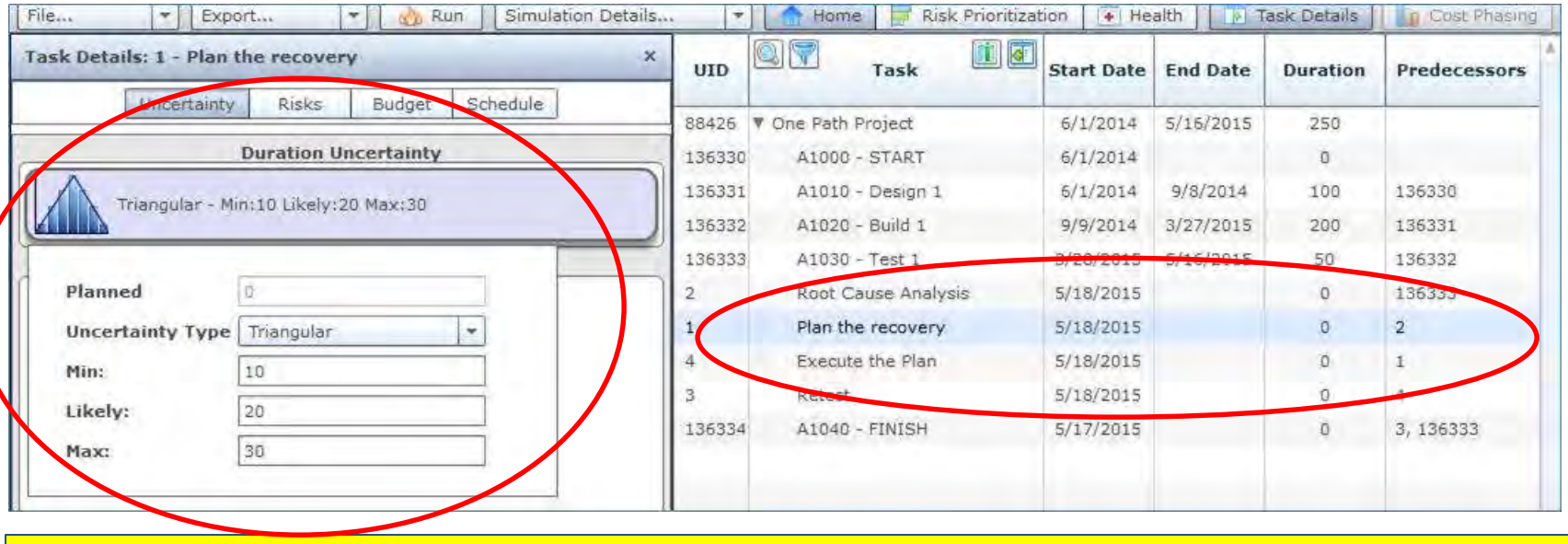
Set up the Probabilistic Branch



We create a 4-activity probabilistic branch, adding 4 activities: Root Cause Analysis, Plan the recovery, Execute the Plan and Retest

Notice that they all have a remaining duration of 0 working days – they will not affect the schedule unless they occur

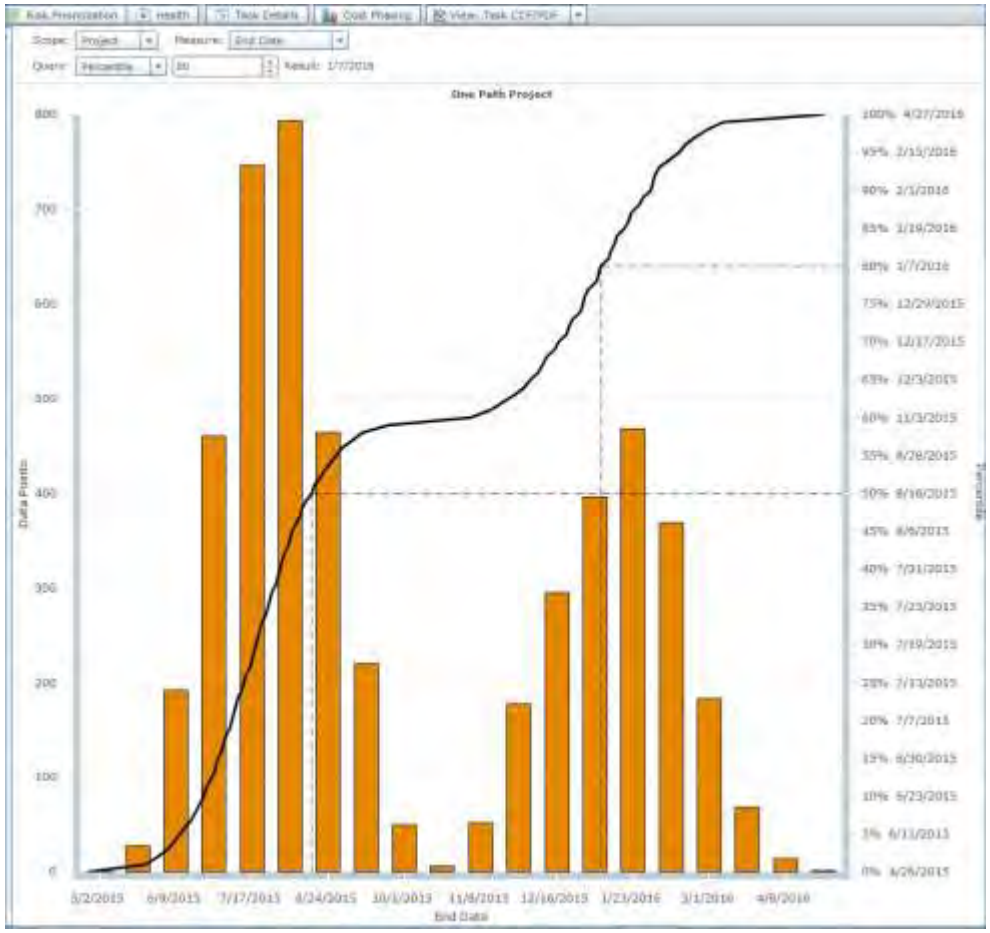
Give the New Activities Ranges of Impact, if they Happen



Highlight the new activities in turn an give them uncertainties:

- Root Cause Analysis 20d – 40d – 60 d
- Plan the Recovery 10d – 20d – 30d
- Execute the Plan 10d- 30d- 50d
- Retest 20d – 30d – 50d (probably less time than the first test)

With the Probabilistic Branch in Place, Results may show Bi-modal Distribution



Probabilistic branch develops a shoulder at 60%

There can be more than one probabilistic outcome from a node. The probabilities need to sum to 100%.

Probabilistic branch can represent more planning than just a single probabilistic activity

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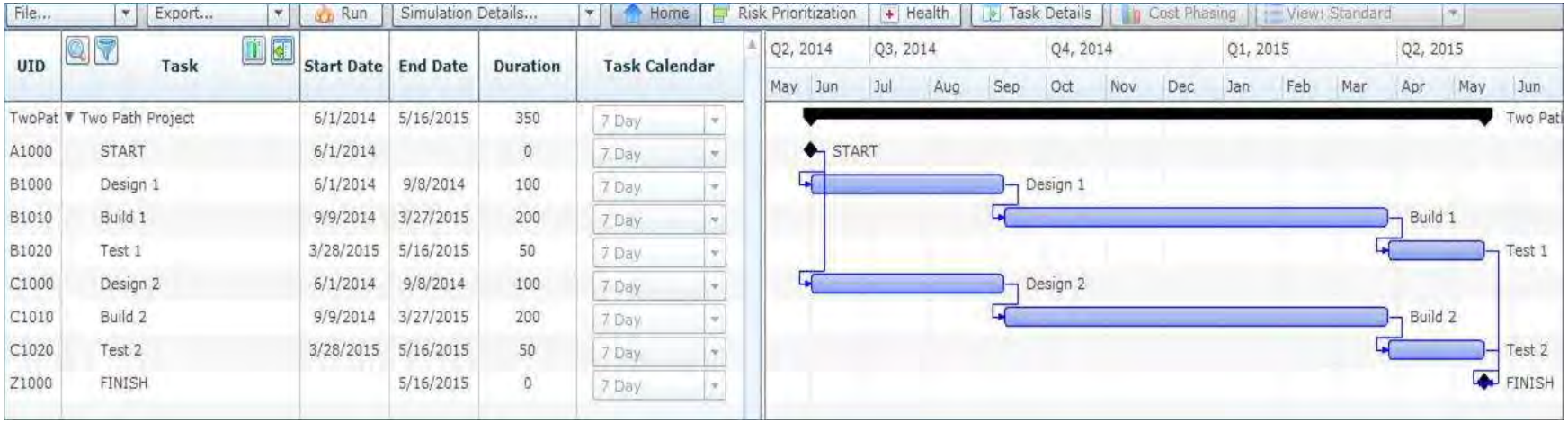
Probabilistic Calendars (1)

- In many applications a weather-related event can impede progress and affect the schedule without regard to the dates permitted by predecessors
  - Monsoon weather can impede installation of jackets and topsides for offshore platforms
  - Freezing weather can stop supplies getting in to a jobsite
  - Thawing ground may make it difficult to move equipment
- Other calendar-related events can be important for the schedule
  - Activities such as moving into a building can be determined by calendar of events

Probabilistic Calendars (2)

- The static schedule might show that the weather-sensitive activity will take place outside of the weather window
- However, with schedule risk the date of the weather-sensitive activity is uncertain
- Risk on predecessors might push an otherwise safe activity into the weather window, causing it to be unlikely to occur

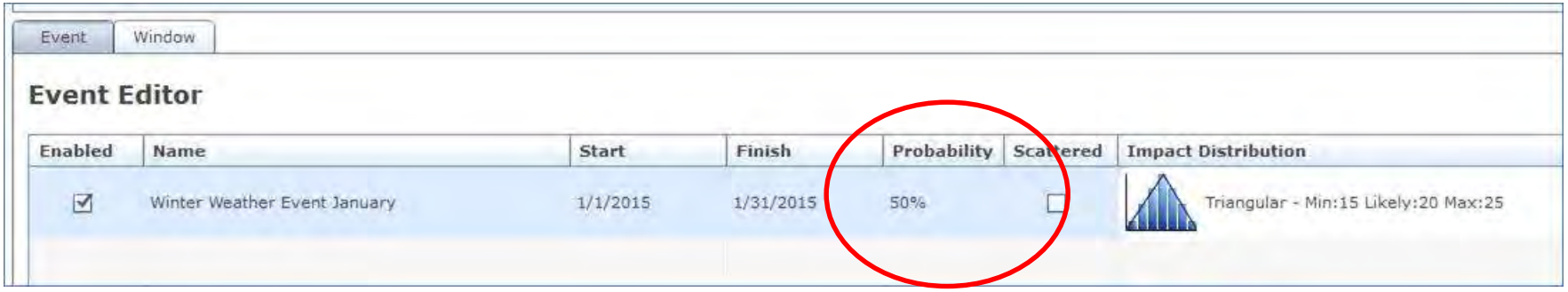
Simplify Probabilistic Calendar by using Two Path Schedule



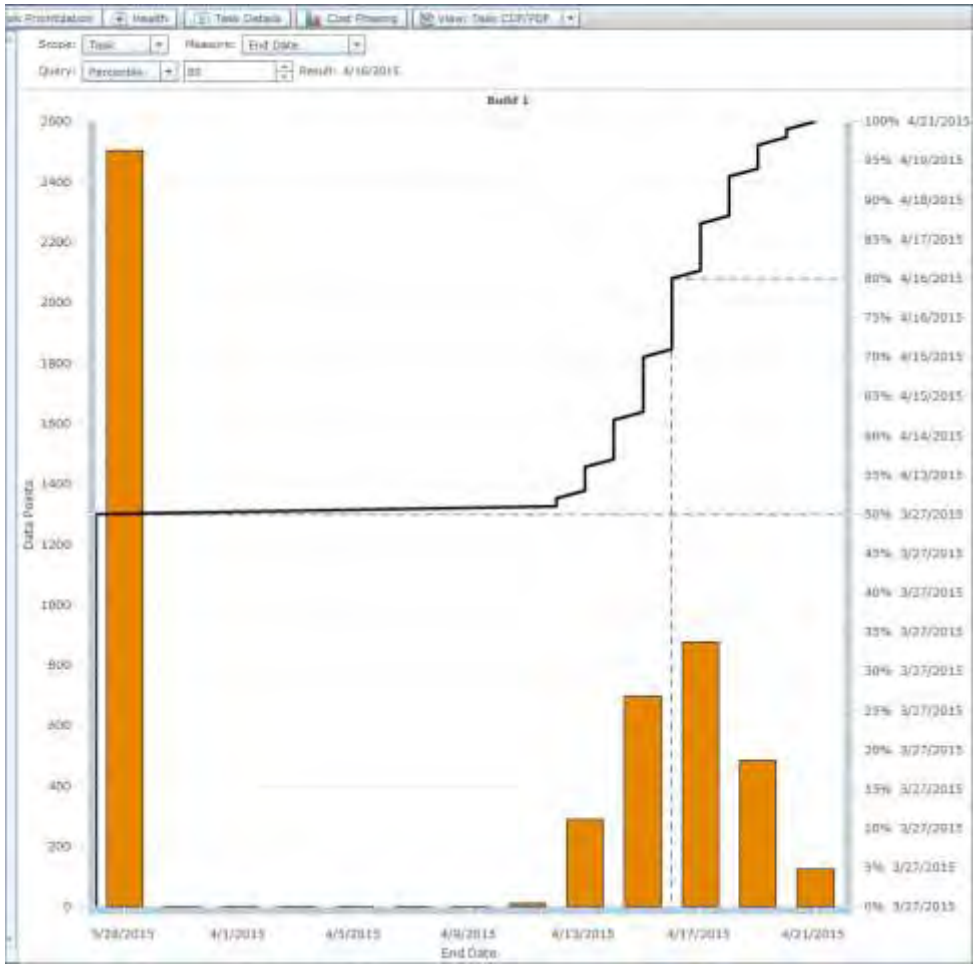
UID	Task	Start Date	End Date	Duration	Task Calendar
TwoPat	Two Path Project	6/1/2014	5/16/2015	350	7 Day
A1000	START	6/1/2014		0	7 Day
B1000	Design 1	6/1/2014	9/8/2014	100	7 Day
B1010	Build 1	9/9/2014	3/27/2015	200	7 Day
B1020	Test 1	3/28/2015	5/16/2015	50	7 Day
C1000	Design 2	6/1/2014	9/8/2014	100	7 Day
C1010	Build 2	9/9/2014	3/27/2015	200	7 Day
C1020	Test 2	3/28/2015	5/16/2015	50	7 Day
Z1000	FINISH		5/16/2015	0	7 Day

Using the 2-Path schedule. There are no risks on this schedule

Set Probability of Winter Weather Event to 50%



Winter Weather Event only 50% Likely



Build 1 may finish in March 2015 but may be delayed by a month because of the 50% likely January weather event

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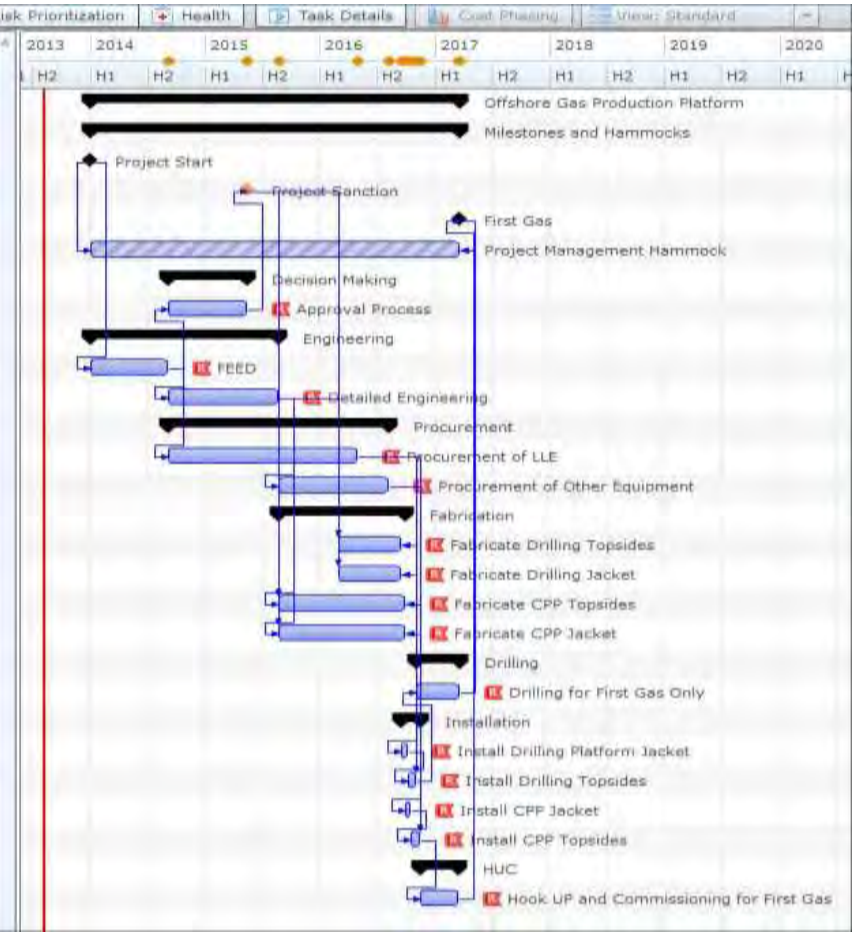
Monsoon Calendar Prohibits Offshore Installation (1)

UID	Task	Start Date	End Date	Duration	Task Calendar
Gas Pla	Offshore Gas Production Platfor	1/1/2014	3/20/2017	1,175	7 Day
Gas Pla	Milestones and Hammocks	1/1/2014	3/20/2017	1,175	7 Day
A1000	Project Start	1/1/2014		0	7 Day
A1010	Project Sanction		5/15/2015	0	7 Day
A1020	First Gas		3/20/2017	0	7 Day
A1030	Project Management Ham	1/1/2014	3/20/2017	1,175	7 Day
Gas Pla	Decision Making	9/8/2014	5/15/2015	250	7 Day
B1000	Approval Process	9/8/2014	5/15/2015	250	7 Day
Gas Pla	Engineering	1/1/2014	8/23/2015	600	7 Day
C1000	FEED	1/1/2014	9/7/2014	250	7 Day
C1010	Detailed Engineering	9/8/2014	8/23/2015	350	7 Day
Gas Pla	Procurement	9/8/2014	8/7/2016	700	7 Day
D1000	Procurement of LLE	9/8/2014	4/29/2016	600	7 Day
D1010	Procurement of Other Equ	8/24/2015	8/7/2016	350	7 Day
Gas Pla	Fabrication	8/24/2015	9/26/2016	400	7 Day
E1000	Fabricate Drilling Topsides	3/1/2016	9/16/2016	200	7 Day
E1010	Fabricate Drilling Jacket	3/1/2016	9/16/2016	200	7 Day
E1020	Fabricate CPP Topsides	8/24/2015	9/26/2016	400	7 Day
E1030	Fabricate CPP Jacket	8/24/2015	9/26/2016	400	7 Day
Gas Pla	Drilling	11/1/2016	3/20/2017	140	7 Day
F1000	Drilling for First Gas Only	11/1/2016	3/20/2017	140	7 Day
Gas Pla	Installation	9/17/2016	11/15/2016	60	7 Day
G1000	Install Drilling Platform Ja	9/17/2016	10/6/2016	20	7 Day
G1010	Install Drilling Topsides	10/7/2016	10/31/2016	25	7 Day
G1020	Install CPP Jacket	9/27/2016	10/16/2016	20	7 Day
G1030	Install CPP Topsides	10/17/2016	11/15/2016	30	7 Day
Gas Pla	HUC	11/16/2016	3/15/2017	120	7 Day
H1000	Hook UP and Commission	11/16/2016	3/15/2017	120	7 Day



Monsoon Calendar Prohibits Offshore Installation (2)

- Notice that the installation activities are, mostly, nominally before the monsoon season that occurs November - February
  - Exception to this is that the last Installation activity, CPP Topsides, is already scheduled to complete in November
- With schedule risks on predecessors the other installation activities will occur during monsoon
- This calendar might also affect some pipe laying activities

Fixed Window of Non-Work

File... | Export... | Run | Probabilistic Calen... | Home | Risk Prioritization | Health

Calendars
Categories
Correlation
Cost Estimate
Inflation
Liquidated Damages
Probabilistic Calendars
Resources
Risks
Simulation Options
Templated Uncertainty

Probabilistic Calendar Editor

Calendars | Add | Remove

Enabled	Name	Tasks	Notes
☑	Monsoon Calendar	Apply to Tasks	

Event | Window

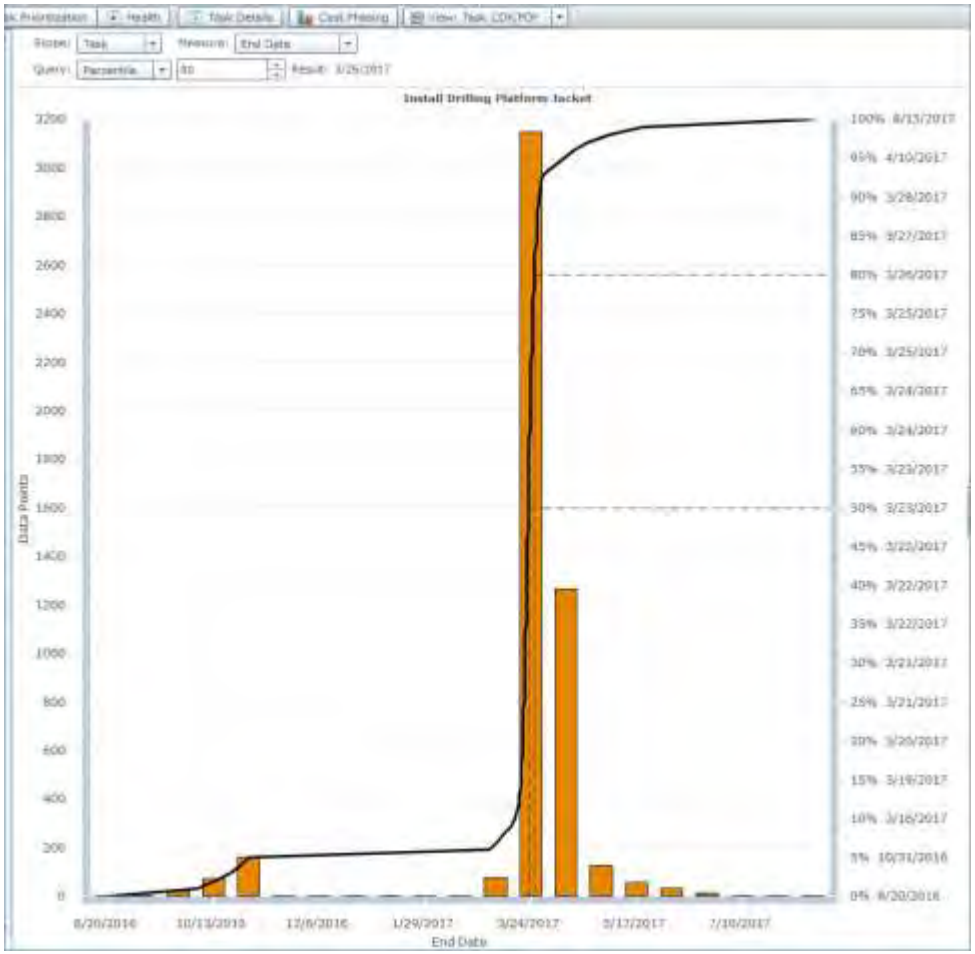
Window Editor

Windows | Add | Remove

Enabled	Name	Start Date Distribution	Finish Date Distribution
☑	Monsoon Season	Fixed - Value:11/1/2016	Fixed - Value:11/2/2017

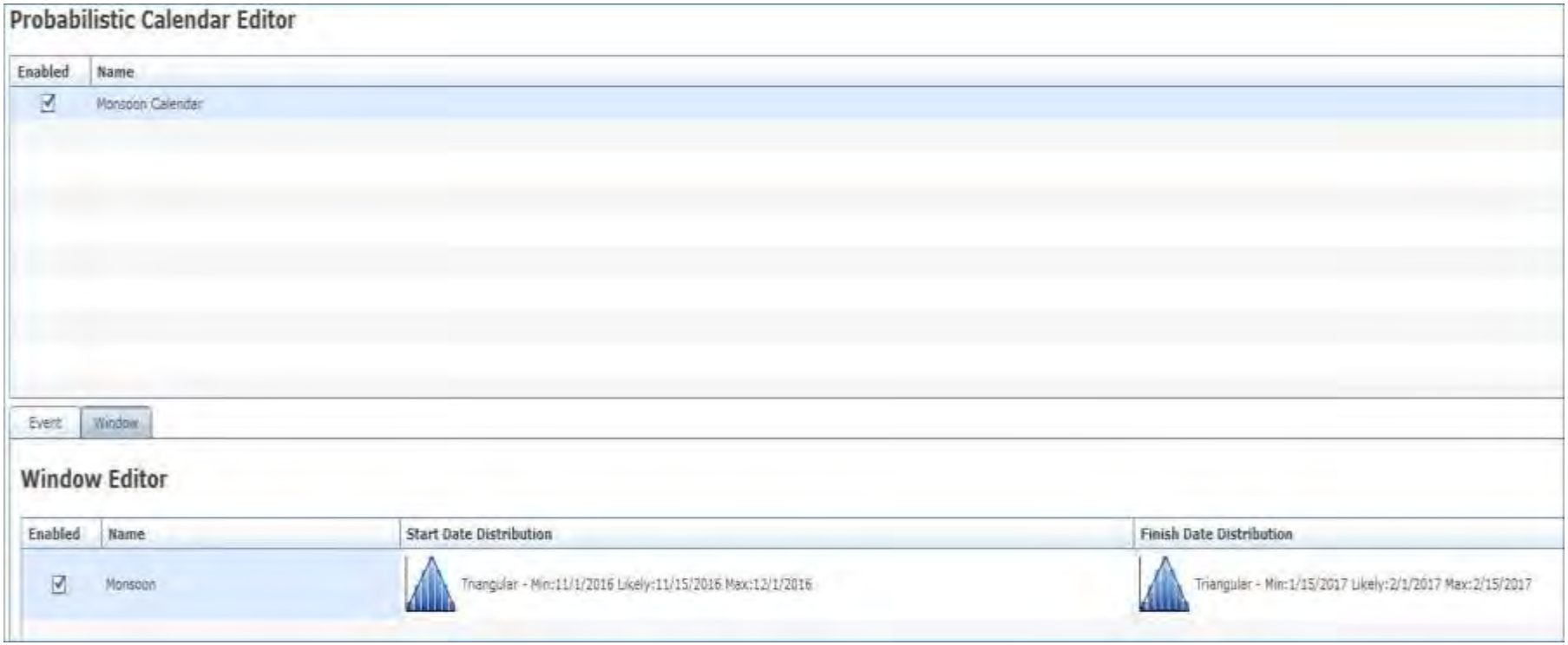
> Add Monsoon Calendar > Apply to Installation tasks > Window > add the impact and dates > Enable this calendar

Effect of Probabilistic Calendar on Install Drilling Jacket

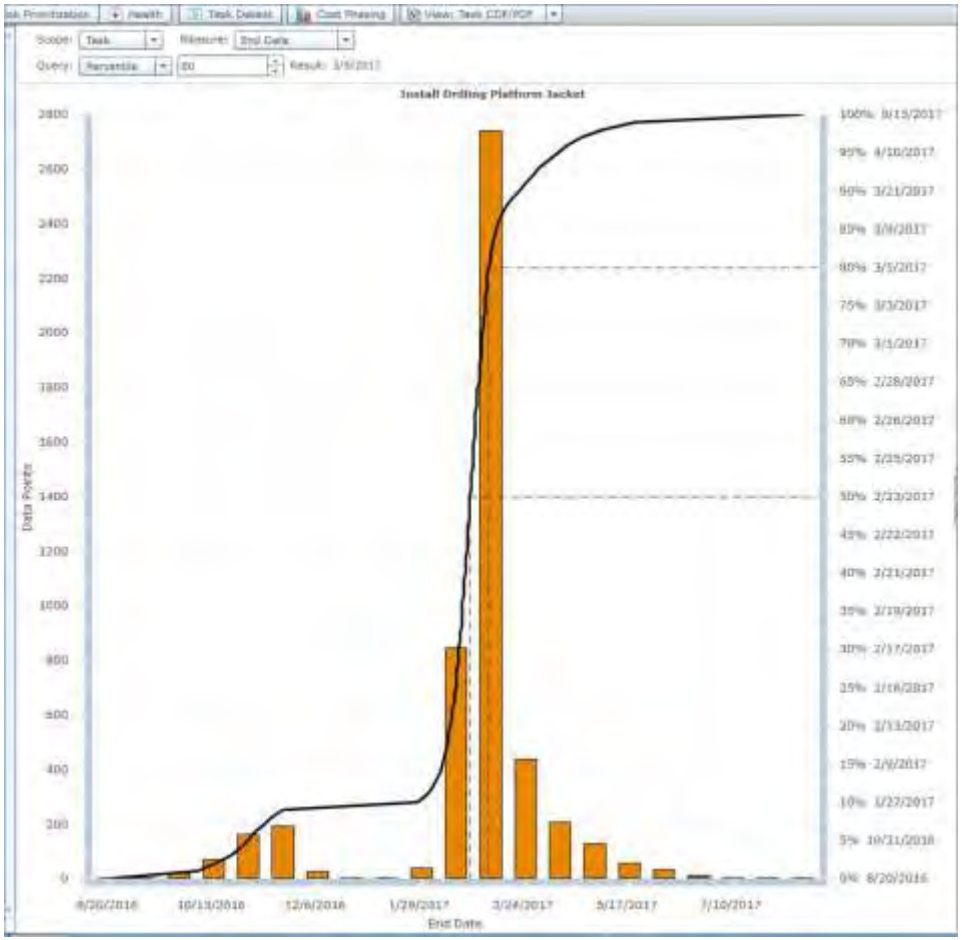


Notice that the period from November to the end of February represents no completion because of the calendar. Predecessor activities have usual histograms

Start and Finish of Monsoon Window is Uncertain (1)



Start and Finish of Monsoon Window is Uncertain (2)



Notice that the window of finish dates is now narrower because the start and finish of the Monsoon season is uncertain

Risk Prioritization Method

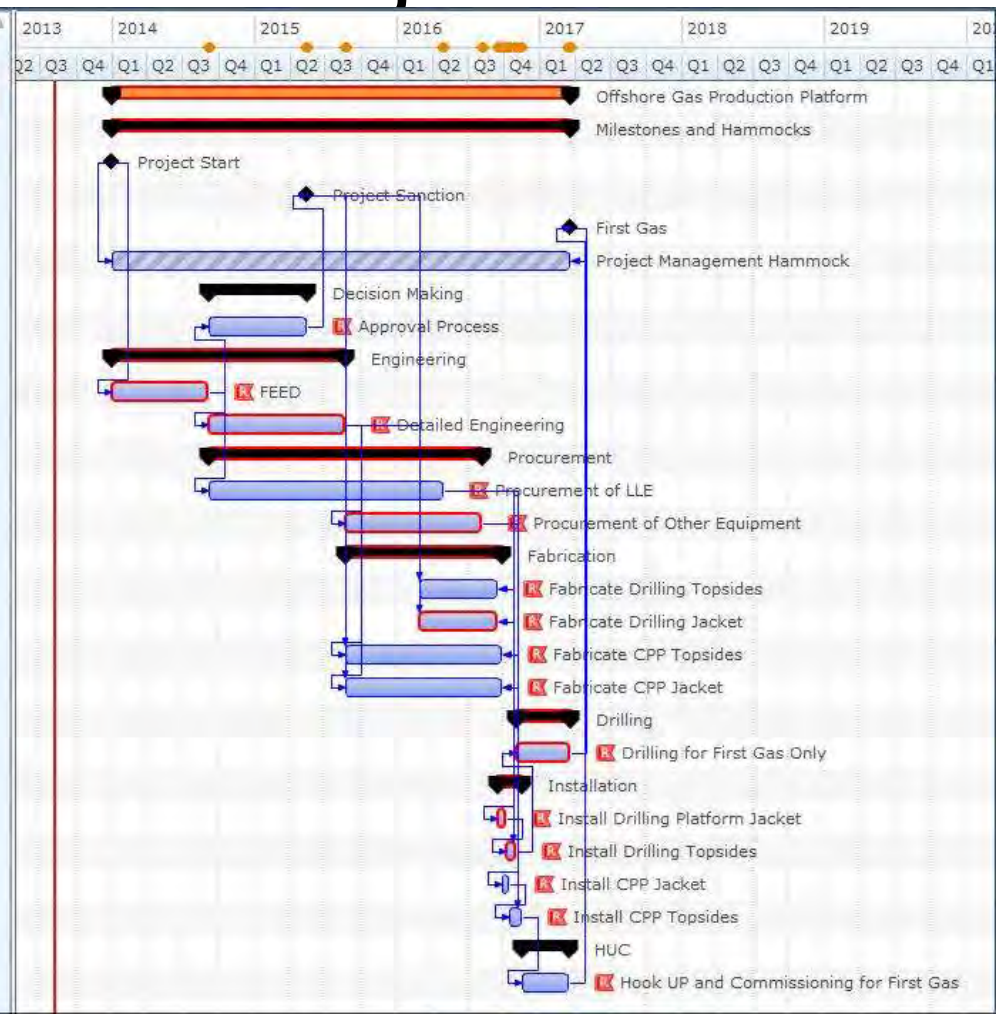
- Risks should be prioritized through the project schedule and the Monte Carlo simulation method to inform the risk mitigation exercise
- For management we need to identify those risks by “days saved” if they were fully mitigated so management can do benefit/cost
- For management we should identify “days saved” at the target level of certainty, say P-80

Two Approaches to Risk Prioritization using Quantitative Methods

- Typical Tornado Diagram with Risks (not activities or paths) as the arguments help to prioritize the risks
- However, with the structure of the schedule the Tornado Diagram is instructive but not definitive
  - The order of the risks' importance can change when one is removed, since that exposes other paths that were "risk slack paths" before

Use the Offshore Gas Production Platform Project

UID	Task	Start Date	End Date	Duration
Gas Pla	▼ Offshore Gas Production Platfor	1/1/2014	3/20/2017	1,175
Gas Pla	▼ Milestones and Hammocks	1/1/2014	3/20/2017	1,175
A1000	Project Start	1/1/2014		0
A1010	Project Sanction		5/15/2015	0
A1020	First Gas		3/20/2017	0
A1030	Project Management Ham	1/1/2014	3/20/2017	1,175
Gas Pla	▼ Decision Making	9/8/2014	5/15/2015	250
B1000	Approval Process	9/8/2014	5/15/2015	250
Gas Pla	▼ Engineering	1/1/2014	8/23/2015	600
C1000	FEED	1/1/2014	9/7/2014	250
C1010	Detailed Engineering	9/8/2014	8/23/2015	350
Gas Pla	▼ Procurement	9/8/2014	8/7/2016	700
D1000	Procurement of LLE	9/8/2014	4/29/2016	600
D1010	Procurement of Other Equ	8/24/2015	8/7/2016	350
Gas Pla	▼ Fabrication	8/24/2015	9/26/2016	400
E1000	Fabricate Drilling Topsides	3/1/2016	9/16/2016	200
E1010	Fabricate Drilling Jacket	3/1/2016	9/16/2016	200
E1020	Fabricate CPP Topsides	8/24/2015	9/26/2016	400
E1030	Fabricate CPP Jacket	8/24/2015	9/26/2016	400
Gas Pla	▼ Drilling	11/1/2016	3/20/2017	140
F1000	Drilling for First Gas Only	11/1/2016	3/20/2017	140
Gas Pla	▼ Installation	9/17/2016	11/15/2016	60
G1000	Install Drilling Platform Ja	9/17/2016	10/6/2016	20
G1010	Install Drilling Topsides	10/7/2016	10/31/2016	25
G1020	Install CPP Jacket	9/27/2016	10/16/2016	20
G1030	Install CPP Topsides	10/17/2016	11/15/2016	30
Gas Pla	▼ HUC	11/16/2016	3/15/2017	120
H1000	Hook UP and Commission	11/16/2016	3/15/2017	120



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This project has reference ranges by category and 8 Risk Drivers

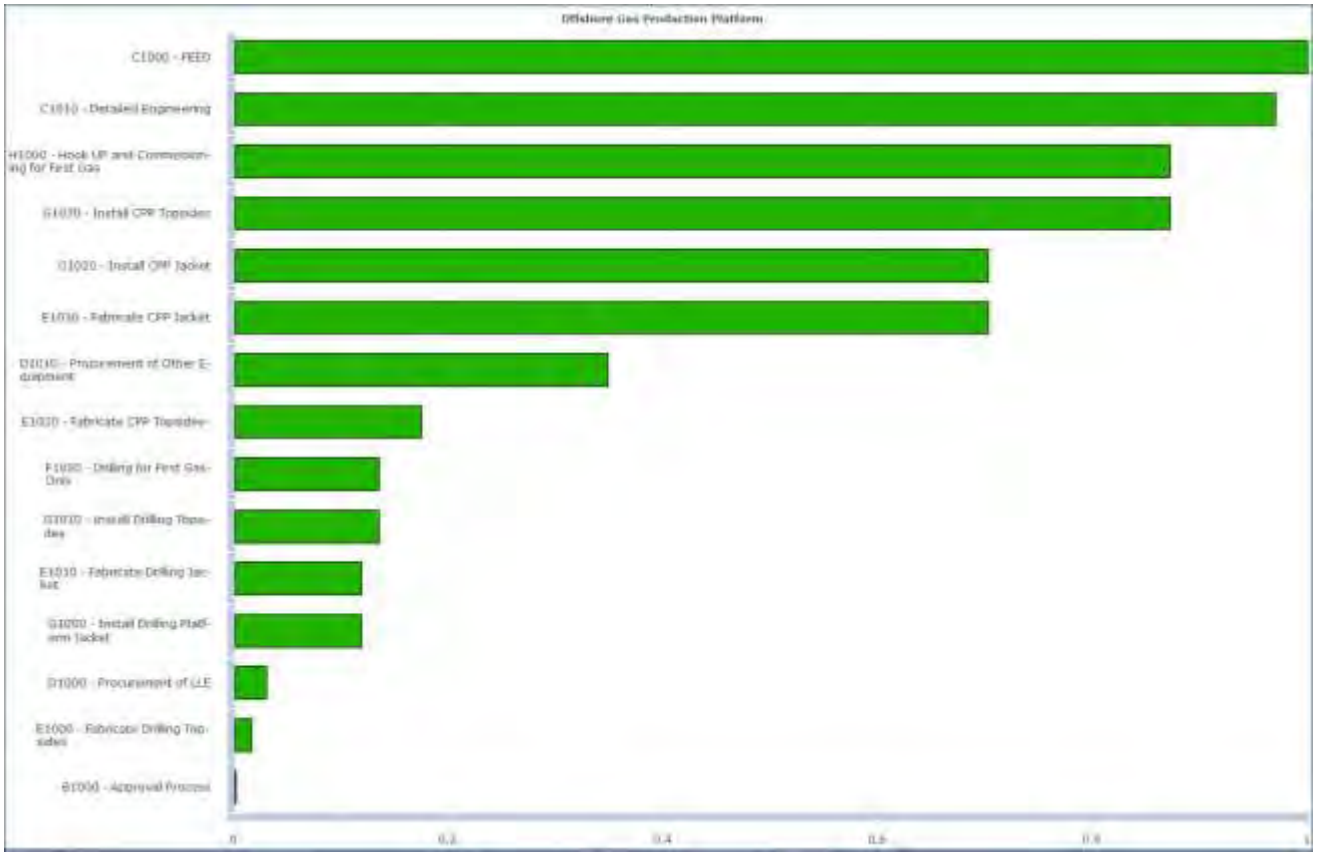
Standard Sensitivity Tornado

This standard Duration Tornado chart shows activities in order of their correlation with finish date.

These are not risks, and risks cannot be teased out of these results,

Also, these bars are sorted by correlations rather than days, and correlations are hard to understand

Criticality Tornado Diagram based on Percent of Iterations on the Critical Path

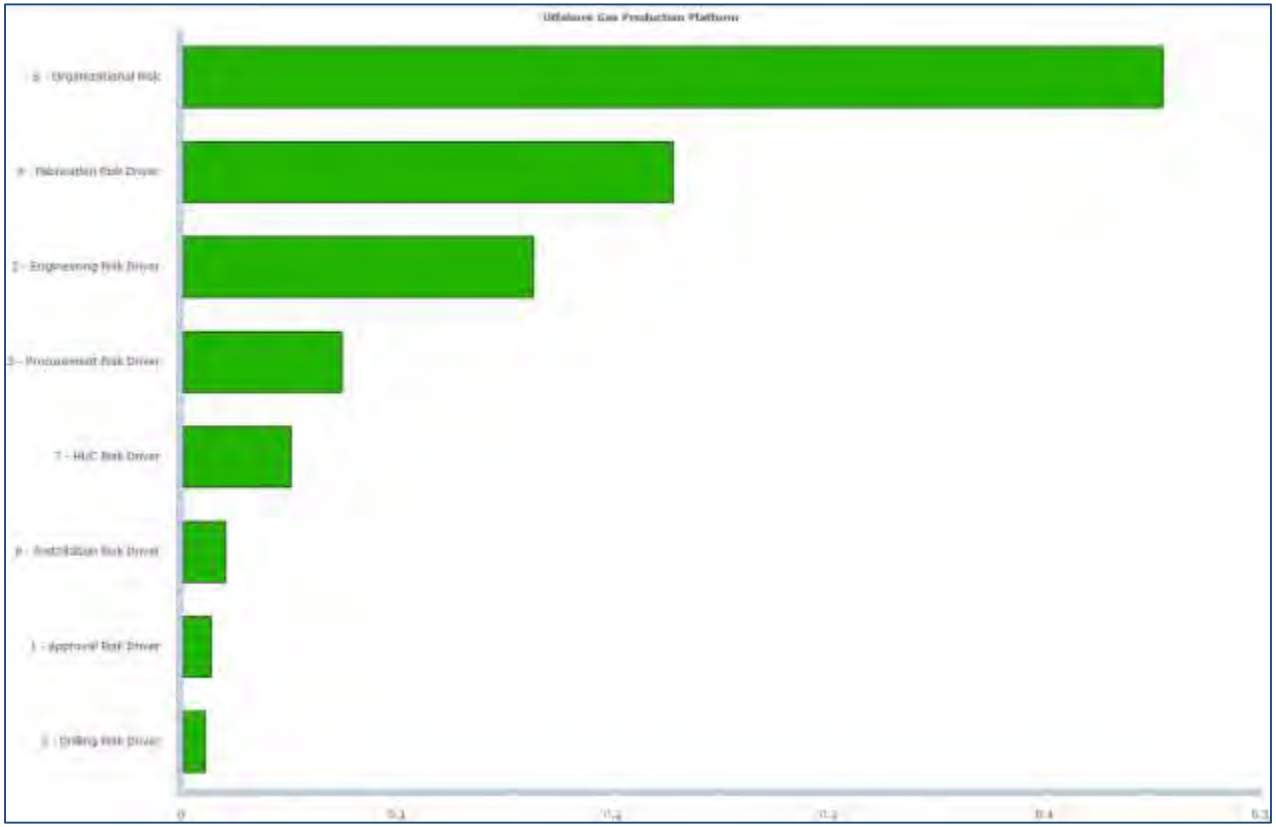


Using the Criticality Index.

These are also not risks but activities sorted by their percentage of iterations on the critical path

Shows which paths are the most likely to delay the project, so new information, but not risks

Risk Tornado Highlights Risks, Not Activities or Paths



This special risk-based tornado diagram focuses on the entire impact of the risks, including their probability, impact range and the activities to which they are assigned

Still, based on correlation concepts

Risk Prioritization Approach

- Identify the level of uncertainty desired (P-80)
- Simulate the schedule as many times as there are risks (For the first risk this is = single pass method)
- Then identify the risk that saves the most days when it is eliminated
  - Eliminating the risk (probability = 0 or “disabled”) represents complete mitigation, an ideal but impractical goal
  - Once the most impactful risk is identified and eliminated, look for the second most-important risk, disable it, then look for the third risk….. This is the Iterative method

Run Prioritization
View the Risk List in Priority Order

Risks are prioritized by “days saved” if they were completely disabled in the right order
Do not spend much time mitigating those lower on the list before handling those at the to p

Prioritized Risks in a Table

Gas Platform-1 - Risk Prioritization (80%)		
UID	Name	Days Saved
8	Organizational Risk	106
4	Fabrication Risk Driver	37
2	Engineering Risk Driver	16
7	HUC Risk Driver	16
3	Procurement Risk Driver	11
6	Installation Risk Driver	4
1	Approval Risk Driver	0
5	Drilling Risk Driver	-2
	Total Days Saved from Risk Drivers	**188**
	Uncertainty Days Saved	140
	Total Schedule Contingency	**328**

The Grid view shows the risks in priority order, determined by Monte Carlo Simulation of the project schedule, with their "Days Saved."

INT 3 Schedule Risk Analysis

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ICEAA Professional Development
and Training Workshop
San Diego, CA
June 9 - 12, 2015

Hulett & Associates