Applied Probability and Simulation to Understand Risk in Operation Eagle Claw

A Case study in the Flaw of Average-Based Decision Making

Overview

Situation: Iran, November 1979, the American Embassy was over run by Iranian revolutionaries who took 52 Americans hostage. In April 1980 U.S. forces attempted a rescue codenamed OPERATION EAGLE. It ended in failure at Desert One due to helicopter failure.

Decision: How many helicopters to take on the mission knowing six were required to lift the rescue team and the hostages?

Objective: Take a sufficient number of helicopters to keep the risk of mission failure due to helicopter failure under given limit (e.g. 5%).

OA Contribution: None in the planning and execution of the operation. OA was engaged in the post mission analysis to investigate on risk assessment.

Situation: Risk Assessment in Operation EAGLE CLAW

- Issue 11 of the "Holloway Report" (Operation Eagle Claw's Planning Evaluation)
  - RH-53D SEA STALLION Force Size or Risk versus Resources. How many is enough? 6? 8? Or 12?
- Calculation based on Expected Value
  - Historically reliability of each RH-53D SEA STALLION is 75%
  - Based on expected value 8 helicopter are needed (8 * 0.75 = 6)

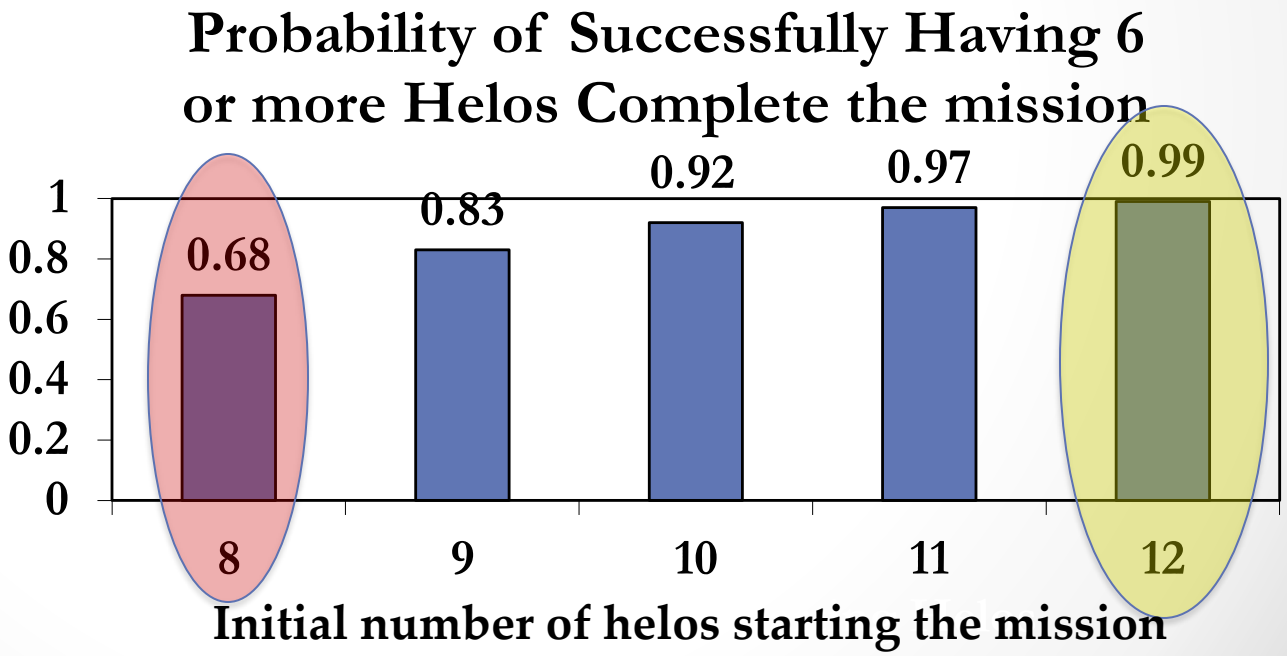
Problem:

Expected value decision making

OA Distribution: Application of Applied Probability

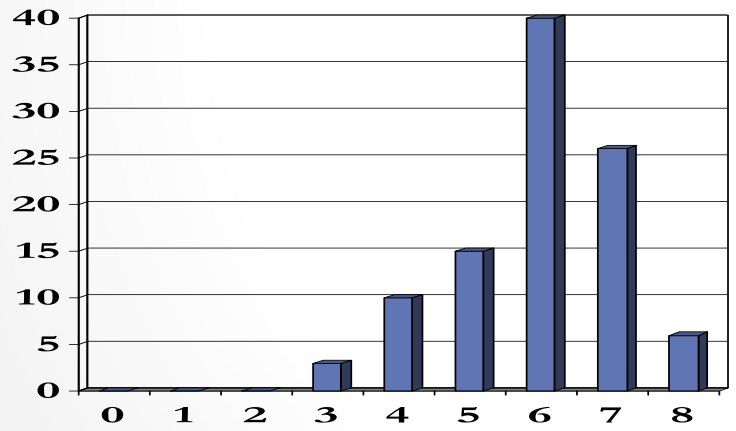
- Assuming that the reliability of each helicopter is independent of each other applied probability gives a calculation for the overall mission success

To limit the risk of failure **under 1%** due to heli-copter failure **12 helicopter** are necessary

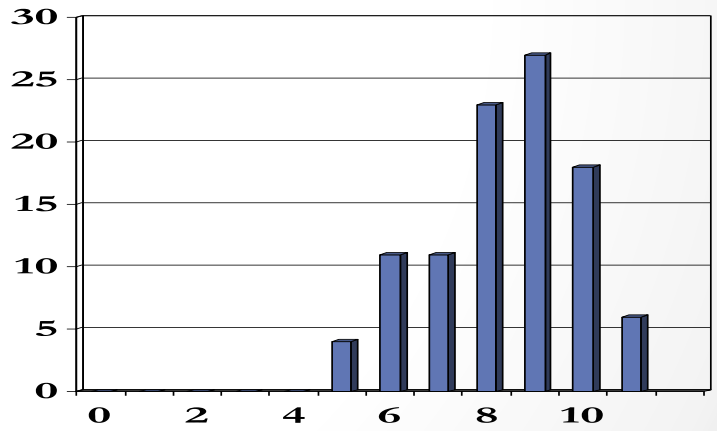


OA Distribution: Simulation Results (Monte Carlo)

- The Monte Carlo simulation of the helos as independent events gives even a little bit more pessimistic probabilities for success but are in the same range as the applied probabilities



100 Simulations with 8 Helos: 72/100 Missions Successful



100 Simulations with 11 Helos: 94/100 Missions Successful

What is Proper Risk Assessment?

- Risk Assessment is the identification, evaluation, and estimation of the levels of risks involved in a situation.
- Risk can include unknown knowledge about the situation, unknown knowledge about the development of the course of action or unknown knowledge about the processes driving the situation.
- Historical data analysis, probability theory and simulation are frequently used to quantify risk and bound uncertainity.

Strengths and Weaknesses Risk Assessment

- Provides insight into marginal benefit of resources to lessen risk.
- The better the historical date base and/or estimates, the better the assessment value.
- In many cases, assumes environment in the immediate future will be the same as the immediate past for data consistency.

Summary

- Risk analysis is driven by you, the decision maker. You define what is an acceptable risk.
- To best utilize your operational analyst to aid in decision making, they need access to you, the decision maker to know about your preferences and to be involved as well in the planning process as during execution.
- The operational analyst brings a variety of tools (optimization, simulation, statistics, and assessment skills) to help you with evidence based decision making.

More Detail Follows

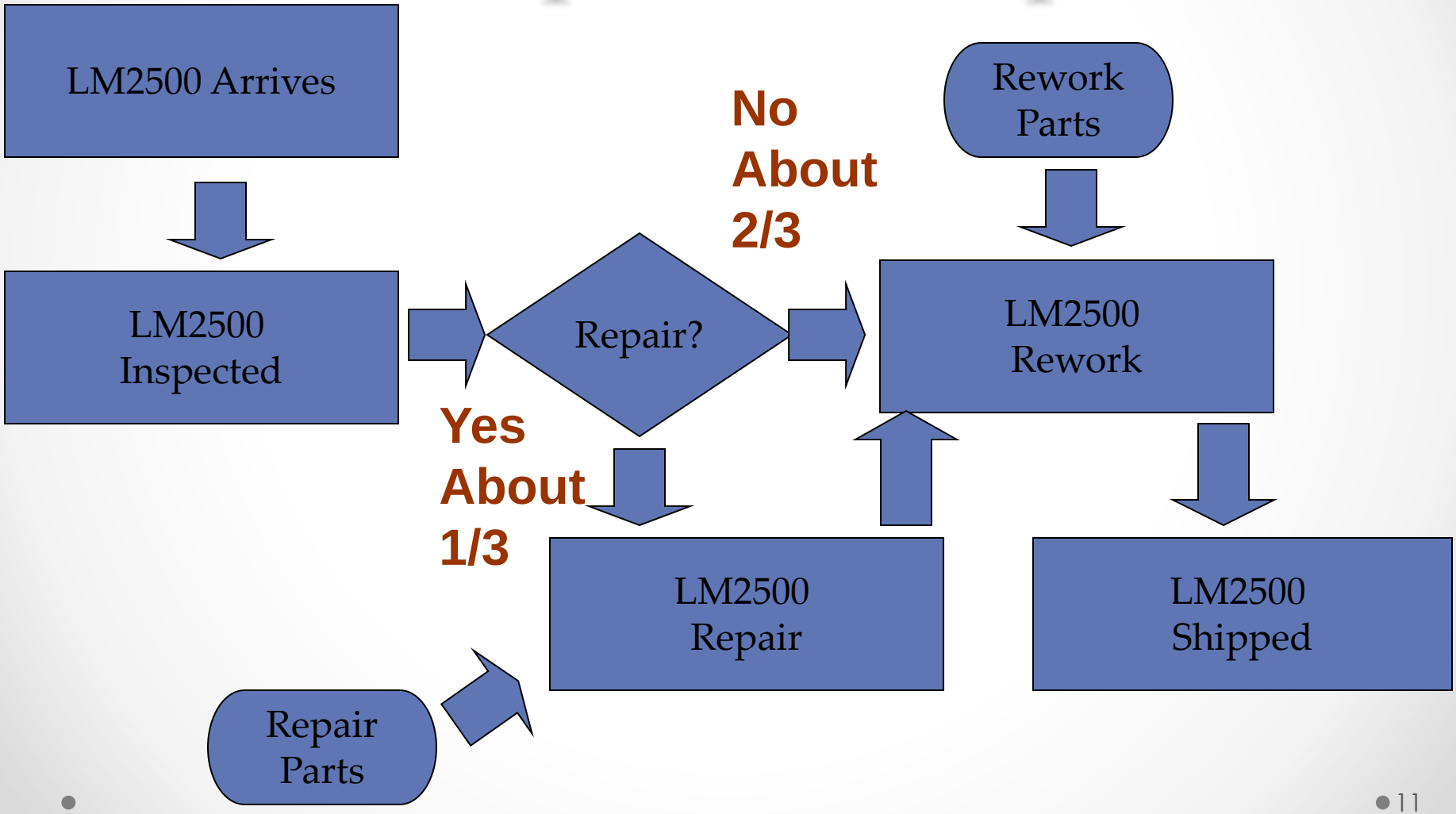
Quantifying Risk by exploring variability

Let's look at a simplified budgeting example

We want to determine the risk of costs over runs in a gas turbine rework facility

Consider: What are sources of highest variability during the budget execution?

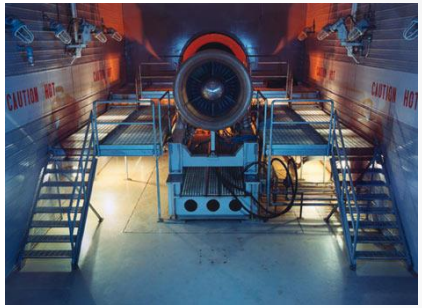
Gas Turbine Rework Depot Example



Quantifying Risk by exploring variability

Possible costs (or outlay) categories:

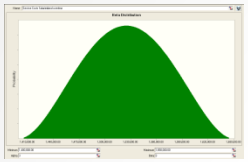
- Salaries in each workshop
- Supplies
- Utilities
- Contract Services
- Fixed Costs



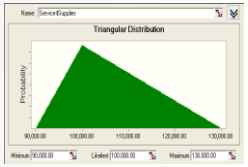
Each category highly correlated with engine needing repair in addition rework.

Which might have the greatest variability?

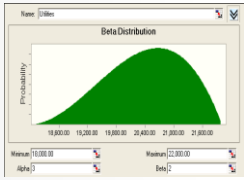
We can build a simulation of our quarterly costs with 30 engines



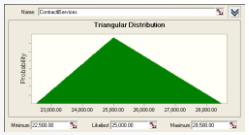
Labor Costs



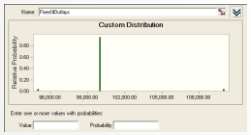
Supplies



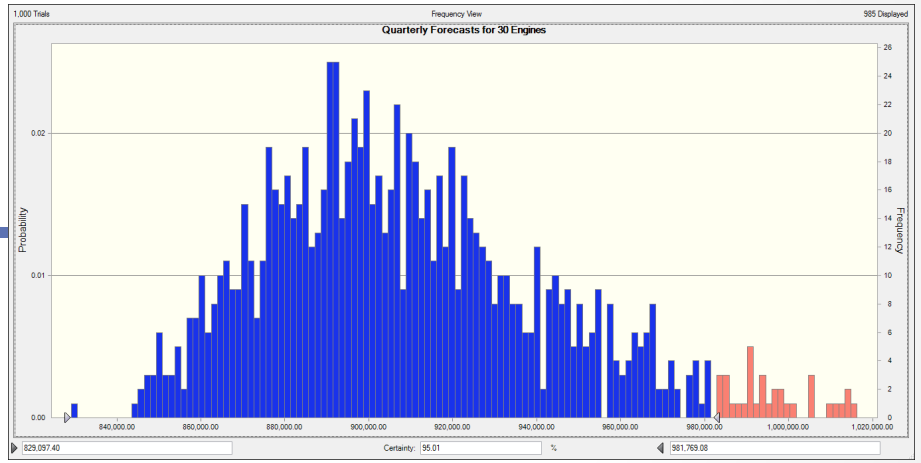
Utilities



Contracts

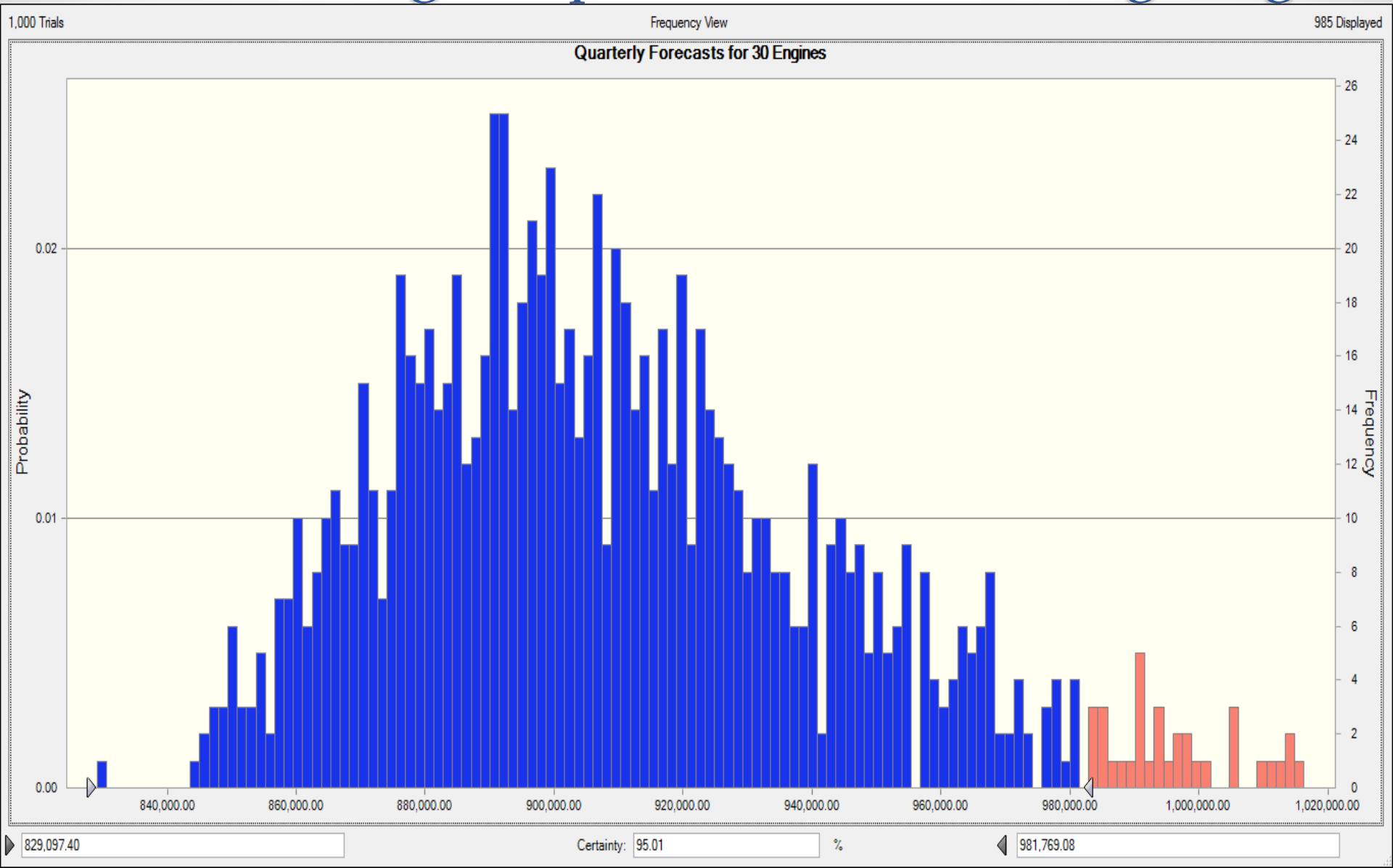


Fixed Costs

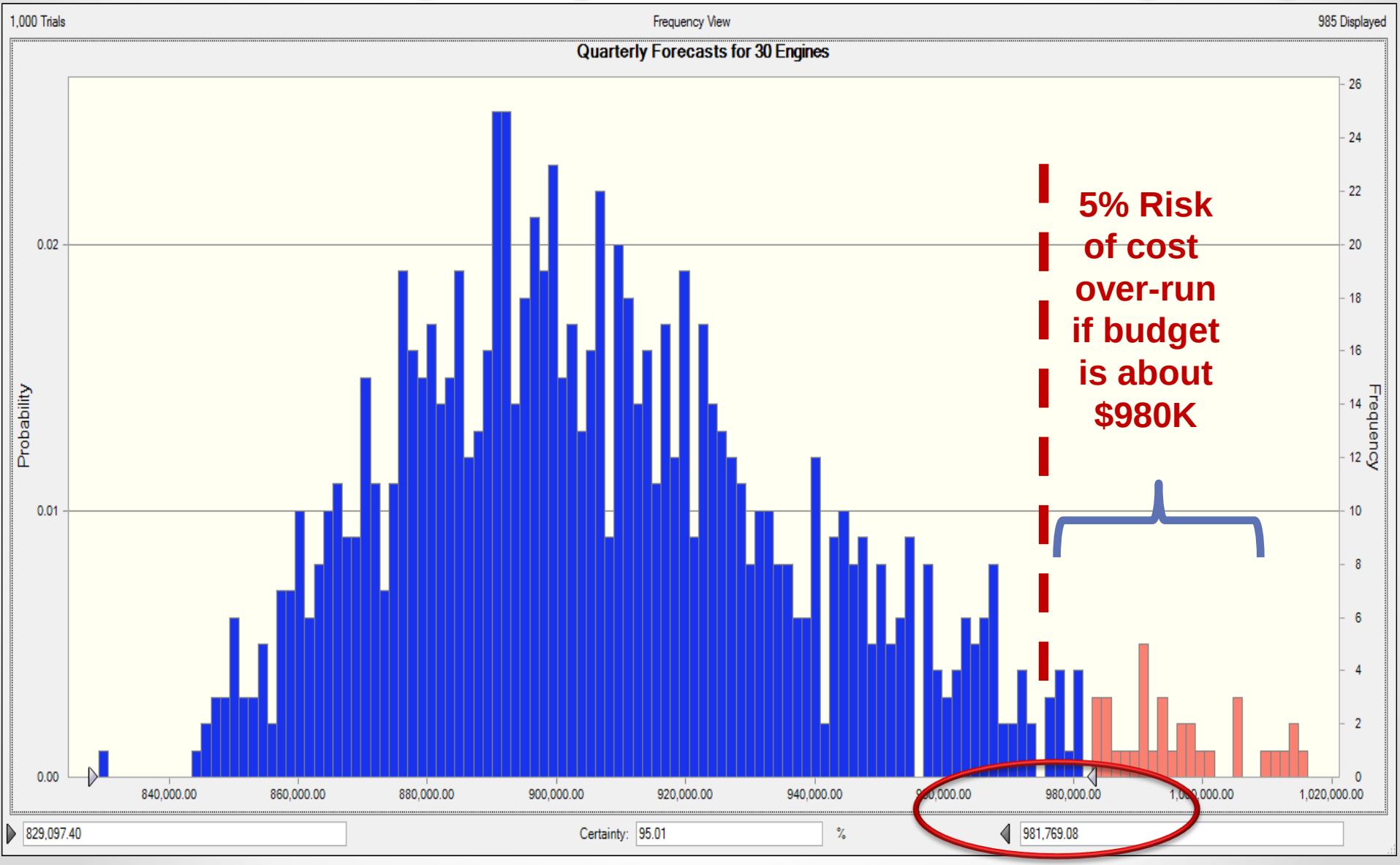


Simulation Histogram Of Quarterly Costs

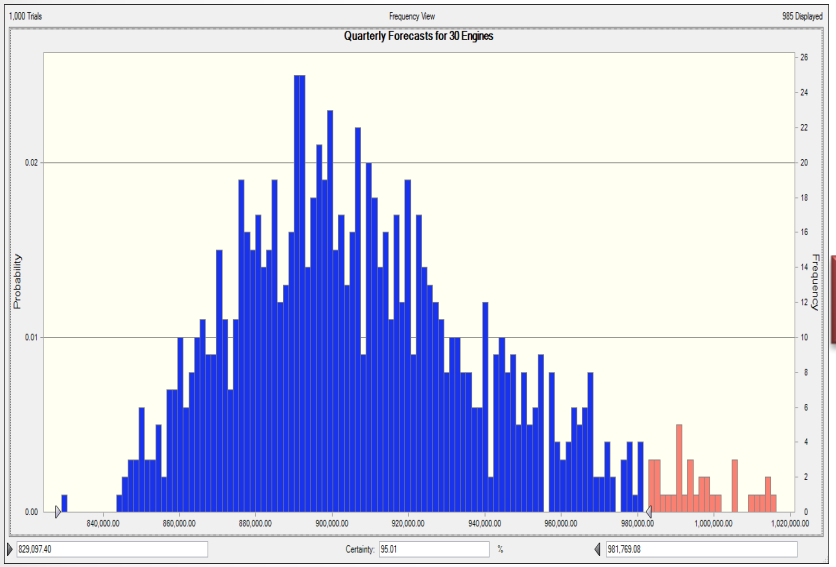
Histogram provides risk in budgeting

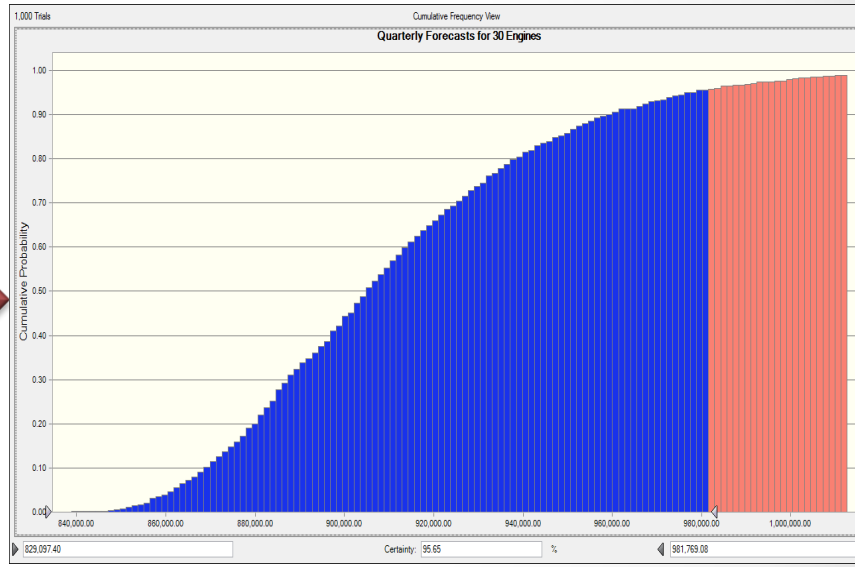


Histogram provides risk in budgeting



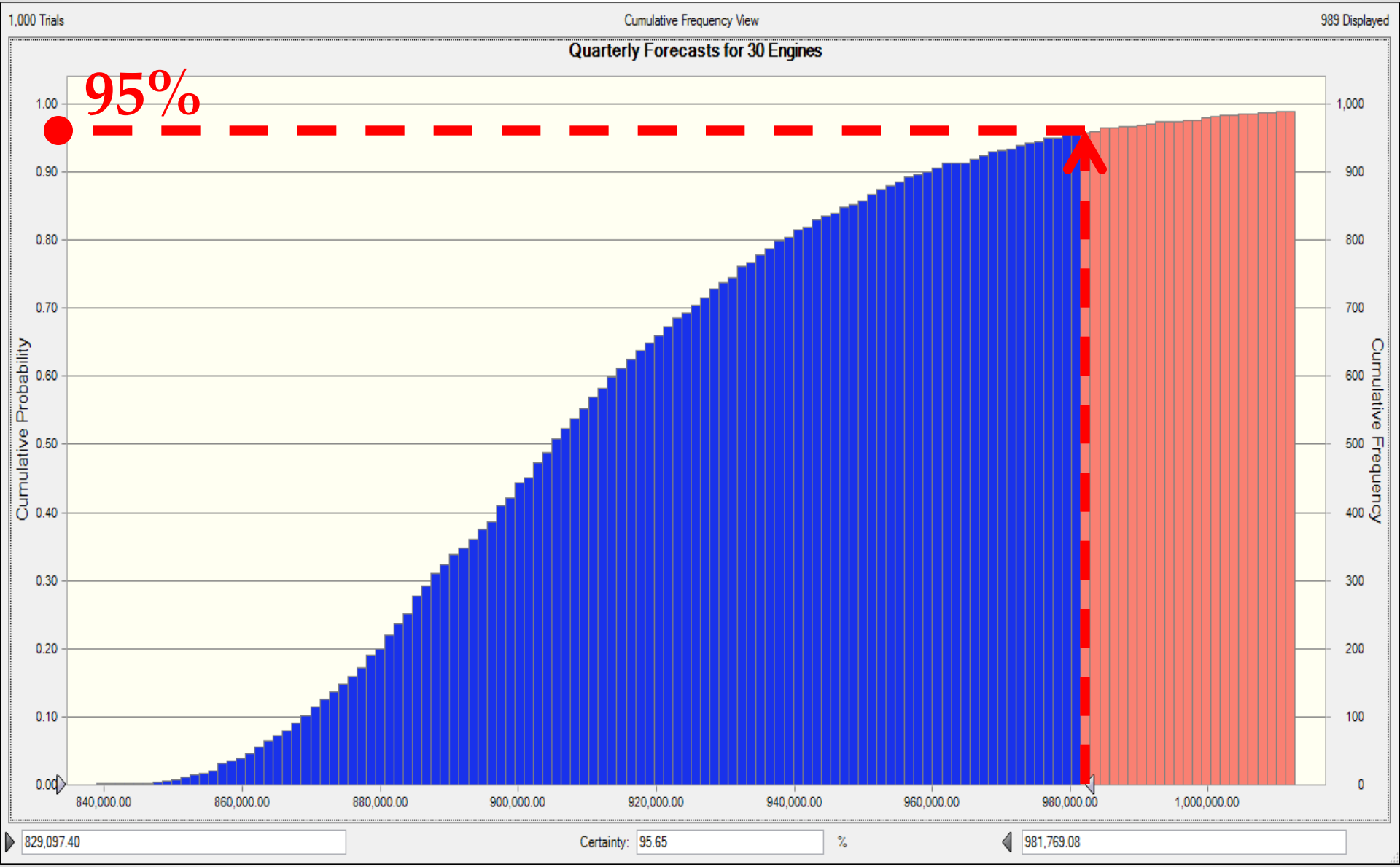
Risk "S" Curve is Cumulative Histogram



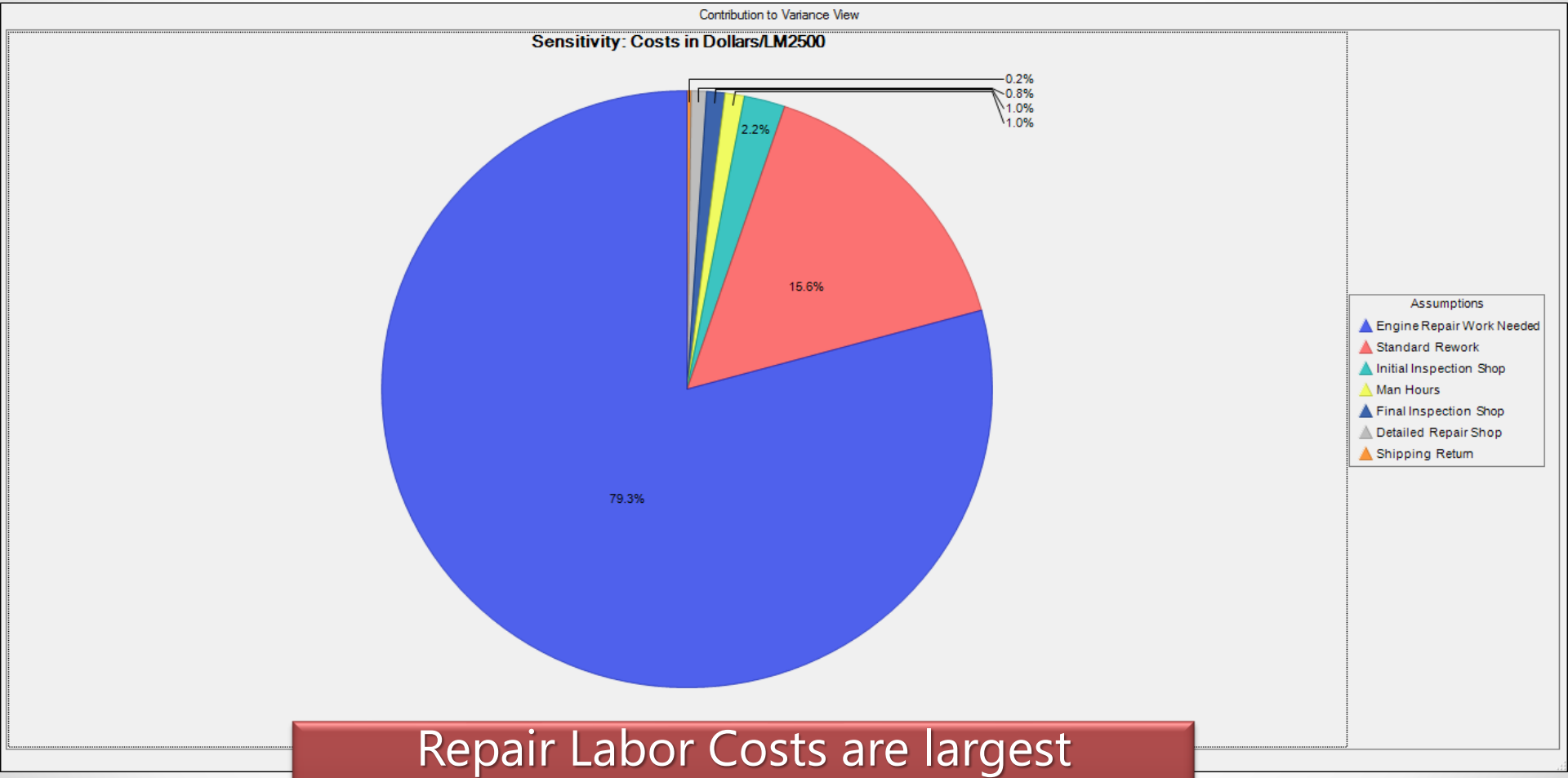


Adding frequency from Histogram on top of each other

The Budget Risk "S" Curve



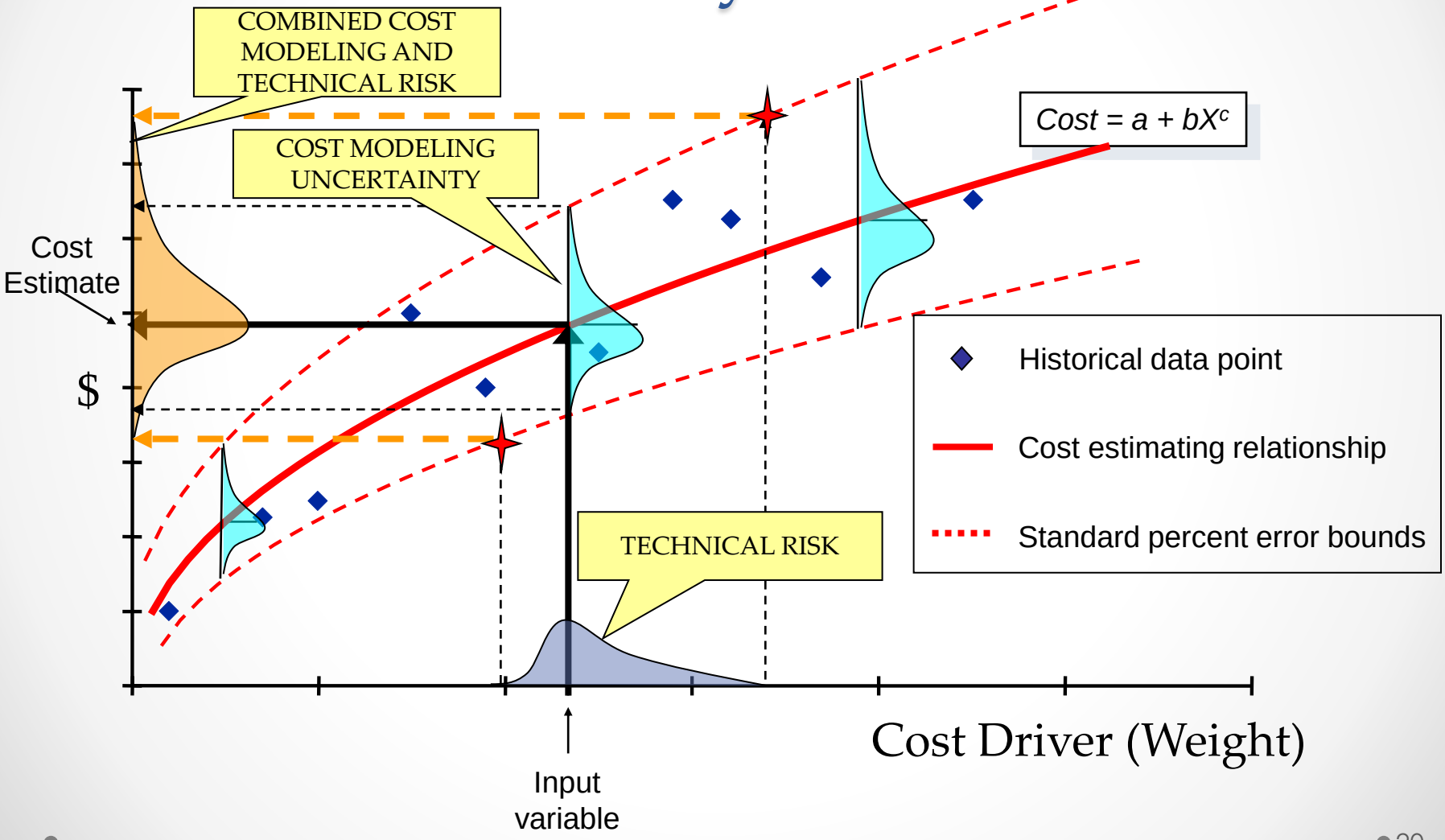
Contributions to variance (risk)



Repair Labor Costs are largest contributor to variance followed by Standard Rework Labor Costs

Contributions to variance (risk) "Tornado Chart"

Risk Assessment on Costs: A Cost Probability Distribution



Black Swans and Surprise

- What are Black Swans?
- Can we prepare for the unknown?
- Can we anticipate surprise?

- ❖Resilience
- ❖Flexible
- ❖Agile
- ❖Innovative

Conclusions

- Risk is a component of uncertainty and variability
- CAREFUL: Average Based Decision Making!

Recommended Reading