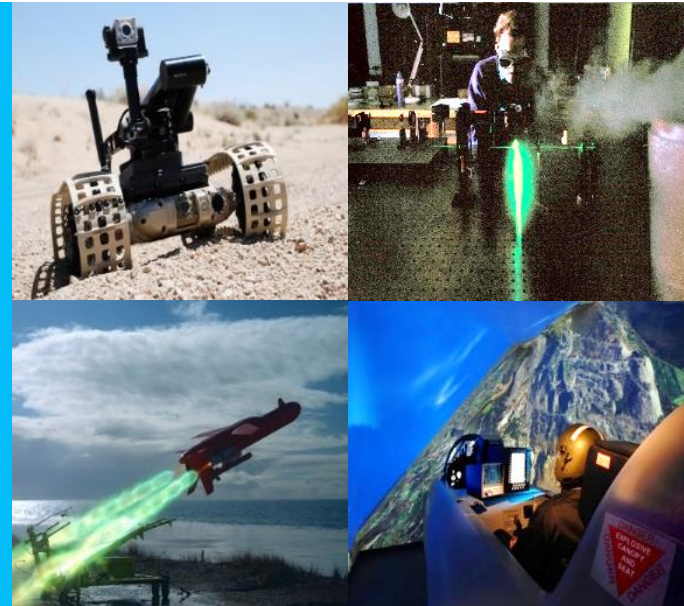


Cost Risk Analysis (CRA) and Schedule Risk Analysis (SRA) explained

**Palisade EMEA 2016 Risk Conference
Edinburgh, Scotland**



Dale Shermon

**QinetiQ Fellow / Head of Profession –
Cost Engineering**

22 September 2016

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- **Introduction**
- **Definition of terms**
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- **Summary**

QinetiQ Businesses



Air and Space



Maritime, land and weapons



North America



Cyber, Information & training



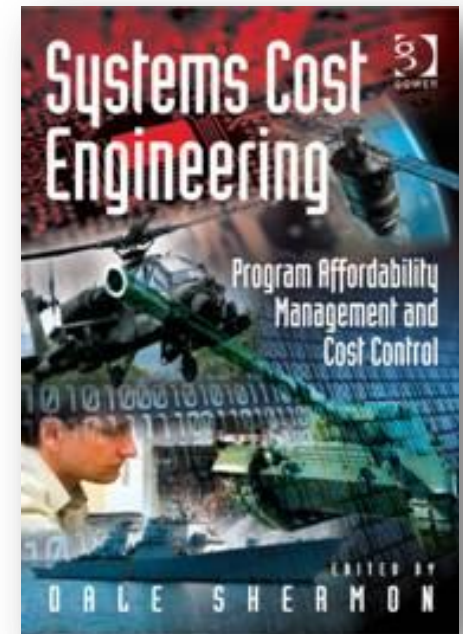
OptiSense®



International

Dale Shermon

- Estimating since 1984, parametric estimating since 1987
- QinetiQ Fellow and Head of Profession – Cost Engineering
- Life member of ICEAA and ICEAA Certified Cost Estimator / Analyst with Parametrics (CCEA-P)
- Author of “Systems Cost Engineering” book
- Fellow of ACostE and member of council
- Chairman of SCAF
- Published article
- Member of APM
- ISPA “Frank Freiman” Award
- Thought leader

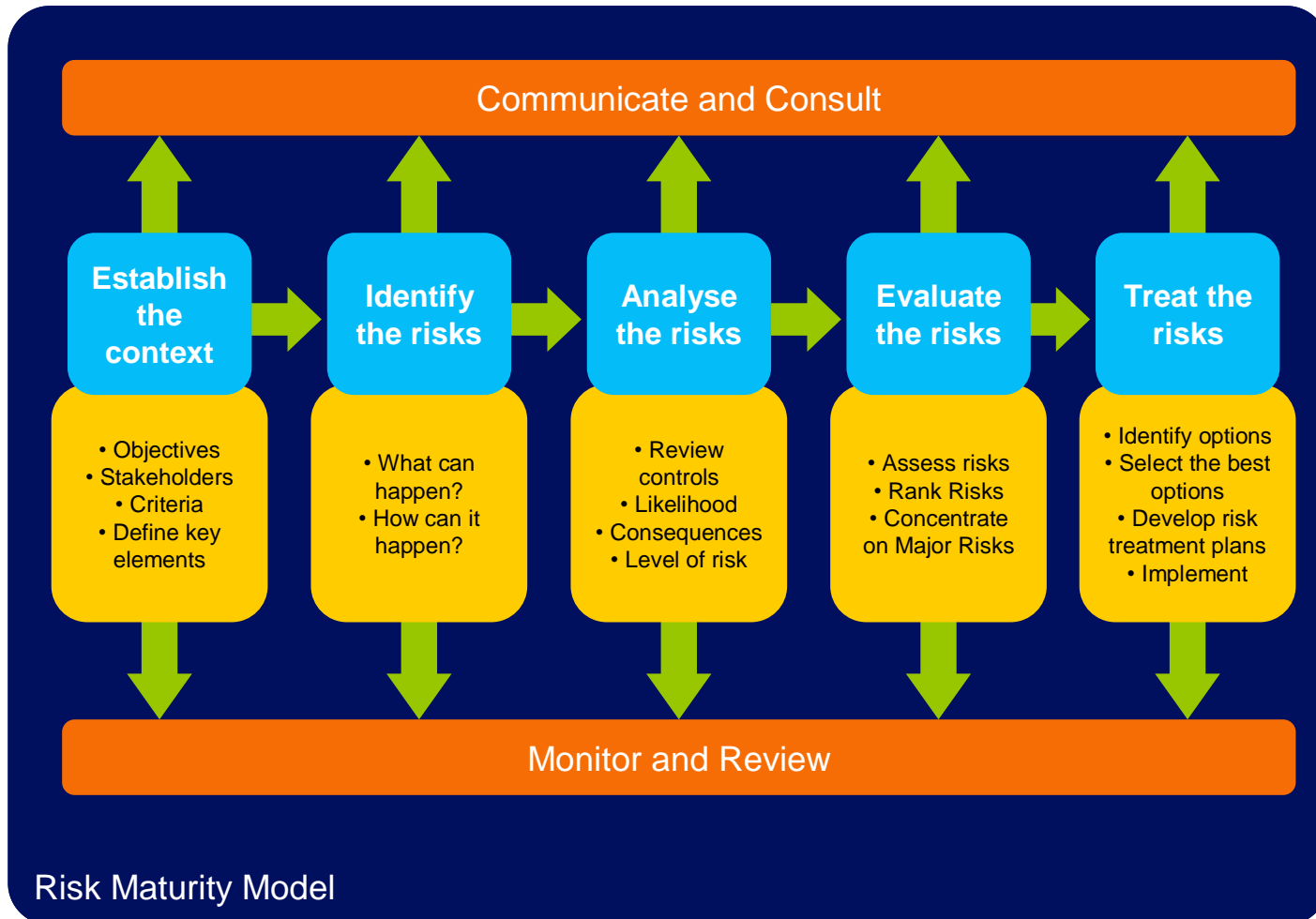


Definition of terms

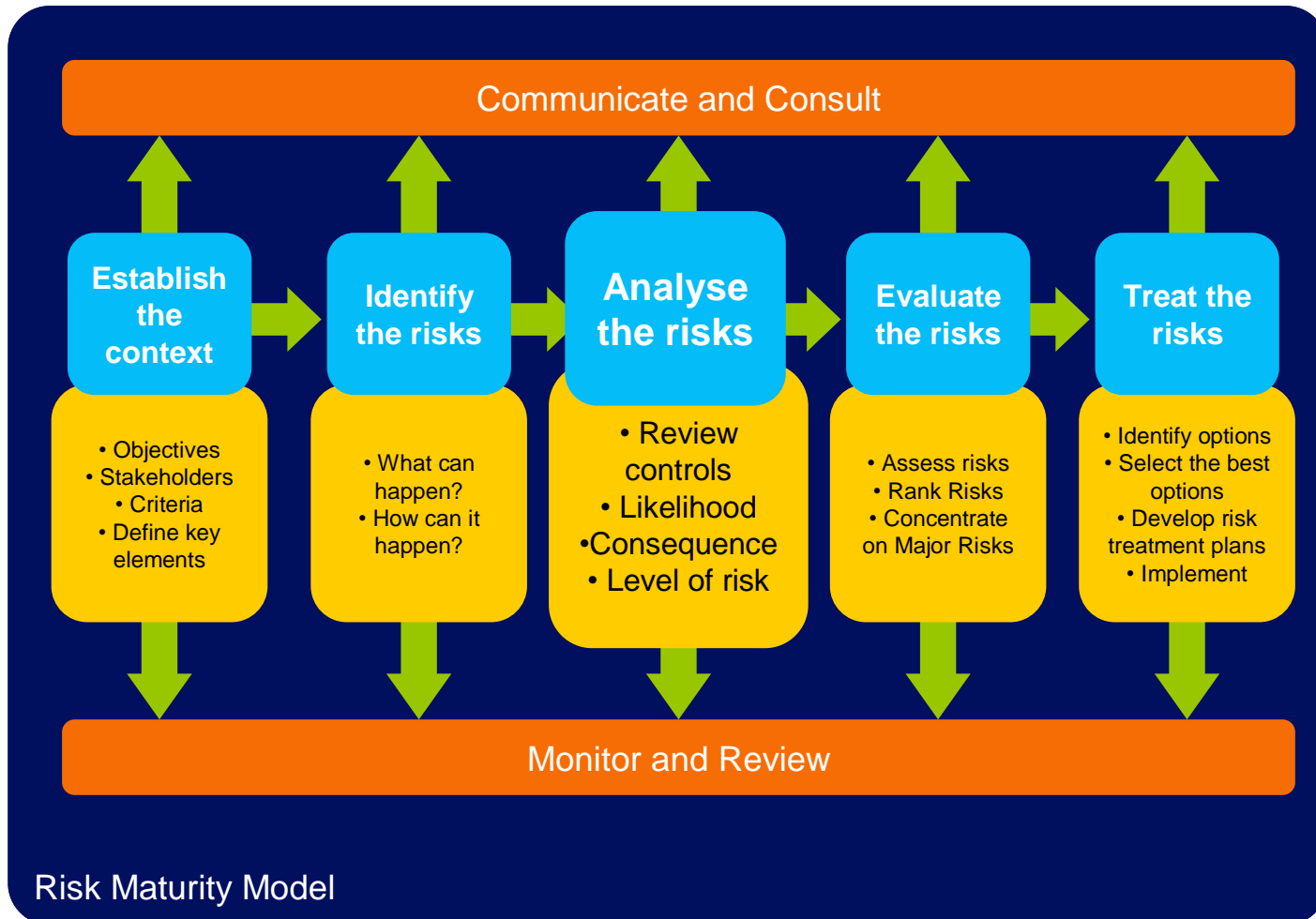
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QinetiQ Risk Management Process



Risk Analysis Process



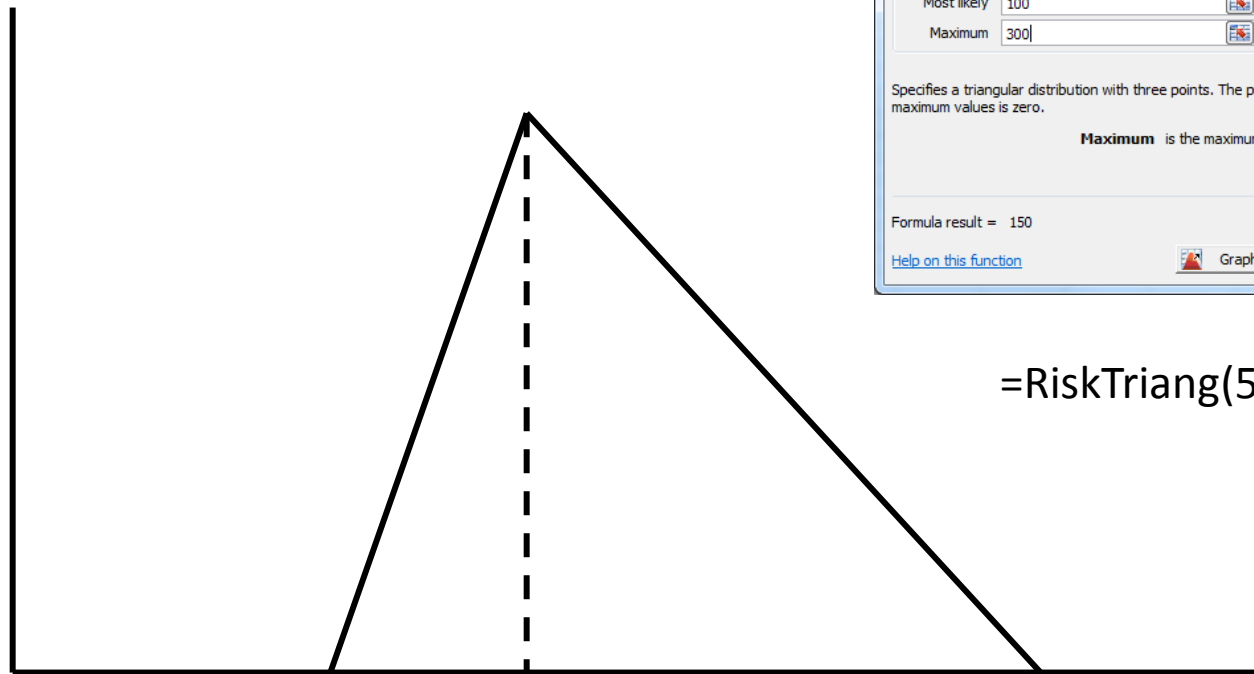
Definitions

Term	Technique	Probability	Impact
Baseline	Deterministic	100%	Absolute (Most Likely)
Uncertainty	Three point estimate (3PE)	100%	Distribution (Min, ML, Max)
Risk	Probability and Impact	<100%	Distribution (Min, ML, Max)
Mitigation	Uncertainty	100%	Distribution (Min, ML, Max)

Uncertainty – 3-point estimate

3-point estimate – the tolerance or uncertainty within the baseline activity schedule or resource estimate

Probability %



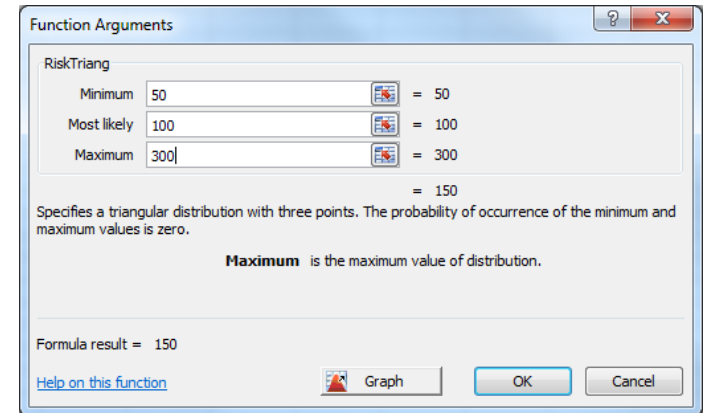
Minimum

Most
Likely

Maximum

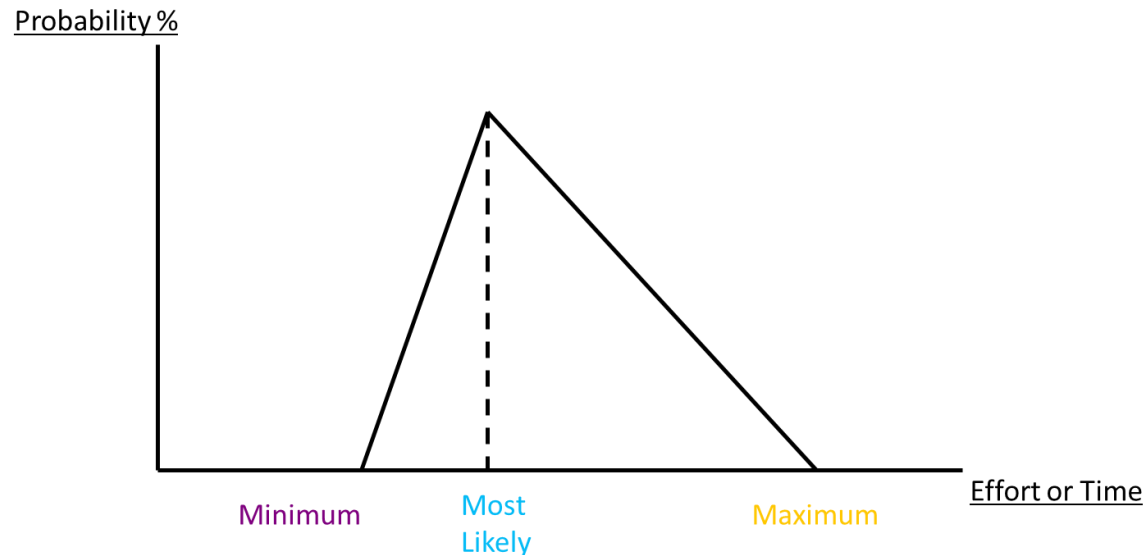
Effort or Time

=RiskTriang(50,100,300)



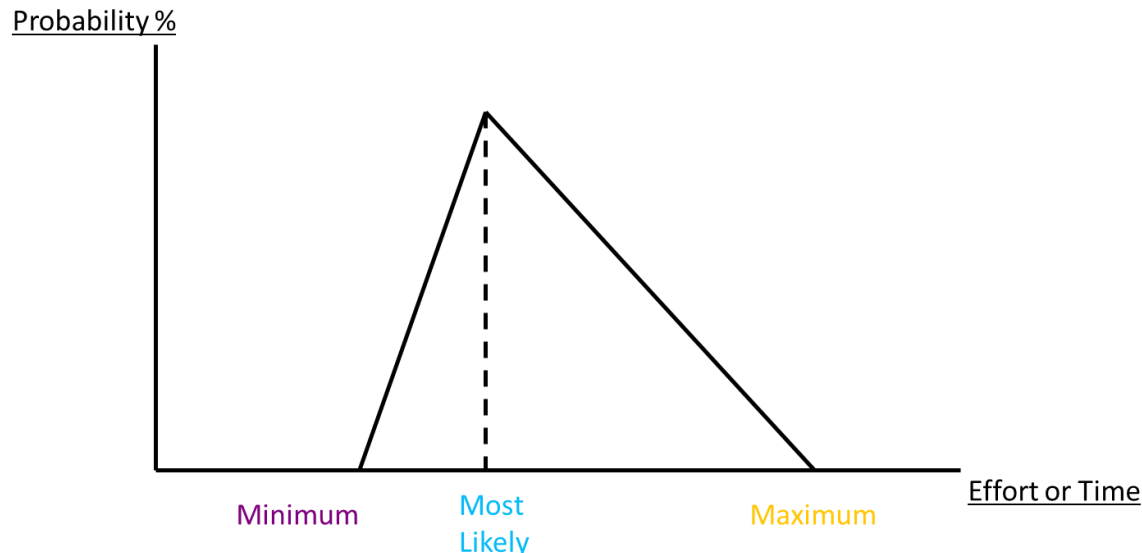
Uncertainty – 3-point estimate

- **Most Likely** – a genuine expert opinion of the typical resources (or time) required to complete a task;
 - The estimate that represents “normal working practise”.
 - Represents our most frequent outcome; the peak!
 - It recognises that we don’t get it right first time.
 - Excludes contingency, risk or uncertainty.



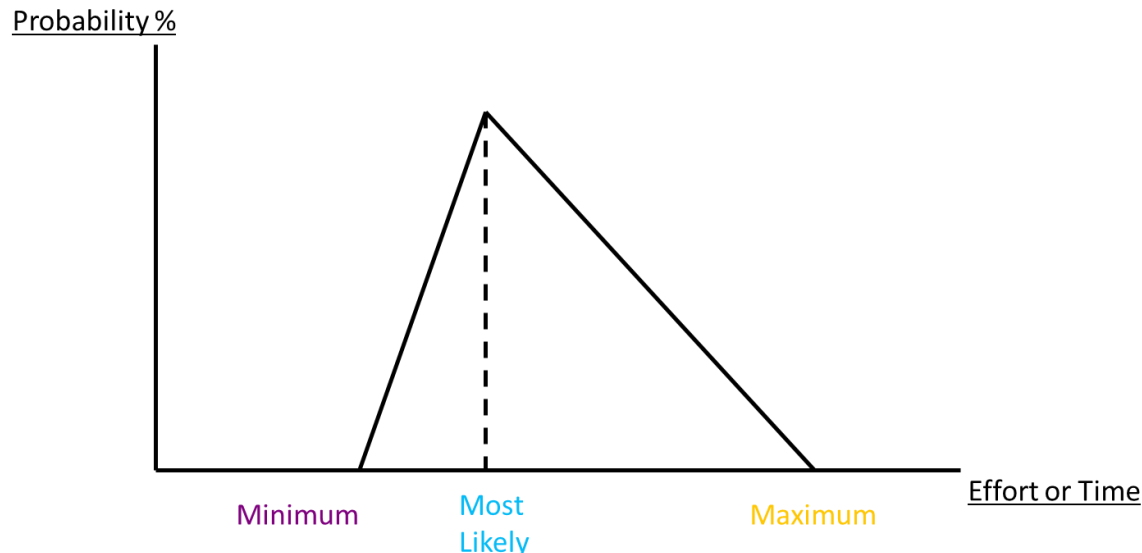
Uncertainty – 3-point estimate

- **Maximum** – a genuine expert opinion of the worst case resources (or time) required to complete a task;
 - The largest possible estimate
 - It represents zero confidence (0%) that this situation will ever be exceeded
 - If you can conceivably do the task for this effort (or schedule) then it is not zero confidence
 - It recognises the worst case estimate of the planned activities.
 - Excludes risk events that will cause a deviation from the baseline.



Uncertainty - 3-point estimate

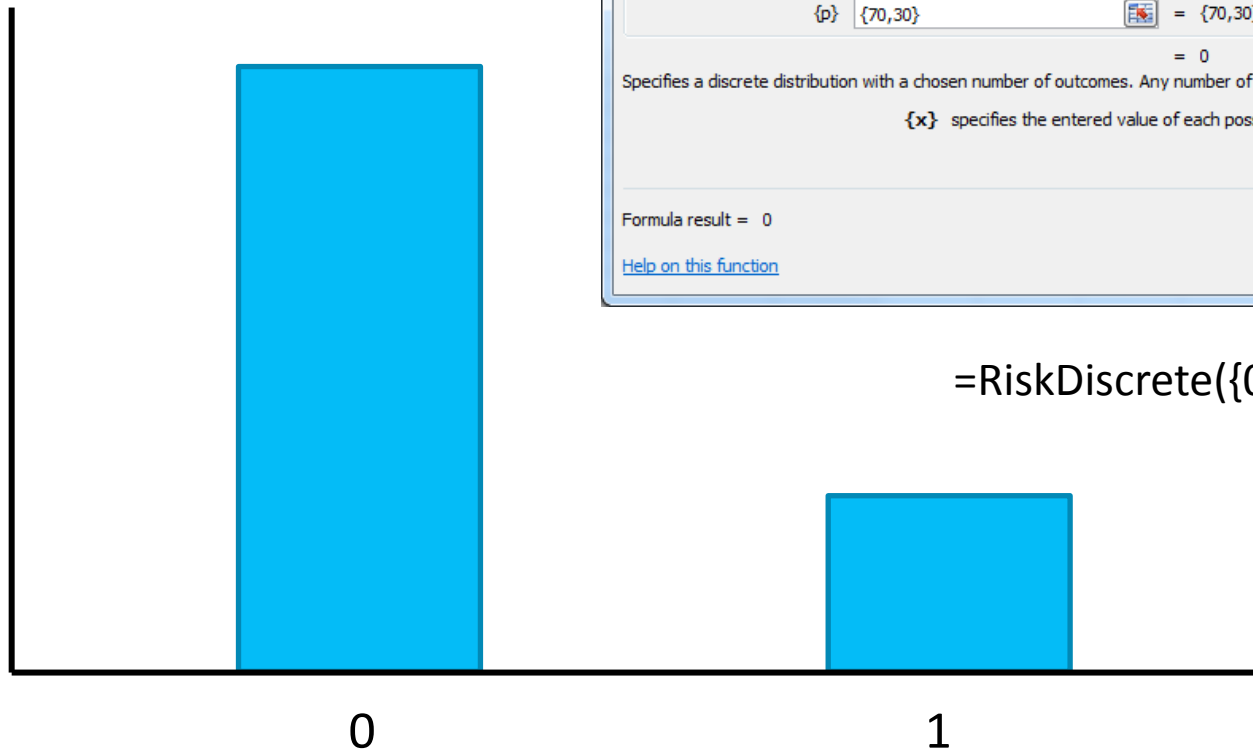
- **Minimum** – a genuine expert opinion of the best case resources (or time) required to complete a task;
 - The smallest possible estimate
 - It represents zero confidence (0%) that this situation will ever be beaten.
 - If you can conceivably do the task for this effort (or schedule) then it is not zero confidence
 - It recognises the best case estimate of the planned activities.
 - Excludes opportunity events that will cause a deviation from the baseline.



Risk - Probability

Probability – the chance of an occurrence; the measure of the likelihood of an unplanned deviation from the baseline plan.

Probability %



Function Arguments

RiskDiscrete

{x} {0,1} = {0,1}

{p} {70,30} = {70,30}

= 0

Specifies a discrete distribution with a chosen number of outcomes. Any number of outcomes may be entered.

{x} specifies the entered value of each possible outcome.

Formula result = 0

[Help on this function](#)

OK Cancel

=RiskDiscrete({0,1},{70,30})

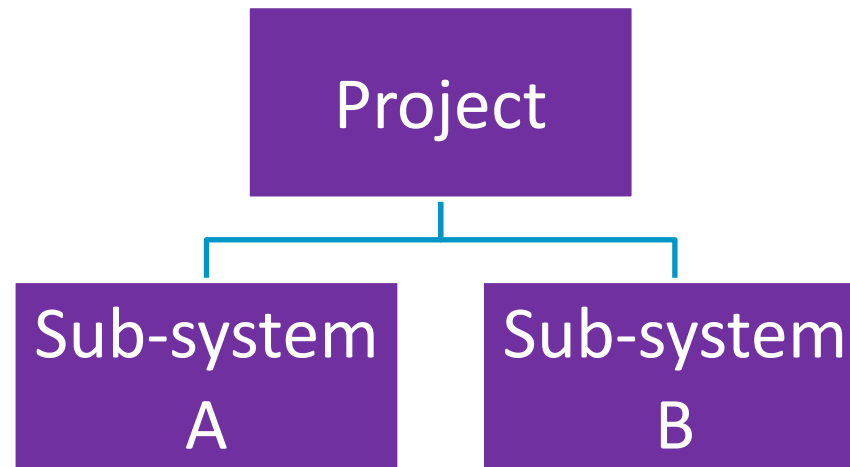
Effort or Time

Development of cost analysis

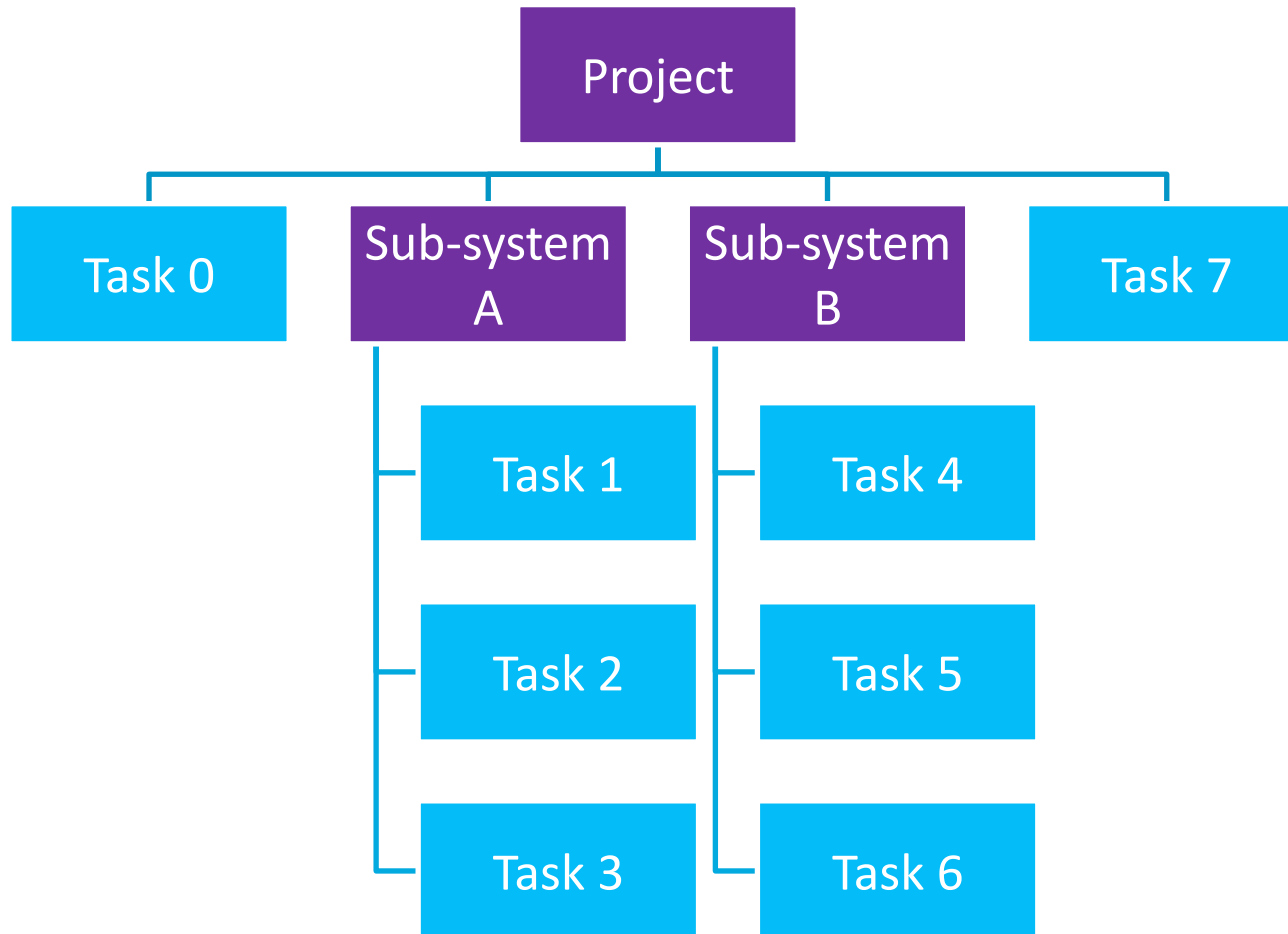
Dale Shermon | QinetiQ Fellow



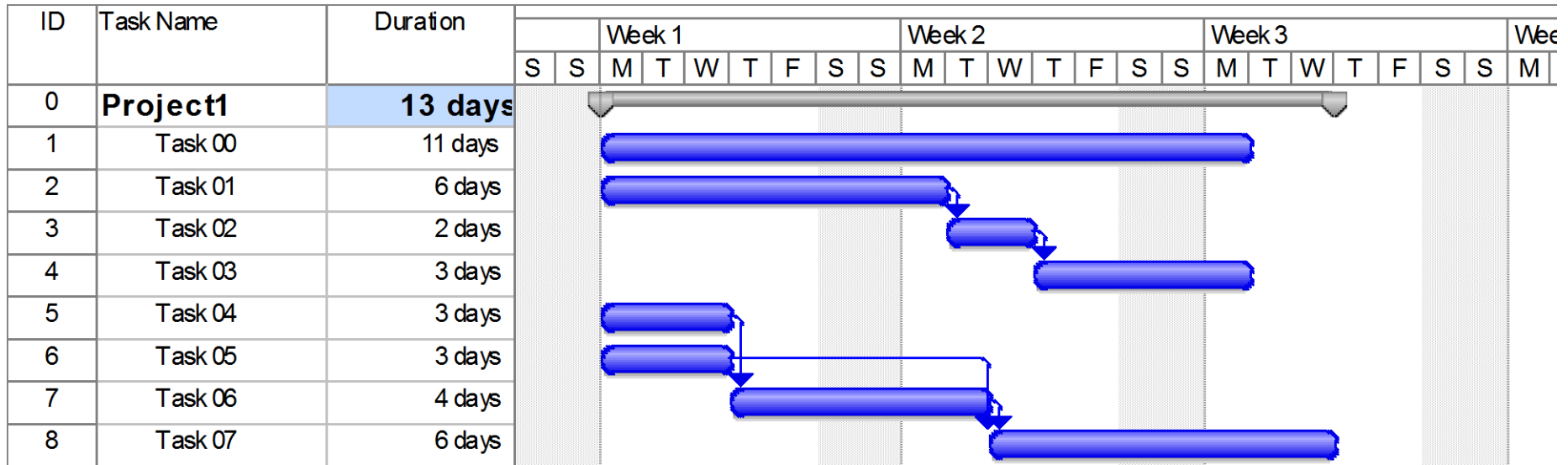
Product or Equipment Breakdown Structure (EBS)



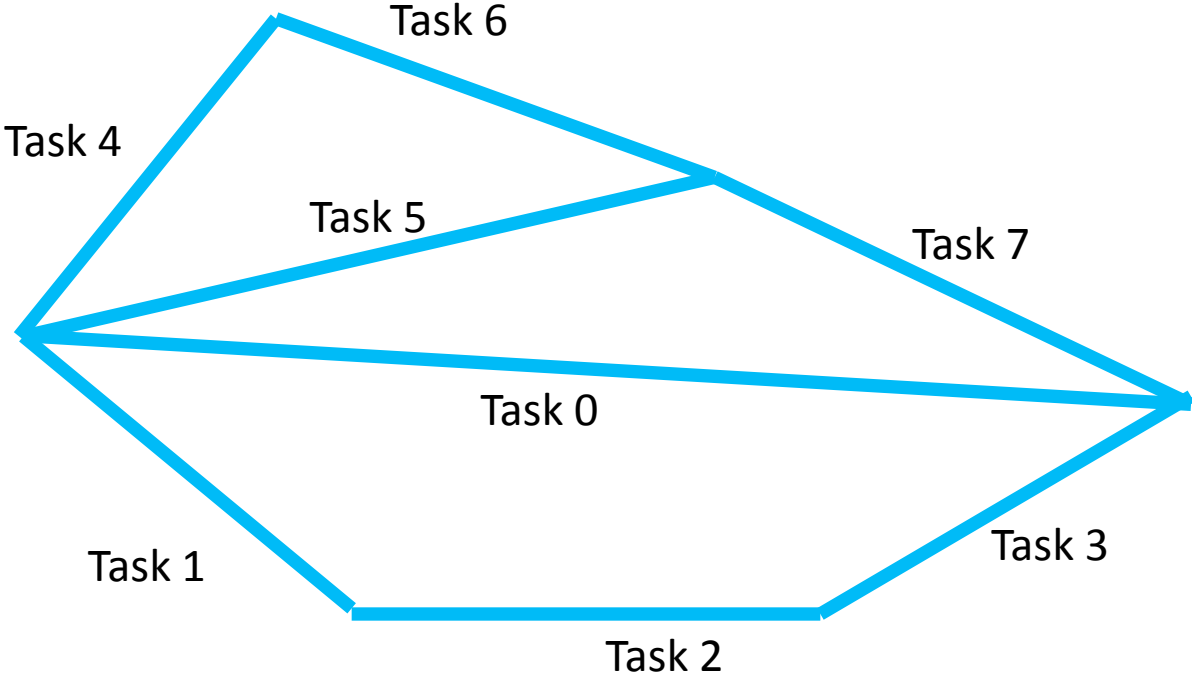
Work Breakdown Structure (WBS)



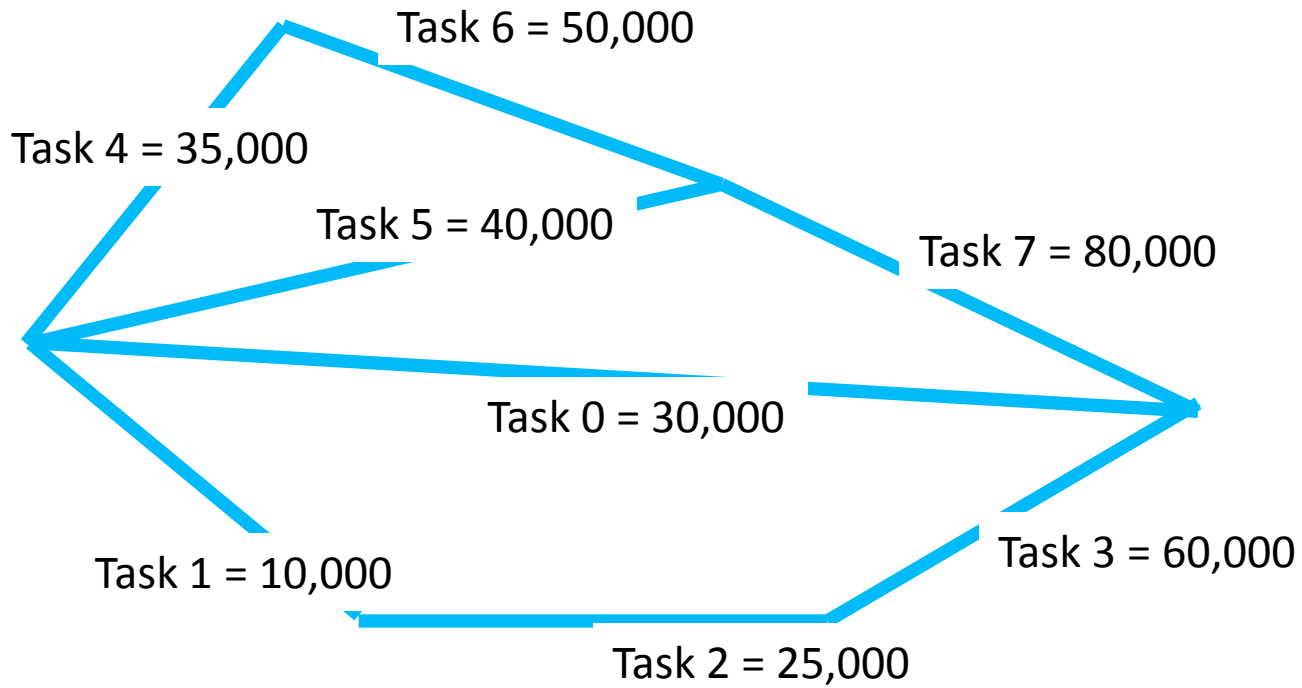
MS-Project schedule



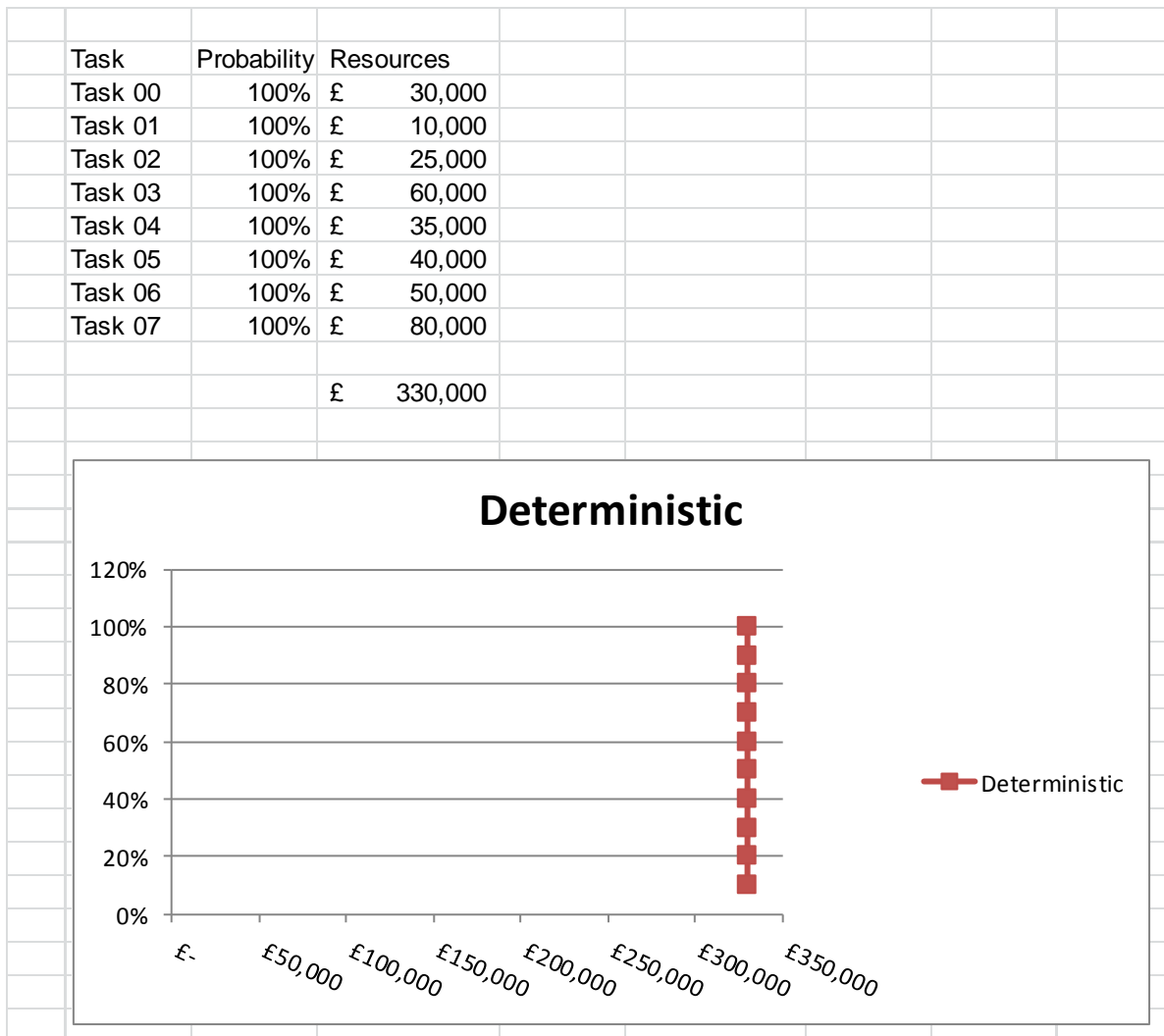
Network



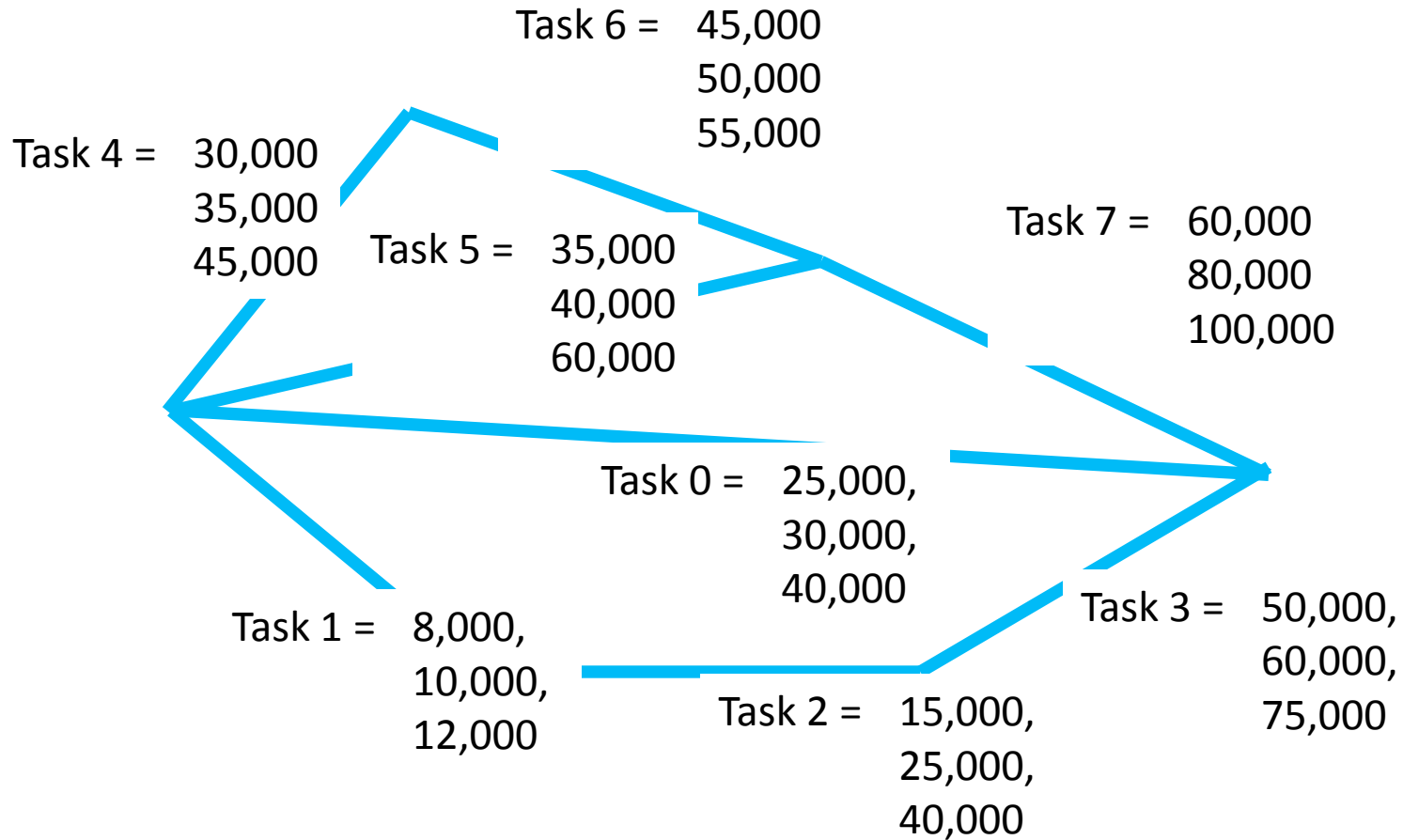
Deterministic cost



Deterministic cost - Analysis



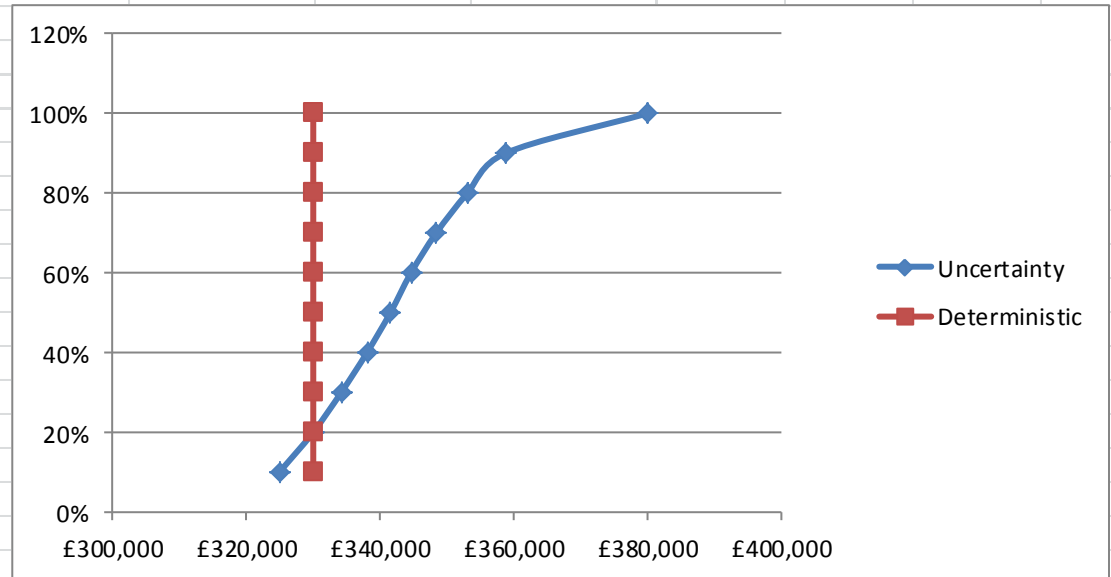
Uncertainty cost – 3PE



Uncertainty cost – Analysis

Task	Probability	Resources	Minimum	Maximum		
Task 00	100%	£ 30,000	£ 25,000	£ 40,000		£ 31,667
Task 01	100%	£ 10,000	£ 8,000	£ 12,000		£ 10,000
Task 02	100%	£ 25,000	£ 15,000	£ 40,000		£ 26,667
Task 03	100%	£ 60,000	£ 50,000	£ 75,000		£ 61,667
Task 04	100%	£ 35,000	£ 30,000	£ 45,000		£ 36,667
Task 05	100%	£ 40,000	£ 35,000	£ 60,000		£ 45,000
Task 06	100%	£ 50,000	£ 45,000	£ 55,000		£ 50,000
Task 07	100%	£ 80,000	£ 60,000	£ 100,000		£ 80,000
		£ 330,000	£ 268,000	£ 427,000		£ 341,667

	Deterministic	Uncertainty
10%	£ 330,000	£ 324,887
20%	£ 330,000	£ 329,955
30%	£ 330,000	£ 334,165
40%	£ 330,000	£ 338,030
50%	£ 330,000	£ 341,528
60%	£ 330,000	£ 344,618
70%	£ 330,000	£ 348,398
80%	£ 330,000	£ 353,058
90%	£ 330,000	£ 358,717
100%	£ 330,000	£ 379,987



Uncertainty cost – Analysis

Task	Probability	Resources	Minim
Task 00	100%	£ 30,000	£
Task 01	100%	£ 10,000	£
Task 02	100%	£ 25,000	£
Task 03	100%	£ 60,000	£
Task 04	100%	£ 35,000	£
Task 05	100%	£ 40,000	£
Task 06	100%	£ 50,000	£
Task 07	100%	£ 80,000	£
		£ 330,000	£

Function Arguments

RiskPercentile

Data source: = 150

Percent value: = 50

Sim #: =

= 150

Returns the value of the entered percentile of the simulated distribution of the cell, output, or input.

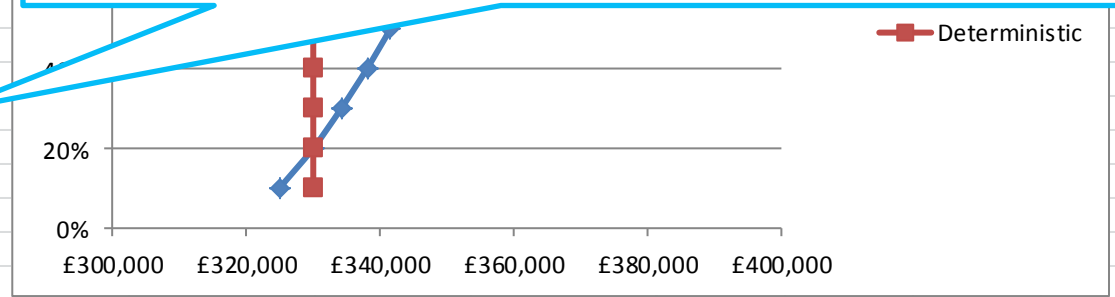
Data source is the cell, output, or input for which the percentile of its simulated distribution is calculated.

Formula result = 150

[Help on this function](#)

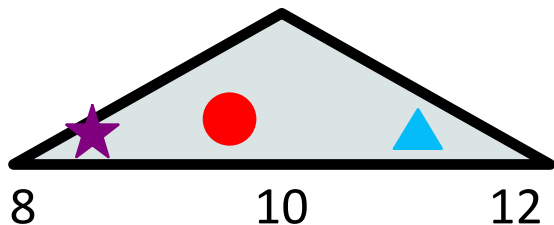
	Deterministic	Uncertainty
10%	£ 330,000	£ 324,887
20%	£ 330,000	£ 329,955
30%	£ 330,000	£ 334,165
40%	£ 330,000	£ 338,030
50%	£ 330,000	£ 341,528
60%	£ 330,000	£ 344,618
70%	£ 330,000	£ 348,398
80%	£ 330,000	£ 353,058
90%	£ 330,000	£ 358,717
100%	£ 330,000	£ 379,987

=RiskPercentile(\$H\$20,90)

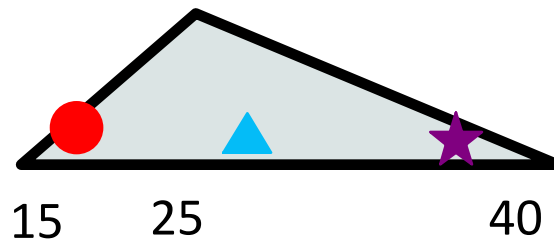


Uncertainty Analysis

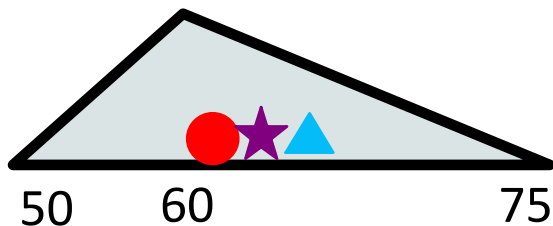
Task 1 =



Task 2 =



Task 3 =



Iterations

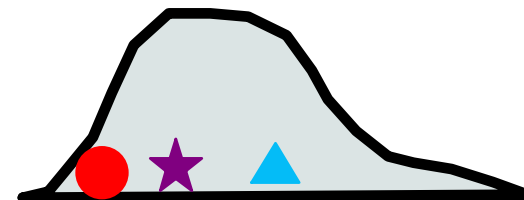
A ★ 8.5 B ▲ 11.5 C ● 9.5

38 27 15.5

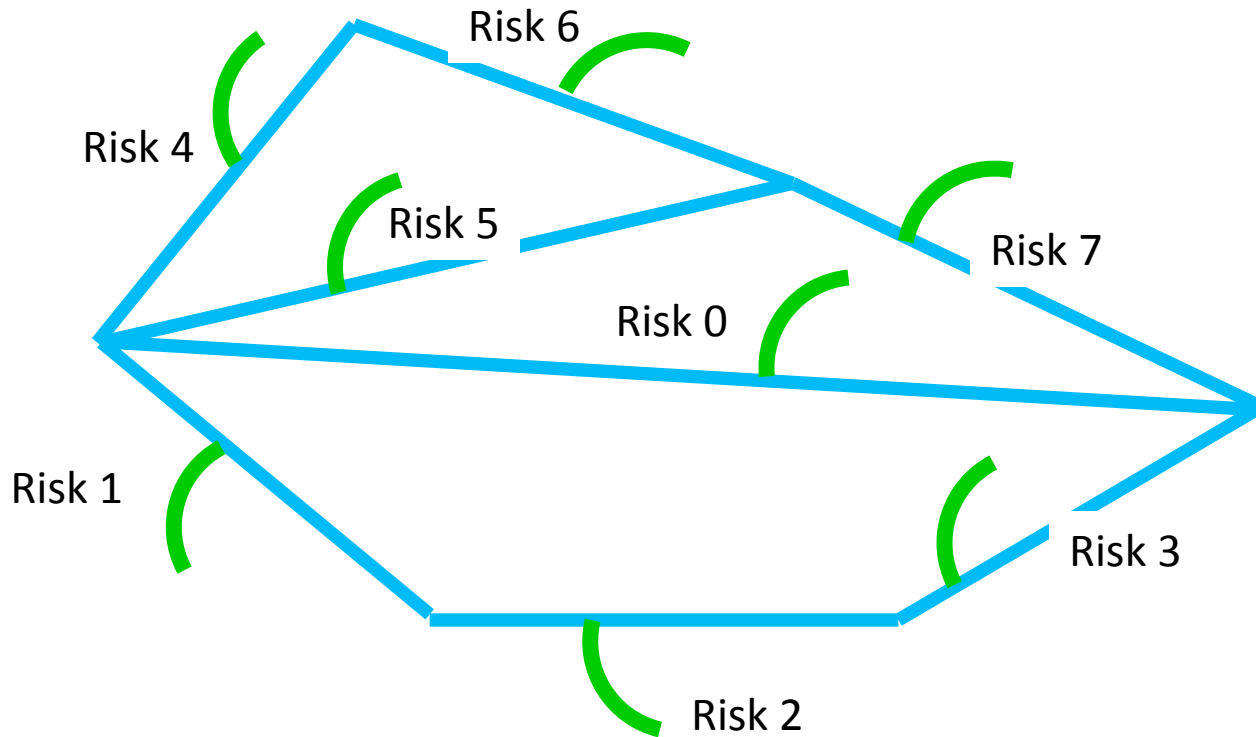
63 65 61

109.5 103.5 86

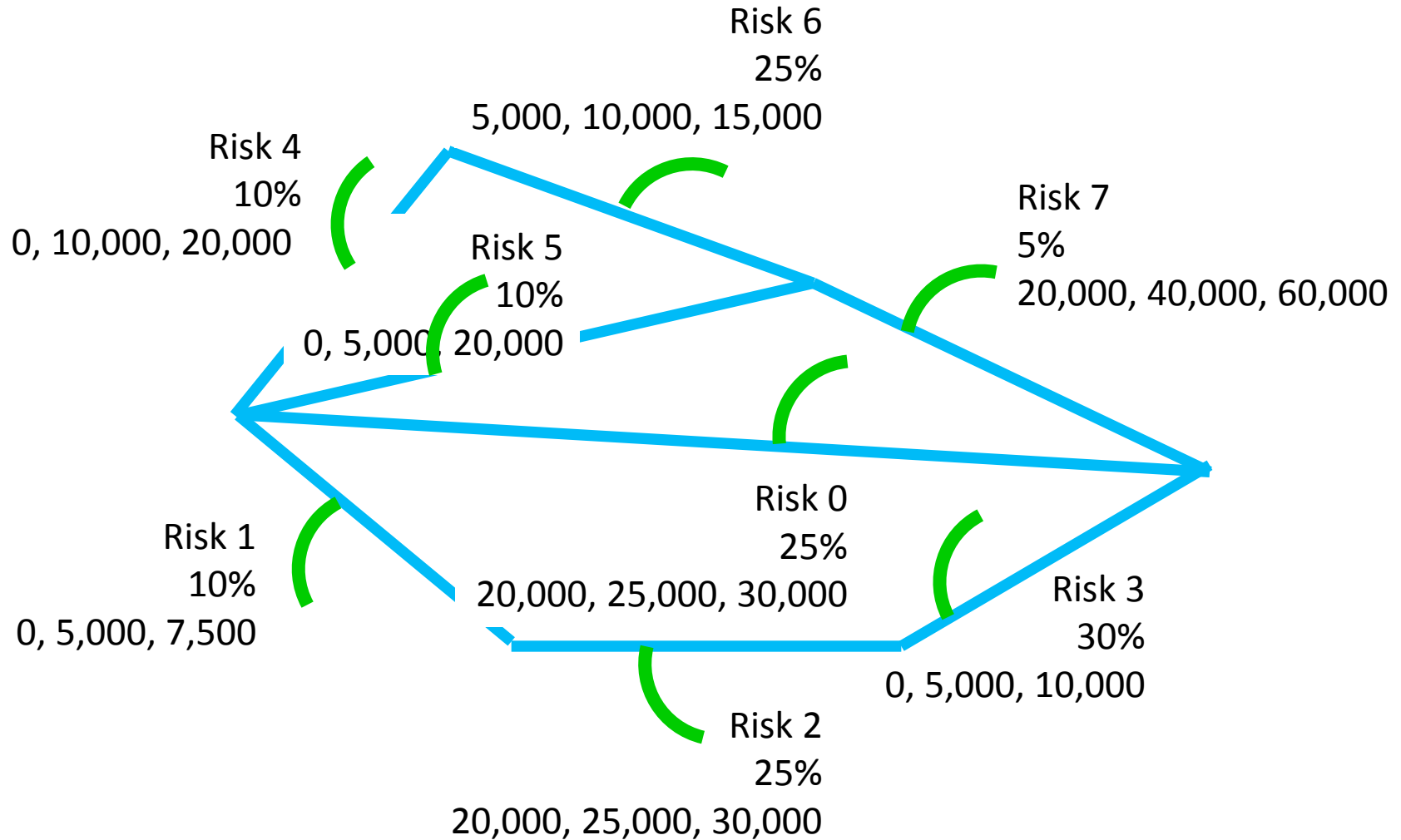
Result =



Risk – Deviations from the plan



Risk – Pre-mitigation

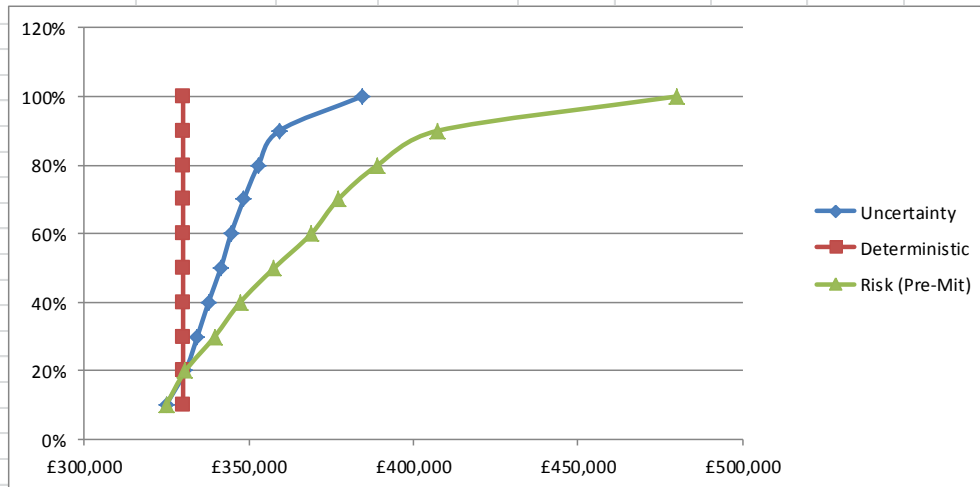


Risk – Pre-mitigation - Analysis

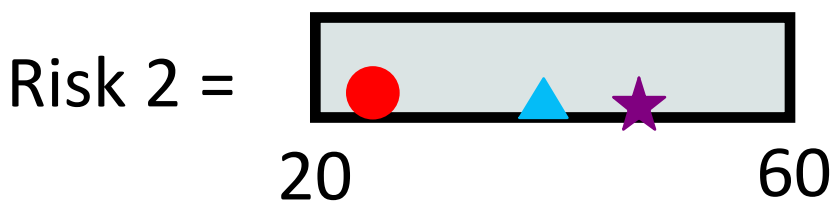
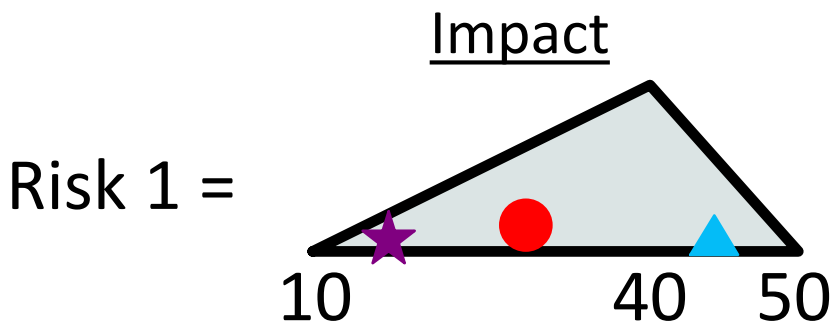
Task	Probability	Resources	Minimum	Maximum					
Task 00	100%	£ 30,000	£ 25,000	£ 40,000	£	31,667			
Task 01	100%	£ 10,000	£ 8,000	£ 12,000	£	10,000			
Task 02	100%	£ 25,000	£ 15,000	£ 40,000	£	26,667			
Task 03	100%	£ 60,000	£ 50,000	£ 75,000	£	61,667			
Task 04	100%	£ 35,000	£ 30,000	£ 45,000	£	36,667			
Task 05	100%	£ 40,000	£ 35,000	£ 60,000	£	45,000			
Task 06	100%	£ 50,000	£ 45,000	£ 55,000	£	50,000			
Task 07	100%	£ 80,000	£ 60,000	£ 100,000	£	80,000			
		£ 330,000	£ 268,000	£ 427,000	£	341,667			

	Probability		Resources	Minimum	Maximum				
Risk 00	25%	75%	£ 25,000	£ 20,000	£ 30,000	0	£	-	
Risk 01	10%	90%	£ 5,000	£ -	£ 7,500	0	£	-	
Risk 02	25%	75%	£ 25,000	£ 20,000	£ 30,000	0	£	-	
Risk 03	30%	70%	£ 5,000	£ -	£ 10,000	0	£	-	
Risk 04	10%	90%	£ 10,000	£ -	£ 20,000	0	£	-	
Risk 05	10%	90%	£ 5,000	£ -	£ 20,000	0	£	-	
Risk 06	25%	75%	£ 10,000	£ 5,000	£ 15,000	0	£	-	
Risk 07	5%	95%	£ 40,000	£ 20,000	£ 60,000	0	£	-	
							£	-	

	Deterministic	Uncertainty	Risk (Pre-Mit)
10%	£ 330,000	£ 324,797	£ 324,797
20%	£ 330,000	£ 330,689	£ 330,689
30%	£ 330,000	£ 334,330	£ 339,599
40%	£ 330,000	£ 337,718	£ 347,370
50%	£ 330,000	£ 341,461	£ 357,676
60%	£ 330,000	£ 344,584	£ 368,981
70%	£ 330,000	£ 348,452	£ 377,151
80%	£ 330,000	£ 352,897	£ 389,153
90%	£ 330,000	£ 359,261	£ 407,418
100%	£ 330,000	£ 384,430	£ 480,184

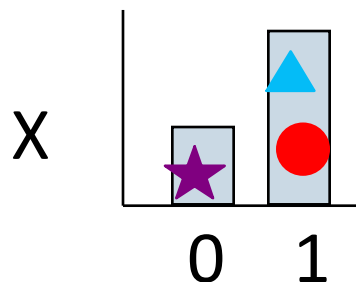
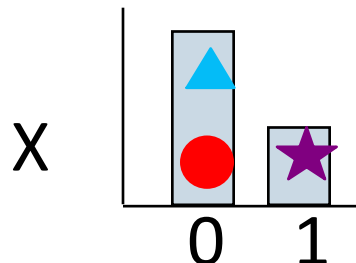
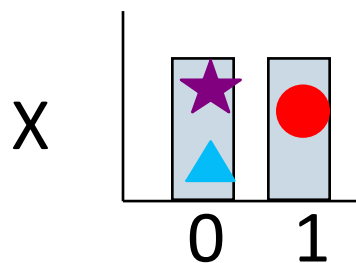


Risk Analysis



Risk 3 = 30

Probability



Iterations

A ★ B ▲ C ●

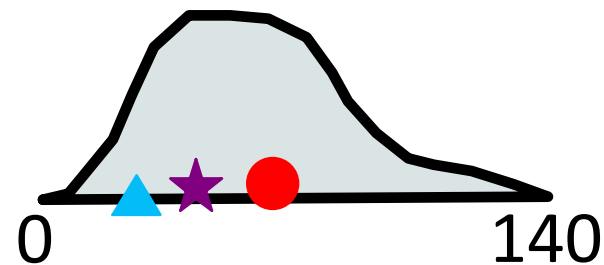
= 0 0 30

= 45 0 0

= 0 30 30

45 30 60

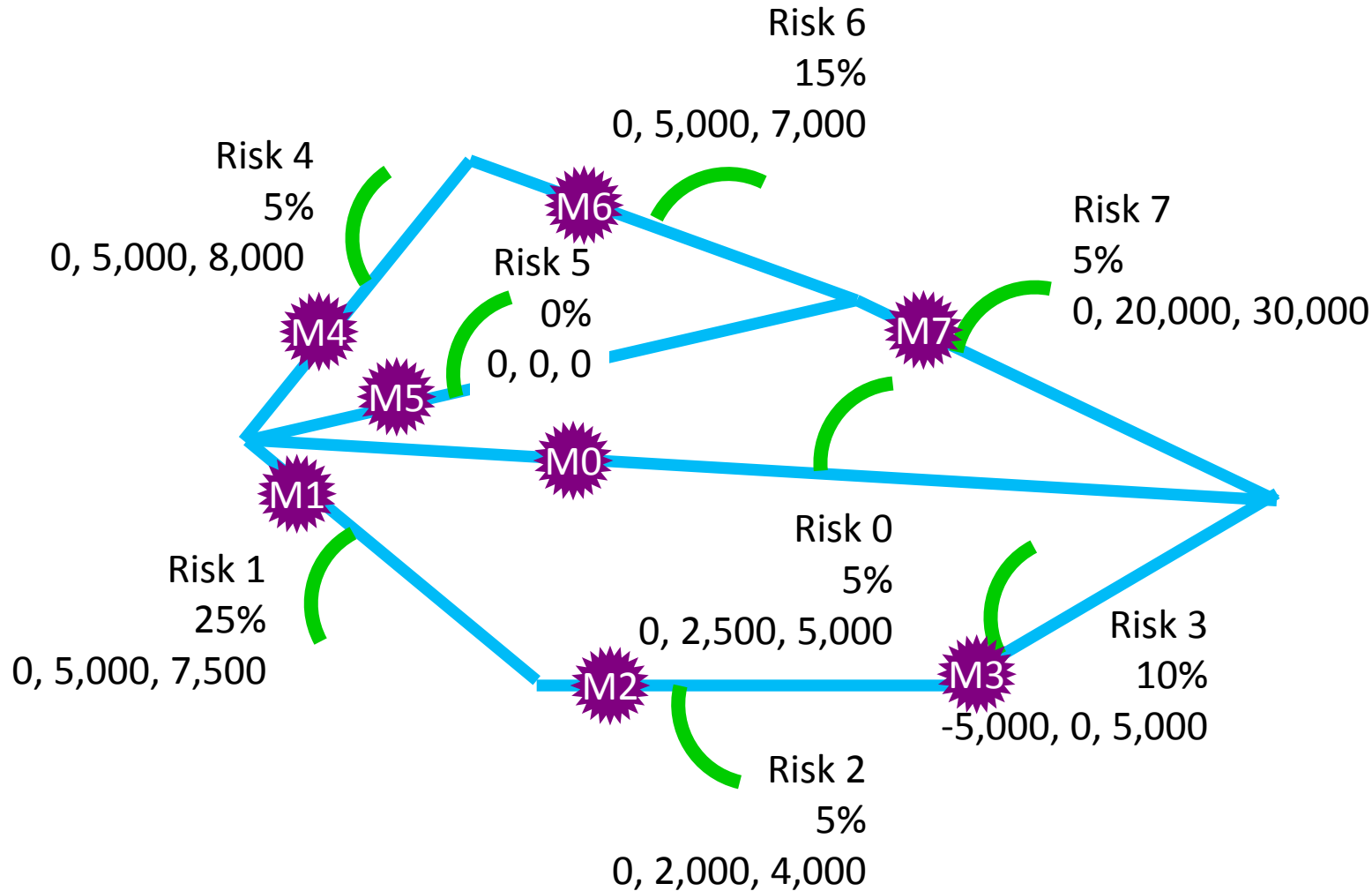
Result =



Risk – Post-mitigation

Did the mitigation succeed?

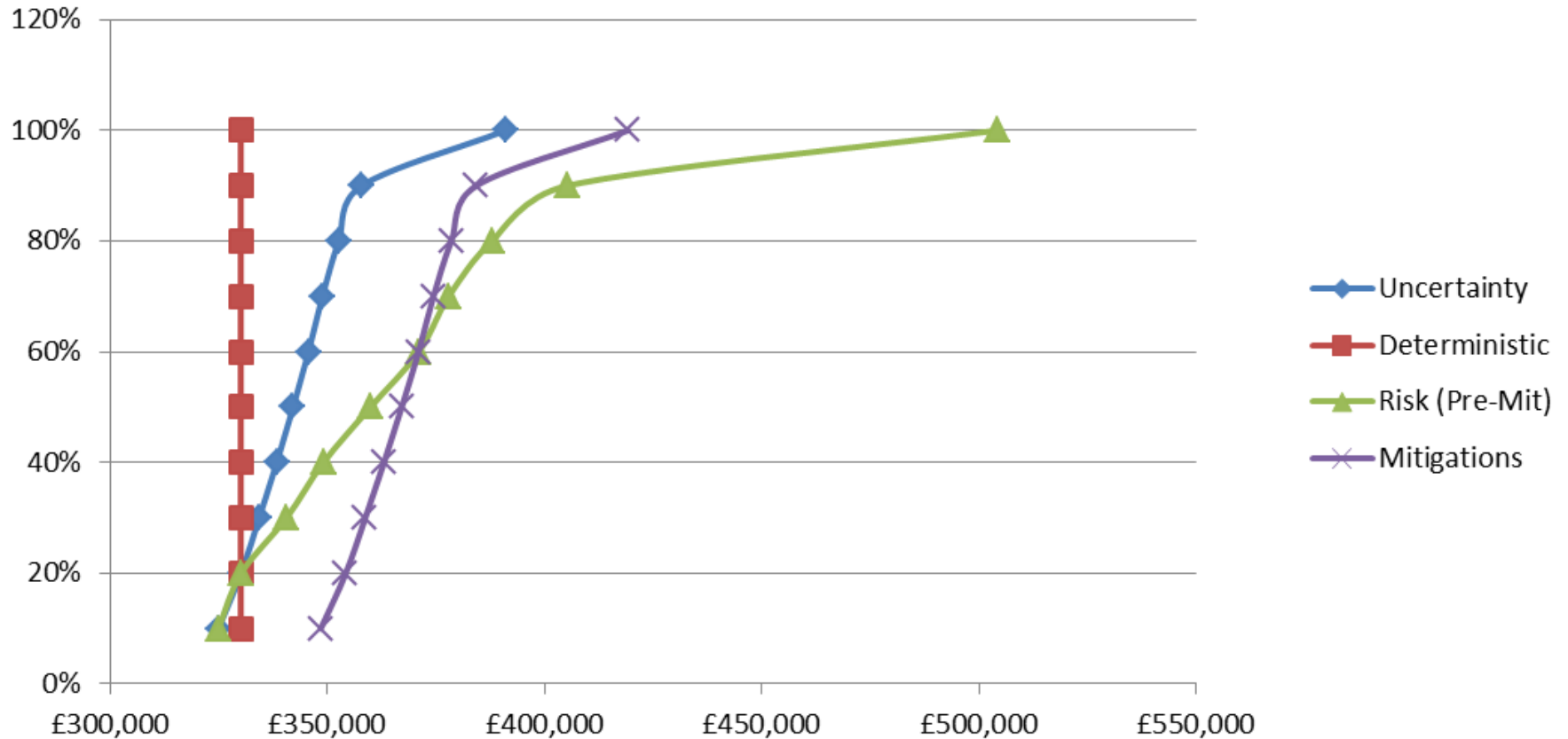
Mitigation provides an opportunity to save money against the risk



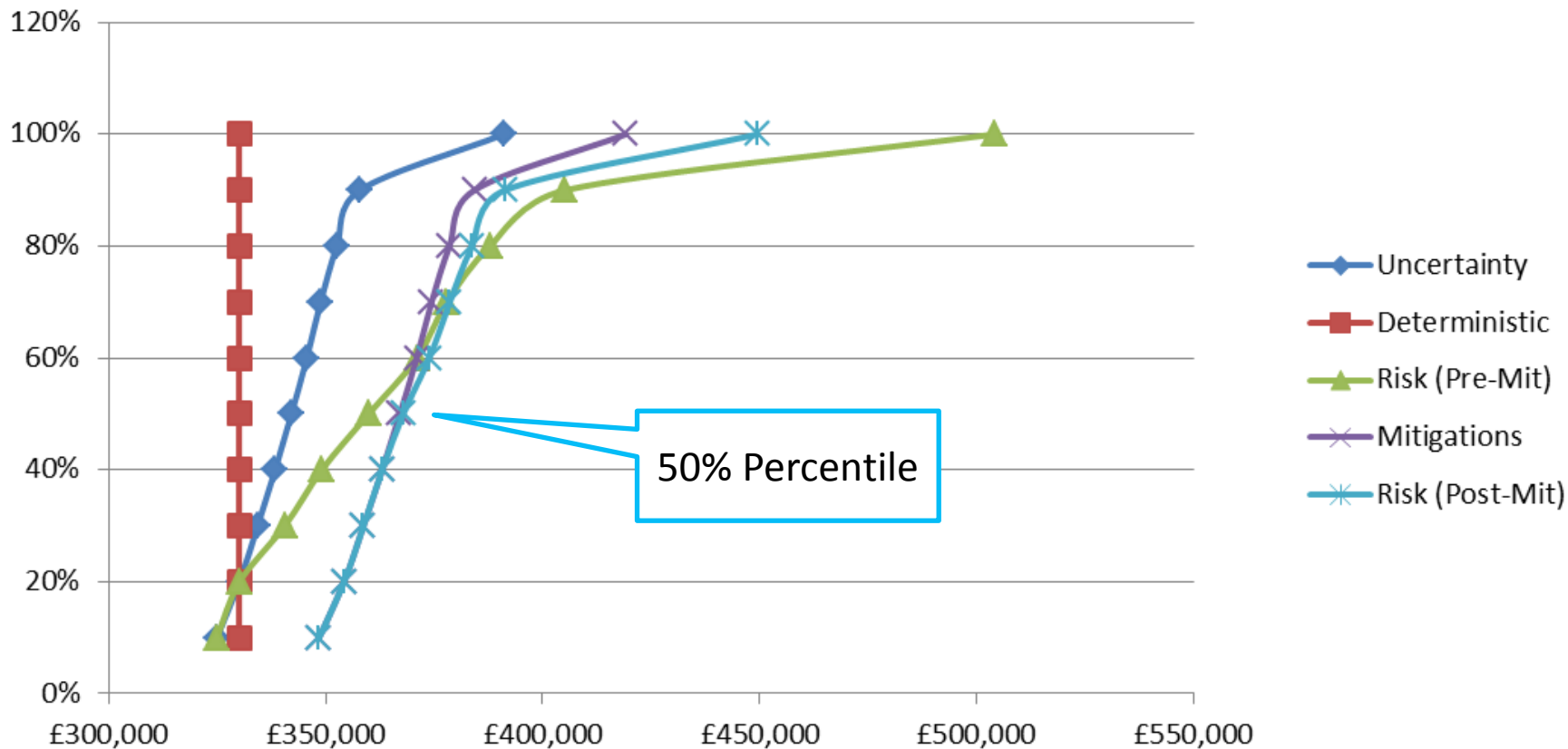
Risk – Post-mitigation - analysis

Task	Probability	Resources	Minimum	Maximum		
Task 00	100%	£ 30,000	£ 25,000	£ 40,000		£ 31,667
Task 01	100%	£ 10,000	£ 8,000	£ 12,000		£ 10,000
Task 02	100%	£ 25,000	£ 15,000	£ 40,000		£ 26,667
Task 03	100%	£ 60,000	£ 50,000	£ 75,000		£ 61,667
Task 04	100%	£ 35,000	£ 30,000	£ 45,000		£ 36,667
Task 05	100%	£ 40,000	£ 35,000	£ 60,000		£ 45,000
Task 06	100%	£ 50,000	£ 45,000	£ 55,000		£ 50,000
Task 07	100%	£ 80,000	£ 60,000	£ 100,000		£ 80,000
		£ 330,000	£ 268,000	£ 427,000		£ 341,667
Mitigation	Probability	Resources	Minimum	Maximum		
Mitigation 00	100%	£ 3,500	£ 3,000	£ 4,000		£ 3,500
Mitigation 01	100%	£ 2,000	£ 1,000	£ 3,000		£ 2,000
Mitigation 02	100%	£ 4,000	£ 2,000	£ 6,000		£ 4,000
Mitigation 03	100%	£ 1,000	£ 500	£ 1,500		£ 1,000
Mitigation 04	100%	£ 2,000	£ 2,000	£ 2,000		£ 2,000
Mitigation 05	100%	£ 5,000	£ 5,000	£ 5,000		£ 5,000
Mitigation 06	100%	£ 2,500	£ 2,000	£ 3,000		£ 2,500
Mitigation 07	100%	£ 5,000	£ 4,000	£ 6,000		£ 5,000
		£ 25,000	£ 19,500	£ 30,500		£ 25,000
Post-Mit	Probability	Resources	Minimum	Maximum		
Risk 00	5%	£ 2,500	£ -	£ 5,000	0	£ -
Risk 01	25%	£ 5,000	£ -	£ 7,500	0	£ -
Risk 02	5%	£ 2,000	£ -	£ 4,000	0	£ -
Risk 03	10%	£ -	-£ 5,000	£ 5,000	0	£ -
Risk 04	5%	£ 5,000	£ -	£ 8,000	0	£ -
Risk 05	0%	£ -	£ -	£ -	0	£ -
Risk 06	15%	£ 5,000	£ -	£ 7,000	0	£ -
Risk 07	5%	£ 20,000	£ -	£ 30,000	0	£ -
		£ 39,500	-£ 5,000	£ 66,500		£ -

Risk – Post-mitigation - analysis



Risk – Post-mitigation – analysis including risks

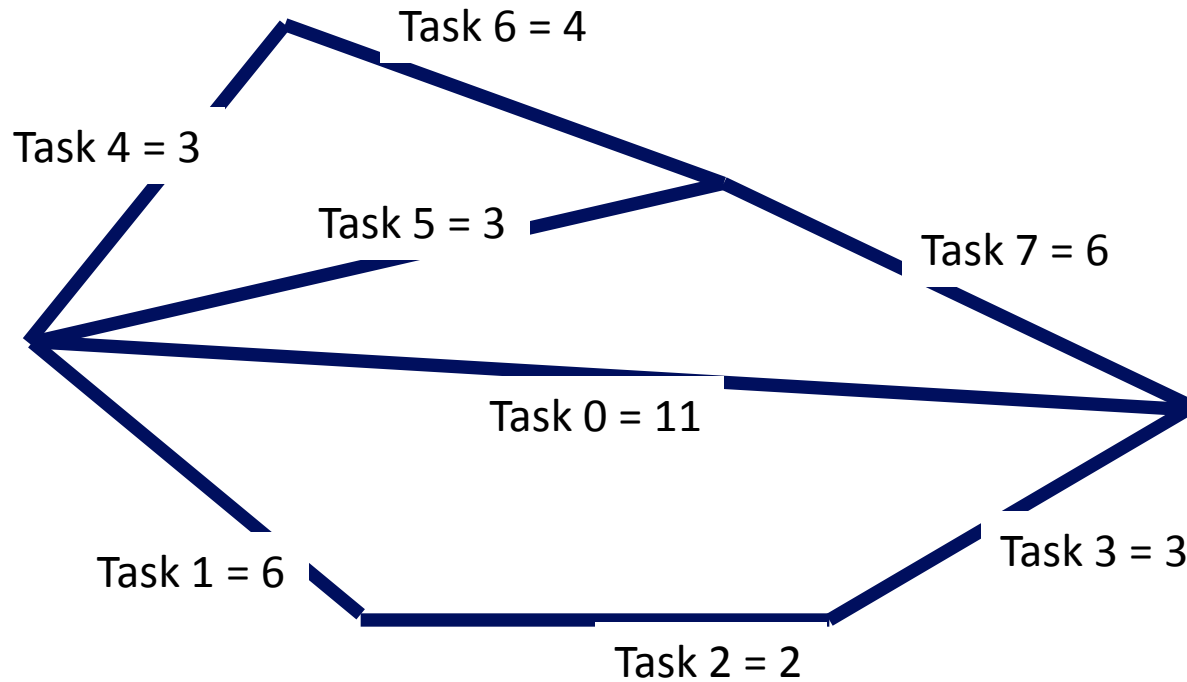


Development of schedule analysis

Dale Shermon | QinetiQ Fellow

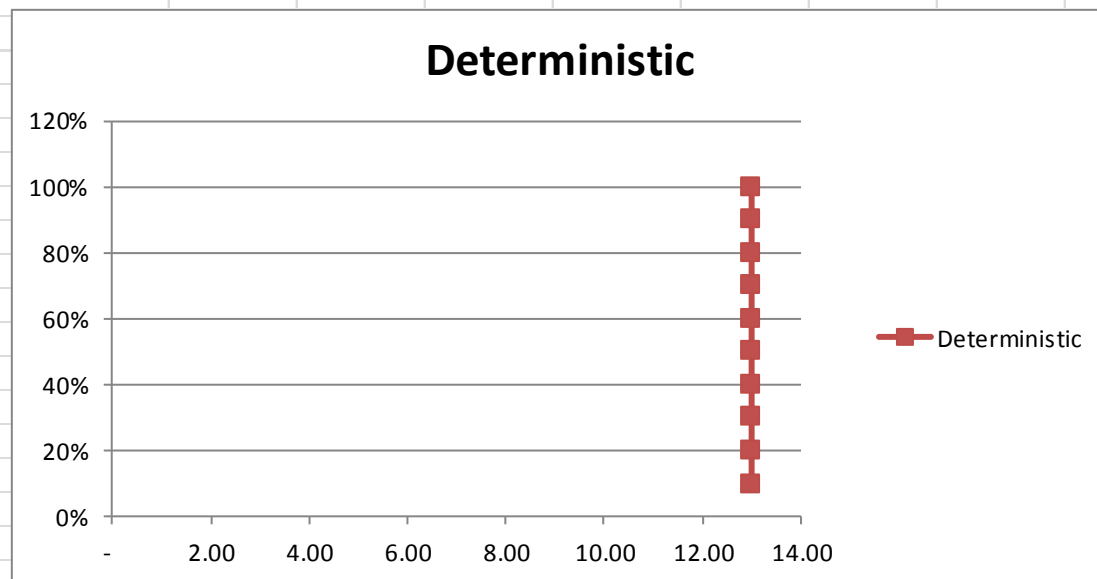


Deterministic Schedule

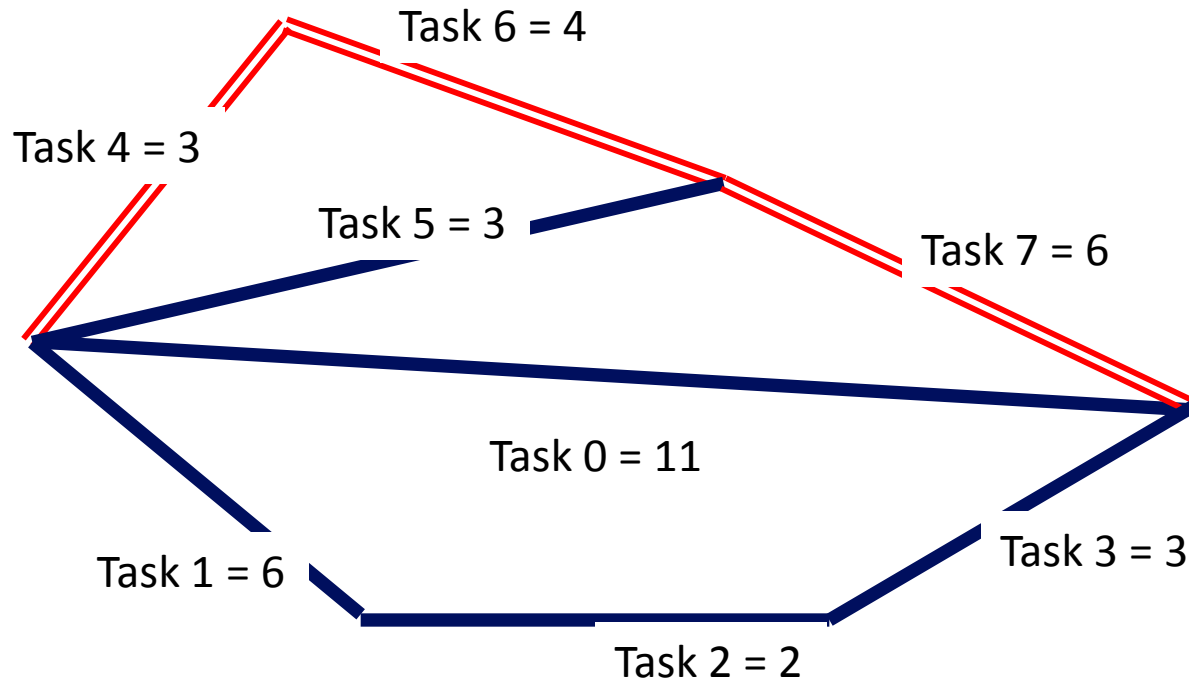


Deterministic Schedule - Analysis

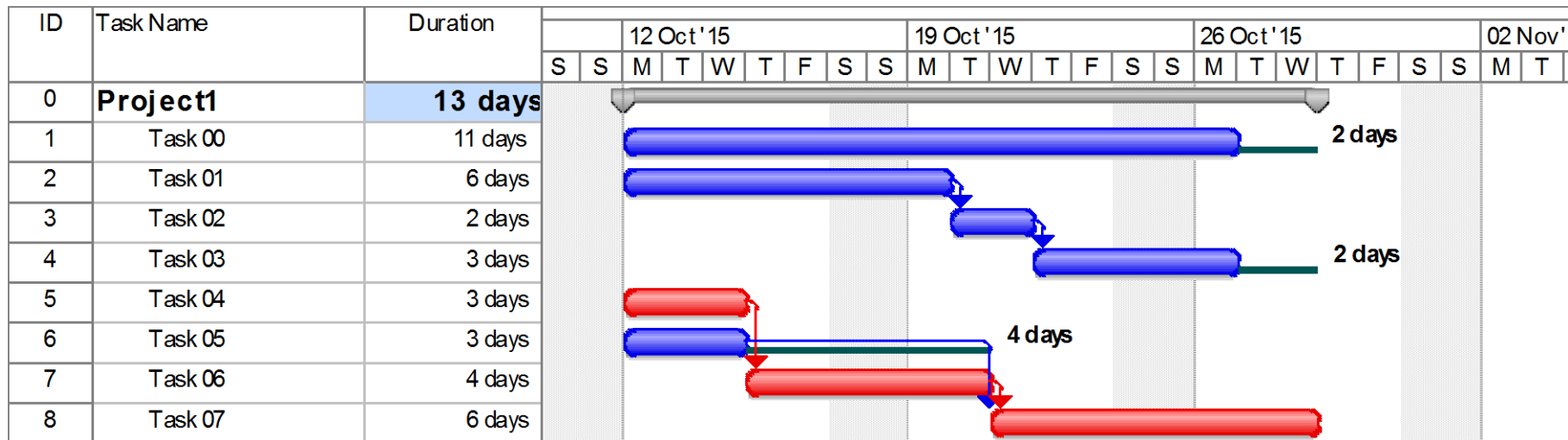
Task	Probability	Duration		
Task 00	100%	11		
Task 01	100%	6		
Task 02	100%	2		
Task 03	100%	3		
Task 04	100%	3		
Task 05	100%	3		
Task 06	100%	4		
Task 07	100%	6		
Path	Total path	Float		
00	11	2		
01, 02, 03	11	2		
04, 06, 07	13	-	Critical path	
05, 07	9	4		
Longest path =	13			



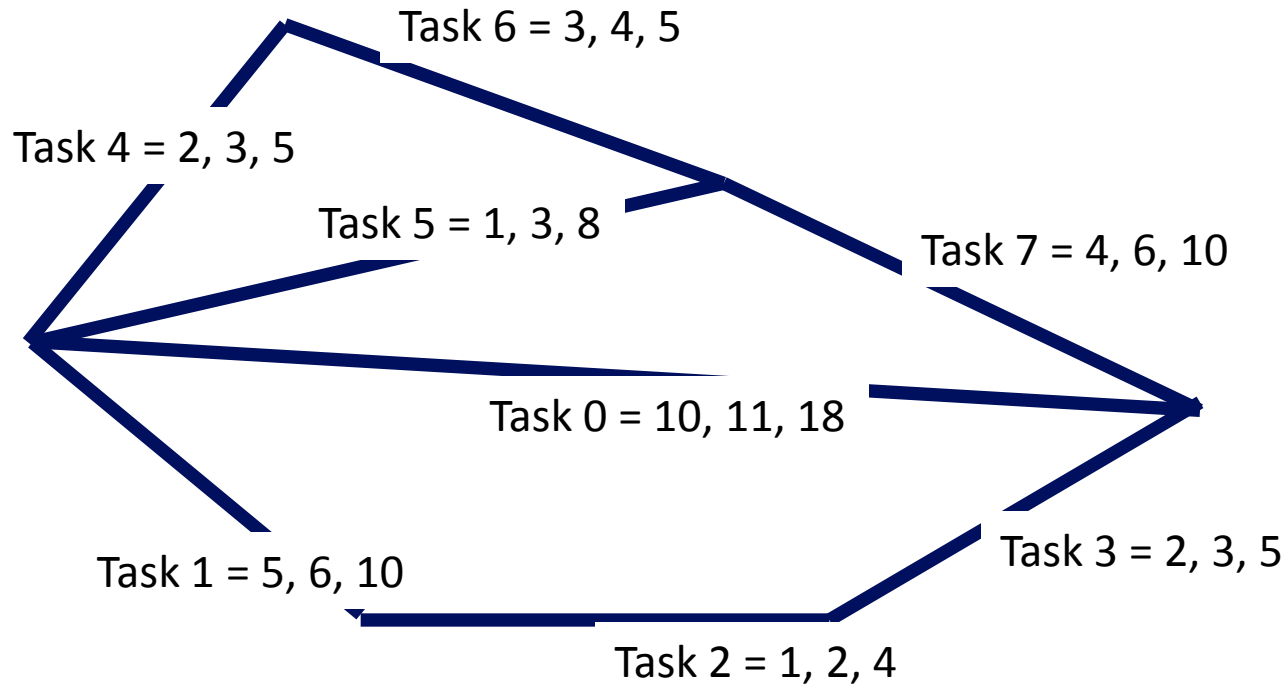
Critical path analysis



MS-Project schedule



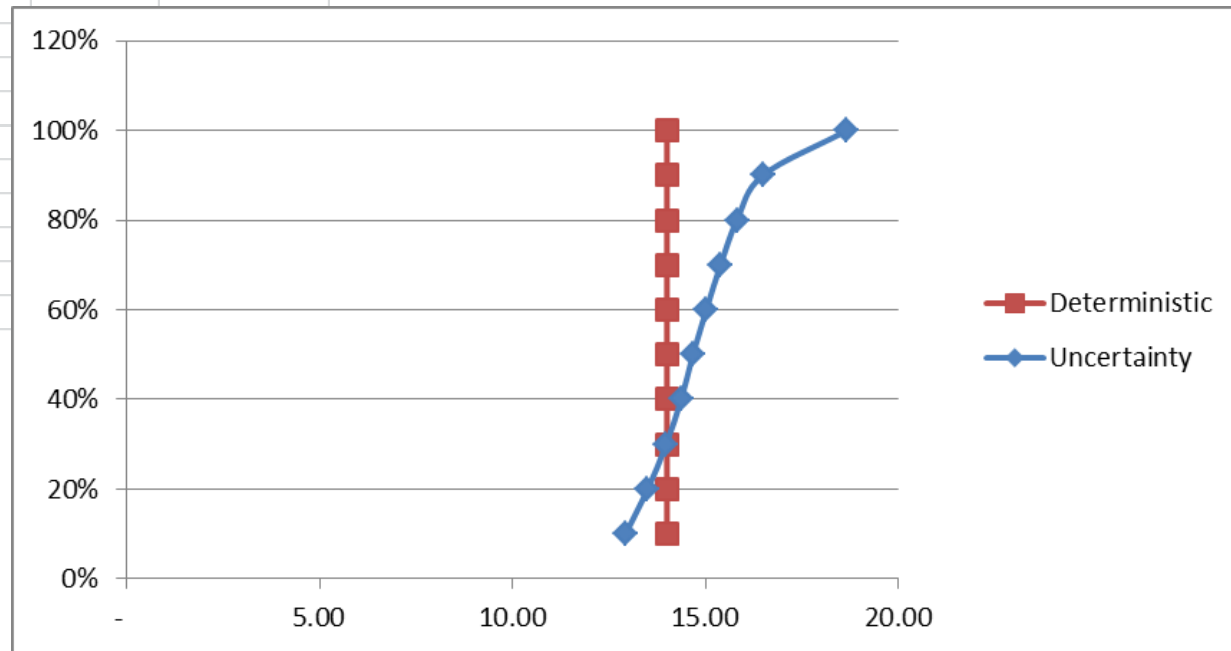
Uncertainty Schedule – 3PE



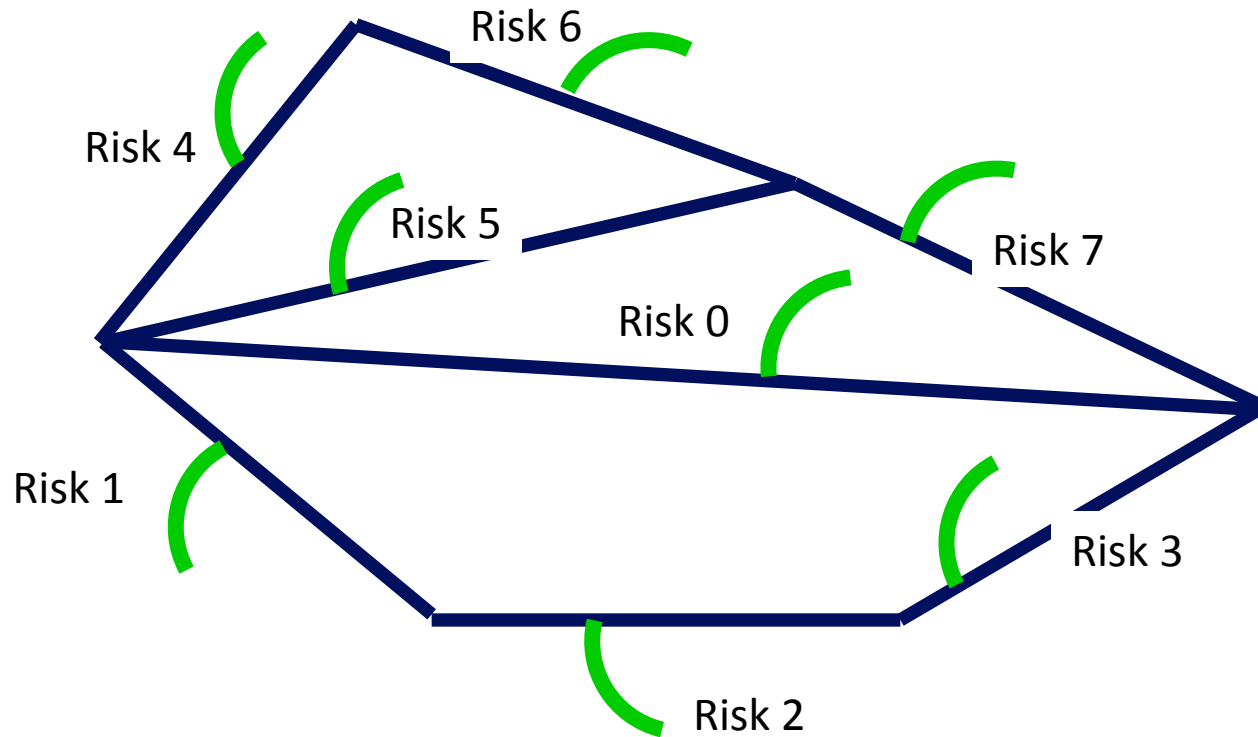
Uncertainty Schedule analysis

Task	Probability	Duration	Minimum	Maximum
Task 00	100%	11	10	18
Task 01	100%	6	5	10
Task 02	100%	2	1	4
Task 03	100%	3	2	5
Task 04	100%	3	2	5
Task 05	100%	3	1	8
Task 06	100%	4	3	5
Task 07	100%	6	4	10

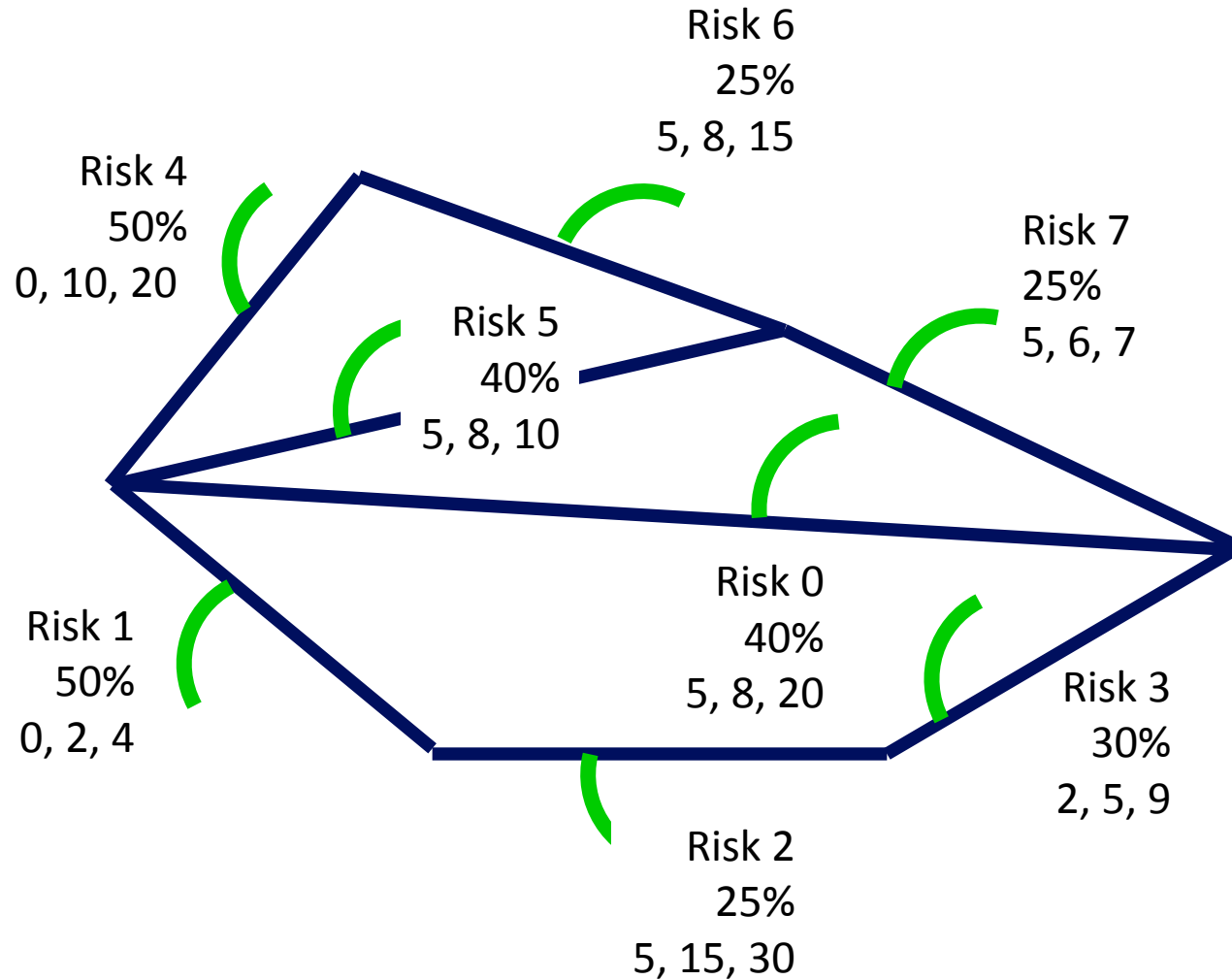
Path	Total path
00	13
01, 02, 03	13
04, 06, 07	14 Critical path
05, 07	11
Longest path =	14



Schedule Risk – Deviation from the plan



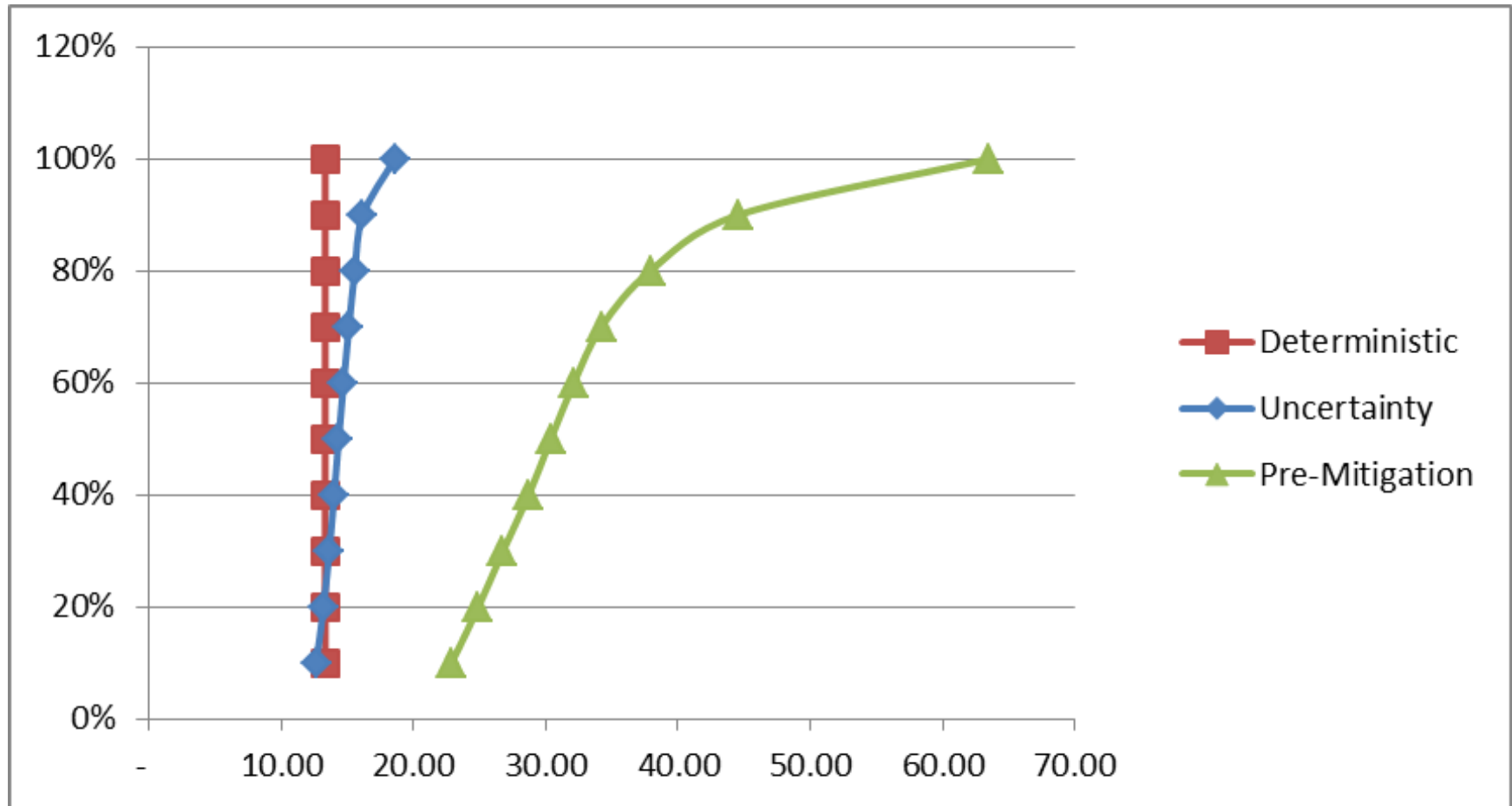
Schedule Risk – Pre-mitigation



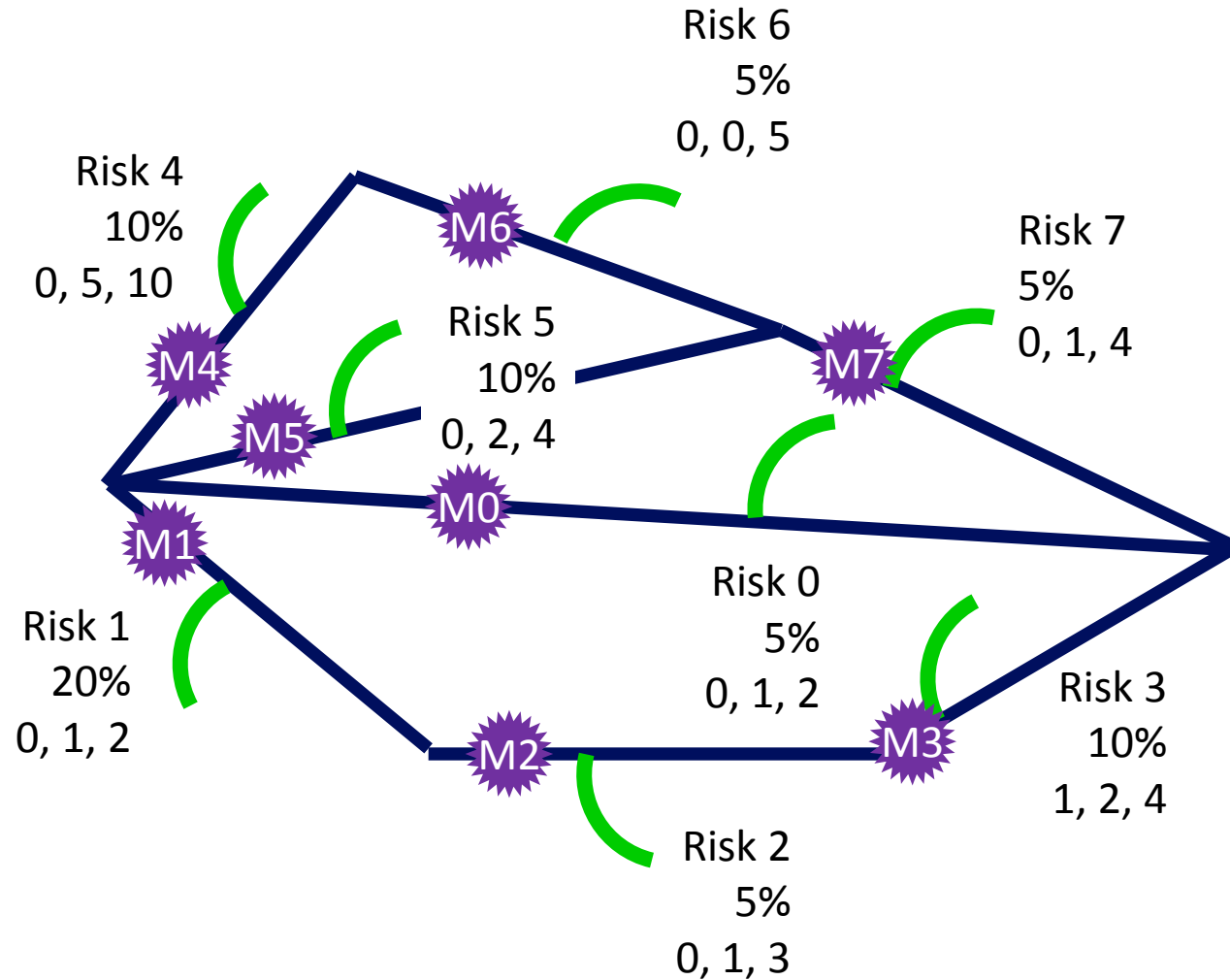
Schedule Risk – Pre-mitigation analysis

Task	Probability	Duration	Minimum	Maximum		
Task 00	100%	11	10	18		13
Task 01	100%	6	5	10		7
Task 02	100%	2	1	4		2
Task 03	100%	3	2	5		3
Task 04	100%	3	2	5		3
Task 05	100%	3	1	8		4
Task 06	100%	4	3	5		4
Task 07	100%	6	4	10		7
	Probability	Resources	Minimum	Maximum		
Risk 00	40%	8	5	10	0	0
Risk 01	50%	2	0	4	0	0
Risk 02	25%	15	5	30	0	0
Risk 03	30%	5	2	9	0	0
Risk 04	50%	10	0	20	0	0
Risk 05	40%	8	5	20	0	0
Risk 06	25%	8	5	15	0	0
Risk 07	25%	6	5	7	0	0
Uncertainty						
Path	Total path	Float				
00	13	0				
01, 02, 03	13	1				
03, 04, 07	13	-	Critical path			
05, 07	11	3				
Longest path =	13					
Pre Mitigation						
Path	Total path	Float				
00	13	0				
01, 02, 03	22	9				
03, 04, 07	13	-	Critical path			
05, 07	11	3				
Longest path =	22					

Schedule Risk – Pre-mitigation analysis



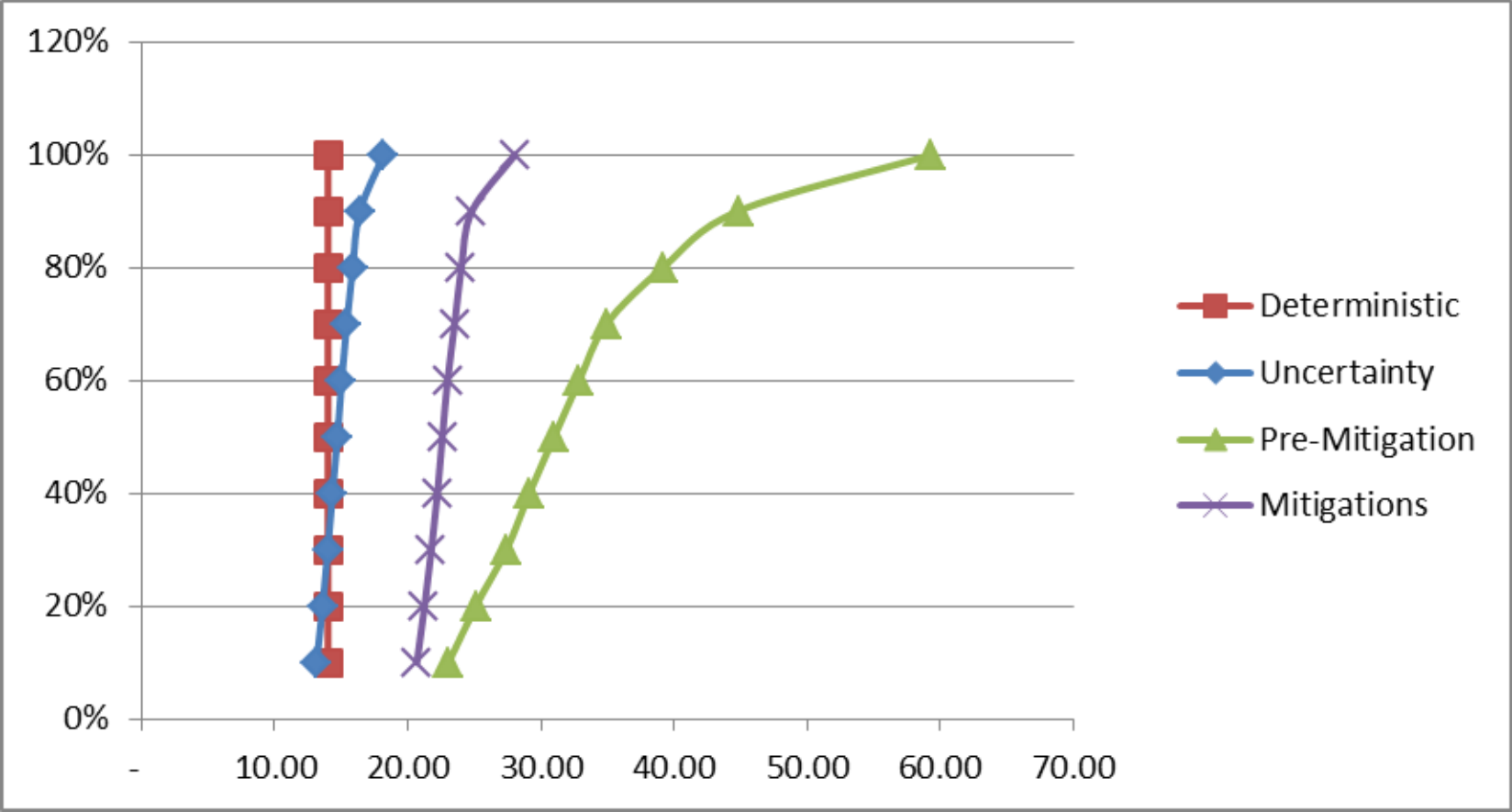
Schedule Risk – Post-mitigation



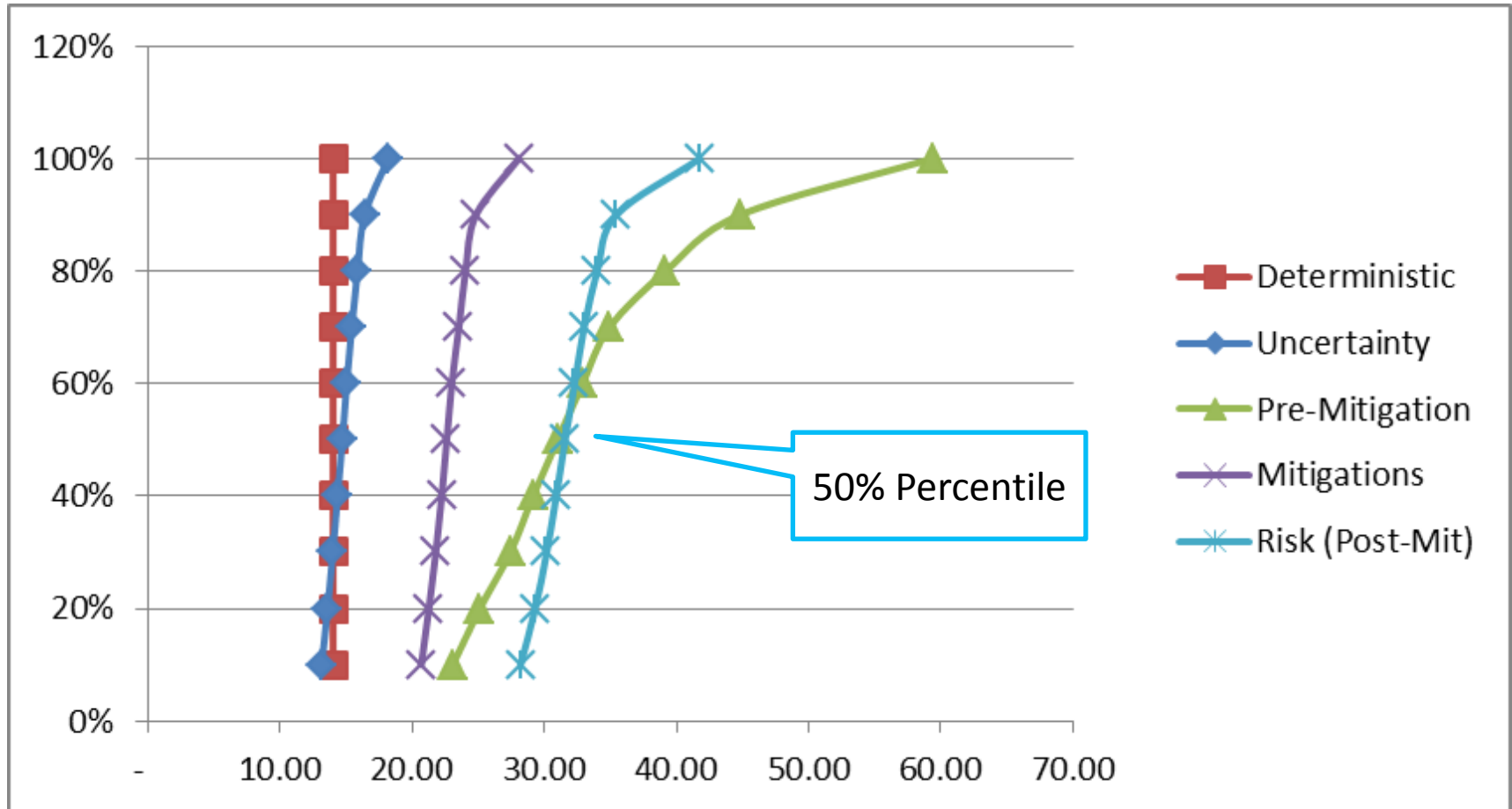
Schedule Risk – Post-mitigation

Task	Probability	Duration	Minimum	Maximum		
Task 00	100%	11	10	18		13
Task 01	100%	6	5	10		7
Task 02	100%	2	1	4		2
Task 03	100%	3	2	5		3
Task 04	100%	3	2	5		3
Task 05	100%	3	1	8		4
Task 06	100%	4	3	5		4
Task 07	100%	6	4	10		7
Task	Probability	Duration	Minimum	Maximum		
Mitigation 00	100%	4	1	8		4
Mitigation 01	100%	3	1	4		3
Mitigation 02	100%	2	1	3		2
Mitigation 03	100%	3	1	5		3
Mitigation 04	100%	3	1	4		3
Mitigation 05	100%	3	1	4		3
Mitigation 06	100%	3	1	5		3
Mitigation 07	100%	3	1	4		3
Pre-Mit	Probability	Resources	Minimum	Maximum		
Risk 00	40%	8	5	10	0	0
Risk 01	50%	2	0	4	0	0
Risk 02	25%	15	5	30	0	0
Risk 03	30%	5	2	9	0	0
Risk 04	50%	10	0	20	0	0
Risk 05	40%	8	5	20	0	0
Risk 06	25%	8	5	15	0	0
Risk 07	25%	6	5	7	0	0
Post-Mit	Probability	Resources	Minimum	Maximum		
Risk 00	5%	1	0	2	0	0
Risk 01	20%	1	0	2	0	0
Risk 02	5%	1	0	3	0	0
Risk 03	10%	2	1	4	0	0
Risk 04	10%	5	0	10	0	0
Risk 05	10%	2	0	4	0	0
Risk 06	5%	0	0	5	0	0
Risk 07	5%	0	0	4	0	0

Schedule Risk – Post-mitigation - analysis



Schedule Risk – Post-mitigation – analysis with risks



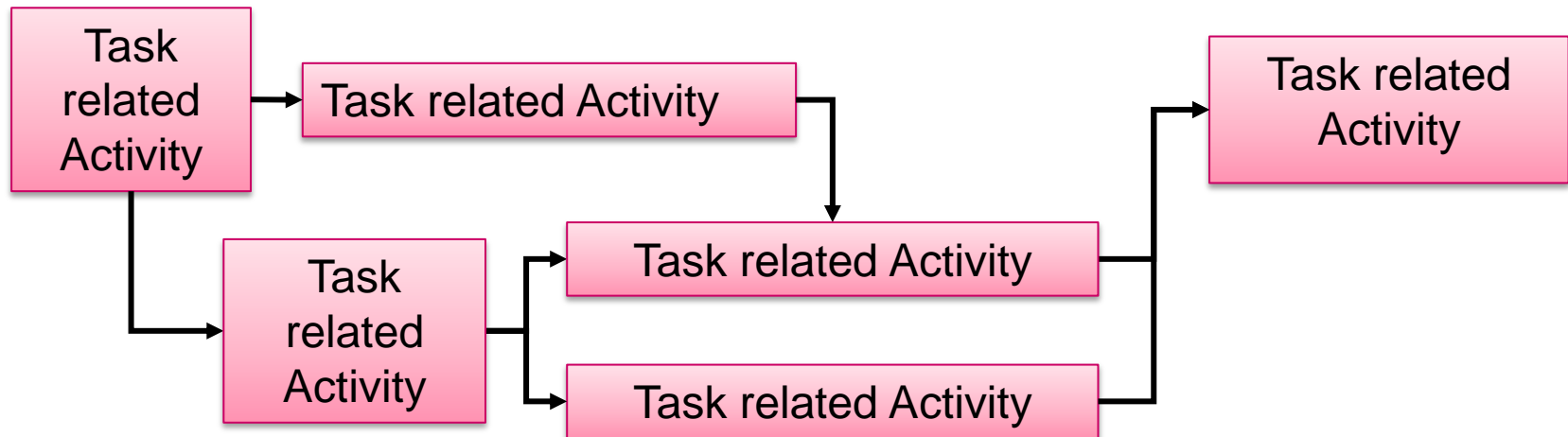
Combined cost and schedule risk analysis

Dale Shermon | QinetiQ Fellow



Project activities

Overhead related Activity



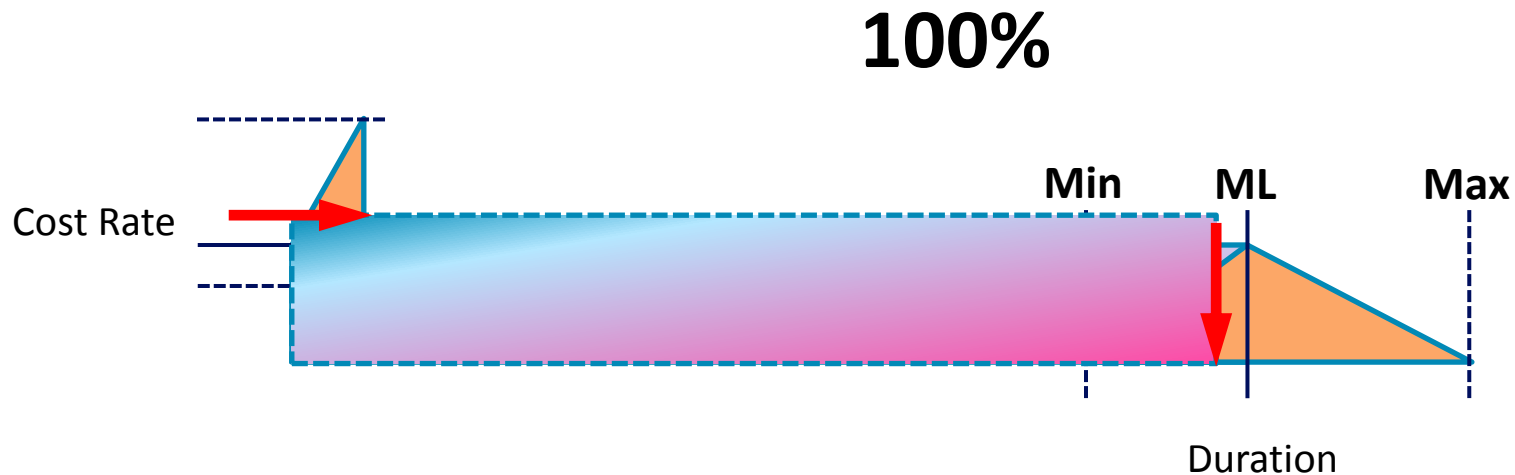
Combined estimation of Cost and Duration

- **Costing a Schedule**

- Fixed activity cost
- Fixed resource cost rate
- **Resource Loading:** Activity cost as product of resource cost rate and duration

- **Uncertainty:**

- Monte Carlo estimation



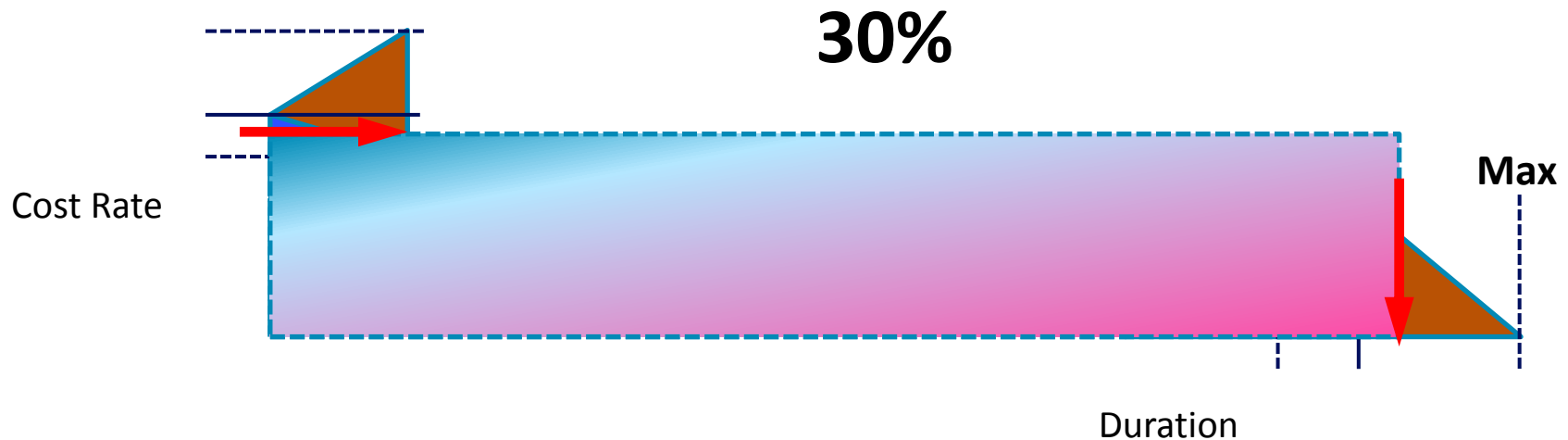
Combined estimation of Cost and Duration

- **Costing a Schedule**

- Fixed activity cost
- Fixed resource cost rate
- **Resource Loading:** Activity cost as product of resource cost rate and

- **Uncertainty + Risk:**

- Monte Carlo simulation



Interpretation of the confidence levels

Dale Shermon | QinetiQ Fellow



One coin toss analogy



Coin 1 (Duration)

Win	Lose
Win	Lose

You Win when Heads is called and Heads are tossed!

In projects: you Win when schedule is on time or before the milestone!

Or

You Win when the actual is less than the budget!

Two coin toss analogy



Coin 1 (Duration)

		Coin 1 (Duration)	
		Win	Lose
Coin 2 (Cost)	Lose	Lose	Lose
	Win	Win	Lose

You Win when Heads is called and Heads are tossed on both coins!

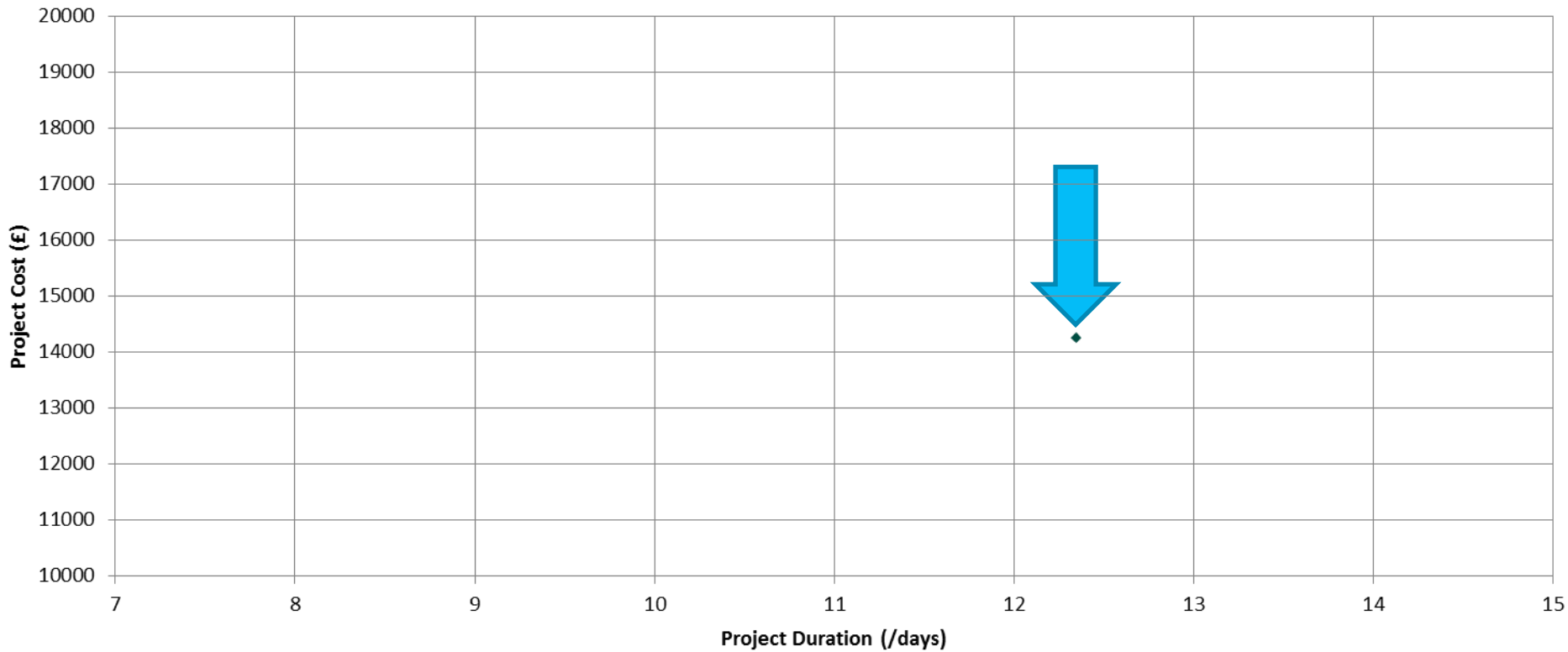
In projects: you only Win when both:

- Cost is less than budget and
- schedule is prior to the milestone!

Simulation

- 1 Iteration:

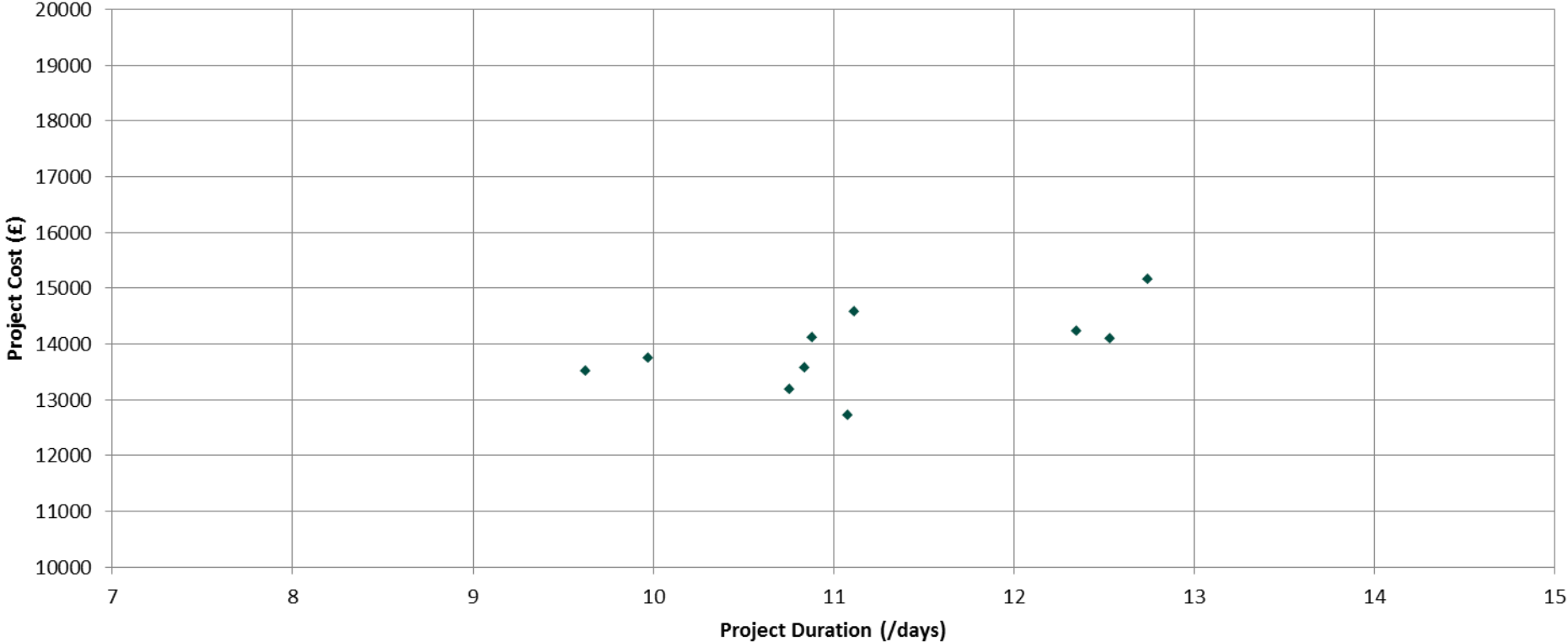
Simulation Outcomes - Cost versus Duration



Simulation

- 10 Iterations:

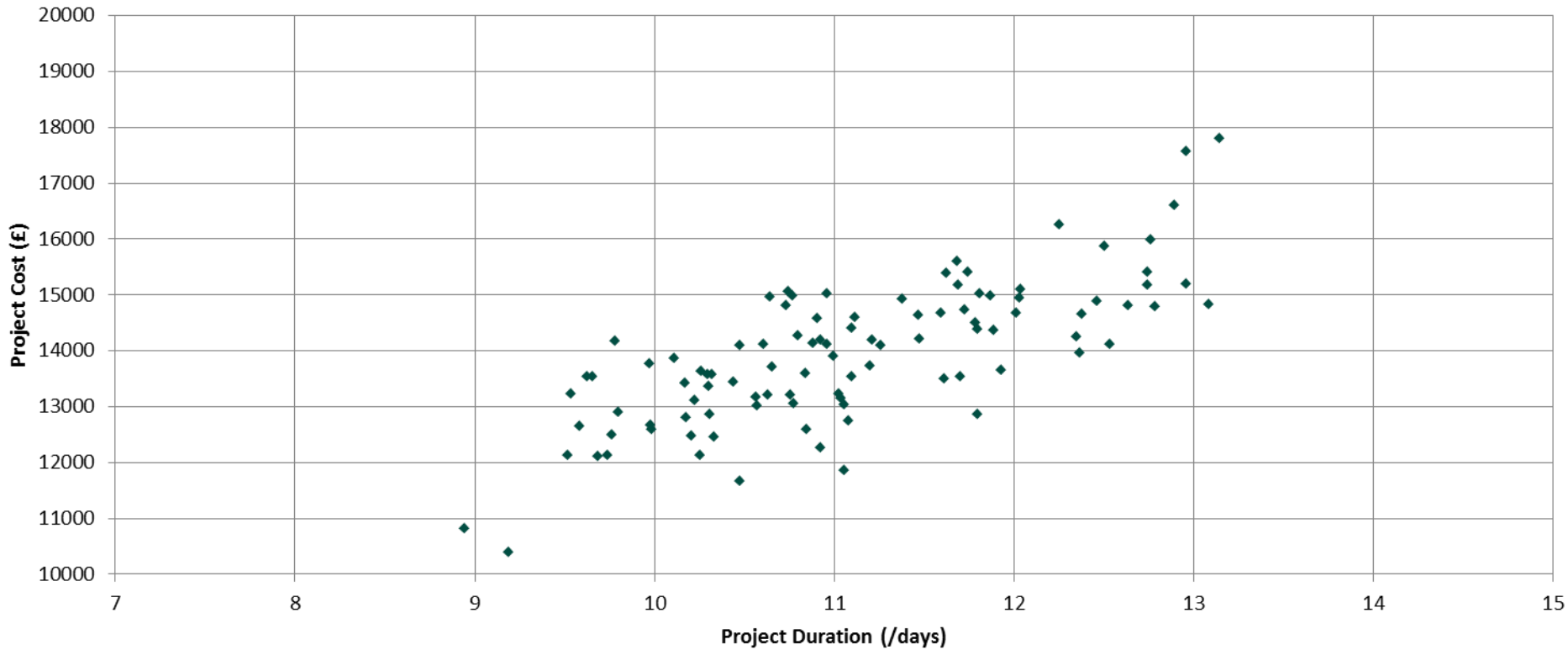
Simulation Outcomes - Cost versus Duration



Simulation

- 100 Iterations:

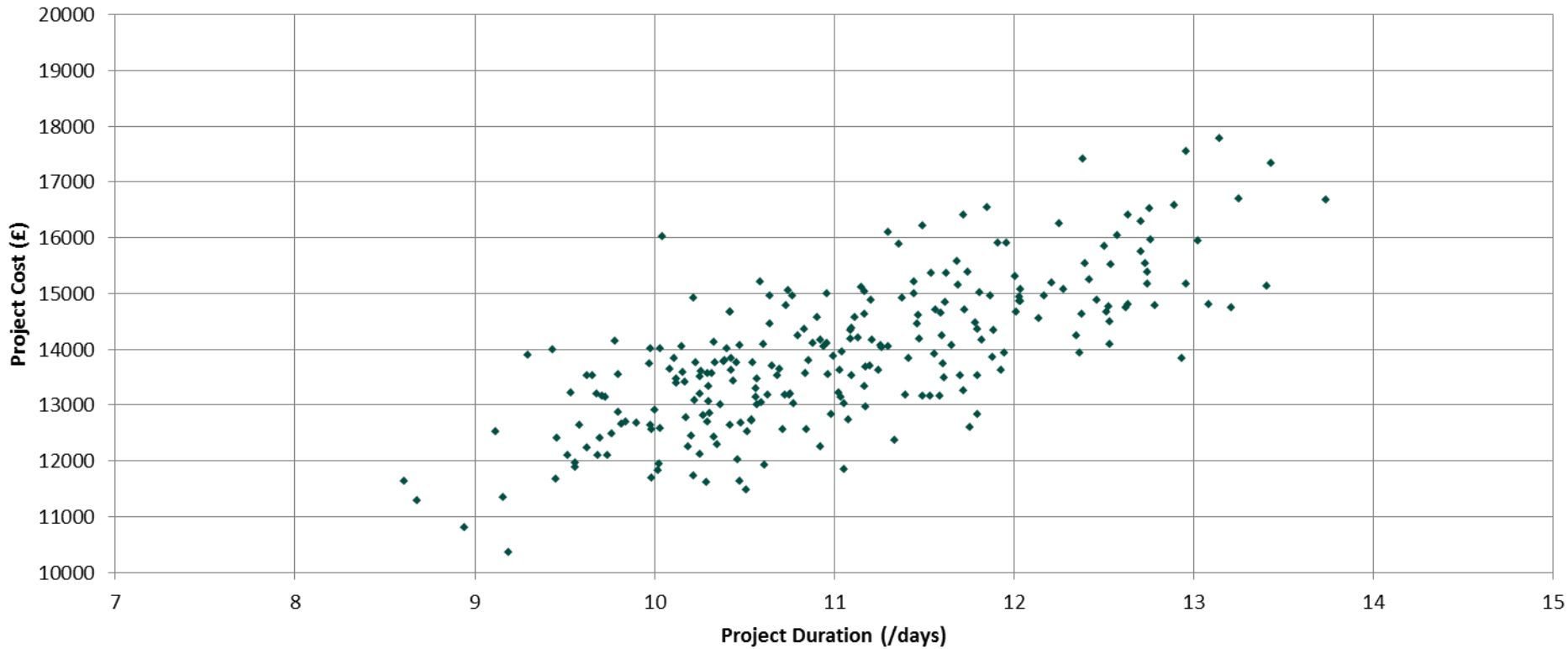
Simulation Outcomes - Cost versus Duration



Simulation

- 250 Iterations:

Simulation Outcomes - Cost versus Duration

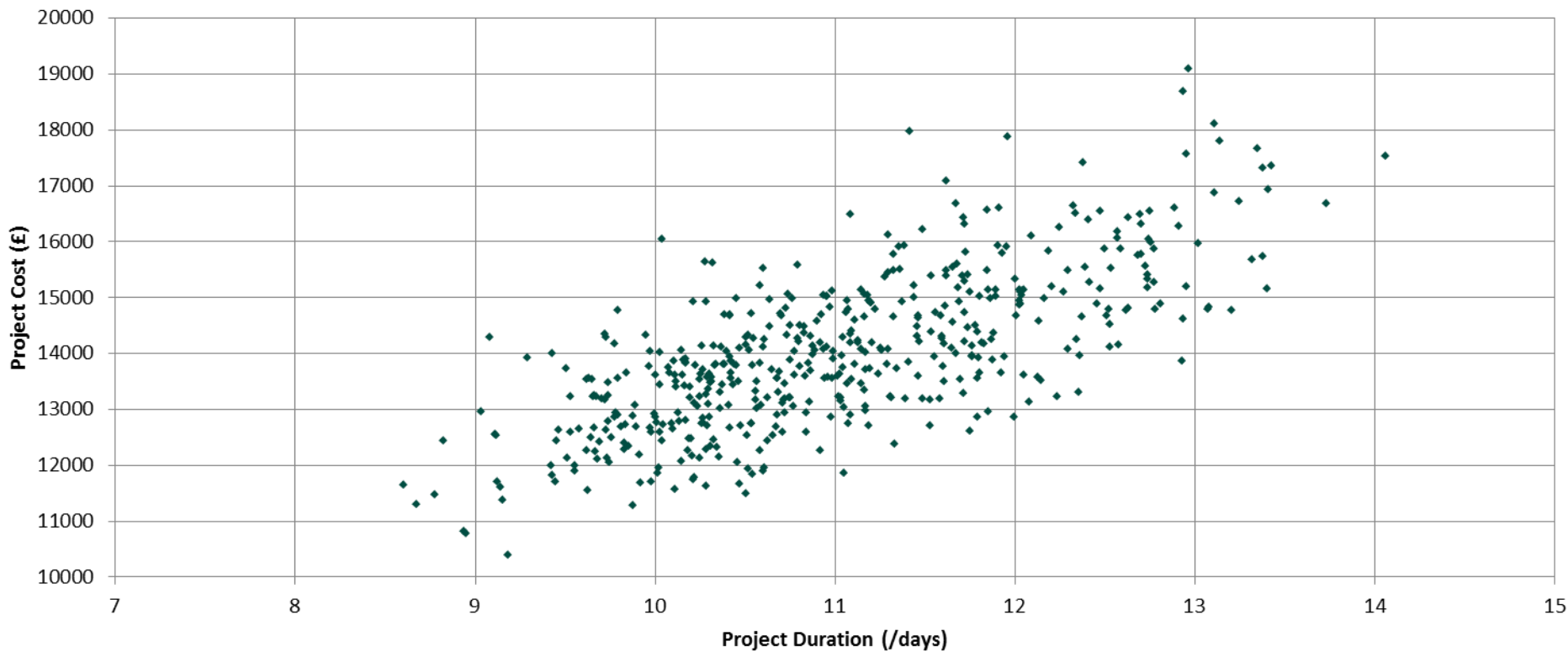


Simulation



- 500 Iterations:

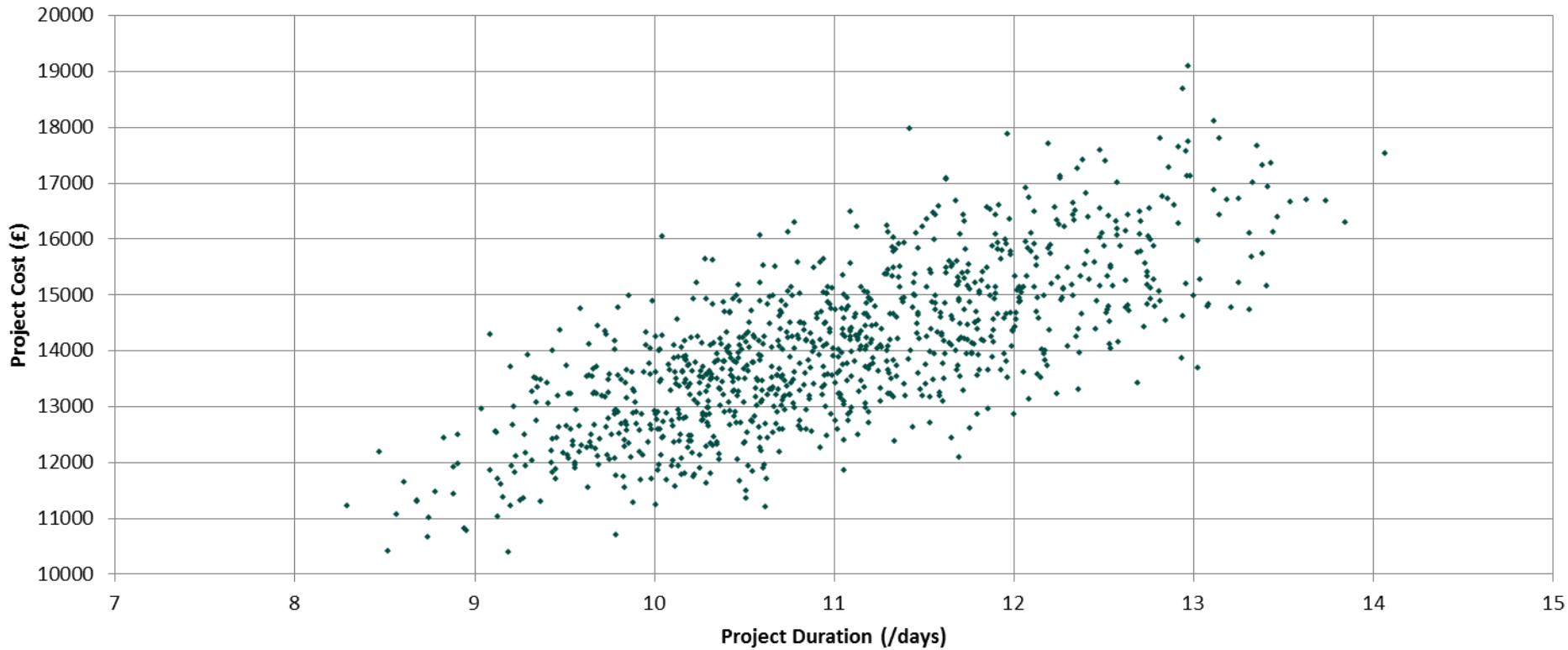
Simulation Outcomes - Cost versus Duration



Simulation

- 1000 Iterations:

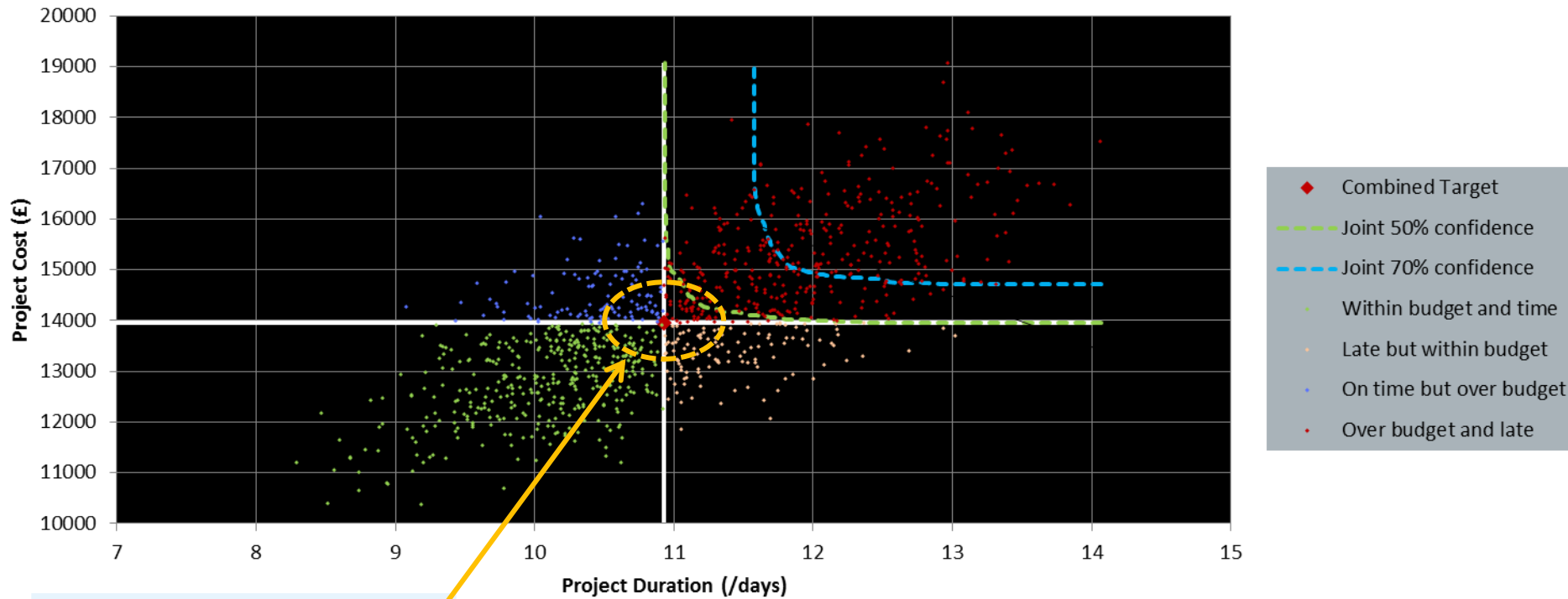
Simulation Outcomes - Cost versus Duration



Using Simulation Results

- What does it mean?

Joint-Confidence lines (True and Uncorrelated) overlaid with MC Project Outcomes and Combined Target Region

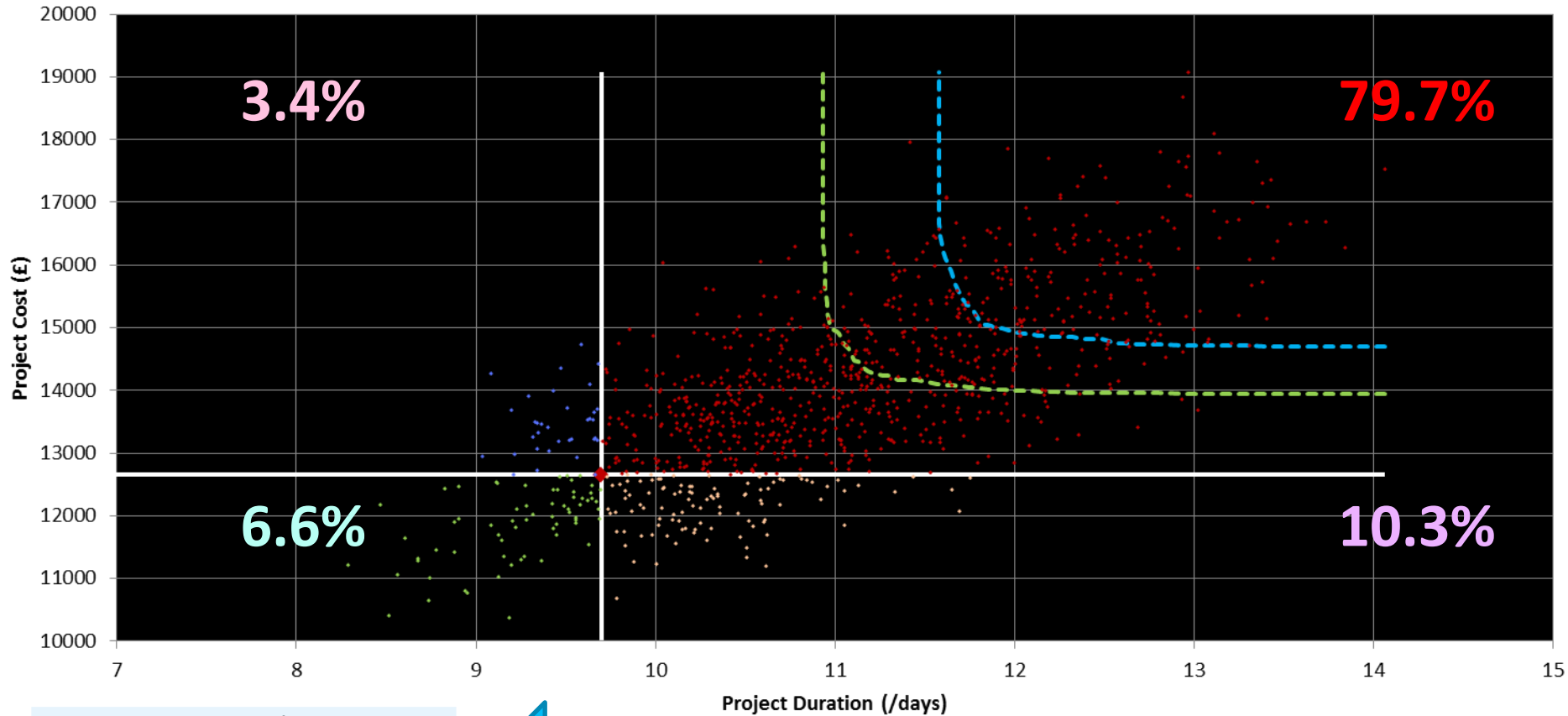


Target Setting:

Budget (£)	13948
Target Duration (days)	10.93

Using Simulation Results

- Deterministic estimate - "You have £12,650 and 9.7 days!"

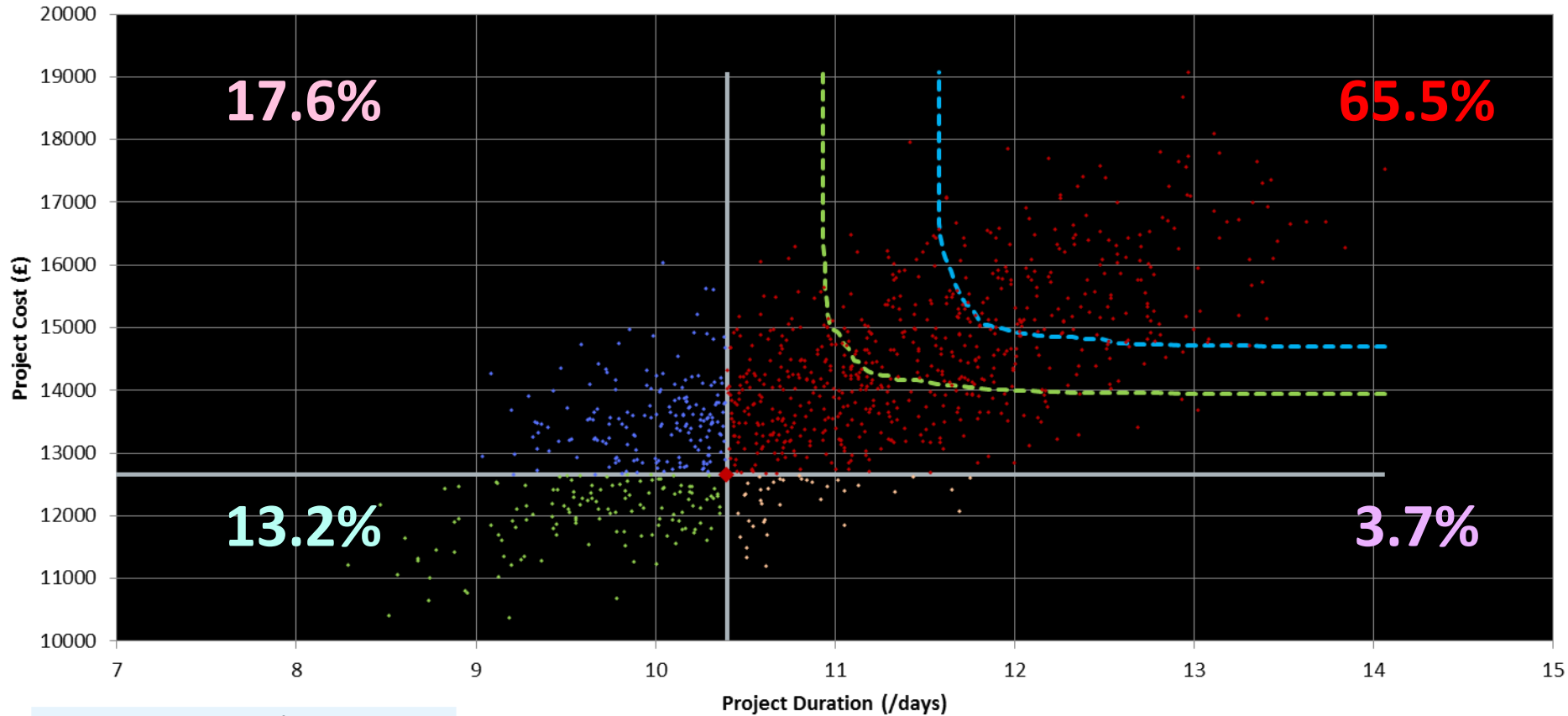


Target Setting:	
Budget (£)	12650
Target Duration (days)	9.7

Deterministic
values

Using Simulation Results

- “I need more time... but is this enough?”

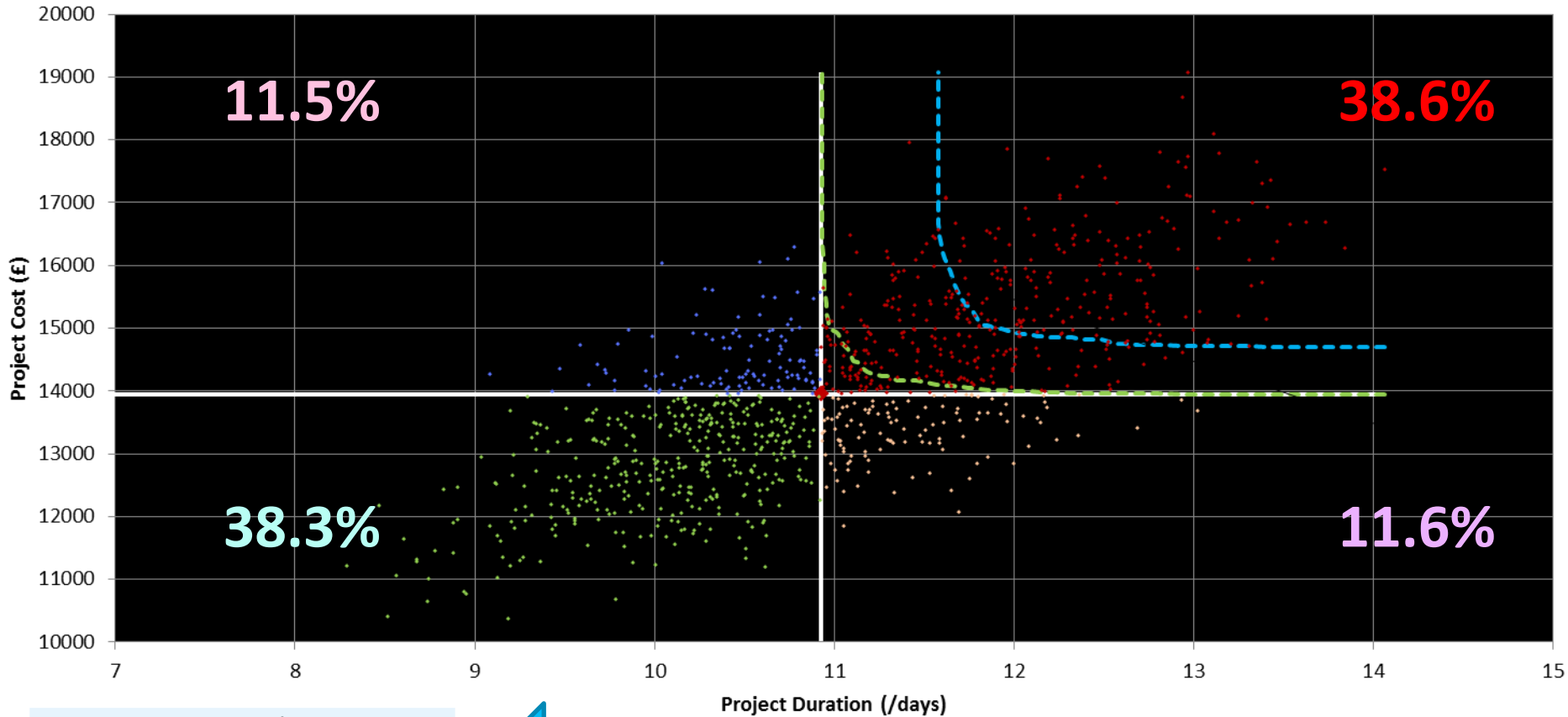


Target Setting:

Budget (£)	12650
Target Duration (days)	10.4

Using Simulation Results

- 50th percentile cost versus 50th percentile duration:

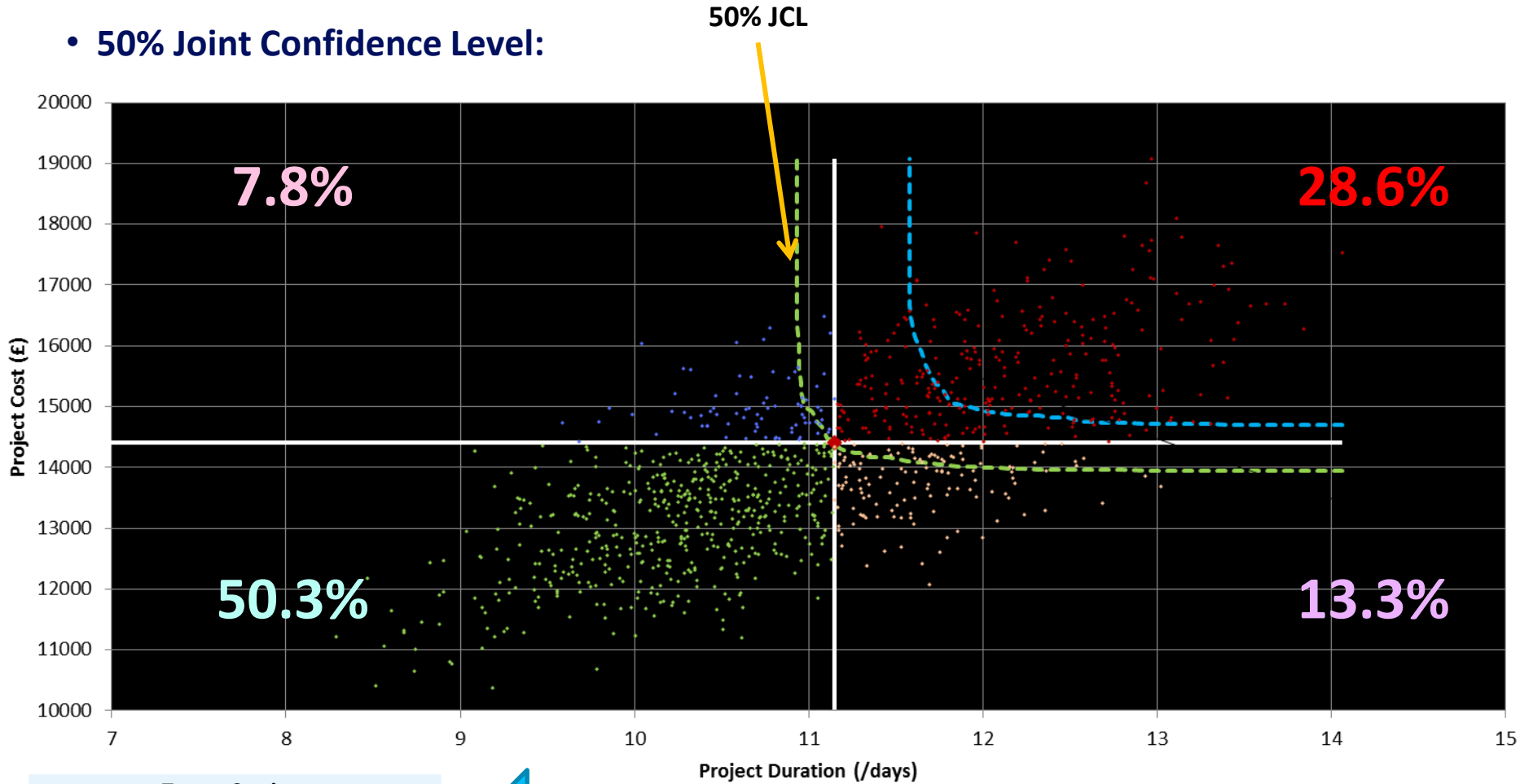


Target Setting:	
Budget (£)	13948
Target Duration (days)	10.93

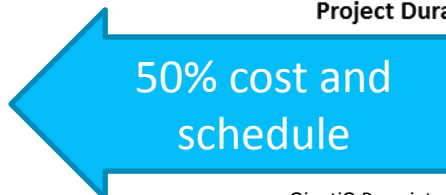
50% cost or
50% schedule

Using Simulation Results

- 50% Joint Confidence Level:

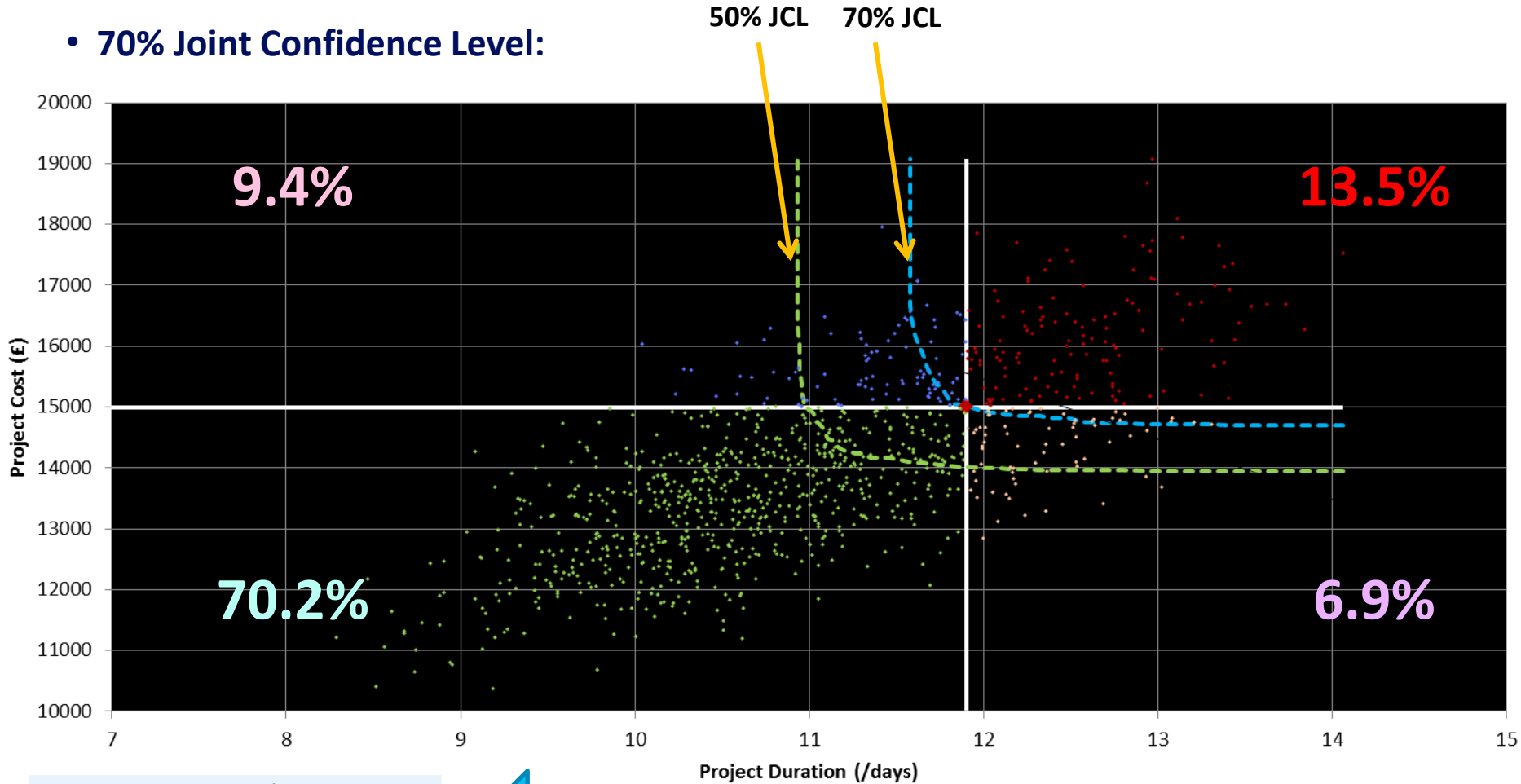


Target Setting:	
Budget (£)	14400
Target Duration (days)	11.15

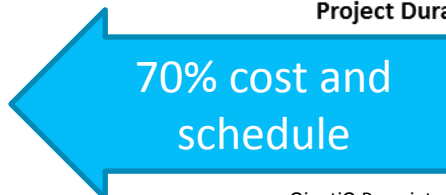


Using Simulation Results

- 70% Joint Confidence Level:



Target Setting:	
Budget (£)	1500
Target Duration (days)	11.9



Summary

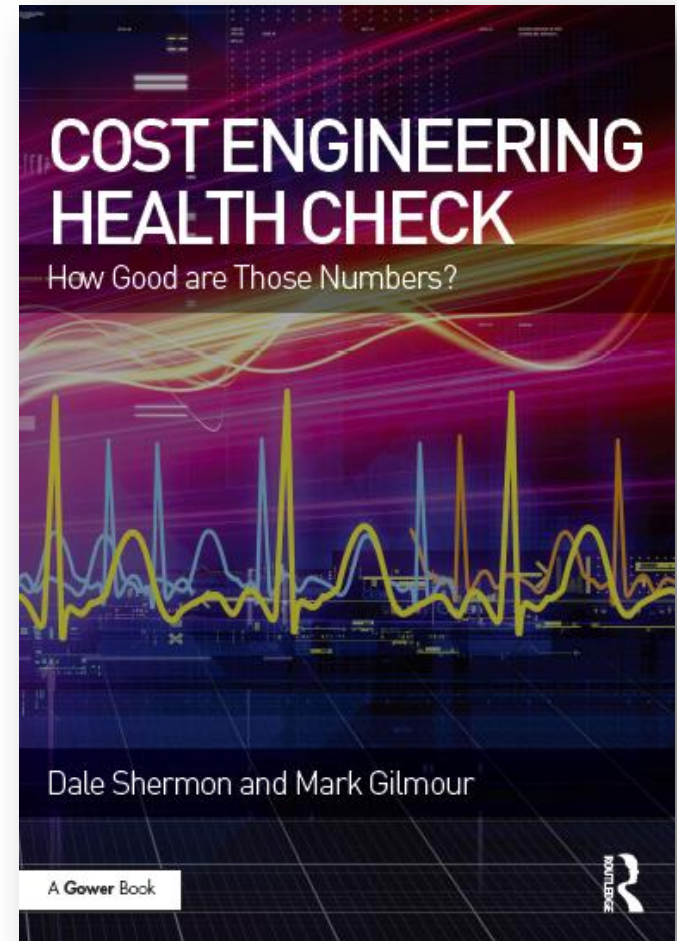
Dale Shermon | QinetiQ Fellow



Thoughts

- **Monte Carlo analysis sounds impressive, but understand it and discover its as simple as rolling a dice.**
- **Ensure risk and uncertainty terms are used correctly.**
- **Project managers need to embrace combine cost and schedule risk analysis to truly understand the outcome of their projects.**
- **50% confidence of cost and 50% confidence of schedule does not equate to 50% overall!**

- **Hope you found the presentation interesting – Many thanks!**



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