Cost Risk and Uncertainty Analysis

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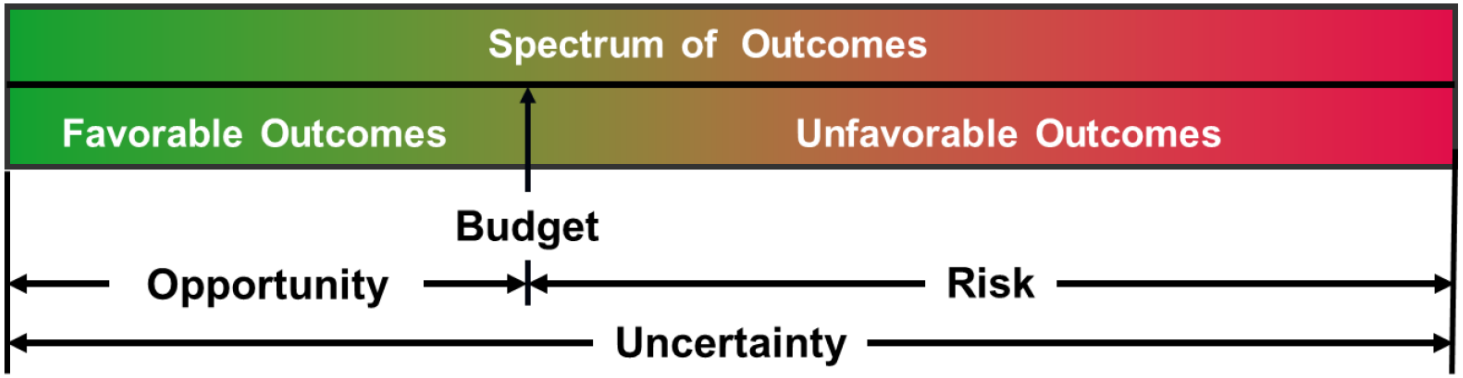
Agenda

- What is Cost Risk and Uncertainty?
- Why is it important?
- Sources of Uncertainty
- Excluded Uncertainty
- Capturing Risk and Uncertainty
- Distributions
- Correlation
- The Simulation
- The Results

What is Cost Risk and Uncertainty?

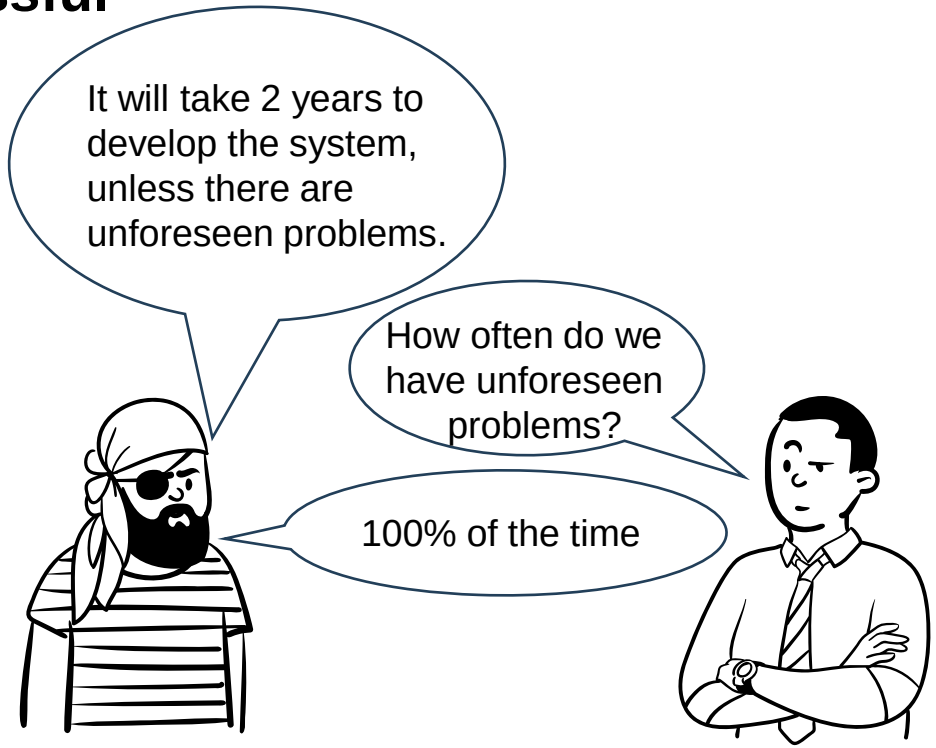
- **Risk – is the probability of loss or failure**
- **Opportunity – a favorable event or outcome**
- **Uncertainty – is the indefiniteness about the outcome of a situation**



The Goal of the analysis is to determine the range of possible outcomes to support program execution and decision support

Why is it Important?

- **DoD cost estimates need to be reasonable and realistic in order to set budgets or adjust budgets in order for programs to be successful**



A Quality Cost Estimate is not just a Point Estimate

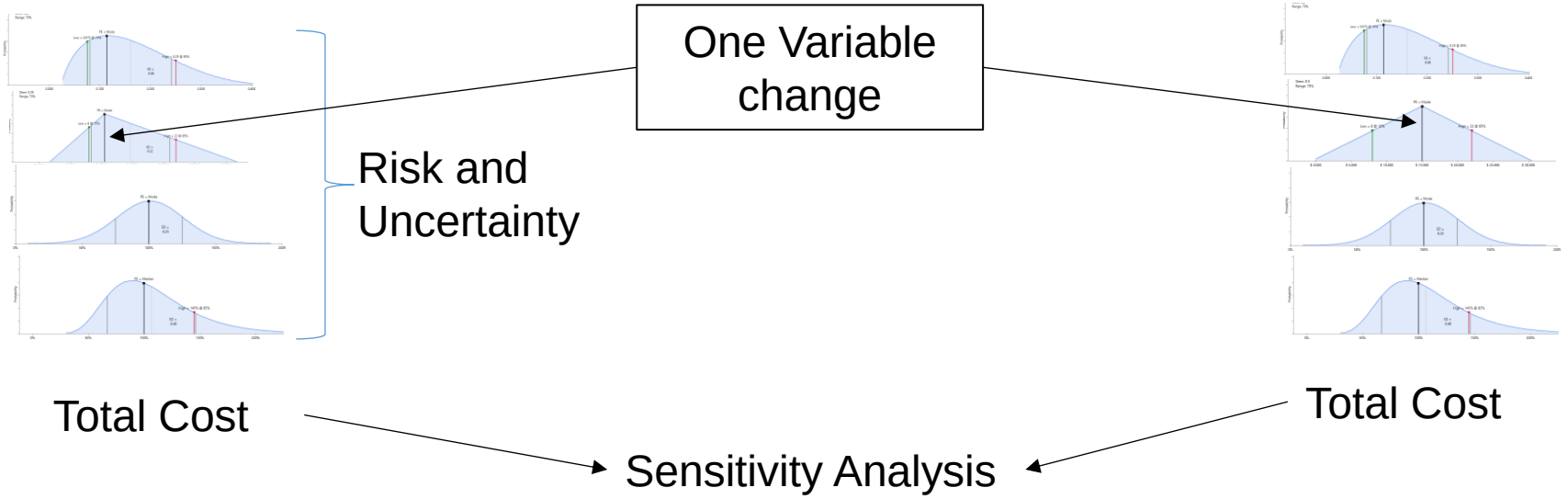
Sources of Uncertainty

- **Uncertainty from Methods/Inputs**
  - **Cost Estimating Relationships (CER) based on their error**
  - **Complexity Factors/Analogies based on the error in the engineering judgment**
  - **Build Ups based on man-hours, labor rates or overhead rates**
- **Uncertainty from Risk Register/Program Strategies**
  - **Risk of negative events and impacts of such**
  - **Ground Rules and Assumptions that may not be correct**
  - **Strategy, Contract, Requirements changes**
  - **Planned schedule durations**
  - **Known Unknowns**

The Model needs to combine all sources of uncertainty to assess the cost risk

Side Note

- **Risk and Uncertainty Analysis Vs. Sensitivity Analysis**
  - **There is a lot of overlap in these areas and some things can be included in both categories**
  - **You can use your Risk Analysis to identify elements for your Sensitivity analysis**
  - **Where your risk analysis shows the level of uncertainty in your Point Estimate your Sensitivity analysis will show how sensitive your total estimate is to a variable**



Excluded Uncertainty

- **Uncontrollable Events**
  - **Industry collapses**
  - **Global Epidemics**
  - **Natural Disasters**
  - **Unknown Unknowns**
- **Elements that can be considered Certain**
  - **Elements of inconsequentially low cost (unless there are many of these elements)**
  - **Sunk Costs**
  - **Unit of measure conversions**
  - **Production Quantities (variations in production quantities are best done as discrete what-if cases)**

Areas where uncertainty is cannot be modeled appropriately conduct sensitivity analysis (i.e. Data Rights, GR&A)

Capturing Risk and Uncertainty

- **Objective Uncertainty**
  - Based on statistical analysis of relevant data
  - CER should be bound with the standard error in the predictions
  - Historical Data will often have some variation that can be used
- **Subjective Uncertainty**
  - Based on expert opinion
  - Need to ask multiple experts to get a range of views
  - Asking situation based questions about the worst case or the best case will give an idea of amount of uncertainty
- **Third Party Tool**
  - Developed under a separate model
  - If using PRICE or SEER to develop costs for element these will come with uncertainty ranges

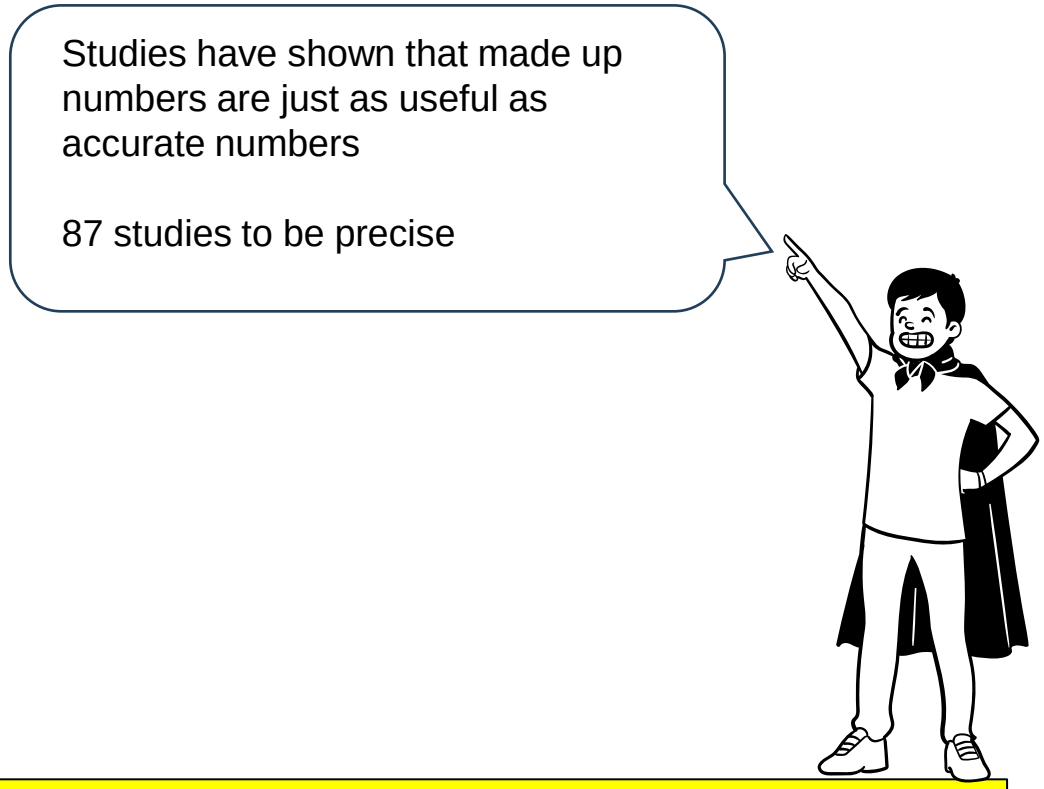
Side Note

- **SME inputs**
  - **Be interested in the technical details of the program you are supporting because they matter, and it is good for your relationship with the SME**
  - **Don’t anchor the SME**
  - **Do challenge the SME with hypotheticals**
  - **Give them time to think about it and return to them to confirm the inputs**
  - **Repeat what they say using different terms**
  - **Show them how what they say looks like Graphically**
  - **Ask another SME**
  - **Thank them for their help**

Documentation

No matter the source or the rational for the uncertainty it needs to be documented

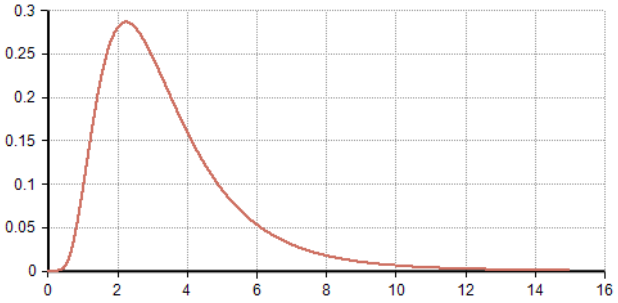
- **Who provided info?**
- **What did they provide?**
- **When did they provide?**
- **Where does it apply?**
- **Why does it apply?**
- **…**



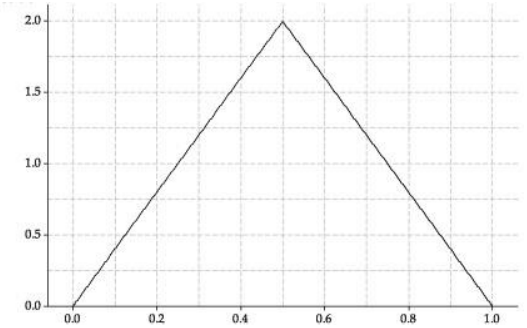
Document, Document, Document!!!

Picking a Distribution

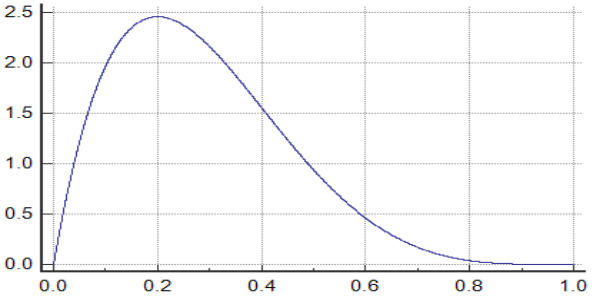
- **Depending on the situation and the source and amount of information being used for uncertainty the distribution shape will differ**



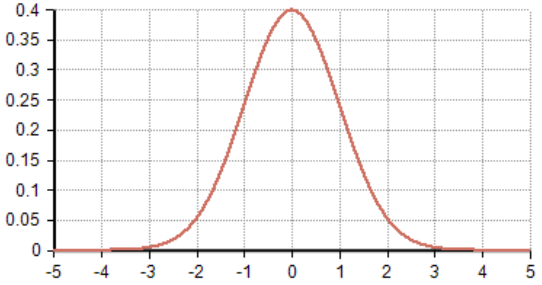
Lognormal



Triangular

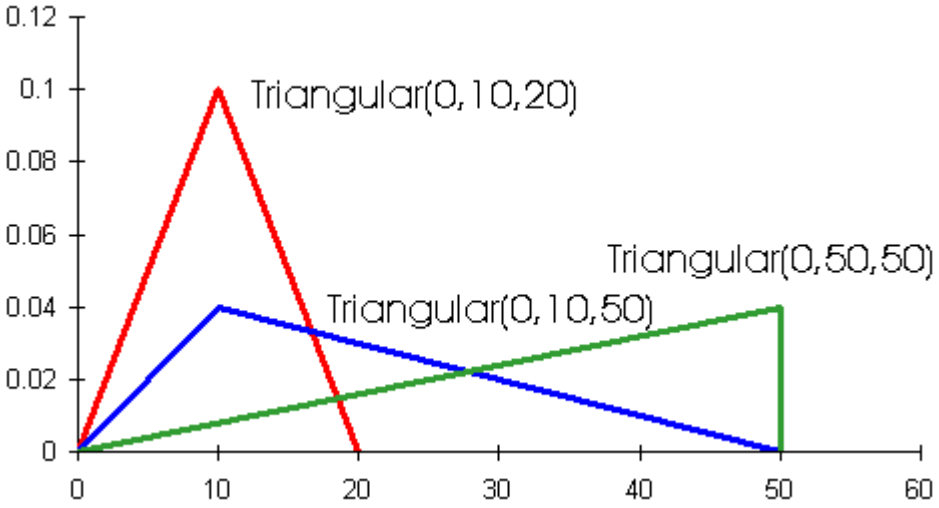


Beta



Normal

Distributions - Skewness



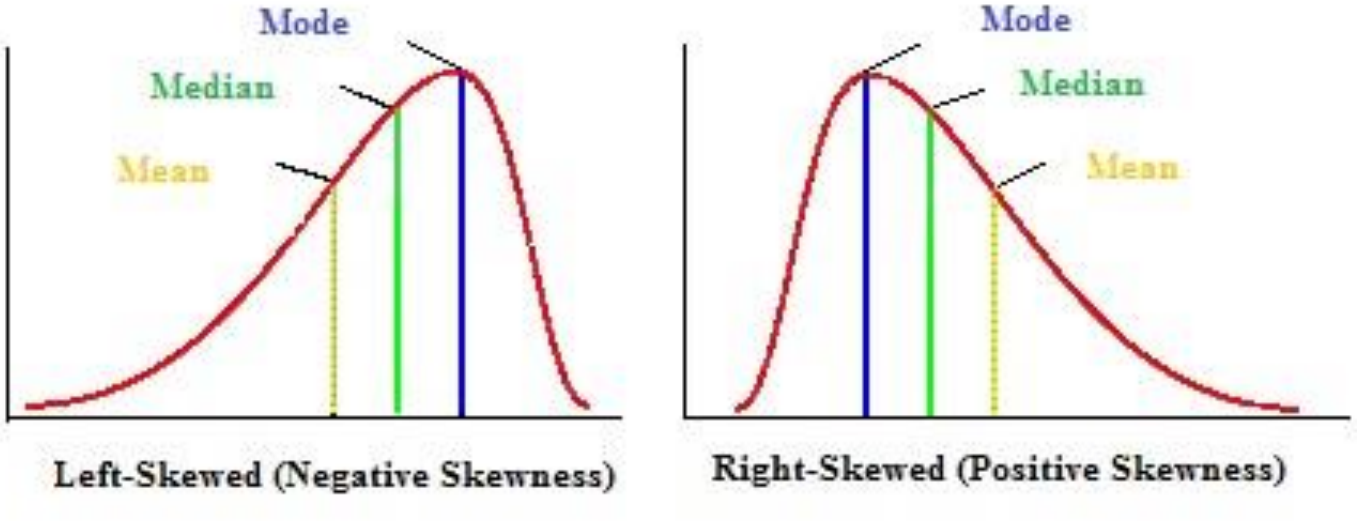
Same Distribution Shape

<u>+ Different Inputs</u>

Very Different Meaning

Very important to understand where unadjusted calculation falls on distribution

Distributions - Terms



- **Mode – Most common number based on distribution**
- **Median – Middle number based on distribution**
- **Mean – Average number based on distribution**

Correlation

- **What is Correlation?**
  - **Is the measure of how much two variables move together within their uncertainty ranges, if one increases the other increases if one decreases the other decreases or in the case of negative correlation one increases the other decreases**
    - **Functional Correlation – resulting from same variable being used in multiple equations this type of correlation is inherited from the uncertainty on the variables**
    - **Applied Correlation – is the intentional adjustment of the correlation by the analyst between two or more separate variables or elements with uncertainty**

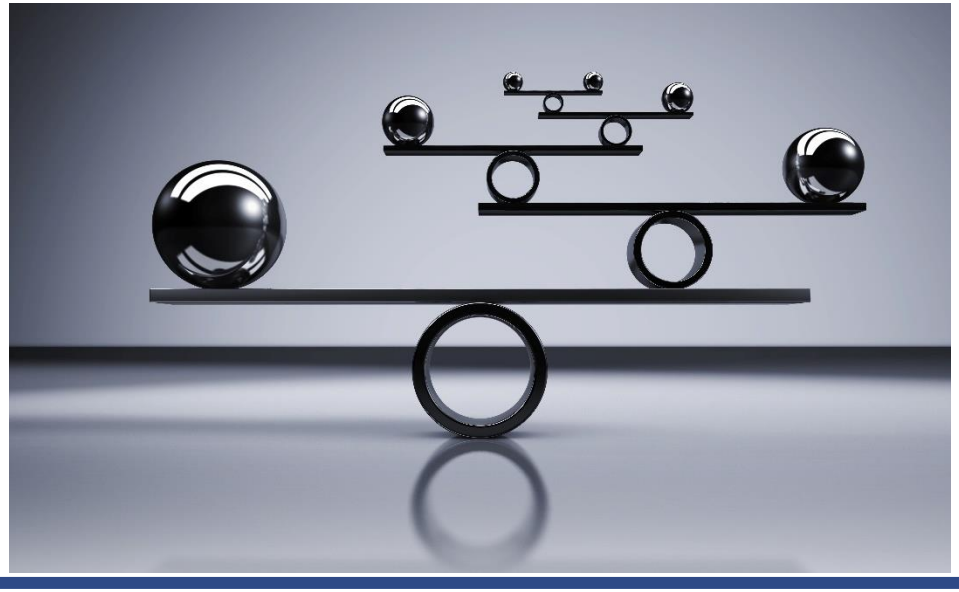
In the absence of better information 0.3 is the recommended default correlation

Strength	Positive	Negative
None	0.0	0.0
Weak	0.3	-0.3
Medium	0.5	-0.5
Strong	0.9	-0.9
Perfect	1.0	-1.0

Correlation is independent from the assigned uncertainty distribution or skew

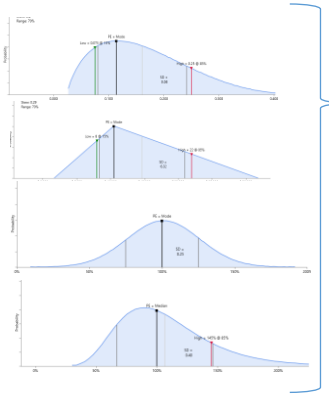
Side Note

- **How to know what correlation to use**
  - **Estimate is for a program, so all the uncertainty is somewhat related hence the recommended minimum of 0.3**
  - **Are there elements that at related?**
    - **Labor Rates, Durations, elements being performed by same contractor or regarding same subsystem/component**
  - **Do you have historical data?**
    - **The R Squared is the square of the correlation**



The Simulation

- **I highly recommend using a tool specifically designed to run a risk and uncertainty simulation but, in a pinch, it is possible to run a simple simulation in Excel**

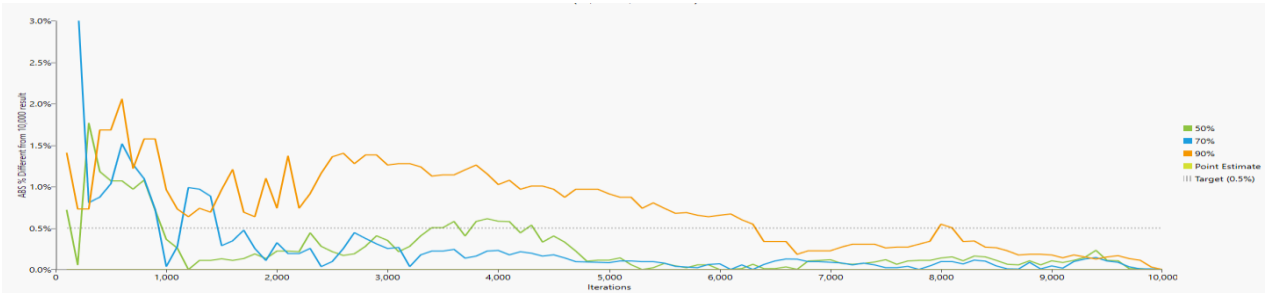


Risk and Uncertainty inputs create functions that define the curve or lines that define the risk area for any given variable some shapes result in more complicated functions

The simulation runs the functions thru numerous random calculations using random probabilities or confidence levels for each function for each calculation or iteration

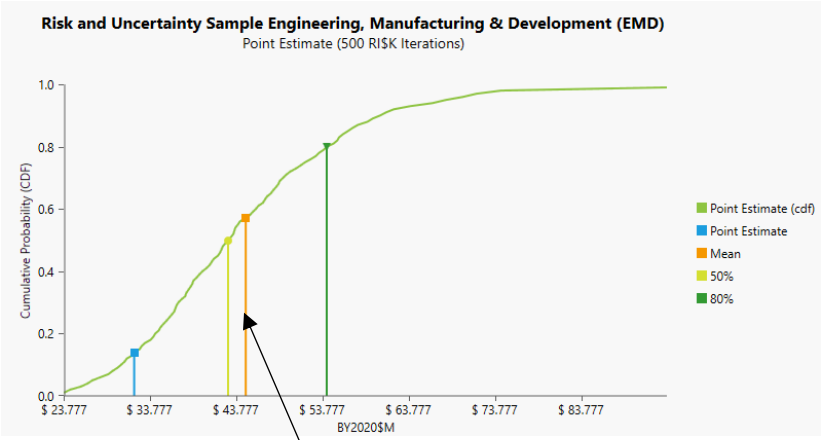
Functions with applied correlation, have some level of adjustment on the random probability in the calculation

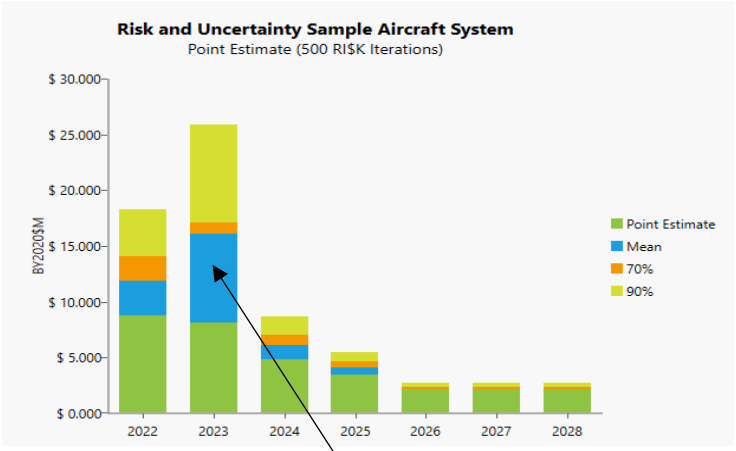
Iterations increase and the numbers stabilize



The Results

- **While the graphics might be different depending on the tool you use there are some key things that should always be available**

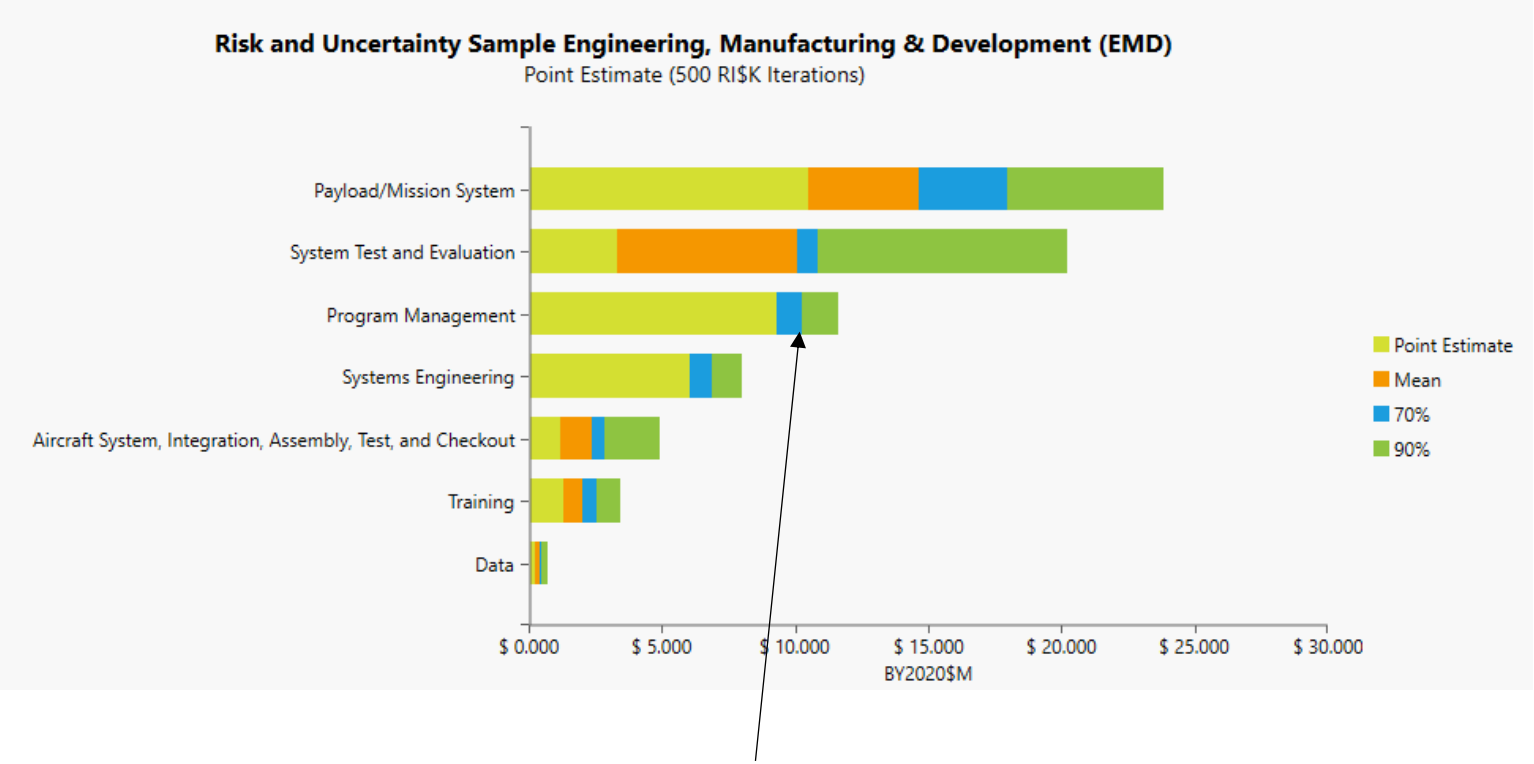




Probability Adjusted Estimate for program budgeting and baseline planning

Allocating Risk dollars over time depending on program needs and mitigation strategies (make sure not allocating risk to Sunk Years)

The Results (cont)



Uncertainty Contributions by Element for Program Awareness, Execution and Decision Support

Conclusion

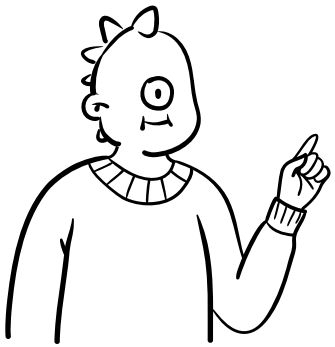
Accounting for Uncertainty can be the difference between program success and failure

I am getting wildly different estimates for how much the software will cost

Based on my experience, I say take the highest estimate and multiply it by 3.

Is experience exactly the same as Pessimism?

Experience is much worse.



Questions?