How to Measure Anything in Project Management

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Author Bios

Dr. Alexander Budzier is a fellow at the Saïd Business School, University of Oxford. He has spent more than a decade at the forefront of research into why projects fail and what it takes to make them succeed. He is the co-founder of Oxford Global Projects and co-author of *Intelligent Change – The Science Behind Digital Transformations.*

Andreas Bang Leed is the head of data science at Oxford Global Projects. He has developed official project estimating guidance in the UK and Brazil, led risk evaluations for Europe's largest infrastructure programs such as high-speed rail and led the development of an AI-based early-warning system to spot high-risk projects in Hong Kong.

Douglas W. Hubbard is the author of earlier books *How to Measure Anything, The Failure of Risk Management* and other books on decision making under uncertainty. He is the founder of Hubbard Decision Research, which applies quantitative methods to major measurement and decision-making problems in business and government.

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How to Measure Anything in Project Management

Hubbard Decision Research with OXFORD GLOBAL PROJECTS

- The book takes an “if matters, it’s measurable” approach.
- In addition to *how* to measure, it covers *why* ,*what* and *when* to measure.
- It uses measurements about the methods themselves using the OGP database of 20,000+ projects, additional original surveys, review of 100+ published empirical studies, standards, and case examples.
- www.howtomeasureanything.com/projectmanagement . The website includes several Excel examples of statistical methods, simulations and AI assistance.

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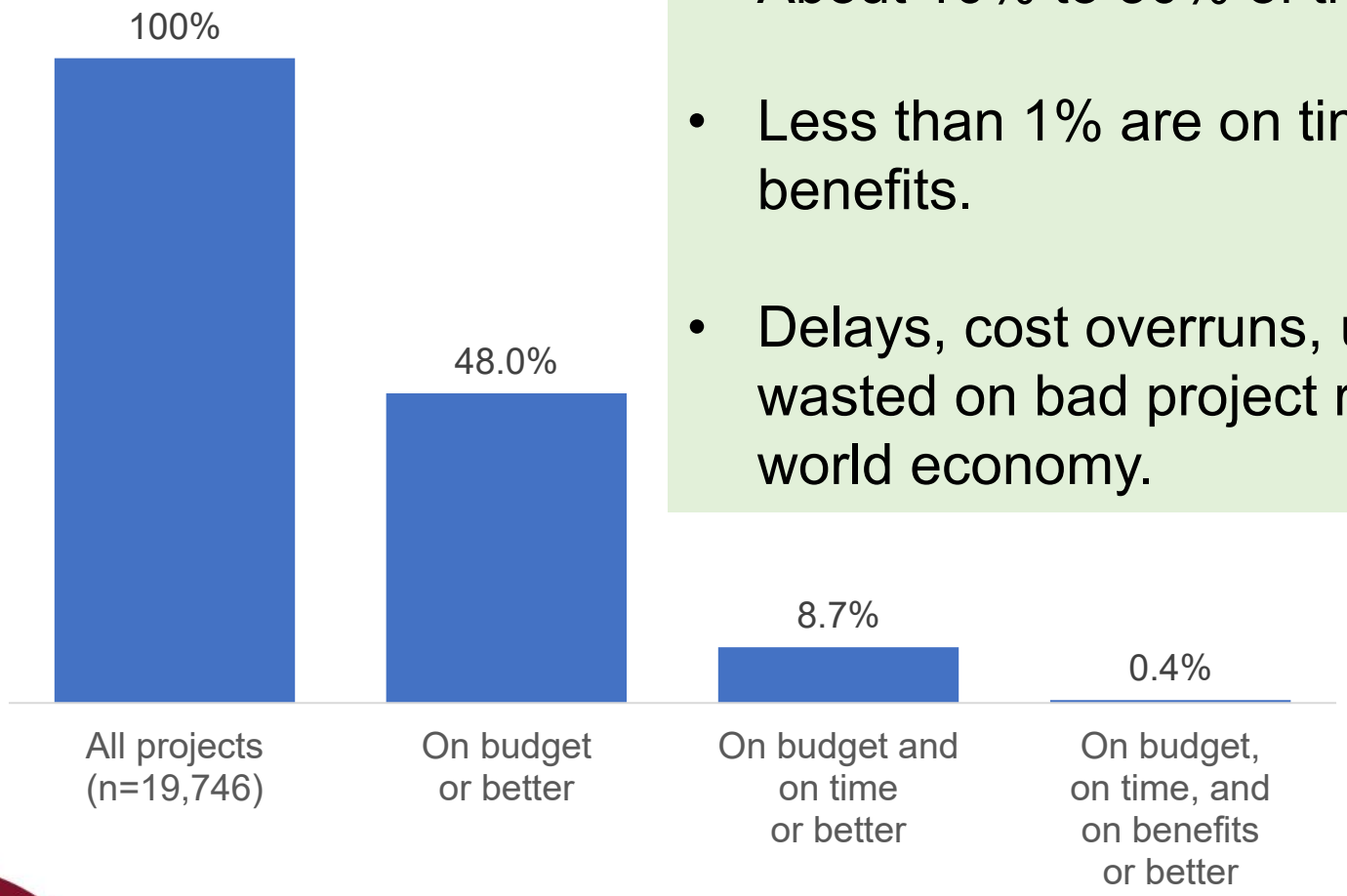
The Status of Project Management



- About 10% to 30% of the entire world economy is projects.
- Less than 1% are on time, on budget, and with expected benefits.
- Delays, cost overruns, unrealized benefits, and resources wasted on bad project represent a significant drain on the world economy.

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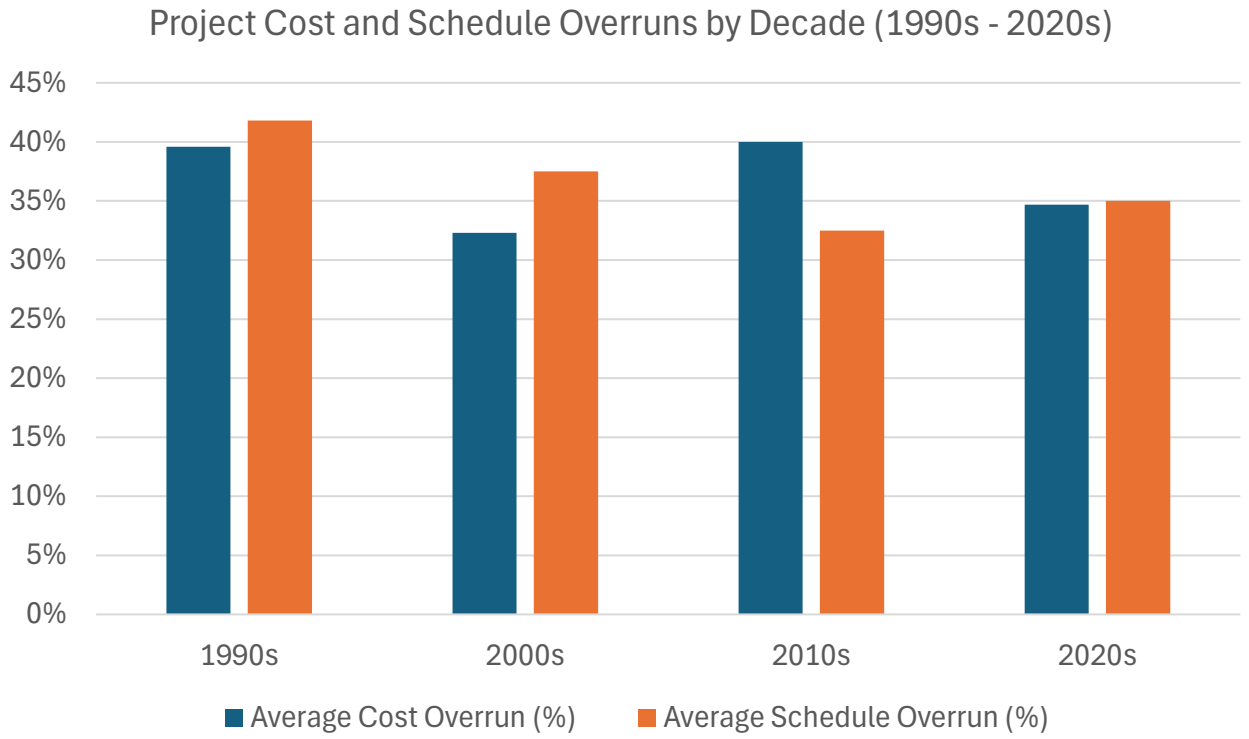
Rapid Growth in “Solutions”

Methods & Standards: ISO 21500, PMBOK, PRINCE, Agile, Scrum and more have been created since the 1980’s

Professional Certifications: Total PMP, PRINCE2 and other certifications has grown from a few thousand in the 1990’s to millions today.

Software: Some PM software options appeared before 1990 but grew dramatically afterward.

But it’s not getting better.



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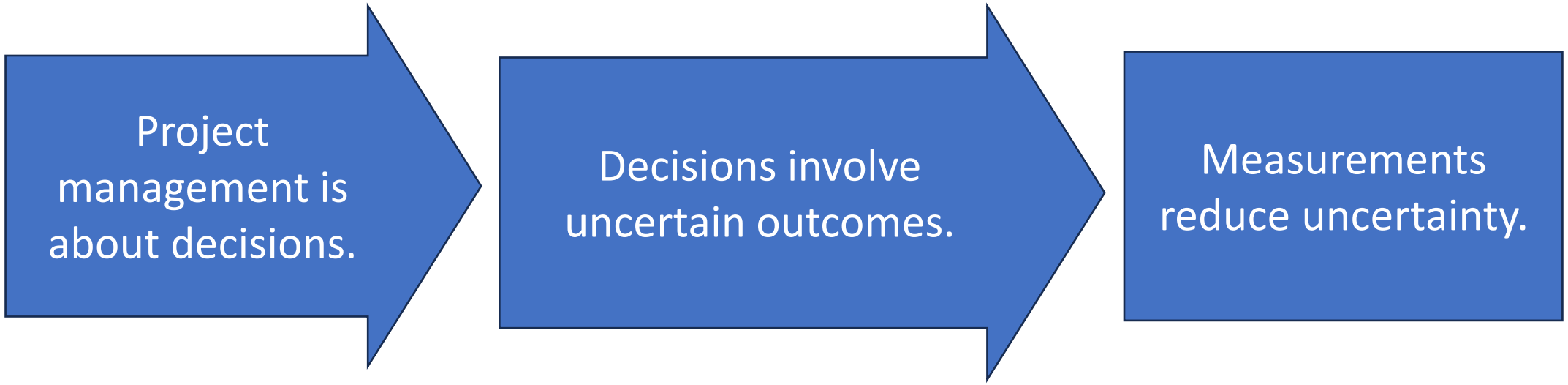
The Meta-Project

Question: What is your single highest priority project?

Answer: How to manage projects.



The Psychology of Project Management

Multiple independent studies have confirmed each of the following aspects of judgments, which are directly relevant to project management.

- **Overconfidence:** Subject matter experts consistently underestimate their own uncertainty.
- **Inconsistency:** Random, irrelevant external factors affect subjective estimates and risk aversion.
- **The Analysis Placebo:** "Structured" methods are perceived as improved judgment even when they don't.
- **Algorithm Aversion:** Algorithms are held to a higher standard than subjective/qualitative methods, leading to an irrational preference for the latter even when their errors are larger.

These can all be corrected.

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HDR/OGP Survey: Initial Results

- We surveyed 209 project managers/sponsors for details about 216 projects.
- Combined with other independent, published, empirical research, here are some findings.

Better

Empirical/Quantitative

- Reference Class Forecasting
- Monte Carlo simulations
- Calibrated experts
- Front End Loading
- Statistical forecasting methods

Mixed

Appearance of Formality?

- Certifications
- Earned Value Management

Worse

Intuition, Qualitative

- Unaided expert intuition
- Risk Matrices
- Bottom-up, deterministic methods

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Reference Class Forecasting (RCF)

There is a persistent underestimation of cost and time in projects.

RCF involves collecting past experience as a basis of estimating uncertainty.

Oxford Global Projects has collected data on over 20,000 projects to make reference classes.

A Few Examples in the OGP Data

Project	Average cost overrun	% of projects with cost overrun ≥ 50%	Average cost overrun for projects ≥ 50%
Roads	25%	14%	111%
Defence	28%	27%	135%
Bridges	31%	20%	118%
Fixed Links	32%	23%	113%
Tunnels	33%	26%	102%
Power Plants	36%	17%	211%
Dams	90%	36%	240%
IT-led Change	107%	21%	519%
Nuclear Power	117%	53%	205%
Olympics	156%	79%	192%

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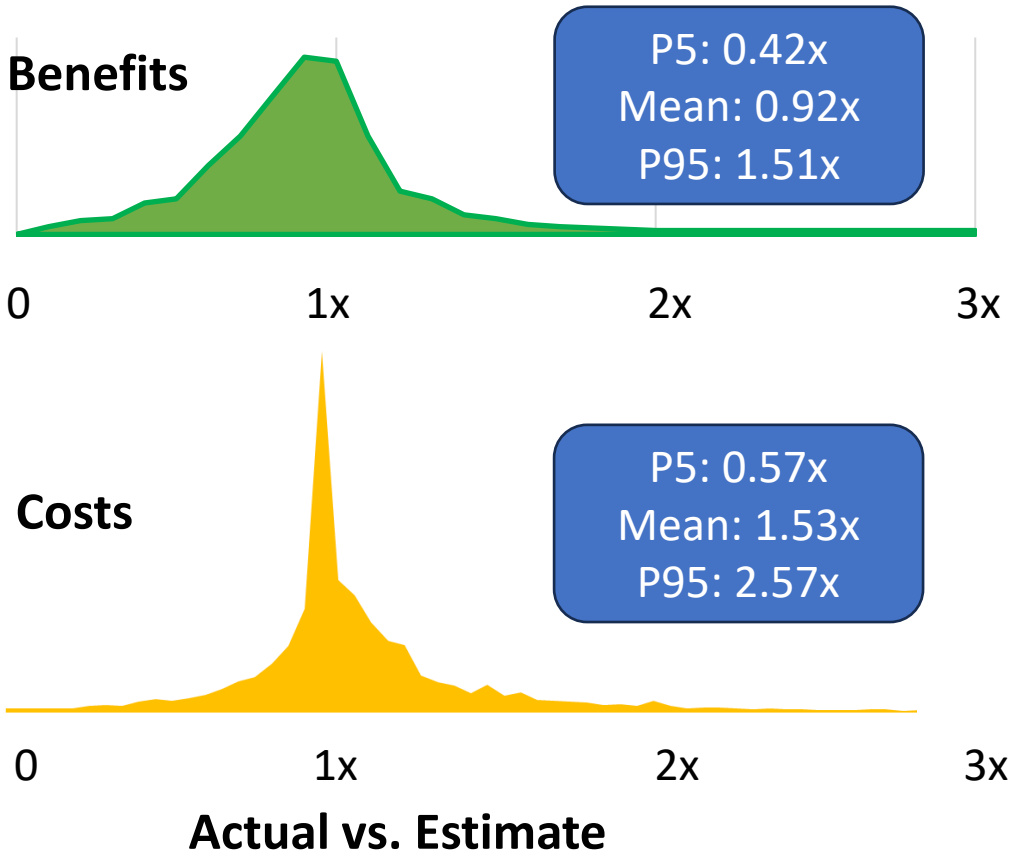
RCF of All Project Costs and Benefits



When benefits are not explicitly measured

- Managers assess most projects as having met or exceeded benefits.
- There is a correlation between meeting planned progress and perception of benefits.

When benefits are explicitly measured

- Most projects do not break even.
- There is no correlation between meeting plans and actual benefits.

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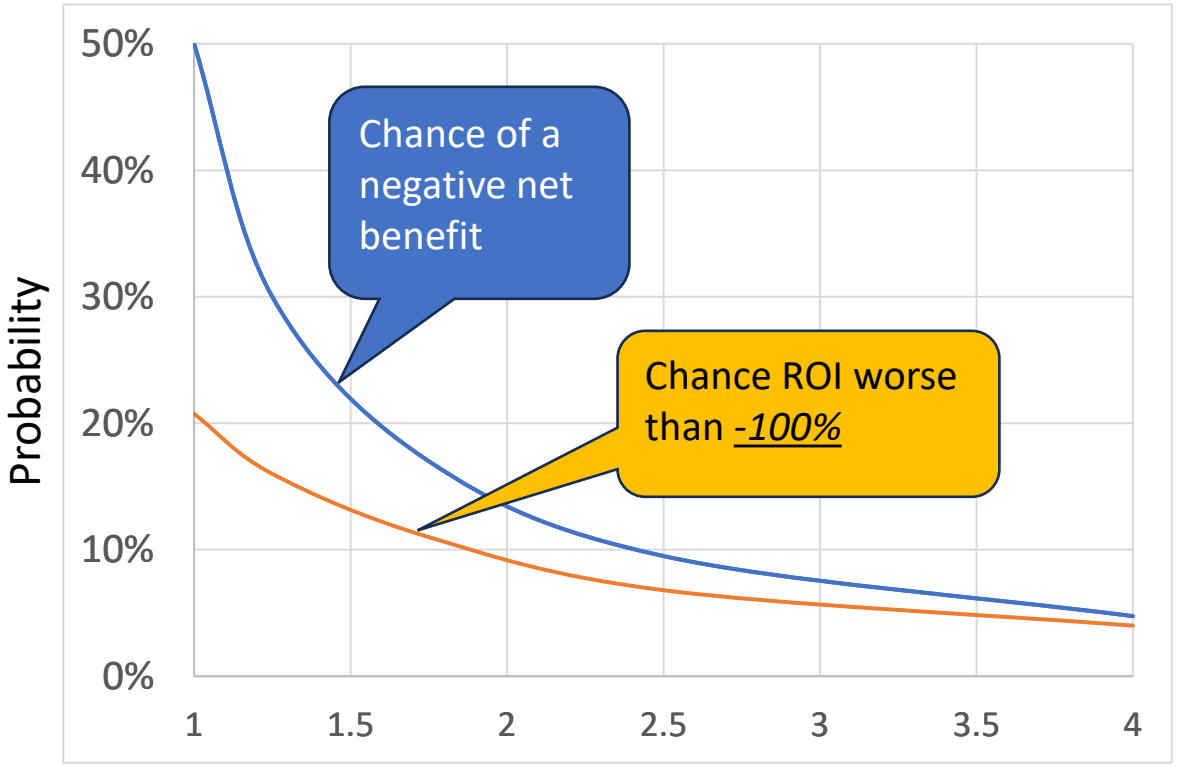
Expected Net Benefits vs. Chance of Net Loss



- A 2x benefit/cost still has a 14% chance of loss and a 9% chance of losing more than the entire investment.
- This does not include cancelled projects or negative impacts.
- ***Taking risk preferences of decision makers literally, most projects would never have been approved by most decision makers.***

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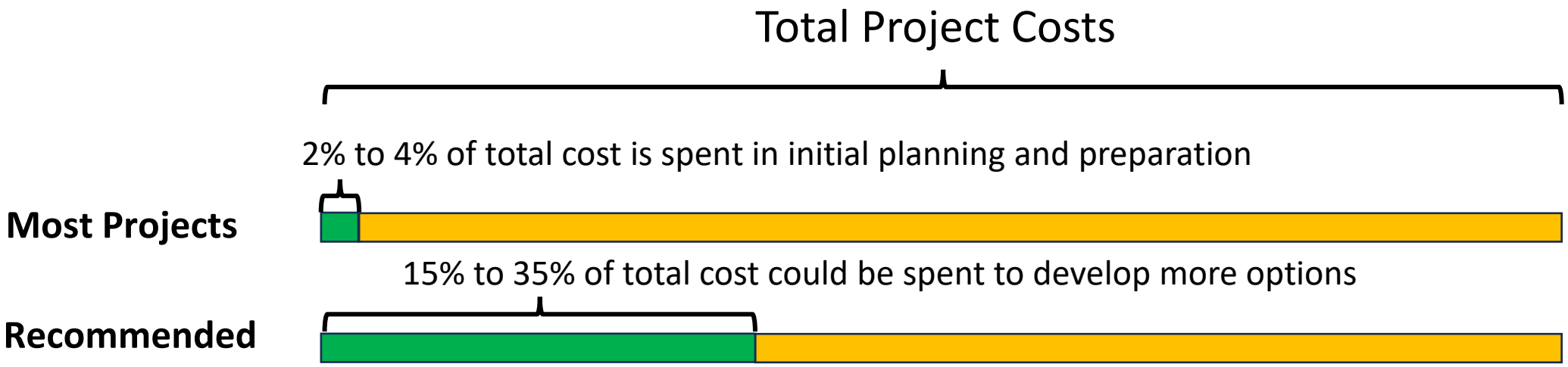
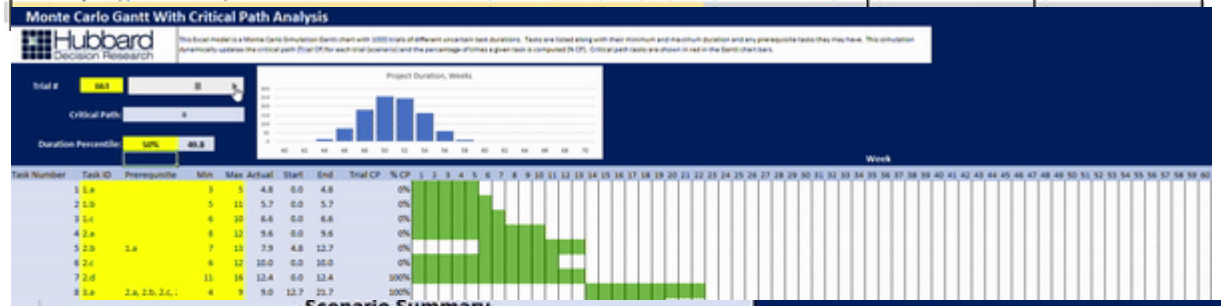
Front End Loading: “Thinking Slow, Acting Fast”

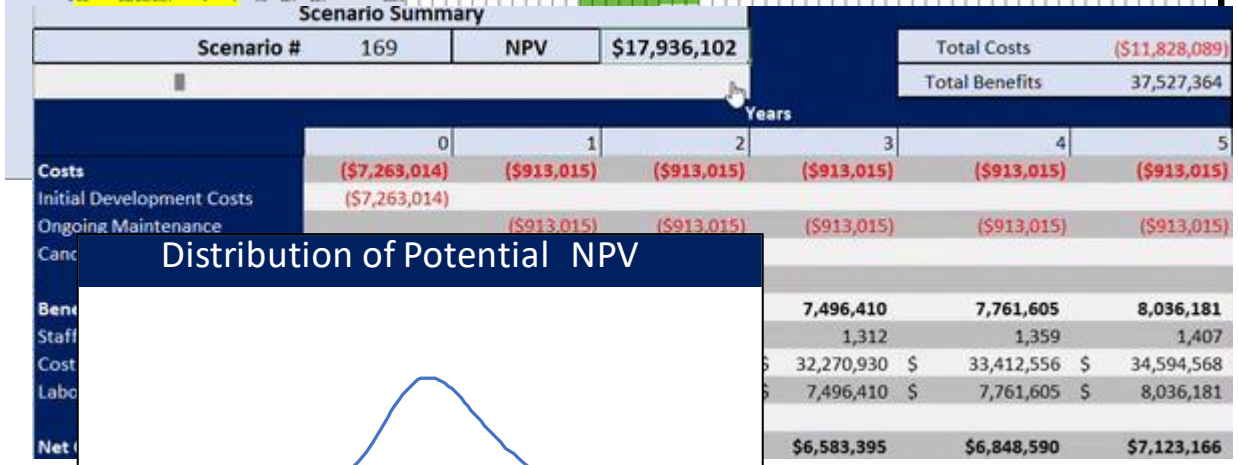


How can more preparation be spent? Many more alternative solutions, determining relevant options and what to measure to inform them, what PM methods are best and the level of detail needed for the project ***“digital twin.”***

A Simple Simulation of a Project

Risk Name	Risk Classification	Probability of a Loss Over 1 Year	Impact: Lower Bound	Impact: Upper Bound	Expected Inherent Loss	Simulated Inherent Loss	Simulated Residual Loss
Economy enters recession	Market risk	40.0%	$ 500,000	$ 10,000,000	$ 1,353,993	$ -	$ -
Failure of a major project	Project risk	15.0%	$ 2,000,000	$ 5,000,000	$ 493,103	$ -	$ -
Increased cost of capital	Interest rate risk	35.0%	$ 150,000	$ 300,000	$ 75,913	$ 246,585	$ -
Exposure to a small lawsuit	Legal risk	10.0%	$ 200,000	$ 500,000	$ 32,874	$ -	$ -
Exposure to a large lawsuit	Legal risk	5.0%	$ 500,000	$ 2,000,000	$ 54,643	$ -	$ -
Loss of major supplier	Operational risk	12.0%	$ 500,000	$ 10,000,000	$ 406,198	$ -	$ -





Published in *International Journal of Forecasting*, 10 (1994), 495-906

Judgmental Decomposition: When Does It Work?

Donald G. MacGregor
Decision Research, Eugene, OR

Society of Petroleum Engineers (2000)

The Application of Probabilistic and Qualitative Methods to Asset Management Decision Making

SSCAG/SCAF/EACE Joint International Conference (2008)

An Assessment of the Inherent Optimism in Early Conceptual Designs and Its Effect on Cost and Schedule Growth

D. Bearden, C. Freaner, R. Bitten, and D. Emmons

Abstract

When missions experience cost growth, cost estimators are often criticized for underestimating the cost of missions in the early conceptual design stage. The final spacecraft and instrument payload configuration at launch, however, can

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Why Don’t We Use More Quantitative Methods?

Have you heard (or said) any of these?

“We don’t have sufficient data.”

“Project cancellation is too complex to predict.”

“My project is unique and too complex to apply scientific analysis of historical data.”

“How do you know you have all the variables?”

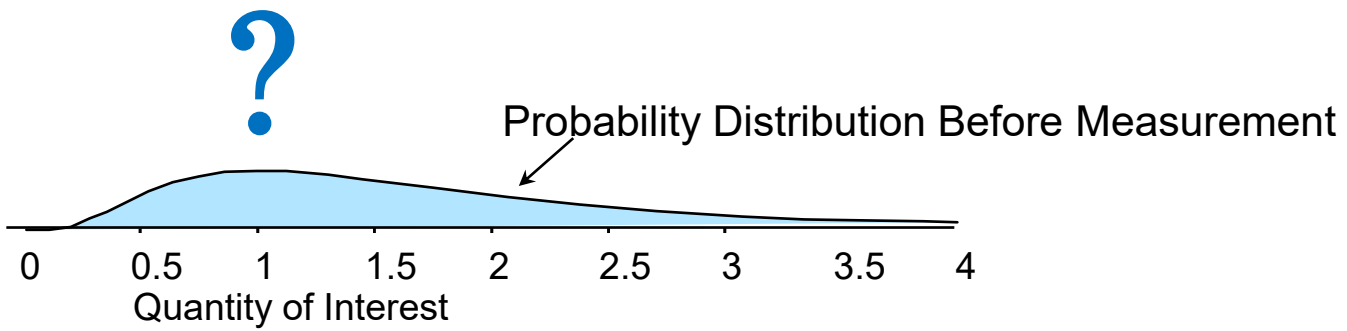
The Three Misconceptions

CONCEPT of Measurement	The definition of measurement itself is widely misunderstood.
OBJECT of Measurement	The thing being measured is not well defined – including what decisions the measurement supports.
METHOD of Measurement	Many procedures of empirical observation are misunderstood. College stats is frequently recalled incorrectly.

Measurement as Uncertainty Reduction

It's not a point value.

Measurement: a quantitatively expressed reduction in uncertainty based on observation.

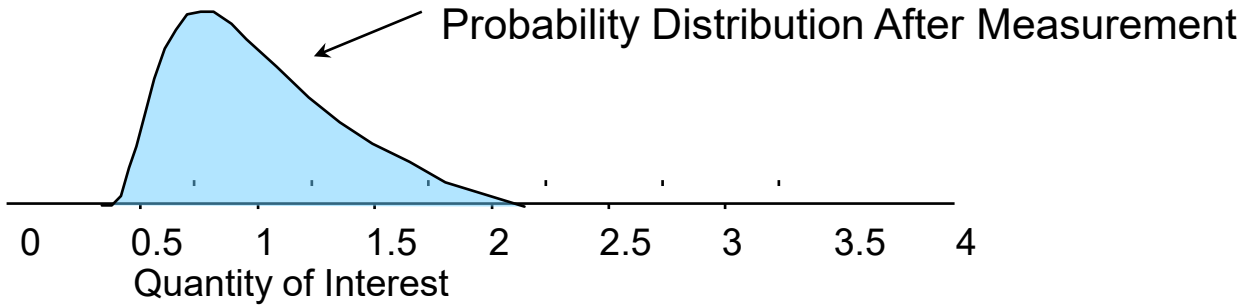


Measurement as Uncertainty Reduction

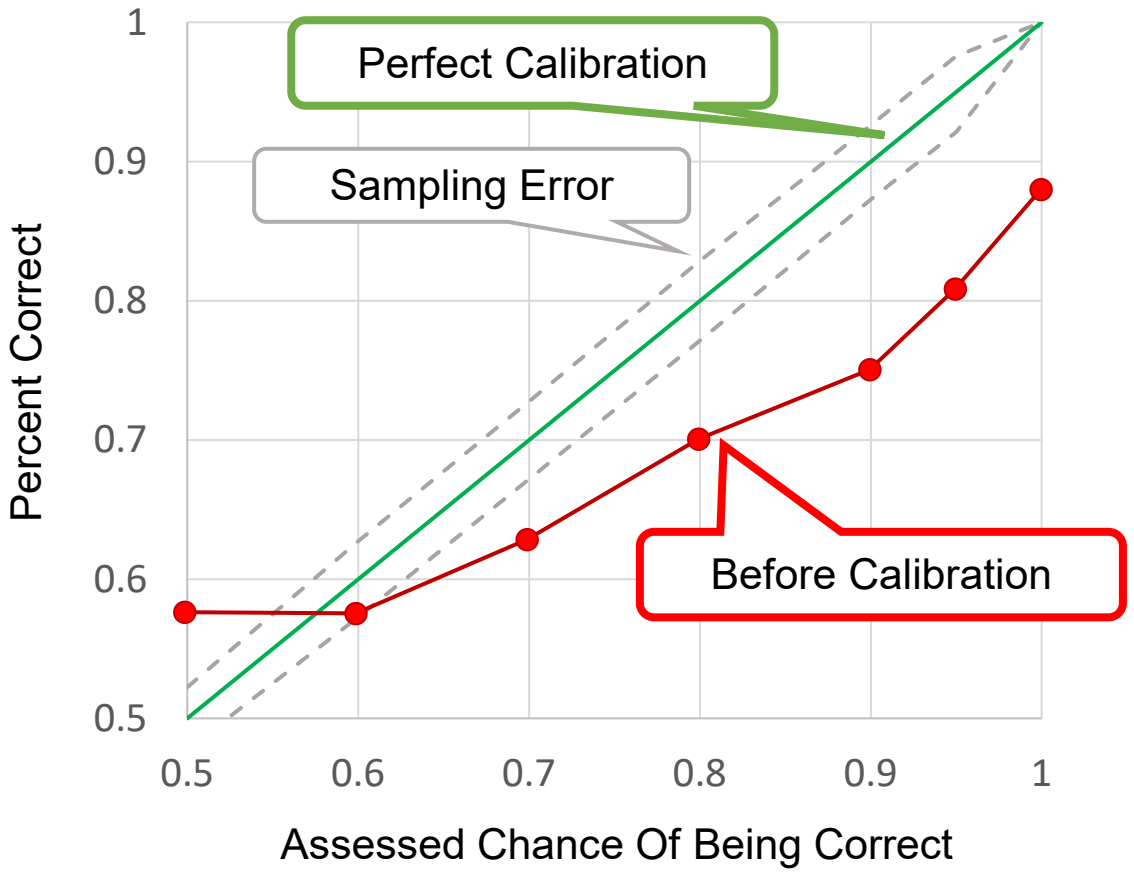
It's not a point value.

Measurement: a quantitatively expressed reduction in uncertainty based on observation.

This often involves Bayesian updates. This may require less data than you think.



Measuring Overconfidence



- HDR trained over 3,000 individuals in subjective estimation of probabilities.
- Almost everyone is overconfident on the first benchmark test.

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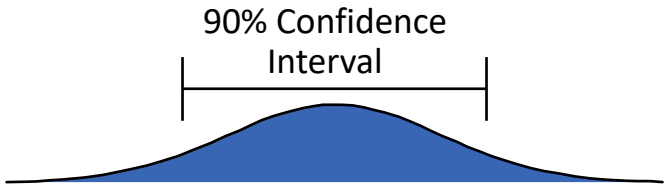
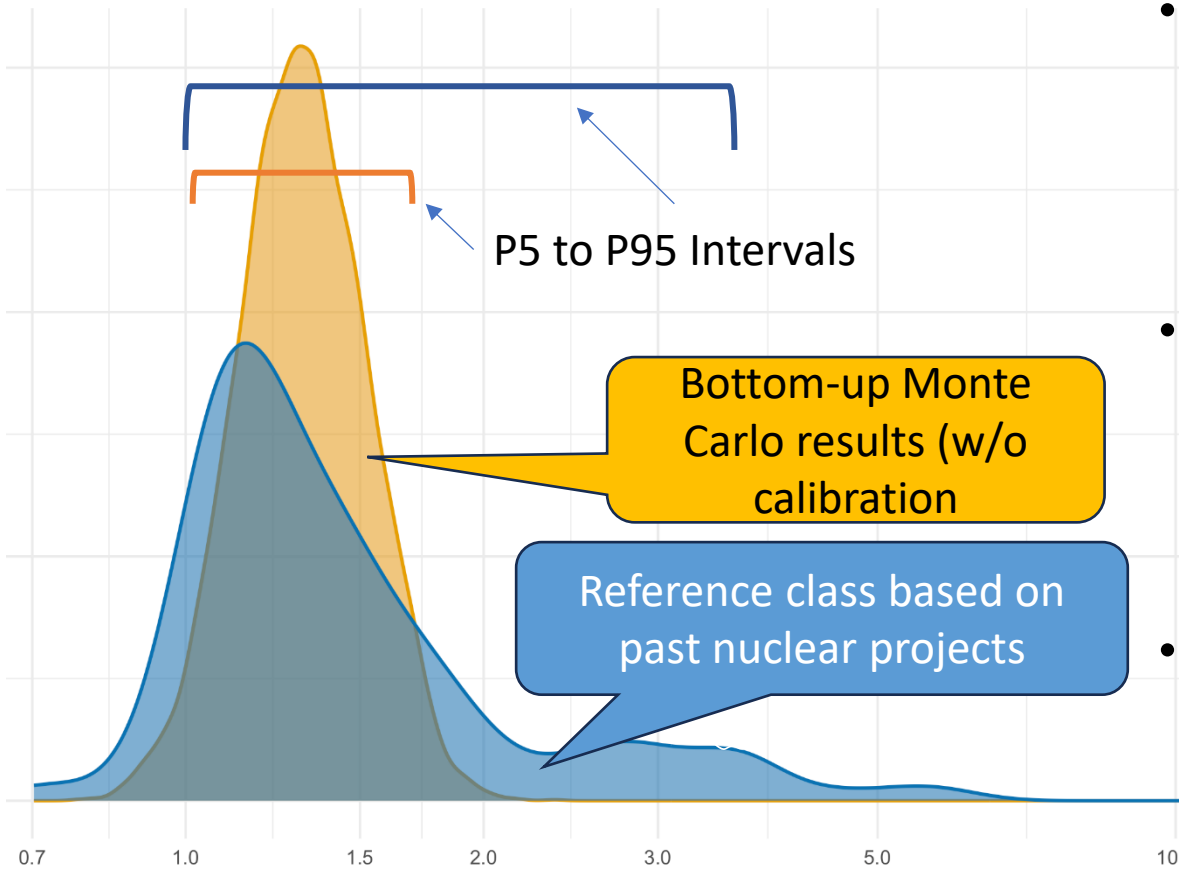
Overconfidence in Range Estimates

- Over 3000 people have attended Hubbard's calibration training.
- Almost everyone is overconfident at first, but they can be trained to be more realistic about uncertainty.



Group	Subject	% Correct (target 90%)
Harvard MBAs	General Trivia	40%
Chemical Co. Employees	General Industry	50%
Chemical Co. Employees	Company-Specific	48%
Computer Co. Managers	General Business	17%
Computer Co. Managers	Company-Specific	36%
Before training	General Trivia & IT	35%-50%
After training	General Trivia & IT	~90%

Converging the RCF vs. Bottom-Up Simulations



- The Swedish Nuclear Waste Programme Monte Carlo was entirely based on uncalibrated SMEs. Typical calibration adjustments easily explain the difference.
- Subjective estimates are highly inconsistent about 20% of variation in expert judgment is due to random personal inconsistency – but it can be eliminated.
- Some algorithms for aggregating multiple experts – including AI's – measurably outperform other methods and even the best individual estimator.

Source: Oxford Global Projects

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The Measurement Inversion

The economic value of measuring a variable is usually inversely proportional to the measurement effort.

Measurements should inform decisions.

The “Measurement Inversion” occurs in nearly every industry, profession, and type of decision.

The cure starts with knowing which variables are the highest information value.

Even marginal reductions can have significant value.

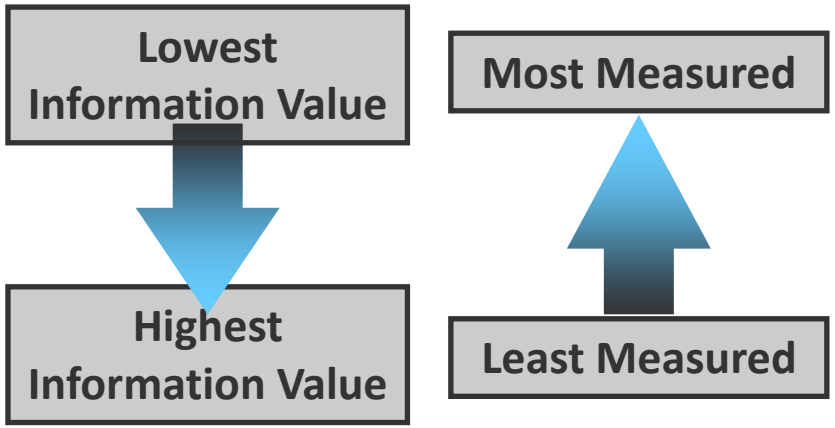
IEEE Transactions on Systems Science and Cybernetics (1966)

Information Value Theory

Ron Howard

Abstract

The information theory developed by Shannon was designed to place a quantitative measure on the amount of information involved in any communication. The early developers stressed that the information



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Project Decisions: Before, During & After

When	Examples of Decisions
Before Analysis, Planning	• What are the solutions and which should be approved? • How much time and budget should be requested. • What options and risk mitigations should be in place?
During Interventions	• Should we pause, cancel accelerate the project? • Should we add more resources? • Should the scope, features, objectives be changed? • Should controls be added to mitigate emerging problems?
After Debrief	• Is a new version/release justified? • How does this data inform decisions in future projects?

Options to be exercised according to algorithms

Exploration vs. Exploitation

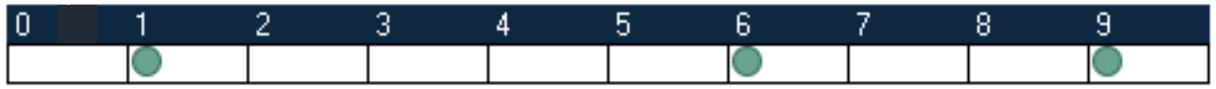
How long do you explore alternative strategies before exploiting the best one so far?

How long do you wait for technology improvements before exploiting is available?

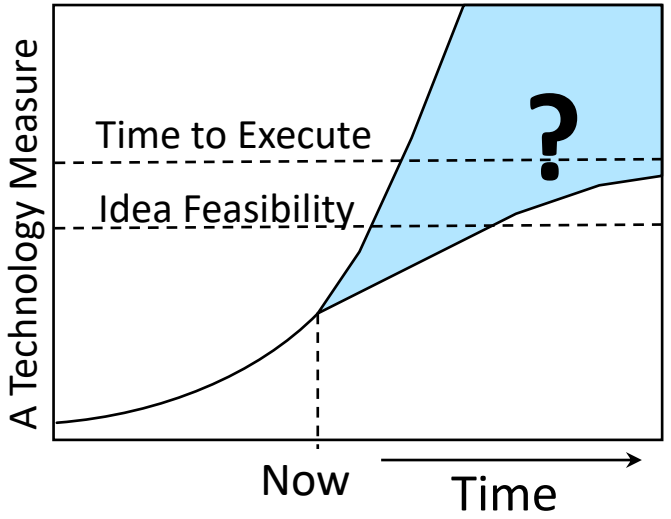
Answer: Probably longer than you think.

Example Project	Initial	YoY Change
Annual Benefits	$1MM	+10%
Investment	-$4MM	-10%

Optimal Year of Action



"Technology Regret" – Acting too soon when later technology would have been better



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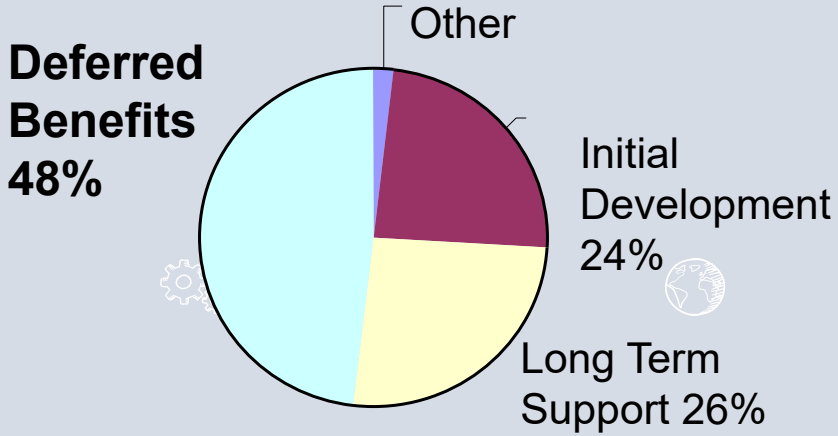
Intervention Options: Two Examples

Scope Change Option

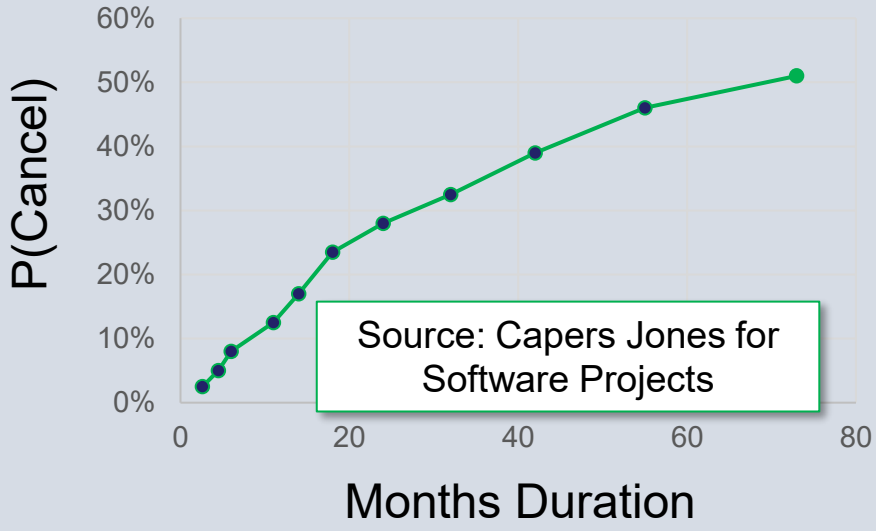
"Scope creep" may be incentivized because its true cost is greatly underestimated.

Software Portfolio Client Case:
Cost of Feature Which Extends Delivery 1 Month



Cancellation Option

The chance of cancellation is routinely ignored. Managing this risk involves either delivering or canceling earlier.



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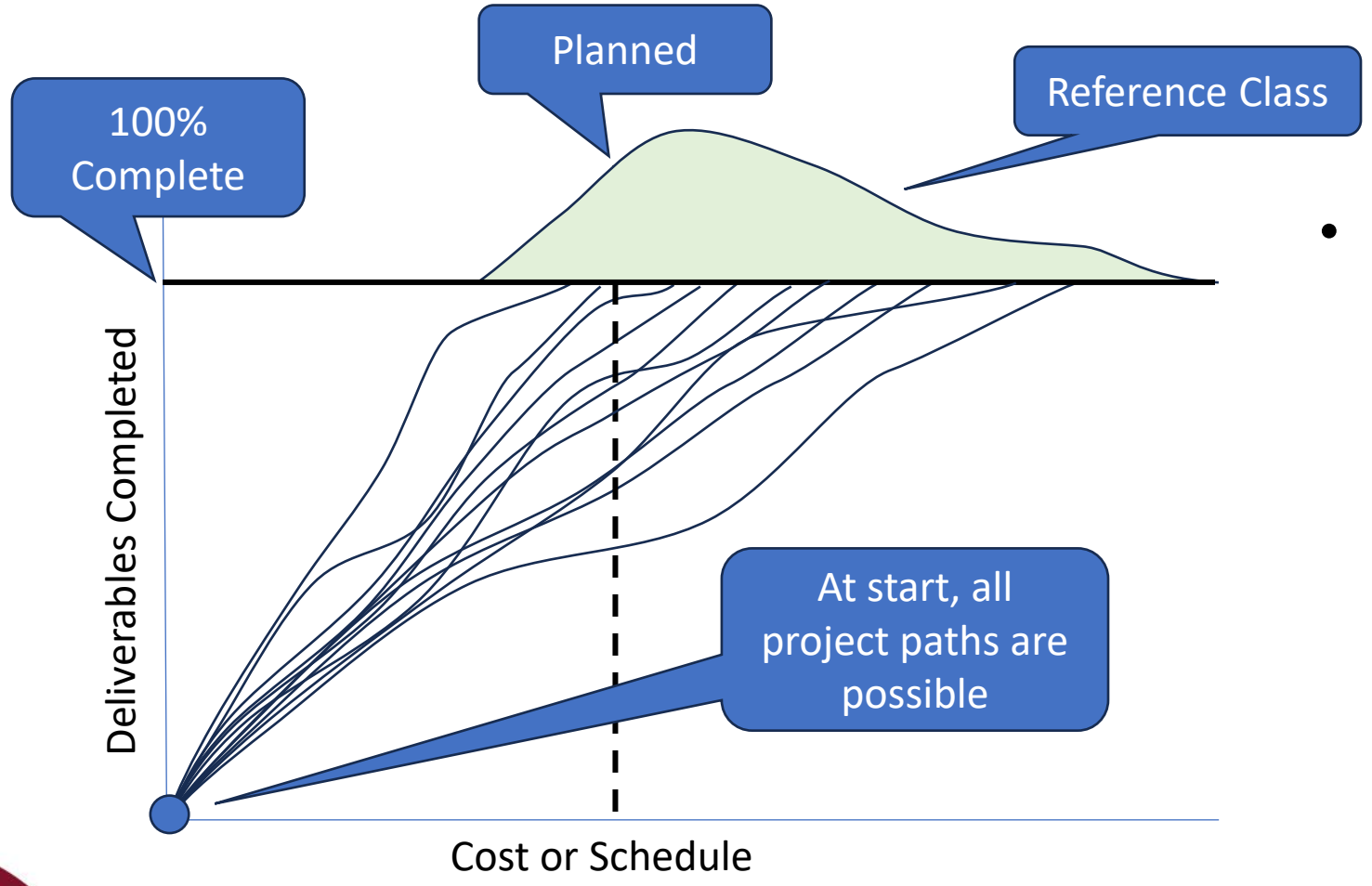
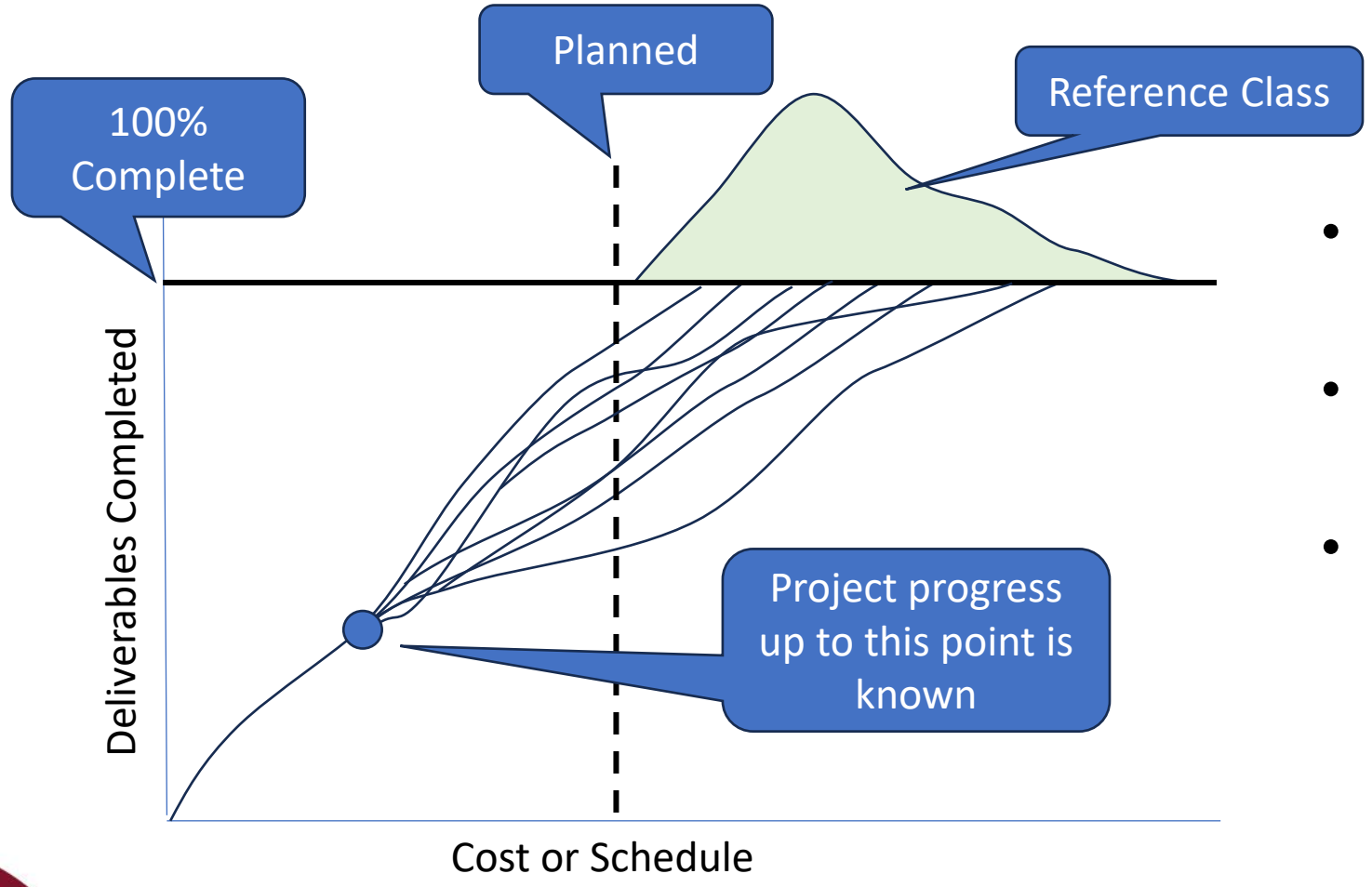
Conditional Reference Class Forecasting



- Your data may include a set of detailed project “paths.”

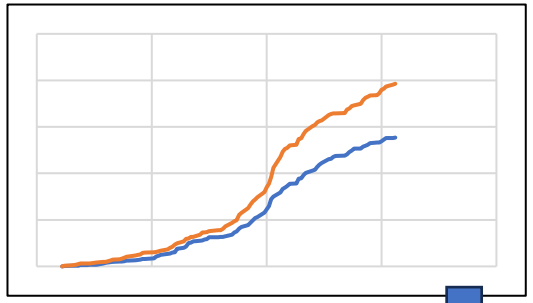
Conditional Reference Class Forecasting



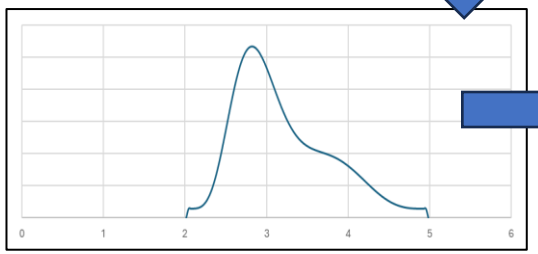
- Your data may include a set of detailed project “paths.”
- As the project progresses, the history of possible paths shrinks.
- This informs project intervention options and can include benefits and risks.

Intervention Options w/Decision-Driven Metrics

Various Progress Metrics, External Trends, Etc.



Various Forecasts



Decision-driven: Every measurement informs a decision model. The value of exercising intervention options is recomputed daily

Contrast this to the typical dashboard. Would interventions be as obvious, seen soon enough, with previously defined contingency plans?

Scenario Summary

Scenario #	169	NPV	$17,936,102

	0	1	2
Costs	($7,263,014)	($913,015)	($913,015)
Initial Development Costs	($7,263,014)		
Ongoing Maintenance		($913,015)	($913,015)
Cancellation? (1=cancelled)	0		
Benefits	-	6,992,893	7,240,275
Staff w/growth	1,182	1,224	1,268
Cost of labor in Doc Mgt	$ 29,074,808	$ 30,103,366	$ 31,168,311
Labor savings		$ 6,992,892.93	$ 7,240,275
Net Cash Flow	($7,263,014)	$6,079,878	$6,327,260

Option Value

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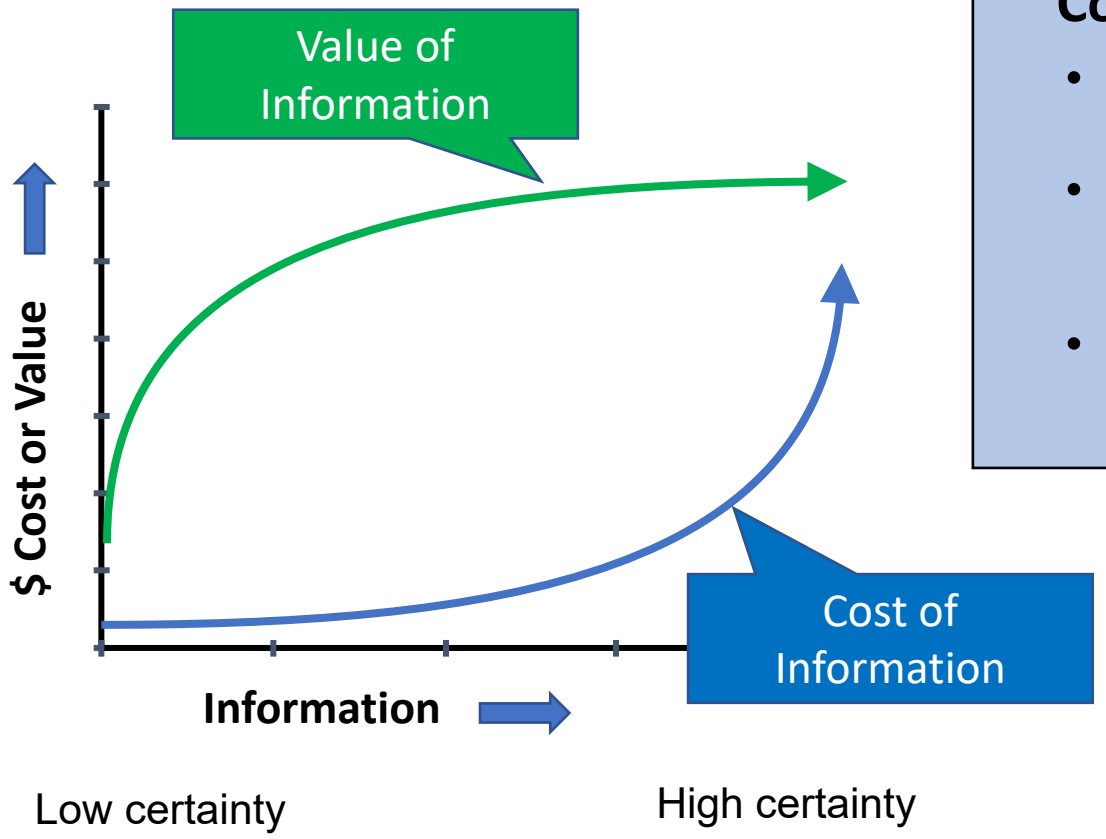
Practical Lessons

Here are a few key things I've learned measuring the "immeasurable"

- It's been measured before.
- You *have more* data than you think, and you *need less* data than you think.
- You probably need *different* data than you think.
- Projects always have observable consequences.
- The best investment in most portfolios is a better measurements of investments.

Information Value & Cost Functions



Cost vs. Value of Information

- Marginal costs start low but accelerate quickly.
- Marginal values accelerate quickly but will level off (sooner than is often expected).
- Initial observations offer the largest ROI.

If you know almost nothing, almost anything will tell you something.

The Meta Project Summary

Think Slow, Act Fast: Front End Loading, more exploration before exploitation, analysis of Technology Regret, intervention options, risk mitigations, simulated in project digital twins. AI will help.

Measure What Matters: Metrics should directly inform previously defined quantitative option models. The biggest uncertainty reductions are the earliest. Even small uncertainty reductions can have high information value.

Fewer Projects, Bigger Wins: Marginal value projects do not match risk-averse decision makers. Quantify risk aversion and apply it consistently.

Make Meta-Measurements: Test ideas about how to run projects or look for previous empirical research. Consistent skepticism is in order.

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Thank You

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