



Automated Cost Estimating Integrated Tools

Modeling a Risk Register in ACE

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Have you ever needed to model a risk register or risk cube in ACE, but weren't quite sure how to make the jump from colored boxes to risk distributions? This presentation will give an overview of how to do just that. It shows how to model your discrete risks by applying risk ranges to the cost of those risk events. We will go one step further to show how to implement the probability that each event will occur, and even apply risk ranges to those probabilities.

- **Understand discrete risk and how to interpret a risk cube, or risk register**
- **Become familiar with the terms Cost Consequence, Likelihood (Probability of Occurrence), and Expected Value**
- **Correlate the probabilities of occurrence and the cost consequences**



The Risk Cube*

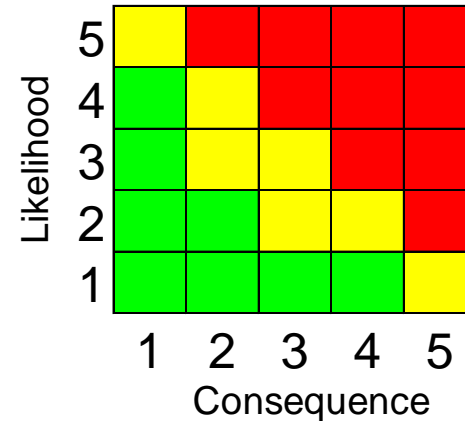
■ Risk Management conventions for a 5x5 Matrix *

■ Consequence

- 1 Minimal or no impact
- 2 Additional resources < 5%
- 3 Additional resources = 5-7%
- 4 Additional resources = 7-10%
- 5 Additional resources > 10%

■ Level Likelihood of Occurrence

- 1 Not Likely (~10%)
- 2 Low Likelihood (~30%)
- 3 Likely (~50%)
- 4 Highly likely (~70%)
- 5 Near certainty (~90%)



■ Risk Register is a more detailed view of the risk cube usually in table format

- Discrete risk description
- Impact or cost consequence if the event occurs
- Probability that the event will occur
- Mitigation plan, etc.

* Note: Taken from Risk Management Guide for DoD Acquisition



- **Defined as:** If risk event A occurs, there is a cost consequence or opportunity. The probability of A occurring is $x\%$
- **If there are only a few discrete events, treat as what-if cases (event cost impact is either “in” or “out” of the estimate)**
- **If there are many discrete events, this presentation explains how to incorporate them into the estimate**



Using the ACE Probability of Occurrence column

- **ACE column “Probability % of Occurrence”**
 - This column is designed specifically to define discrete events
 - This column can be found on the “RISK All Columns” workscreen
- **How to use the “Probability % of Occurrence” column:**
 - Define a percent **likelihood** (from 0 to 100)
 - When participating, the equation/throughput is calculated normally
 - When not participating, the equation’s result is set to zero during the RISK calculation
- **Using this column allows for *uncertainty on the probability of occurrence* as well as *correlating multiple discrete risk events***
 - As with any cost input, you may also assign uncertainty to the *cost consequence*
 - Define it on a separate row then use its Unique ID in the Equation/Throughput column of the discrete risk element’s row



Simple Discrete Example

- Using the Probability of Occurrence column to model a 50/50 probability risk event

	WBS/CES Description	Unique ID	Point Estimate	Equation / Throughput	Probability % of Occurrence
1	*My Program Estimate	*Estimate			
2	Total		100. (0+%) *		
3	My Estimate		100. *	100	
4	Discrete Risk Event #1: Test Failure Cost Consequence		0. (0+%) *	5	50

- BY RI\$K Statistics

WBS/CES Description	Point Estimate	Mean	Std Dev	CV	5%	10%	15%	20%	25%	30%
*My Program Estimate										
Total	100. (0+%)	103.	3.	0.024415	100.	100.	100.	100.	100.	100.
My Estimate	100.	100.			100.	100.	100.	100.	100.	100.
Discrete Risk Event #1: Test Failure Cost	5. (99+%)	3.	3.	1.001002						

35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
100.	100.	100.	105.	105.	105.	105.	105.	105.	105.	105.	105.	105.
100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
			5.	5.	5.	5.	5.	5.	5.	5.	5.	5.

Risk ON



What do you want to see in the PE?

ACE Session Properties

RISK and Config Reporting | Format | Summary

General | Calculation | Errors | Inflation

Cycle Convergence
Maximum Iterations: 100

Undefined Variables

- Raise FATAL error when unknown variables encountered
- Add unknown variables to end of WBS
- Add unknown variables to the Row Parameter column
- Search Parameter Libraries for definitions of undefined variables encountered

RISK

Calculate RISK with default calculation Custom CDFs

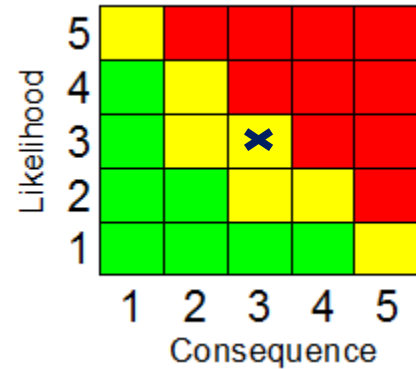
Solution Method: Latin Hypercube Group Seeds

Iterations: 500 Prob Occur PE: **Zero (default)**

Percentile
Low: 15 % High

Zero (default)
Zero (default)
Expected Value
Calculated Value

Cost Consequence = \$5
Likelihood = 50%



Point Estimate	
100. (0+%) *	
100. *	
0.0 (0+%) *	

Point Estimate	
103. (50%) *	
100. *	
2.5 (50%) *	

Expected Value = Cost * Likelihood

Point Estimate	
105. (99+%) *	
100. *	
5.0 (99+%) *	



Displaying the Expected or Calculated Value can be misleading as it contributes cost to the point estimate that may or may not be incurred.

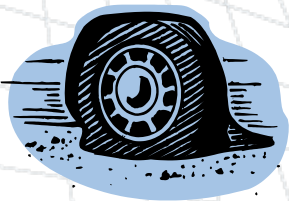
5	Yellow	Red	Red	Red	Red
4	Green	Yellow	Red	Red	Red
3	Green	Yellow	Yellow with X	Red	Red
2	Green	Green	Yellow	Yellow	Red with X
1	Green	Green	Green	Green	Yellow
	1	2	3	4	5

Likelihood

Consequence

■ Disneyland!

- \$500 for 3 days and 2 nights hotel and food
- \$300 for 1 adult 2 children tickets
- \$50 Gas
- Total \$850



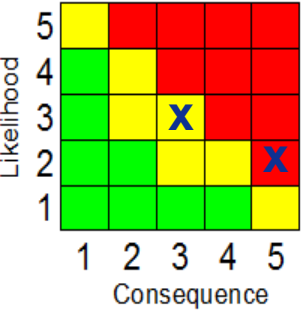
■ What could go wrong?

- \$35 Flat Tire
- \$200 Someone gets sick
 - Additional hotel and food
 - Medicine





Basic Setup



	WBS/CES Description	Unique ID	PE - with Discrete	Equation / Throughput	Probability % of Occurrence
1	*My Summer Vacation	*Estimate			
2	Total Vacation		\$ 850.00 (11%) *		
3	The Basics		\$ 850.00 (22%) *		
4	Hotel and Food		\$ 500.00 (40%) *	250*2	
5	Park Entry		\$ 300.00 (28%) *	100*3	
6	Gas		\$ 50.00 (21%) *	50	
7	Discrete Risks		\$ 0.00 (0+%) *		
8	Flat Tire		\$ 0.00 (0+%) *	FlatTire\$	FlatTireProb%
9	Sick		\$ 0.00 (0+%) *	Sick\$	SickProb%
10					
11	*INPUT VARIABLES	*IN_VAR			
12	* Discrete Risks				
13	Flat Tire Repair Cost	FlatTire\$	\$ 35.00 *	35	
14	Get Sick Cost	Sick\$	\$ 200.00 *	200	
15					
16	Flat Tire Probability (Likelihood=3)	FlatTireProb%	50.000 *	50	
17	Get Sick Probability (Likelihood=2)	SickProb%	30.000 *	30	

Define how much it will cost if the event occurs, the "cost consequence"

Define the Likelihood as the probability, from 0 to 100, of the event happening (the "probability of occurrence")

Reference the Unique IDs for the Cost Consequence and Probability of Occurrence



Results

	WBS/CES Description	Point Estimate	Mean	Std Dev	CV	5%	10%	15%	20%	25%	30%
1	*My Summer Vacation										
2	Total Vacation	\$ 850.00 (11%)	\$ 994.70	\$ 122.93	0.123584	\$ 813.74	\$ 844.85	\$ 866.66	\$ 884.83	\$ 901.25	\$ 916.62
3	The Basics	\$ 850.00 (22%)	\$ 917.20	\$ 80.98	0.088294	\$ 786.44	\$ 813.50	\$ 830.98	\$ 844.91	\$ 858.36	\$ 871.80
4	Hotel and Food	\$ 500.00 (40%)	\$ 523.00	\$ 67.75	0.129541	\$ 416.09	\$ 435.29	\$ 450.02	\$ 462.40	\$ 473.33	\$ 483.24
5	Park Entry	\$ 300.00 (28%)	\$ 327.81	\$ 40.65	0.124000	\$ 268.14	\$ 277.69	\$ 285.00	\$ 291.17	\$ 296.61	\$ 301.54
6	Gas	\$ 50.00 (21%)	\$ 66.39	\$ 18.00	0.271136	\$ 41.30	\$ 44.81	\$ 47.50	\$ 49.77	\$ 51.88	\$ 54.06
7	Discrete Risks	\$ 0.00 (35%)	\$ 77.50	\$ 93.48	1.206213						
8	Flat Tire	\$ 35.00 (99+%)	\$ 17.50	\$ 17.50	1.000100						
9	Sick	\$ 200.00 (99+%)	\$ 60.00	\$ 91.66	1.527678						
10											
11	*INPUT VARIABLES										
12	* Discrete Risks										
13	Flat Tire Repair Cost	\$ 35.00	\$ 35.00			\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00
14	Get Sick Cost	\$ 200.00	\$ 200.00			\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00
15											
16	Flat Tire Probability (Likelihood=3)	50.000	50.000			50.000	50.000	50.000	50.000	50.000	50.000
17	Get Sick Probability (Likelihood=2)	30.000	30.000			30.000	30.000	30.000	30.000	30.000	30.000

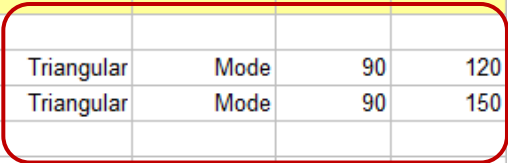
	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
	\$ 931.47	\$ 949.21	\$ 963.92	\$ 980.27	\$ 997.85	\$ 1,016.54	\$ 1,034.44	\$ 1,055.02	\$ 1,079.06	\$ 1,105.64	\$ 1,133.10	\$ 1,167.68	\$ 1,215.29
	\$ 882.81	\$ 893.95	\$ 904.91	\$ 915.09	\$ 925.53	\$ 935.01	\$ 948.45	\$ 960.54	\$ 974.23	\$ 988.08	\$ 1,004.85	\$ 1,024.29	\$ 1,052.47
	\$ 492.31	\$ 500.78	\$ 509.24	\$ 518.08	\$ 527.37	\$ 537.19	\$ 547.67	\$ 558.90	\$ 571.12	\$ 584.65	\$ 600.00	\$ 618.19	\$ 641.95
	\$ 306.52	\$ 311.69	\$ 317.08	\$ 322.73	\$ 328.66	\$ 334.93	\$ 341.61	\$ 348.78	\$ 356.58	\$ 365.22	\$ 374.99	\$ 386.62	\$ 401.78
	\$ 56.33	\$ 58.69	\$ 61.14	\$ 63.70	\$ 66.40	\$ 69.26	\$ 72.30	\$ 75.56	\$ 79.12	\$ 83.05	\$ 87.50	\$ 92.80	\$ 99.68
		\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 235.00	\$ 235.00	\$ 235.00
				\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00
								\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00
	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00	\$ 35.00
	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00	\$ 200.00
	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000
	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000



Layering Discrete Uncertainty

Uncertain Cost Consequence

	WBS/CES Description	Unique ID	PE - with Conseq	Equation / Throughput	Probability % of Occurrence	Distribution Form	PE Position in	Low (% of PE)	High (% of PE)
1	*My Summer Vacation	*Estimate							
2	Total Vacation		\$ 927.50 (33%) *						
3	The Basics		\$ 850.00 (22%) *						
4	Hotel and Food		\$ 500.00 (40%) *	250*2		Triangular	Mode	90	120
5	Park Entry		\$ 300.00 (28%) *	100*3		Triangular	Mode	95	125
6	Gas		\$ 50.00 (21%) *	50		Triangular	Mode	95	175
7	Discrete Risks		\$ 77.50 (70%) *						
8	Flat Tire		\$ 17.50 (50%) *	FlatTire\$	FlatTireProb%				
9	Sick		\$ 60.00 (70%) *	Sick\$	SickProb%				
10									
11	*INPUT VARIABLES	*IN_VAR							
12	* Discrete Risks Cost Consequence								
13	Flat Tire Repair Cost	FlatTire\$	\$ 35.00 (40%) *	35		Triangular	Mode	90	120
14	Get Sick Cost	Sick\$	\$ 200.00 (28%) *	200		Triangular	Mode	90	150
15									
16	* Discrete Risks Likelihood								
17	Flat Tire Probability (Likelihood=3)	FlatTireProb%	50.000 *	50					
18	Get Sick Probability (Likelihood=2)	SickProb%	30.000 *	30					



Applying distributions to the Cost Consequence rows adds a layer of uncertainty to the discrete events

Prob Occur PE:



Layering Discrete Uncertainty

Uncertain Cost Consequence & Probability of Occurrence

	WBS/CES Description	Unique ID	PE- Conseq & Likelihood	Equation / Throughput	Probability % of Occurrence	Distribution Form	PE Position	Low (% of PE)	High (% of PE)
1	*My Summer Vacation	*Estimate							
2	Total Vacation		\$ 850.00 (10%) *						
3	The Basics		\$ 850.00 (22%) *						
4	Hotel and Food		\$ 500.00 (40%) *	250*2		Triangular	Mode	90	120
5	Park Entry		\$ 300.00 (28%) *	100*3		Triangular	Mode	95	125
6	Gas		\$ 50.00 (21%) *	50		Triangular	Mode	95	175
7	Discrete Risks		\$ 0.00 (0+%) *						
8	Flat Tire		\$ 0.00 (0+%) *	FlatTire\$	FlatTireProb%				
9	Sick		\$ 0.00 (0+%) *	Sick\$	SickProb%				
10									
11	*INPUT VARIABLES	*IN_VAR							
12	* Discrete Risks Cost Consequence								
13	Flat Tire Repair Cost	FlatTire\$	\$ 35.00 (40%) *	35		Triangular	Mode	90	120
14	Get Sick Cost	Sick\$	\$ 200.00 (28%) *	200		Triangular	Mode	90	150
15									
16	* Discrete Risks Likelihood								
17	Flat Tire Probability (Likelihood=3)	FlatTireProb%	50.000 (36%) *	50		Triangular	Mode	90	125
18	Get Sick Probability (Likelihood=2)	SickProb%	30.000 (34%) *	30		Triangular	Mode	95	115

Knowing the exact probability of the event occurring is often impossible; applying uncertainty to the Probability of Occurrence is recommended

Triangular Mode 90 125
Triangular Mode 95 115

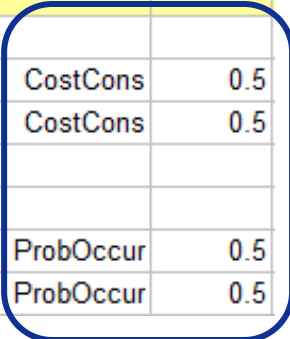


Layering Discrete Uncertainty

Cost Consequences & Probability of Occurrences Correlated

	WBS/CES Description	Unique ID	PE - with Correlation	Equation / Throughput	Distribution Form	Grouping	Group Strength
11	*INPUT VARIABLES	*IN_VAR					
12	* Discrete Risks Cost Consequence						
13	Flat Tire Repair Cost	FlatTire\$	\$ 35.00 (40%) *	35	Triangular	CostCons	0.5
14	Get Sick Cost	Sick\$	\$ 200.00 (28%) *	200	Triangular	CostCons	0.5
15							
16	* Discrete Risks Likelihood						
17	Flat Tire Probability (Likelihood=3)	FlatTireProb%	50.000 (36%) *	50	Triangular	ProbOccur	0.5
18	Get Sick Probability (Likelihood=2)	SickProb%	30.000 (34%) *	30	Triangular	ProbOccur	0.5

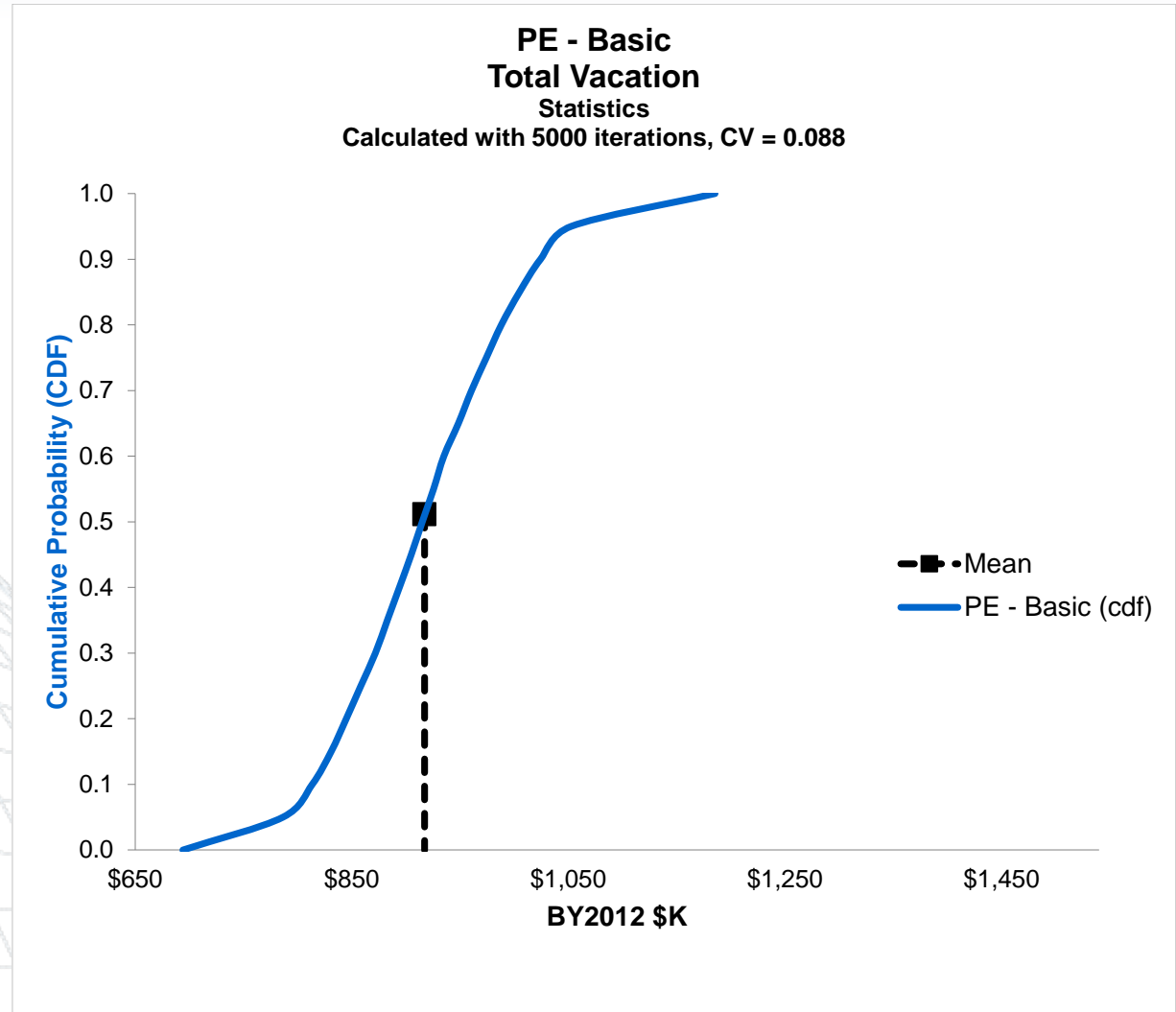
Apply correlation to the probabilities and costs (separately) if necessary to capture relationships between them





PE with Uncertainty

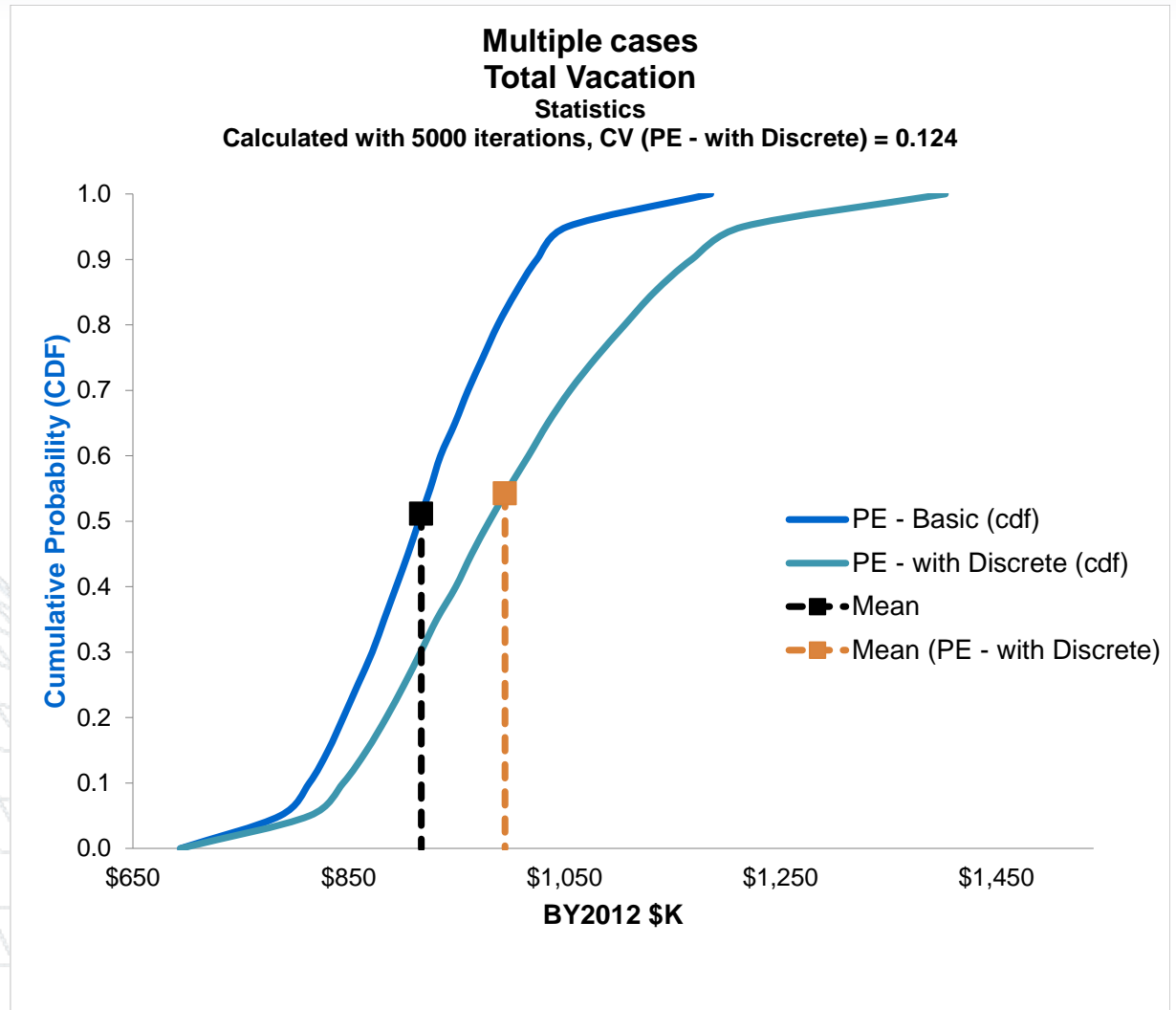
- Continuous Cost Uncertainty Only (Basic Setup)
- No discrete risks





Discrete Risk: Comparisons

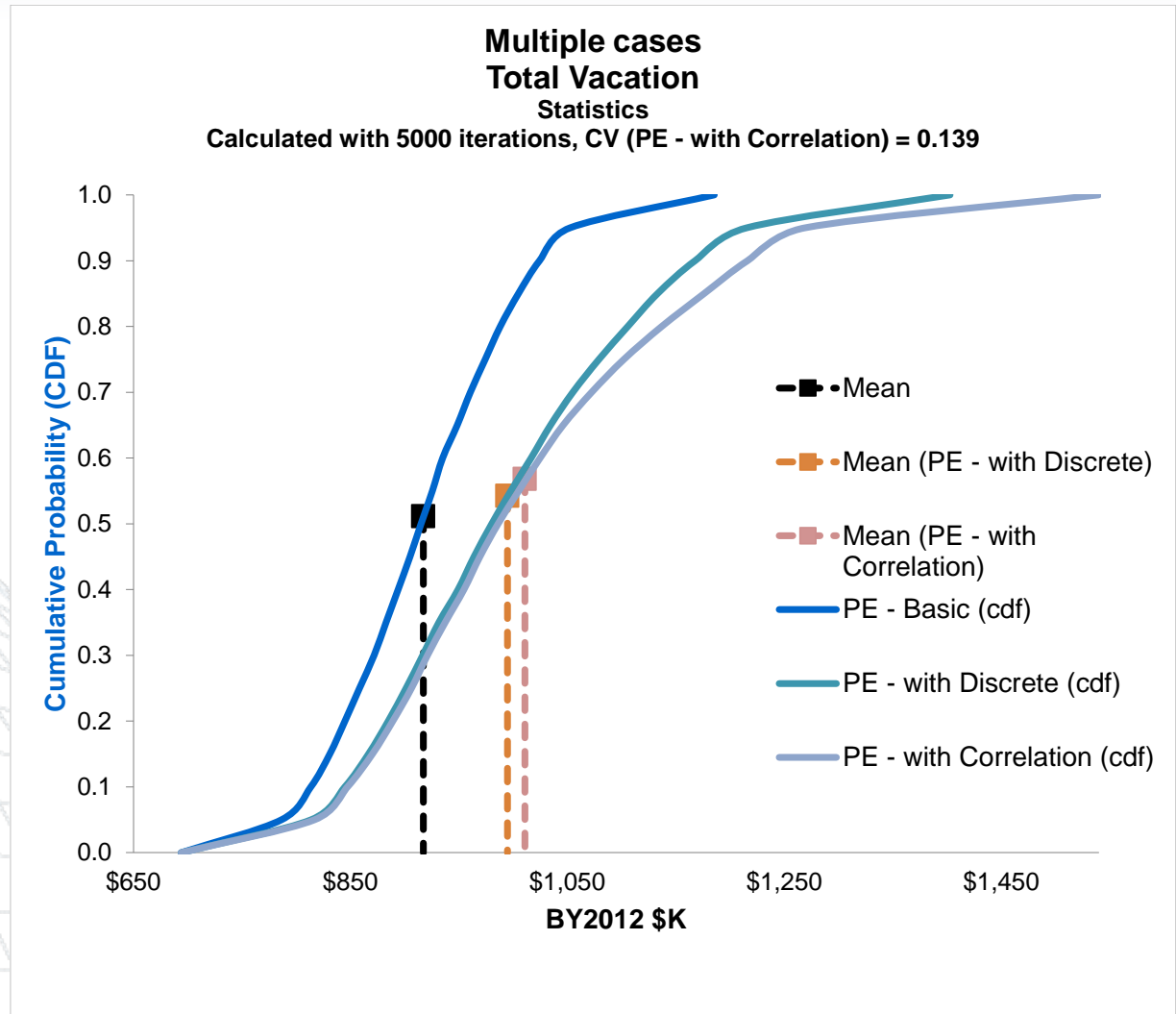
- Continuous Cost Uncertainty Only (Basic Setup)
- Basic Setup with Discrete





Discrete Risk: Comparisons

- Continuous Cost Uncertainty Only (Basic Setup)
- Basic Setup with Discrete
- Basic Setup with Discrete, Uncertain Consequence, and Uncertain Likelihood



The effect of adding uncertainty and correlation increases with the number of discrete risk events (as well as the extent of uncertainty/correlation applied to each event)

- **A Discrete Risk is an event which may or may not occur**
 - There is a likelihood or probability of the event occurring
 - If the event occurs, there is a cost consequence
- **In ACE, store discrete risk events as rows, with the cost consequence on each row**
- **Use the *Probability % of Occurrence* column to specify the probability of occurrence for each risk event**
- **By making variables for each discrete risk event cost consequence and probability, you can apply uncertainty to those also**
- **Correlate the probabilities and the cost consequences**
- **Use the *Prob Occur PE* field on the File>Properties Calculation tab to specify what should be reported as the PE for the risk events**



THANK YOU!

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