

# A Parametric Approach to Project Cost Risk Analysis

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# Preface



- Risk arises when the assignment of the probability of an event is statistically possible
- Uncertainty arises when the probability is indeterminate and must be assigned
- Risk is insurable; uncertainty is not
- Good project management understands the difference and acts to reduce uncertainty, or convert it to risk.

# The challenge



- Most “risk” analysis in aerospace today is actually uncertainty analysis
- The proper goal of our risk analysis should be to make aerospace outcomes certain, or at least insurable

## Current fashions in project cost risk analysis

- Qualitative models, typified by...
  - Qualitative descriptions of risk factors
  - Red, yellow, green color codes, or...
  - Simple graphical displays
- Quantitative models, typified by...
  - Assignment of arbitrary probability distribution functions to elements of the work
  - Use of Monte Carlo simulation to arrive at a total project probability distribution

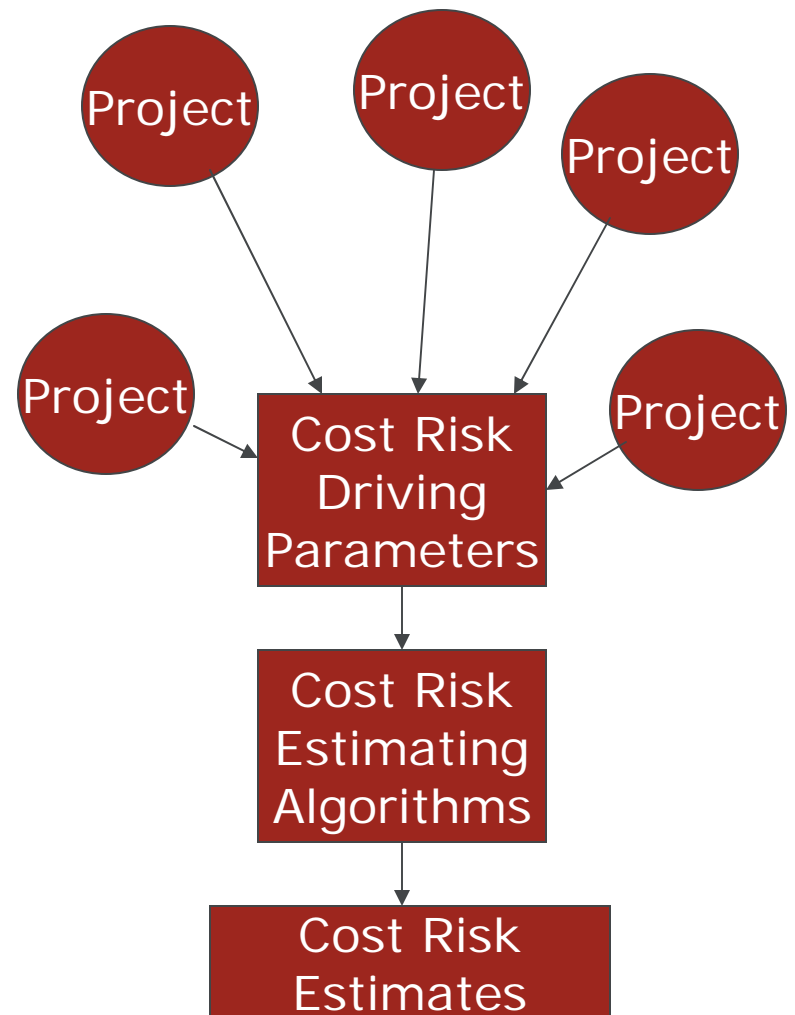
Note that neither of these is a parametric approach!!

## If you wanted to do cost risk analysis parametrically...

...how would you do it?

Essence of the parametric approach...

- Use historical data from similar projects
- Establish parameters and develop algorithms that can be used to predict the cost risk of a future project

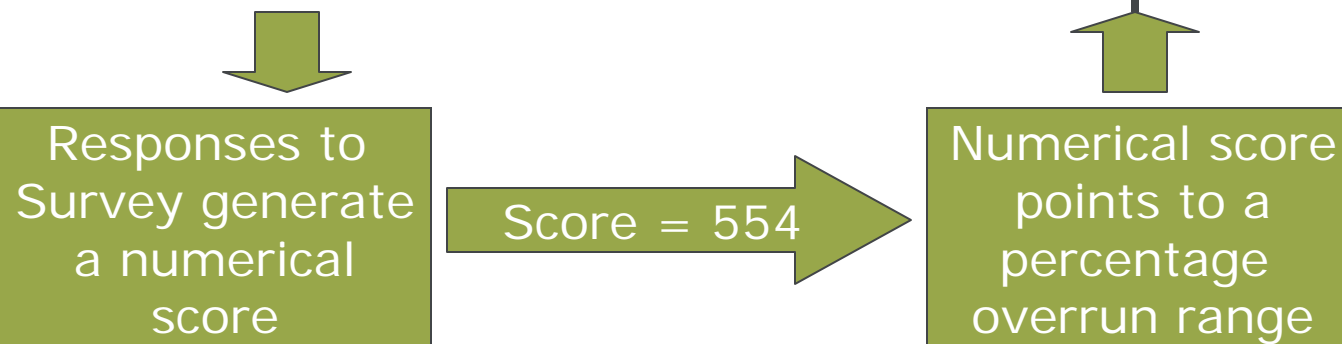
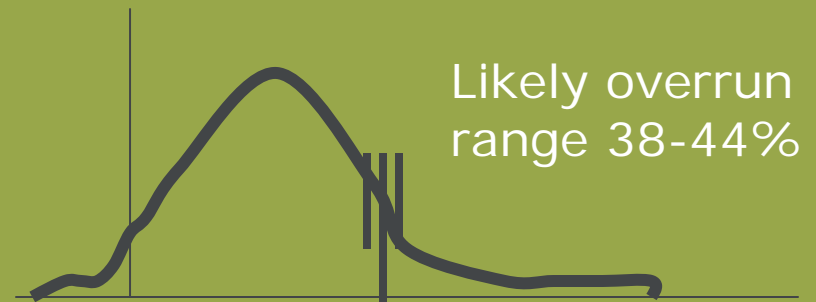


# A way to do it!

A Project Validation Survey that establishes project readiness

- WBS
- Estimation
- Contingencies
- Management
- Personnel
- etc.

Historical percent cost overrun histogram from similar projects



# About the survey



- The survey is based on findings of the GAO and others who have studied the reasons for cost overruns
- Survey questions are numerically weighted for relevancy to overruns
- Has general questions suited to many types of projects (approx. 75 to 150 questions)
- Users can add technology specific questions and lessons learned questions
- The survey numerical “readiness” score is computed from the answers given by the user

## Typical general questions

(All questions are multiple choice)

- What is the contractual arrangement with the lead project performer?
- Is there a WBS dictionary?
- Have all costs been estimated?
- Is the cost estimate independent of the funding source appropriation?
- Was the project team allowed adequate time and resources to develop the estimate?

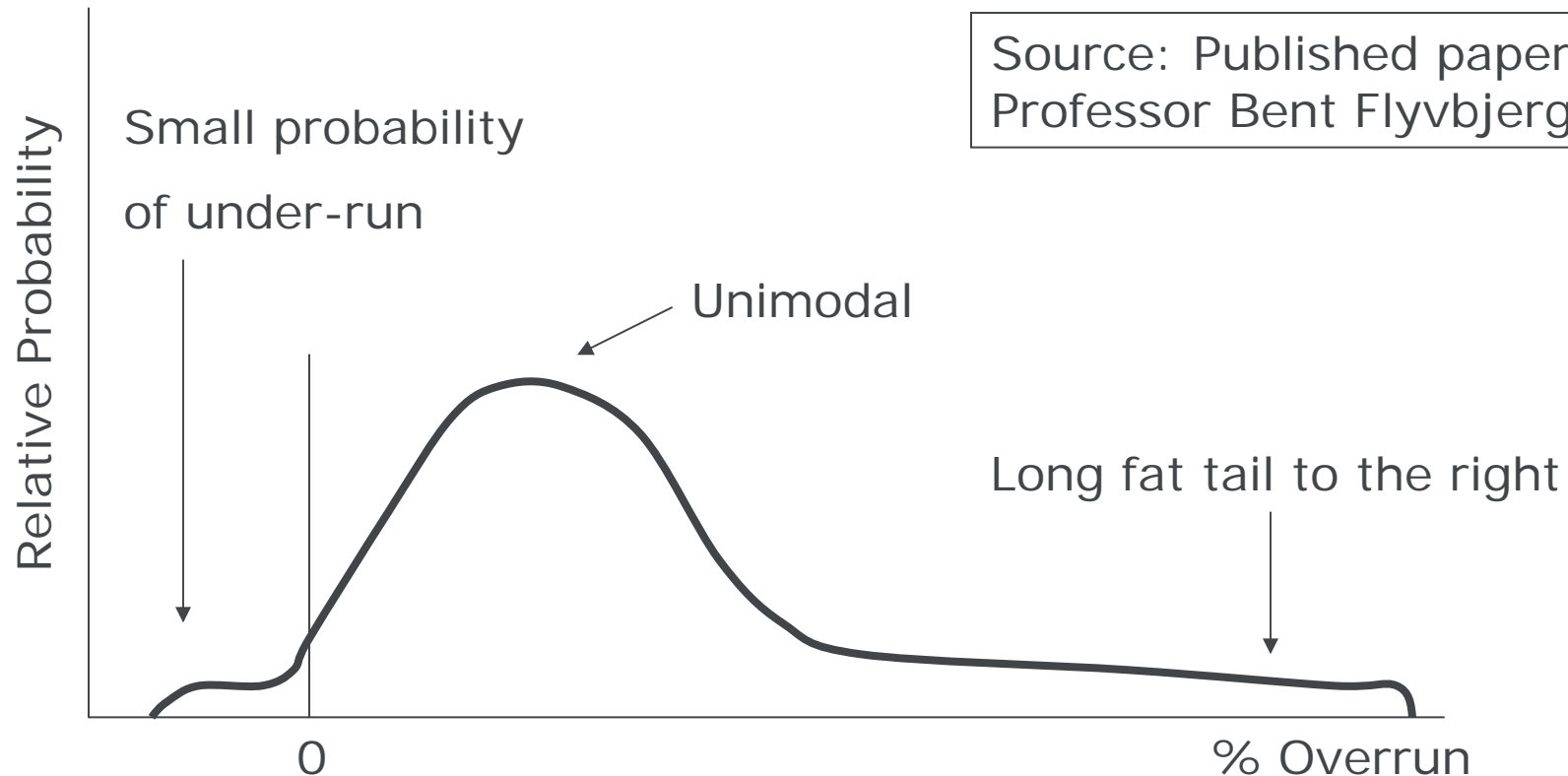
## Typical technology or lessons learned questions

- Are metric units used consistently?
- Is mirror fogging absolutely prevented?
- Measures taken to prevent dropping the finished vehicle in transit?
- All arming switches properly guarded and labeled?
- All drawings through the complete review cycle before release?

## About the histogram

- Initially, industry average for the user's industry, or established by the user if enough experience is available
- Self-modifying as the user enters overrun results from completed projects
- The industry typical initial histogram gradually conforms itself to specific organizational experience

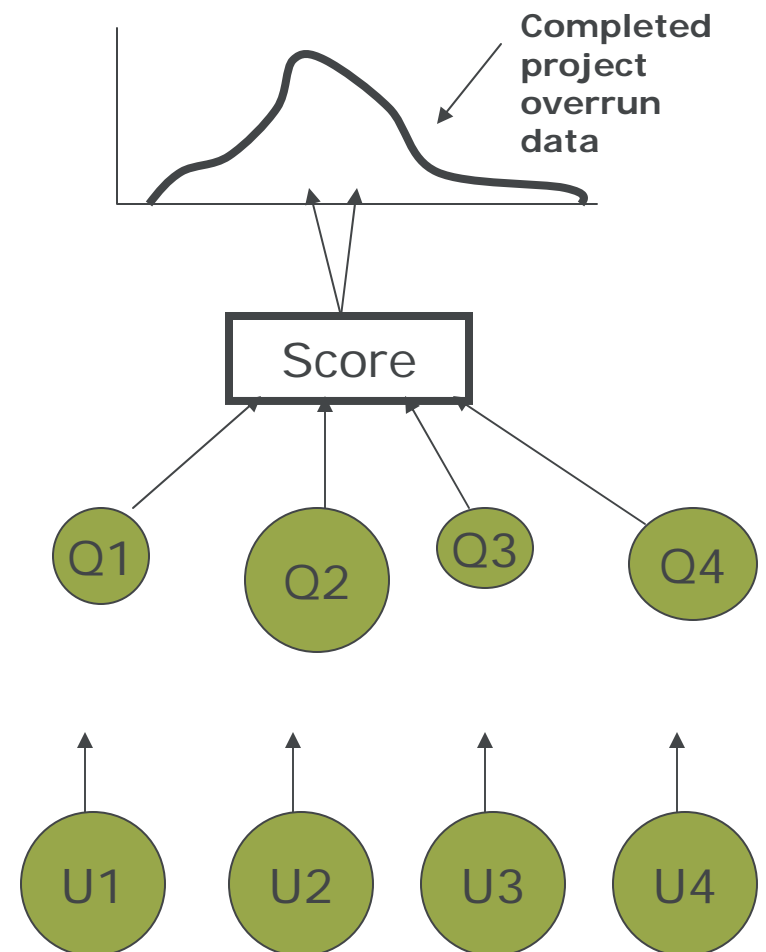
## Typical overrun histogram shape



Overrun distributions generally do not match any of the classic distribution shapes typically used by analysts – they must be treated empirically. Shapes and statistics of central tendency and dispersion vary somewhat from industry to industry but the above shape is typical.

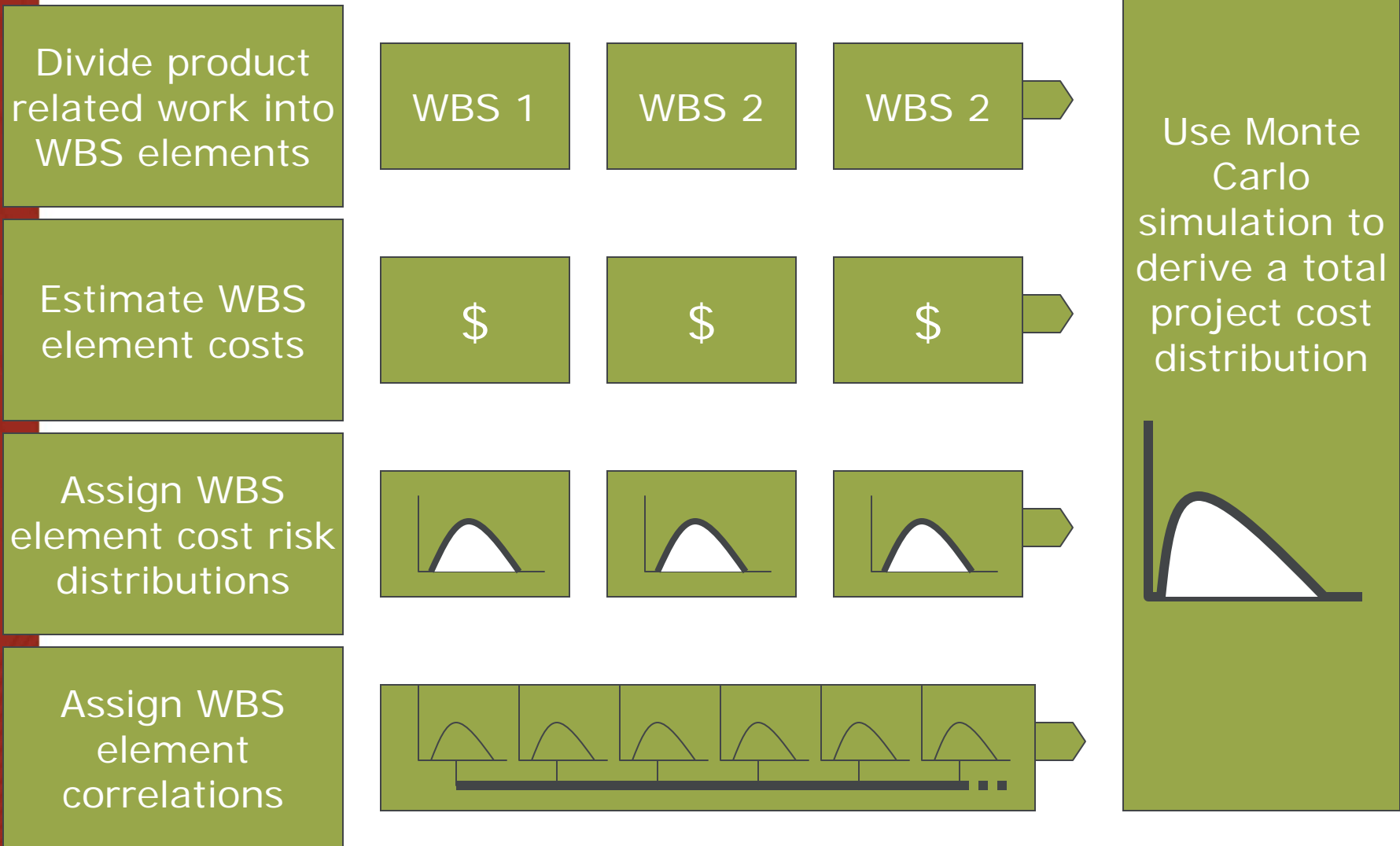
## Model learning features

- Histogram self-modification
- Self-correction of where score points on histogram
- Self-correction of overrun relevance weightings of all survey questions
- Acceptance of user provided additional checklist questions



User can assign relevance weightings to questions

# Dominant quantitative method



## Potential advantages of a parametric approach--1

<b>Feature</b>	<b>Parametric</b>	<b>Monte Carlo</b>
<b>Miss important risks</b>	<b>Less likely</b>	<b>Much more likely</b>
<b>Can do post-project critique</b>	<b>Yes</b>	<b>No</b>
<b>Can learn from experience</b>	<b>Yes</b>	<b>No</b>
<b>Relative cost of use</b>	<b>Faster, cheaper</b>	<b>More expensive, slower</b>
<b>Assign distributions to WBS elements</b>	<b>No</b>	<b>Yes*</b>
<b>Assign WBS correlations</b>	<b>No</b>	<b>Yes*</b>

## Potential advantages of a parametric approach--2

<b>Feature</b>	<b>Parametric</b>	<b>Monte Carlo</b>
<b>Analyze each WBS element for risk</b>	<b>No</b>	<b>Yes*</b>
<b>Use in mid-project</b>	<b>Easier</b>	<b>Harder</b>
<b>Learning to use</b>	<b>Easier</b>	<b>Harder</b>
<b>Point to beneficial mitigation actions</b>	<b>Direct</b>	<b>Less direct or not at all</b>

\* These must be done to satisfy the methodology but serious doubts exist as to whether they can be done with any fidelity.

# Likely model reporting features



- Mostly likely percentage overrun of cost to the nearest 10% for new or ongoing projects
- List of the 20 survey questions that most influenced the reported overruns, in decreasing order of influence
- Current survey questions and current status of relevance weights for all questions
- Suggestions for improving the survey score
- Review of the probabilities of the original histograms and the effects on the histogram of additions of data from historical projects
- Current relationship between survey scores and cost overruns.
- Survey scores and overrun results for all historical projects that have been entered into the model database.
- **Duration risk as well as cost risk**

# Summary



- Here has been presented a truly parametric approach to cost risk analysis that can be adjusted post-project and that can learn from experience
- It has the potential to be superior to Monte Carlo approaches in many ways
- Galorath is currently experimenting with a prototype of this tool

Your  
comments are  
welcome.

See me later or contact me at  
[estump@galorath.com](mailto:estump@galorath.com).

# Backup charts

## Why you can't accurately assign correlations --1

- Human tendency to confuse the everyday and mathematical meanings of "correlation." The everyday meaning is "a relationship exists." The mathematical meaning refers to a very specifically defined type of relationship.
- The need to estimate  $(1/2)N^2 - N$  correlations, where  $N$  = the number of WBS elements. For  $N = 100$ , this number is 4,900.

## Why you can't accurately assign correlations -- 2

- Failure to recognize that correlation is intended to measure the strength of a linear relationship between two random variables. A powerful non-linear relationship can have a correlation near zero, as does a weak linear relationship. Non-linear relationships are quite prevalent, and estimators of correlation will find it all but impossible to distinguish their effects from the effects of linear relationships.
- The fact that some risk drivers will affect only one WBS element, while others can affect several. Correlation thus depends on which ones are most likely to happen. This is very hard to visualize.

## Why you can't accurately assign correlations -- 3

- Labor and material costs can have significantly different correlations. It is all but impossible to account for this effect.
- While underestimating (or ignoring) correlation will result in underestimating risk, overestimating correlation will overestimate risk. If correlation is not accurately estimated, you can't know which you are doing.

## Why you can't accurately assign correlations -- 4

- Correlation between two WBS elements must be strongly related to their product content. If WBS elements are highly aggregated, fewer correlations will need to be estimated, but each estimate will be poorer in quality. If WBS elements are highly disaggregated, the quality of the estimates will be better, but the number of correlations to be estimated will be huge. The tendency will be to make fewer, less accurate estimates.
- The practice, sometimes recommended, of estimating only the strongest correlations, and assigning all of the others a low value (such as 0.2) has little to recommend it.

## Why you can't accurately assign correlations -- 5

- Attempts to estimate correlations amount to replacing serious analysis of root cause risk drivers (which are not correlated) with a mathematical game.
- Attempting to assign probability distributions to WBS elements forces the need to consider correlations. This approach to risk analysis is fundamentally flawed because WBS elements are not risk drivers.

## Problem with assigning cost risk distributions to WBS elements

- Which distribution should be assigned?
- Distributions that have been advocated include:



Triangular

Normal

Lognormal

Beta

Gamma

Trapezoidal

Asymmetric  
normal

They can't all be right!  
(Could they all be wrong?)

## Problems with analyzing each WBS element for cost risk

- WBS elements are NOT risk drivers!!!
- Risk drivers exist outside as well as inside the work breakdown structure
- The WBS generally describes only direct charge work—huge risks can exist within project overhead functions