Evaluating Expected Dredging Costs for Highly Variable Market Conditions

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Market Volatility

- **Historically, dredging/beach costs have been relatively stable and predictable for projects of similar scope.**

- **Recently, costs have been highly variable, with wide ranges.**
  - Limited competition for some projects,
  - Market conditions,
  - Increased distances to offshore sand resources,
  - Contractors accounting for risk in different ways, etc.

- **Wide variations in costs make future cost projections more difficult.**

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Recent Project Example

		GOVT. EST.		BID #1		BID #2	
BID ITEM	**Quantity**	**Unit Price**	**Est. Amount**	**Unit Price**	**Est. Amount**	**Unit Price**	**Est. Amount**
Mob.			$2,476,000		$3,435,000		$4,750,000
Sand	630,000	$6.30	$3,969,000	$6.80	$4,284,000	$9.77	$6,155,100
Tilling	38	$579	$22,000	$295	$11,200	$650	$24,700
Vibration			$186,700		$24,800		$49,500
Turbidity			$37,000		$42,300		$29,000
Endangered Species			$59,600		$9,400		$29,000
TOTAL			**$6,750,200**		**$7,806,700**		**$11,037,300**

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Role of the Consulting Engineer

- Project owners require a reasonable level of confidence in cost guidance.
- Consultants use cost history and market conditions to guide project cost analyses.
  - Other corporate models use probability.
  - Goal is to capture market trends by taking a macro approach to pricing.
  - Should begin at the project-planning phase.

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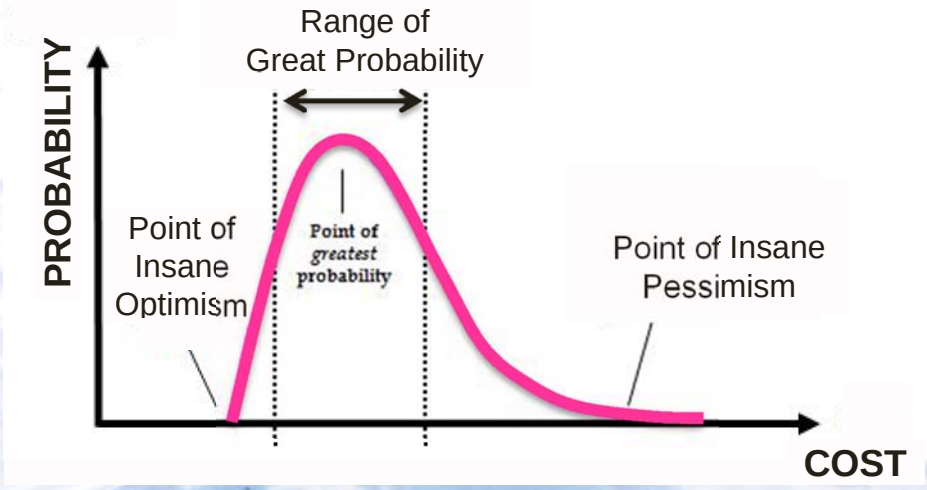
Probabilistic Methods are Widely Used to Study Variability and Uncertainty

This is not news:



This *is* news:

- **The U.S. Army Corps incorporates risk-based analyses in the development of project cost contingencies.**
- **Contractors assess risk and uncertainty to establish their expected project cost.**

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PROBABILISTIC ANALYSIS DOESN'T NEED TO BE DIFFICULT OR EXPENSIVE

- Excel Add-In
- Monte-Carlo Simulator
  - Multiple Probability Distributions
  - Customizable
  - GUI Interface
- Fast and Flexible

Example Product:
"Risk Analyzer"
www.Add-Ins.com/analyzer/
$49.95

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“Project X”: Beach Renourishment

- Cutter Suction Dredge
- 15,000 feet Max. Pump Distance
- 630,000 cubic yards
- Beach Tilling
- Construction Monitoring:
  - Vibration Control
  - Environmental Protection
  - Turbidity Monitoring, etc.

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Probable Costs to Construct “Project X”

	Study Values
• Mobilization	= $2.8M
• Sand Unit Price	= $6.90/cy
• Sand Volume	= 630,000 cy
• Tilling	= $500/ac.
• Acreage	= 40 ac.
• Construction Mon.	= $500,000
TOTAL	= **~$7.6M**

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Assessing Uncertainty with *Risk Analyzer*

1. Assign variables;
2. Combine variables;
3. Assign range of values;
4. Assign probability distributions;
5. Run Monte-Carlo simulation; and
6. Evaluate output.

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1) Assign and 2) Combine Variables

- Mobilization / Demobilization
- Sand Unit Price
- Sand Volume
- Tilling
- Acreage
- Construction Management
- **TOTAL**

VARIABLES CONTAINING UNCERTAINTY

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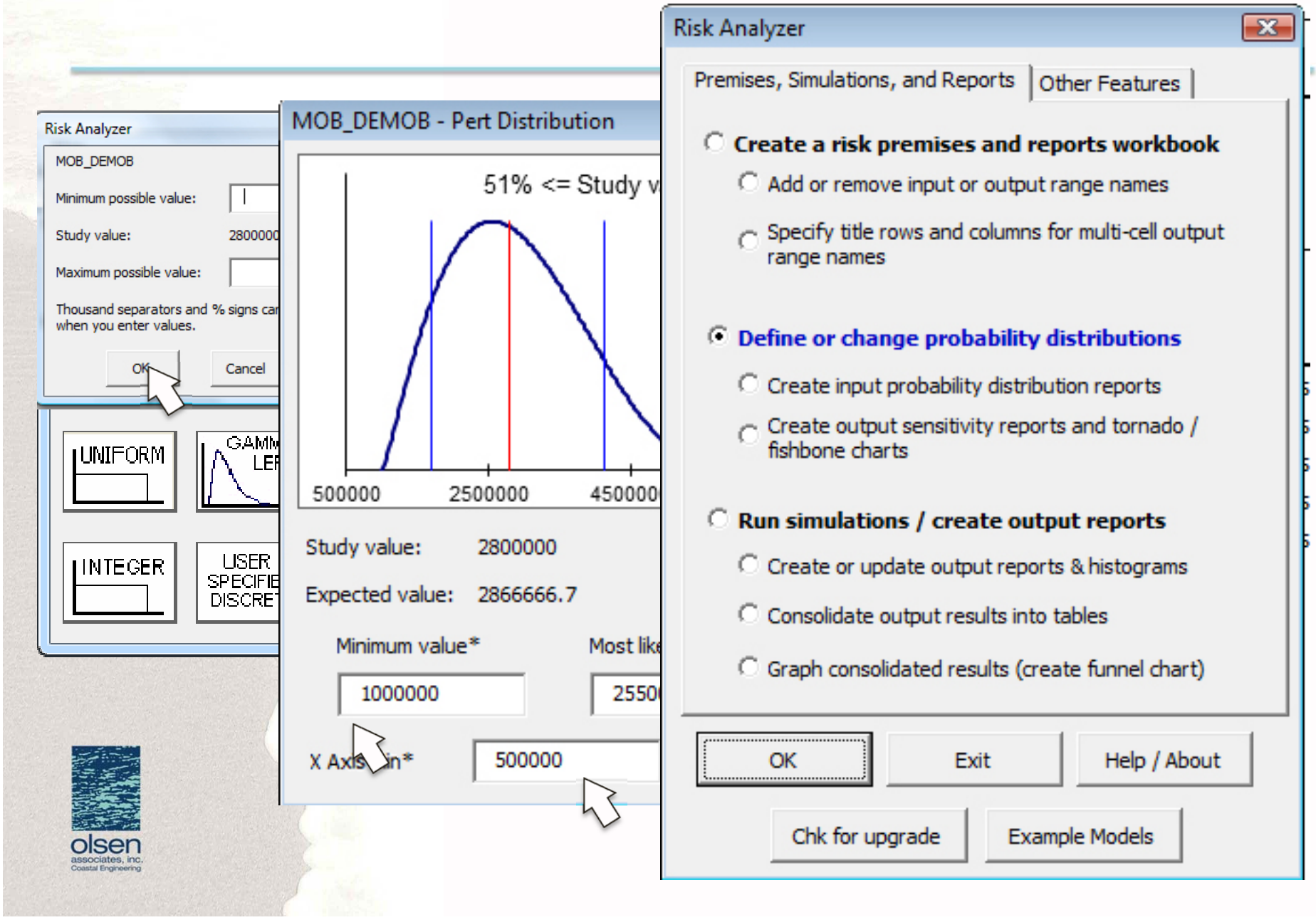
3) Value Ranges and 4) Probability Distributions

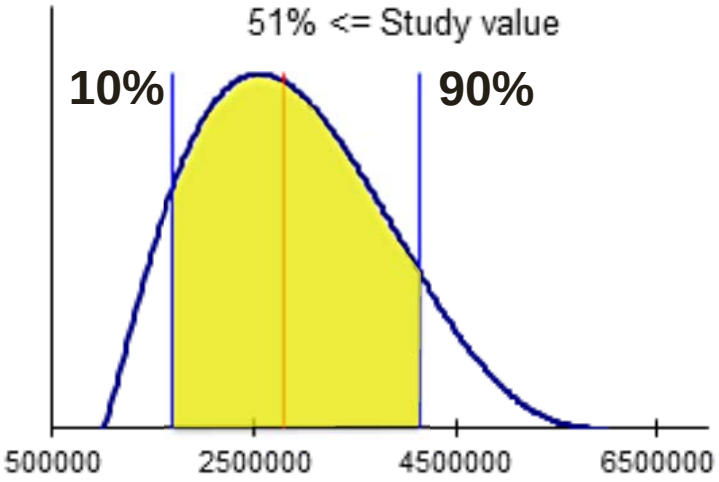


Probability Function (Variable 1)

Mobilization / Demobilization

Study File Value	Min Allowed Value	10/90	Expected Value	90/10	Max Allowed Value
$2,800,000	$1,000,000	$1,695,891	$2,866,667	$4,129,722	$6,000,000

Pert distribution



10% < $1.7M

90% < $4.1M

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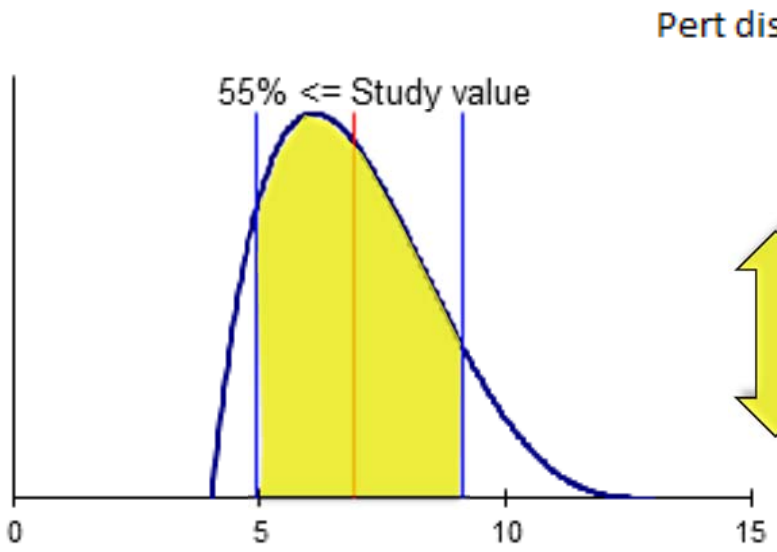
Probability Function (Variable 2)

Sand Unit Price

Study File Value	Min Allowed Value	10/90	Expected Value	90/10	Max Allowed Value
$6.90	$4.00	$4.92	$6.90	$9.12	$13.00



10% < $4.92/cy

90% < $9.12/cy

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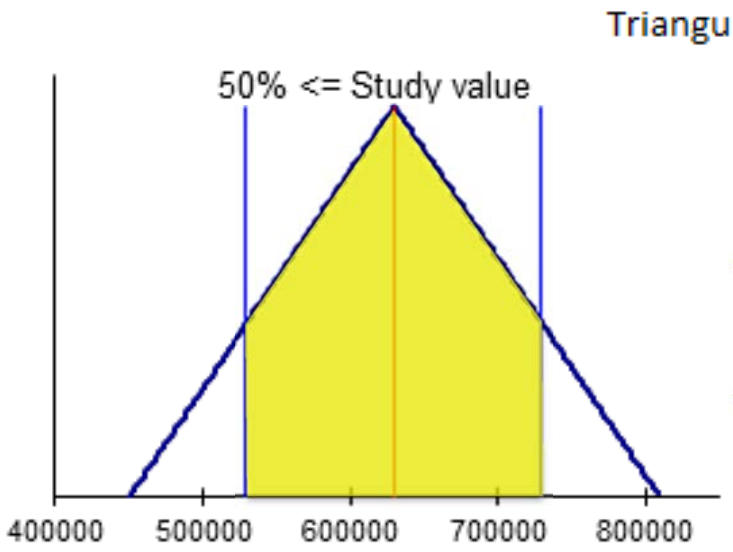
Probability Function (Variable 3)

Sand Volume

Study File Value	Min Allowed Value	10/90	Peak Value	Expected Value	90/10	Max Allowed Value
630,000	450,000	529,779	630,000	630,000	728,781	810,000



10% < 530,000 cy

90% < 730,000 cy

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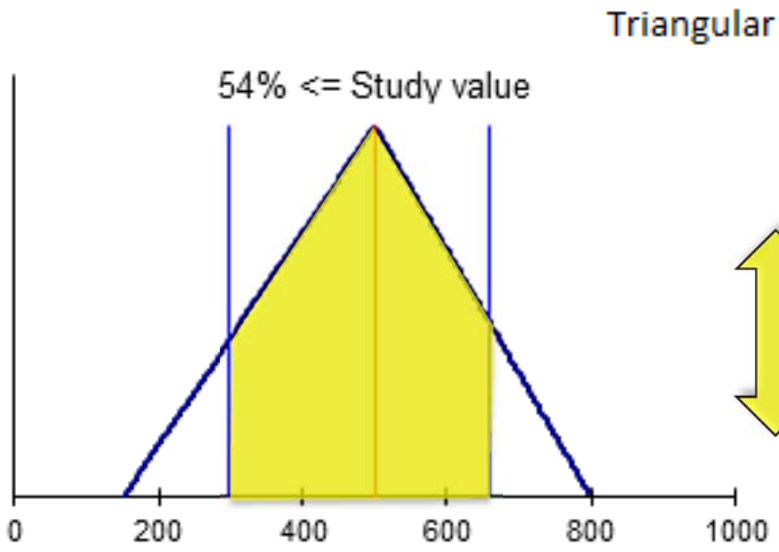
Probability Function (Variable 4)

Tilling

Study File Value	Min Allowed Value	10/90	Peak Value	Expected Value	90/10	Max Allowed Value
$500	$150	$300	$500	$483	$659	$800



10% < $300/ac.

90% < $660/ac

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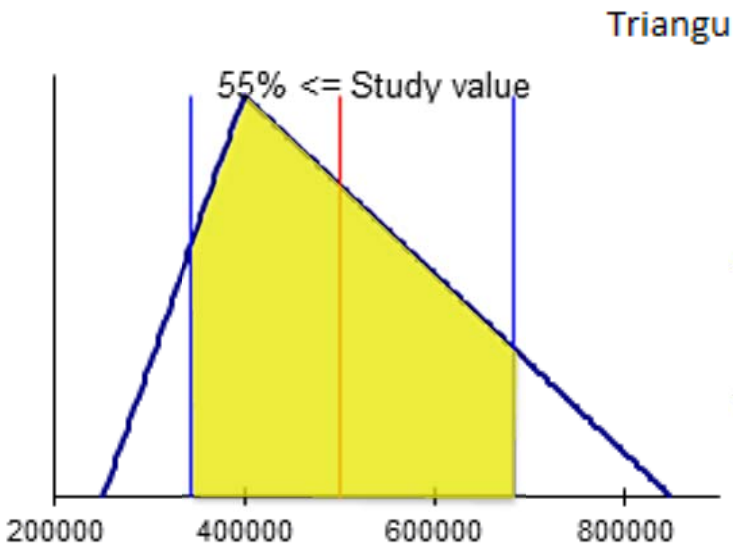
Probability Function (Variable 5)

Construction Mon.

Study File Value	Min Allowed Value	10/90	Peak Value	Expected Value	90/10	Max Allowed Value
$500,000	$250,000	$343,674	$400,000	$500,002	$684,481	$850,000



10% < $340,000

90% < $680,000

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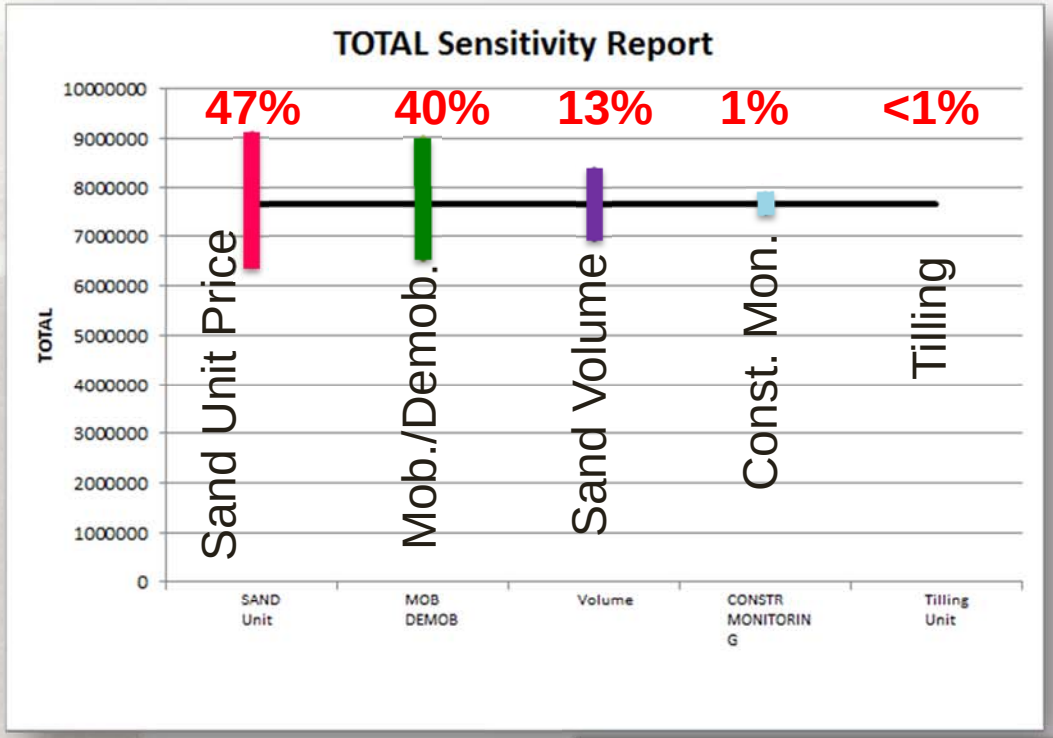
Sensitivity Report



The horizontal line represents the study case. A vertical line represents the output ran between an input's 10% likely and 90% likely values. Inputs with long vertical lines ha the most effect on the output cells.

TOTAL sensitivity to:	10/90	Study	90/10	Variance Amount	Variance Cumulative
Sand Unit Price	6,421,851	7,667,000	9,067,613	47%	47%
Mob./Demob.	6,562,891	7,667,000	8,996,722	40%	87%
Sand Volume	6,975,472	7,667,000	8,348,592	13%	99%
Const. Monitoring	7,510,674	7,667,000	7,851,481	1%	100%
Tilling Unit Price	7,658,981	7,667,000	7,673,362	0%	100%

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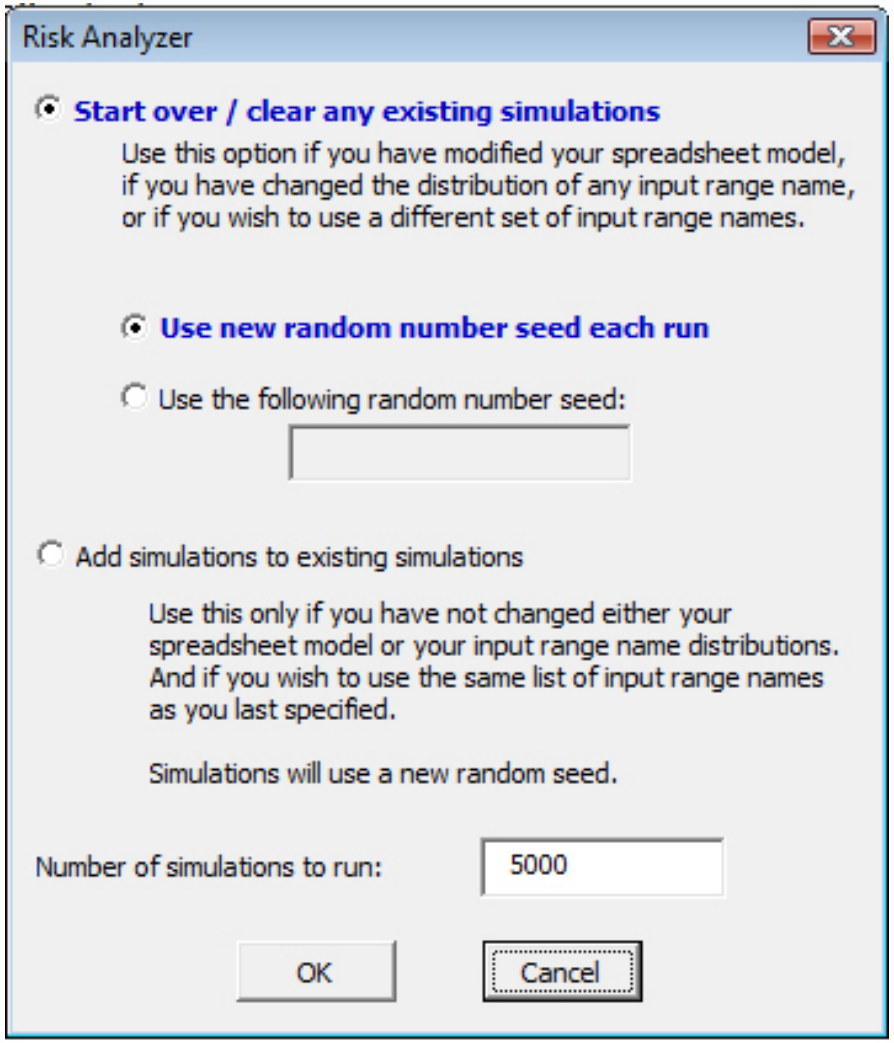
5) Run Monte-Carlo Simulation

A. Select number of simulations.

B. Select variables to include as input & output.

C. Run Simulation.



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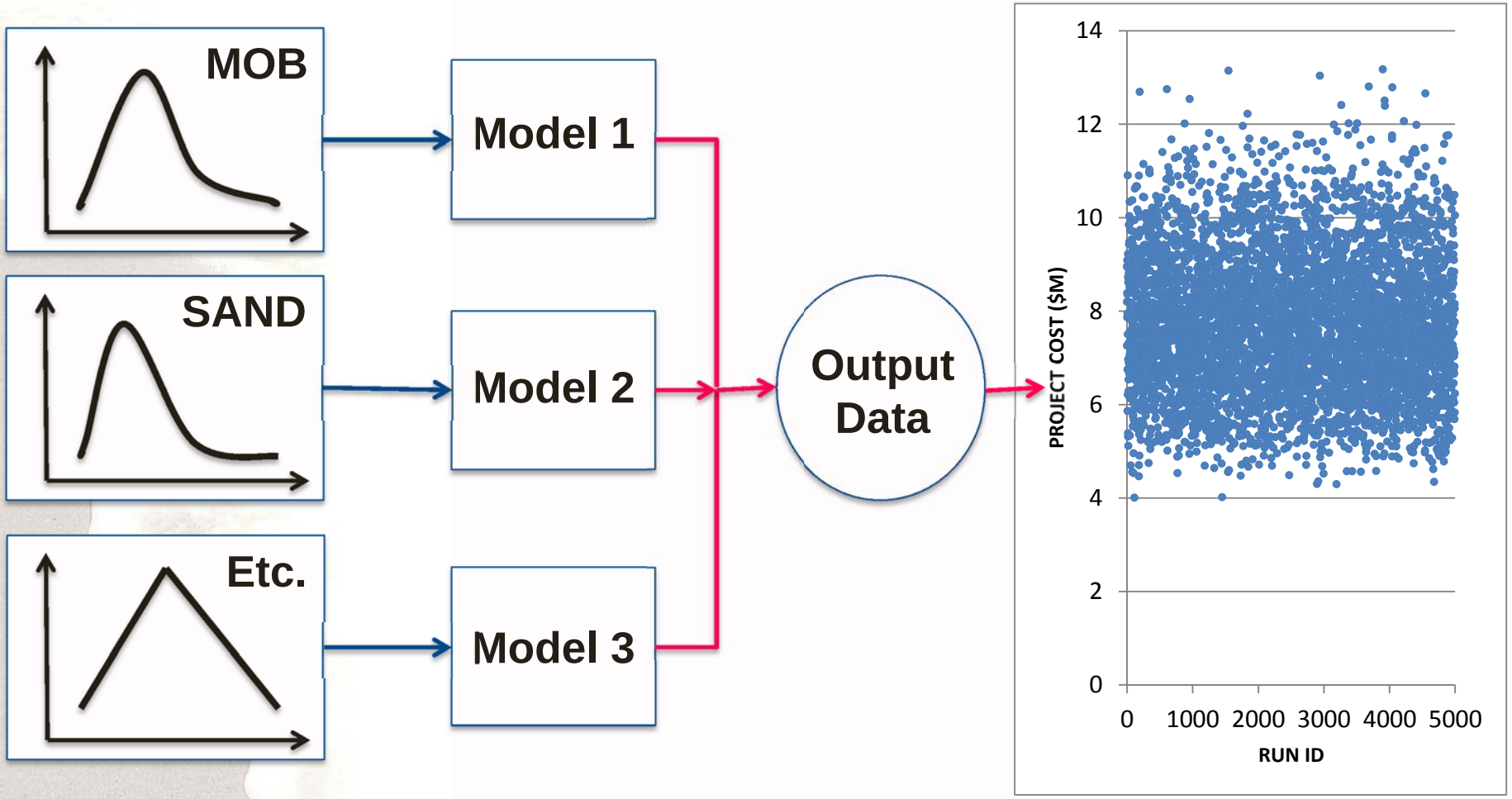
Monte-Carlo Simulation



Input Data Distributions

Simulations

Results after 5,000 runs

6) Output

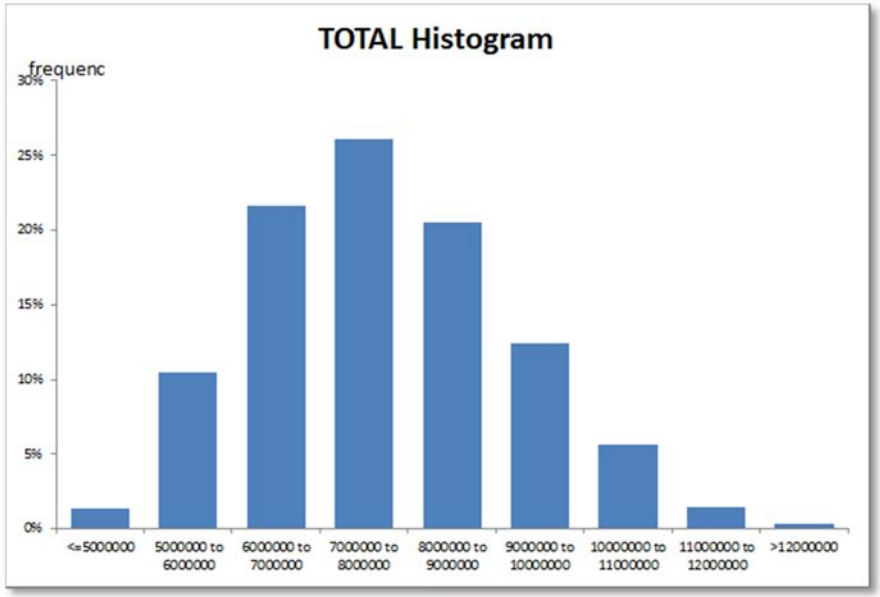
TOTAL Results

Minimum result	$4,005,324
Maximum result	$13,172,321
Expected value	$7,729,394
Std Deviation	$1,469,926

$7,667,000 Study value
50.8% of results are equal or lower
49.2% of results are equal or greater

Out of 5000 simulations
5000 had numeric values.
0 had error values.

Of those with numeric values:	
5% <=	$5,478,438
10% <=	$5,887,403
15% <=	$6,160,818
20% <=	$6,429,166
25% <=	$6,649,449
30% <=	$6,847,088
35% <=	$7,063,554
40% <=	$7,252,459
45% <=	$7,442,526
50% <=	$7,632,781
55% <=	$7,830,838
60% <=	$8,015,045
65% <=	$8,226,169
70% <=	$8,467,876
75% <=	$8,692,286
80% <=	$8,984,447
85% <=	$9,322,581
90% <=	$9,721,374
95% <=	$10,292,018
100% <=	$13,172,321



If TOTAL is: $7,667,000
(Chg to do what ifs)

50.8% of results are equal or lower
49.2% of results are greater

6) Output

50% Prob. price is less than $7.6M

80% Prob. price is less than $9M

5% <=	$5,478,438
10% <=	$5,887,403
15% <=	$6,160,818
20% <=	$6,429,166
25% <=	$6,649,449
30% <=	$6,847,088
35% <=	$7,063,554
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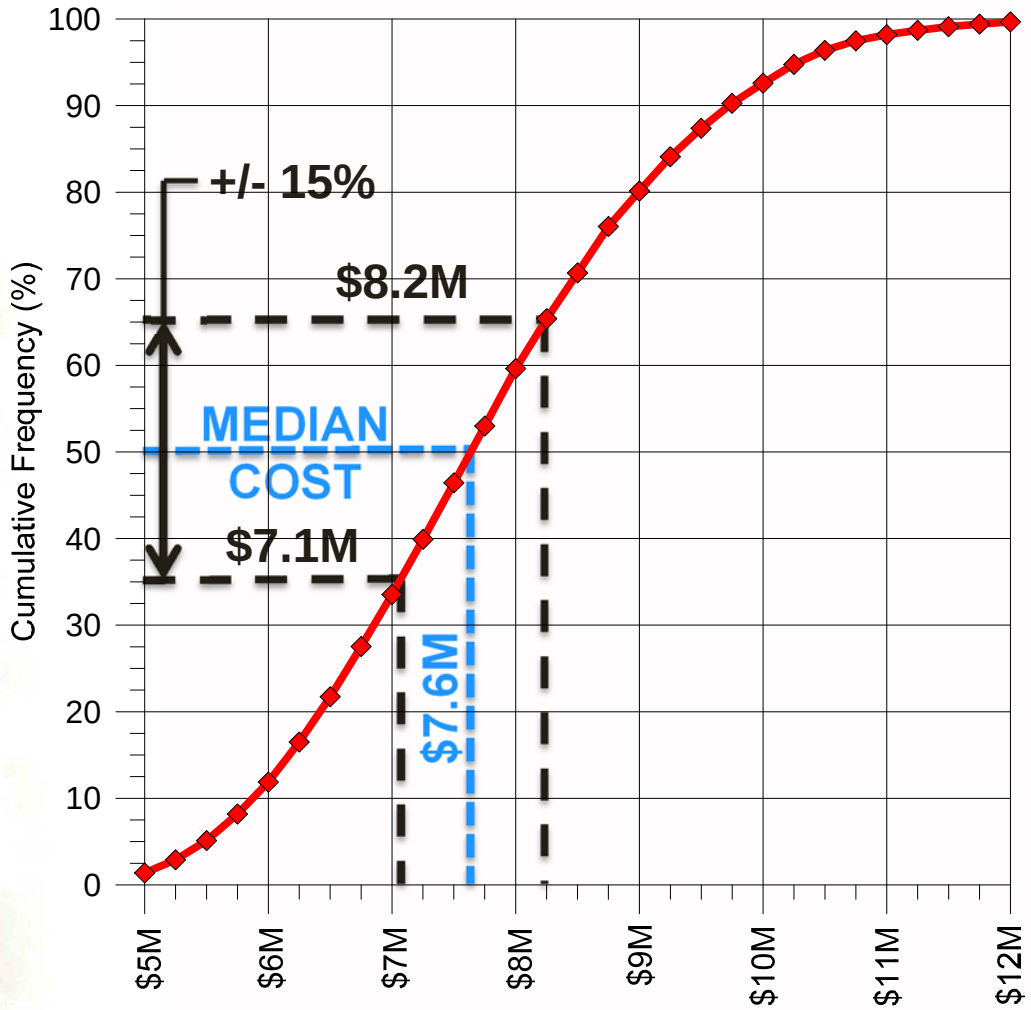
6) Output



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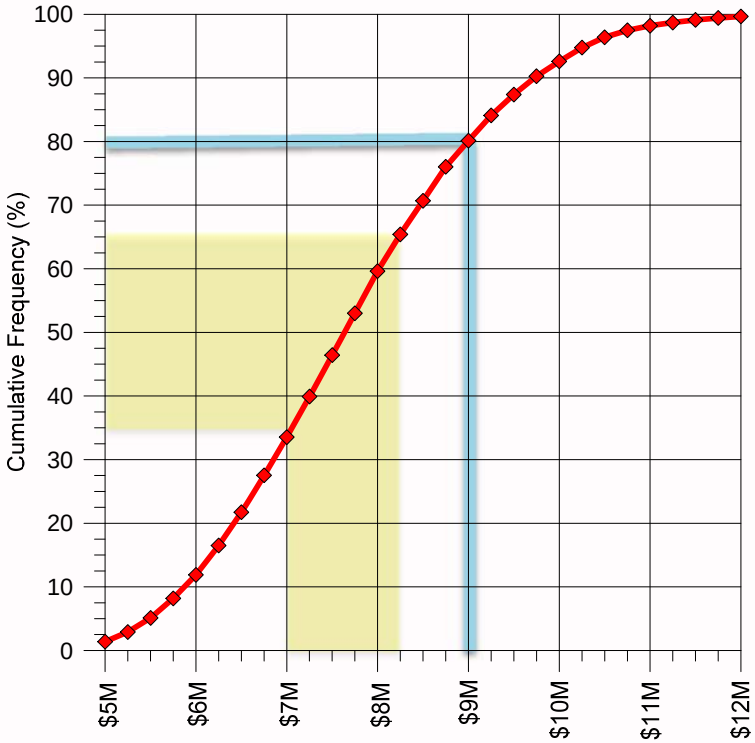
Presenting Model Results

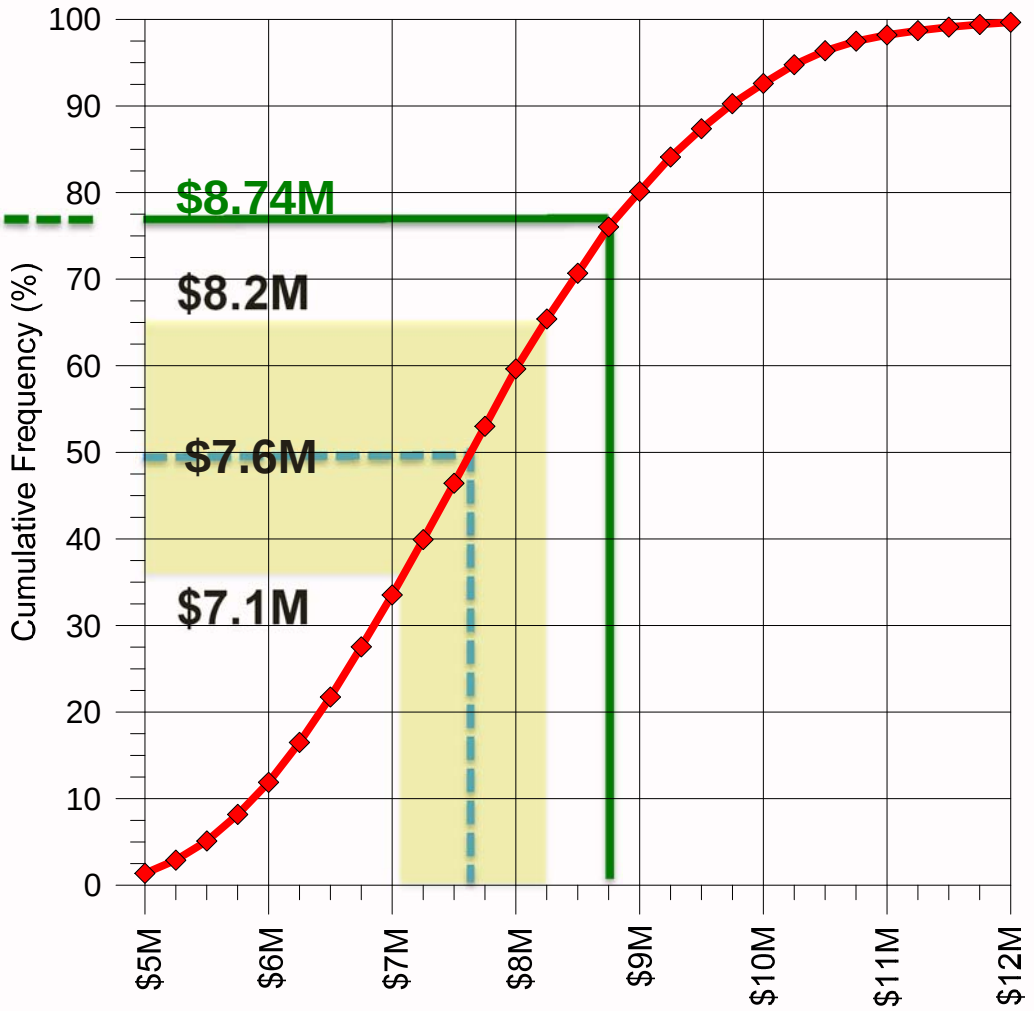
“Project ‘X’ is anticipated to cost between $7.1M and $8.2M.”

“There is a 20% probability that project costs will exceed $9M.”



Study Value Plus 15% Contingency

Original Engineers Estimate
X 115% = $8.74M
(77% Prob.)



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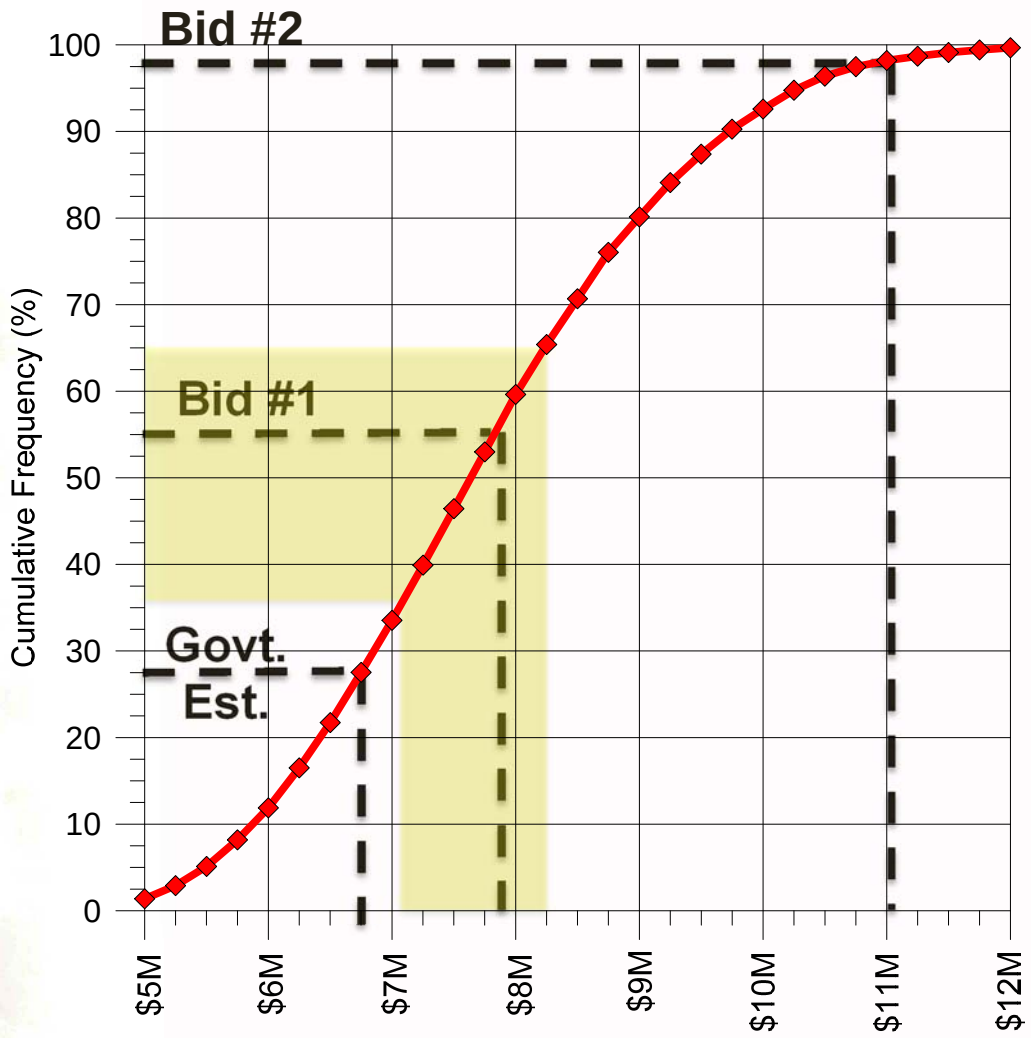
Bid Results, Project X



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Incorporating probability to develop contingencies based on market conditions increases the overall utility of a cost estimate and can be accomplished quickly and easily.

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