estimate

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Why Not Do Project Risk Analysis Parametrically?

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The Concern

- Projects have become larger, more complex, or both
  - Recent GAO study of 95 military projects worth $1.6 trillion reported cost overruns of $295 billion, or 40 percent, and an average delay of 21 months

- Project overruns...
  - Result in late, over budget, de-scoped or cancelled projects
  - Often draw funds away from other matters of sometimes greater importance.

- Much attention is being given to risk analysis -- are current methods lacking or not being applied properly?

- What can be done to improve the situation?

Risk versus Uncertainty

- First, a useful distinction – risk vs. uncertainty

- Many make no distinction between these concepts – they are treated as synonymous, but...a useful distinction is sometimes made by academics

  - In risk situations, we assign probabilities based on data; in uncertainty situations, we may be willing to assign probabilities, but there is no data to back them up – they are purely or mostly subjective

- If the weather guys say that the probability of rain tomorrow is 50%, that's a risk—we have historical data (and also scientific analyses) about rain which make it reasonable to estimate the probability

- If we say that the probability of success in harnessing nuclear fusion for routine energy production within the next ten years is 50%, that's just a guess about uncertainty -- data is non-existent!

Current Fashions in Project "Risk" Analysis

- Qualitative models, typified by... ← Typically used on smaller projects

  - Qualitative descriptions of risk factors

  - Red, yellow, green color codes, or...
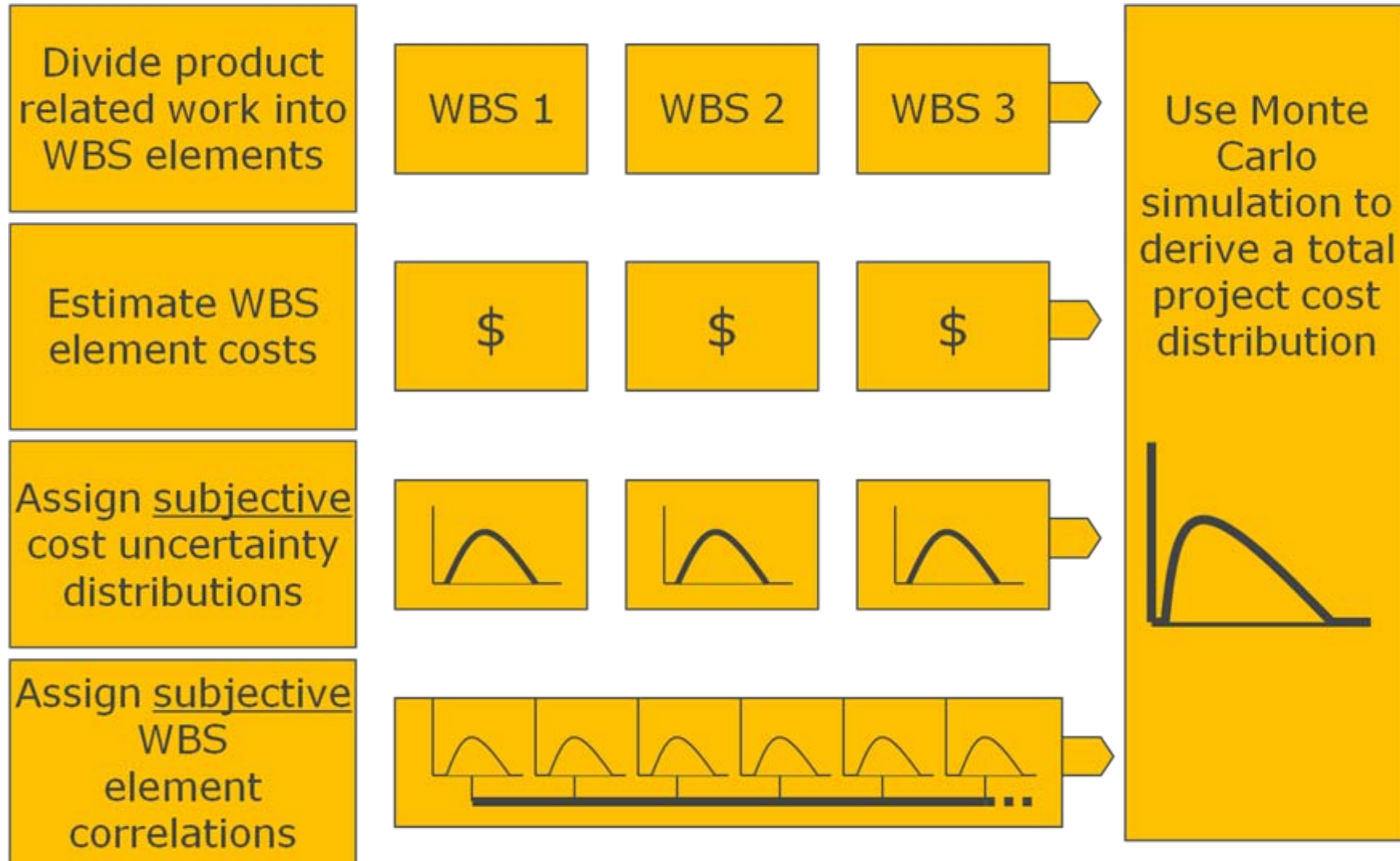
  - Simple graphical displays

- Quantitative models, typified by... ← Typically used on larger projects

  - Assignment of subjective probability distributions to elements of the work

  - Use of Monte Carlo simulation to arrive at a total project probability distribution

> Note that these both deal with uncertainty, not risk, and neither is a parametric approach (neither is data driven)

# Currently Dominant Quantitative Method – Much Recommended

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Divide product related work into WBS elements	WBS 1	WBS 2	WBS 3	Use Monte Carlo simulation to derive a total project cost distribution
Estimate WBS element costs	$	$	$	
Assign subjective cost uncertainty distributions				
Assign subjective WBS element correlations				

5

Principal Weaknesses of Dominant Method

- Focus is on WBS (direct charge work) & ignores risks of indirect charge activities and other risk sources

- Interactions of cost & schedule impacts with difficult technology not adequately accounted for

- Assignment of subjective probabilities to WBS elements known to be subject to over 20 forms of cognitive bias (see, e.g., Wikipedia article on cognitive bias)

- Requirement to accurately assign correlations between all WBS elements essentially impossible to meet

- No feedback after the project as to whether risk analysis was accurate or effective

What Is Parametrics?

Parametrics is a method for estimation of the future based on analysis of past events and trends. "Parameters" that appear to have driven what happened in the past are identified, and connected to past experience through mathematical relationships.

Parametrics is what we do at Galorath in our SEER models. It's also what the insurance industry does in estimating costs of future risks.
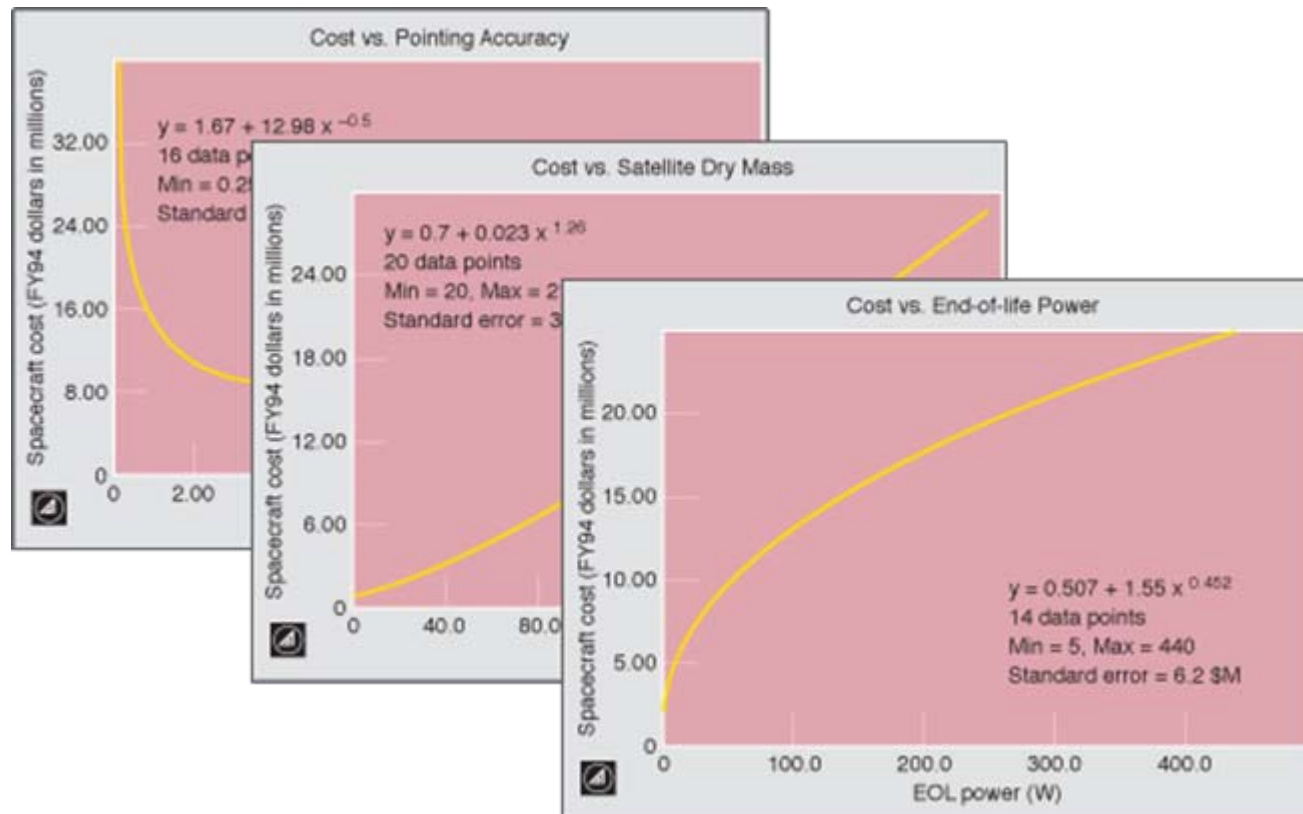
If You Wanted To Do Project Risk Analysis Parametrically…

- …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 or schedule risk of a future project
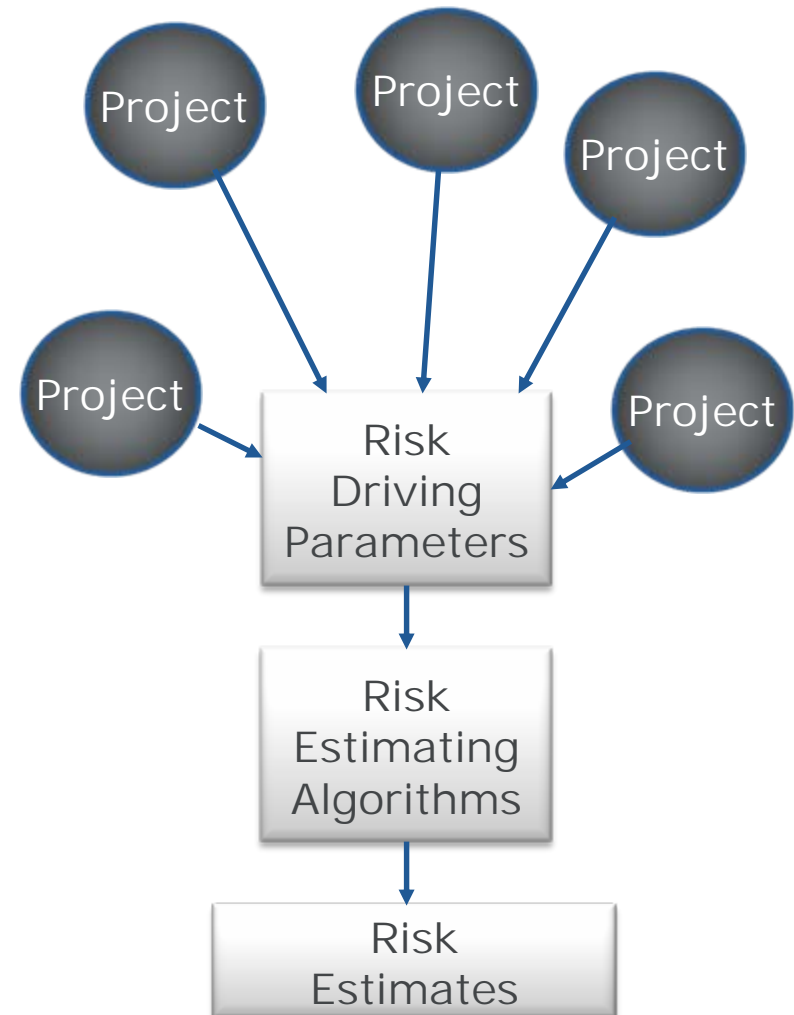
Potential Advantages of a Parametric Approach--1

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

Potential Advantages of a Parametric Approach--2

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

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

Measurable Risks of Interest

- **Money** (project cost) – best proxy for risks of excessive use of physical resources

- **Time** (project duration) – best proxy for risks related to scheduling

- Not directly measurable: "technical" risk, except by its effect on money and time

Difficult but doable – given enough time and money, this puzzle has zero technical risk. Issue: How much time & money is enough?
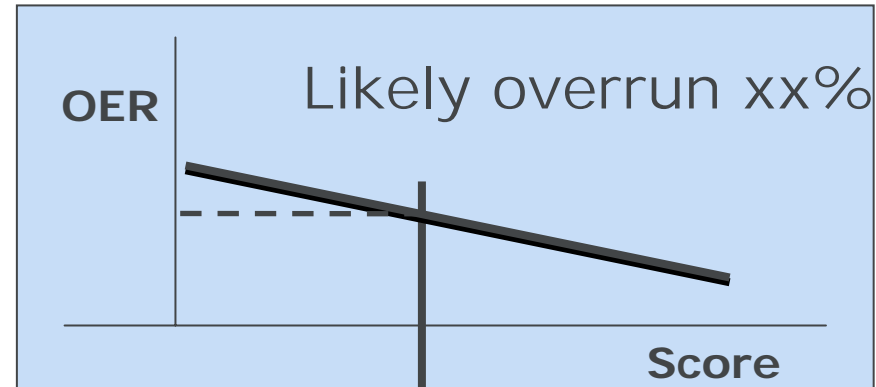
A Way To Do It!

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A Project Validation Survey that establishes project readiness

- WBS
- Estimation
- Contingencies
- Management
- TRL
- etc.

Historical Overrun Estimating Relation from similar projects

OER — Likely overrun xx%

Score

Responses to Survey generate a numerical score

Score = xxx

Numerical score points to an estimated overrun

Our model incorporating this approach has the working name XIPRR (E**X**perience **I**nformed **P**roject **R**isk **R**eduction; pronounced "zipper").

About the Survey

- The survey is based on findings of the GAO, PMI, IEEE, SEI, RAND and others who have studied cost overruns

- Survey questions are numerically weighted for relevance to overruns— weights are initially assigned arbitrarily, but are automatically corrected as project actual results are added to the model

- The survey has general questions suited to many types of projects (approx. 50 questions) plus specialized questions by project type

- Users can add technology specific questions and questions based on lessons learned as experience dictates

- A numerical "validation" score is computed from the answers given by the user

All survey questions are multiple choice

Typical General Questions

- Describe the contractual arrangement with the lead project performer

- Describe the status of the 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?

- Describe the status of low TRL work in the project

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 and approval cycle before release?

- Did we overload the cart?

How the OER is Formed
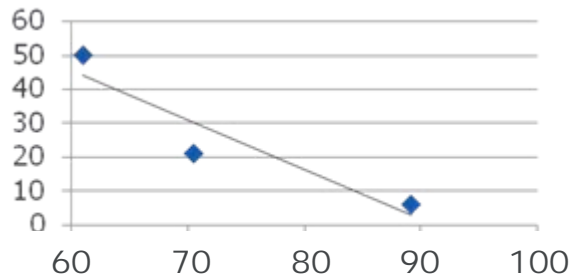
Initially, fitted from three or more historical points from similar projects (project surveys are done retroactively). OER is a decreasing straight line.

OER is calculated using a mathematical process called ordinary least squares regression. As more projects are completed, they can be added to the XIPRR database by the user. The initial fit of the OER line to the data may not be as good as desired.

- The reason is that the initial survey question weights are assigned arbitrarily.

- To optimally correct this a XIPRR process called Dynamic Calibration is invoked. It changes the survey question weights for best fit.
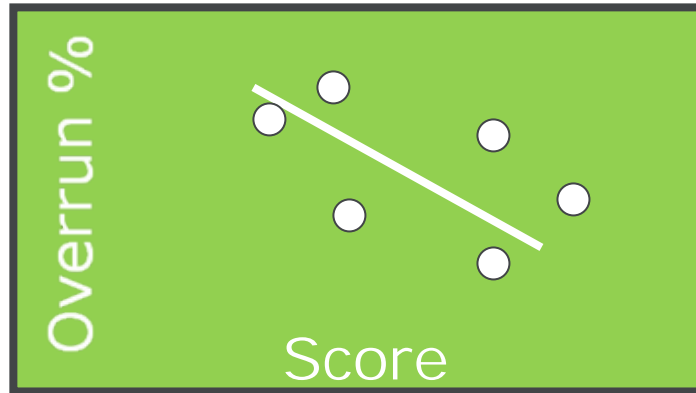
About Dynamic Calibration

- Dynamic Calibration is an automated process that systematically modifies the weights assigned to the survey questions to optimize their fit to the OER.

- The statistic maximized is called the coefficient of determination, more commonly known as R-squared.

- Some survey questions may increase in relative importance; others may decrease – the goal is to find the weights that most closely match the questions to actual overrun experience

- The match is unlikely to ever be perfect because some projects are affected by "unknown unknowns," also called Black Swans, that is, events that are essentially unpredictable (e.g., a severe worldwide credit squeeze)

One form of Dynamic Calibration was initially developed for our SEER-EOS model to make optimum use of limited data.
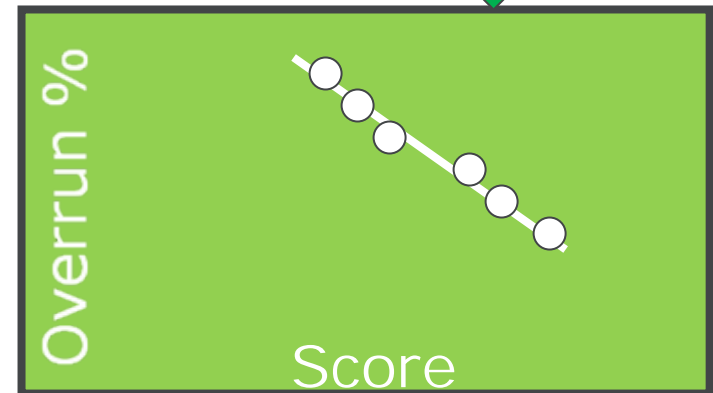
For data free of extreme outliers, it can achieve very high accuracy, often better than 5%.
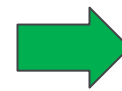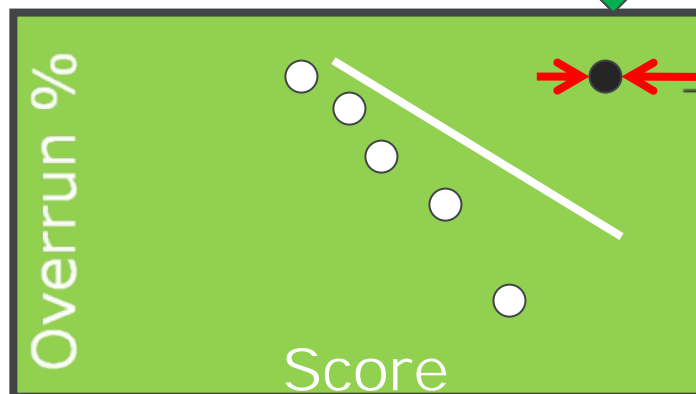
More About Black Swans
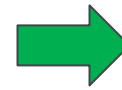
This is a manageable historical database. Dynamic Calibration can adjust the relevance weights to get a result something like this
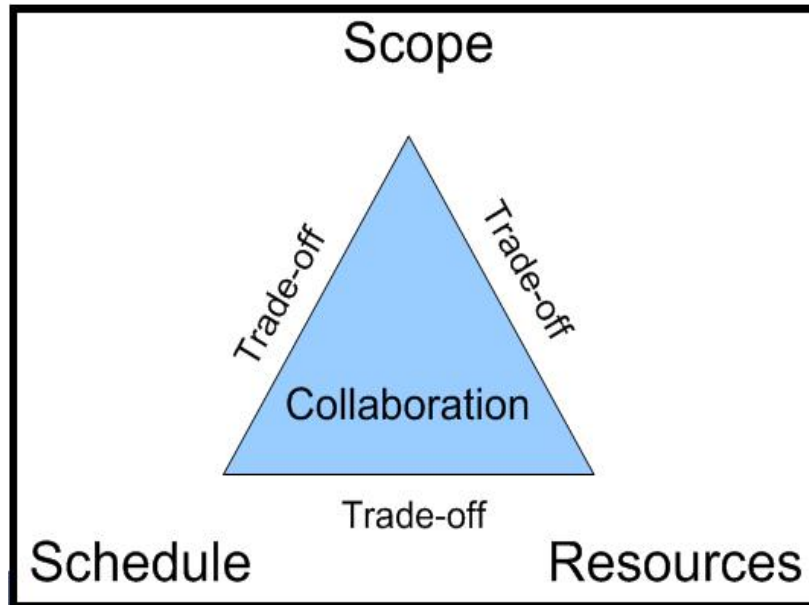
The plot below contains a Black Swan. This outlier will make it impossible to get a good calibration.

XIPRR gives notice of the probable presence of a Black Swan. It can then be removed by the user.

XIPRR in Practice

- XIPRR survey questions are heavily oriented toward what the prime performer (contractor) is doing

- Some questions relate to what the project sponsor is doing (or both sponsor & performer)

Best practice: Sponsor and contractor work the XIPRR survey cooperatively.

Next best practice: Sponsor require that contractor provide answers to survey questions from XIPRR database plus XIPRR records of past performance on completed projects.

Potential Reporting Capabilities

- Mostly likely percentage overrun of cost for new or ongoing projects

- List of the N 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

- Duration risk as well as cost risk

- 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.

XIPRR Today

- As of early 2009, XIPRR is an Excel spreadsheet prototype, suitable for limited demonstrations

- Several planned features are not yet incorporated, including most reports

- The demo survey currently contains (about) 180 questions with multiple choice answers

- Many of the questions are from GAO sources; several are from PMI, IEEE, SEI, RAND, life experiences of Galorath staff, and others

- The prototype math is functional, but no "real life" Dynamic Calibrations have been done

XIPRR Tomorrow?

- Build a formal, professionally programmed standalone model if interest is high enough

- Possibly incorporate some XIPRR-like features into our primary models, SEER for Hardware, SEER for Software, SEER for Manufacturing, SEER for IT

- Build a selection of XIPRR databases for various specialized project risk analysis applications

- Develop versions of XIPRR for use as project independent audit tools
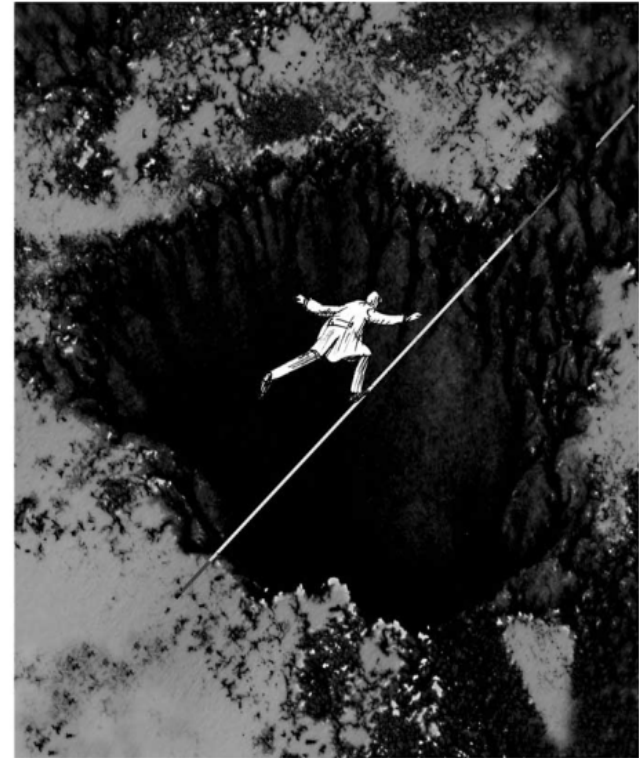
Currently…

- …selected potential XIPRR users are testing a XIPRR prototype by retroactively entering surveys and overrun results from past projects

- Preliminary results from these tests indicate good correlation between survey scores and cost overrun outcomes

Summary

- Here has been presented a parametric approach to cost and duration 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 several ways

- Galorath is currently experimenting with a prototype of this tool called XIPRR.