The Quantitative Risk Management Imperative

by

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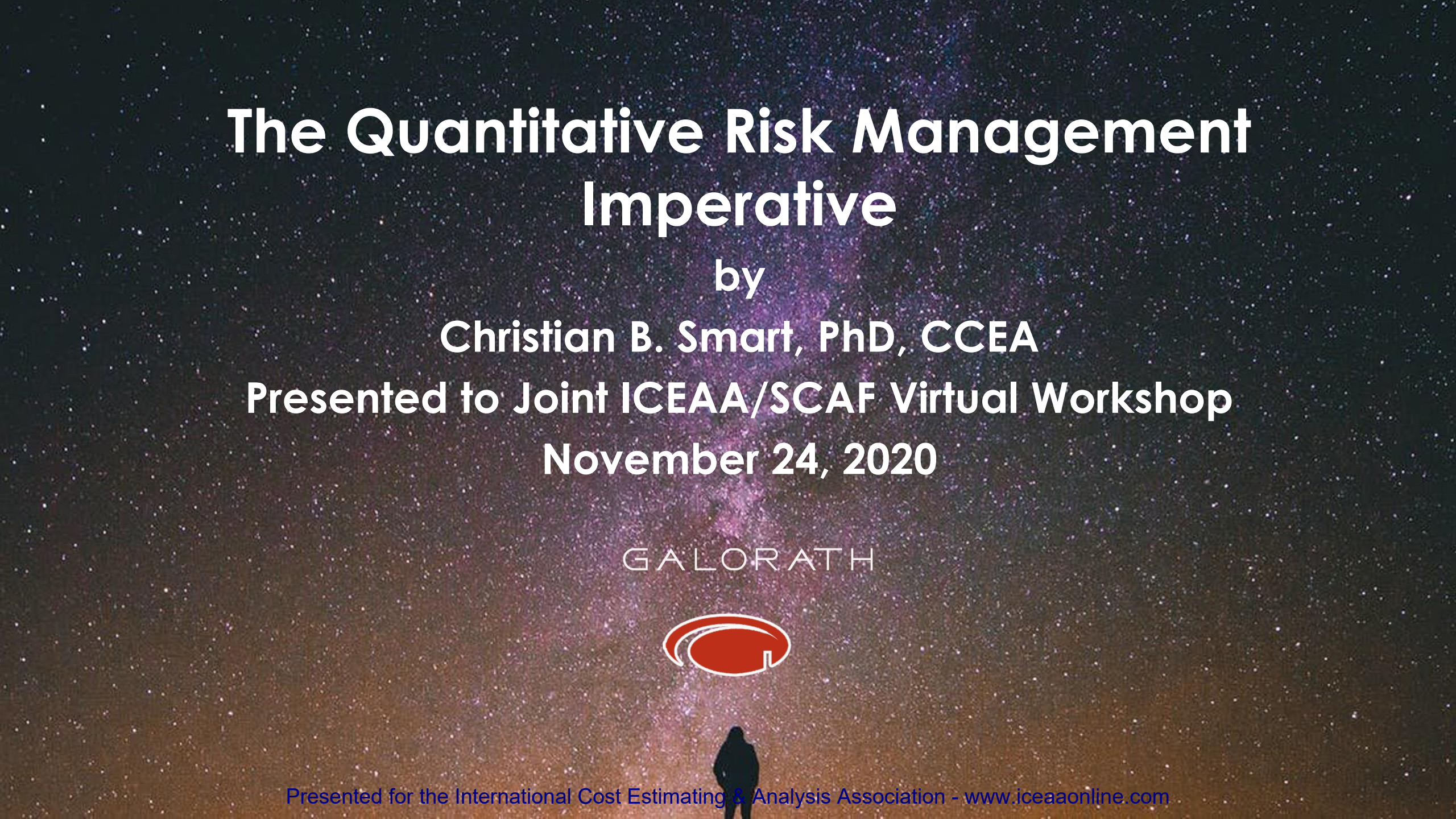
Presented to Joint ICEAA/SCAF Virtual Workshop

November 24, 2020

GALORATH

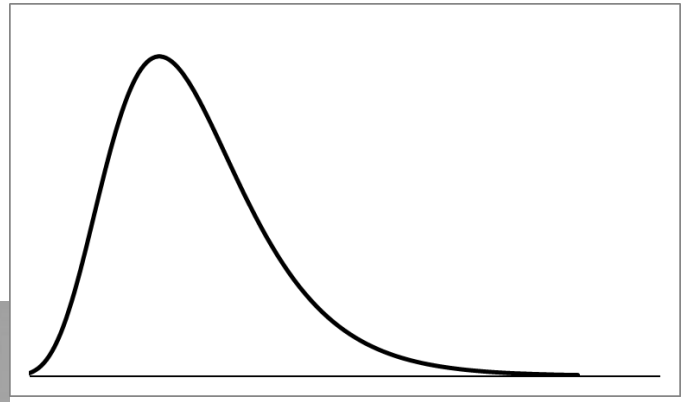


THE MEDIAN IS *NOT* THE MESSAGE

A SINGLE NUMBER DOES NOT SUFFICE IN THE FACE OF UNCERTAINTY!

STEPHEN JAY GOULD

Famous paleontologist, evolutionary biologist, and writer
Diagnosed with a rare form of cancer in 1982



"8 MONTHS TO LIVE"

Told he could expect 8 months to live
Gould researched the medical literature and discovered this expected value was a median and that it was significantly less than the mean

SKEW YOU

Gould lived for another 20 years and died from an unrelated illness – the number Gould was given was highly inaccurate

PROJECT RISK MANAGEMENT

OPPORTUNITY IN RISK

PROJECTS ARE INHERENTLY RISKY

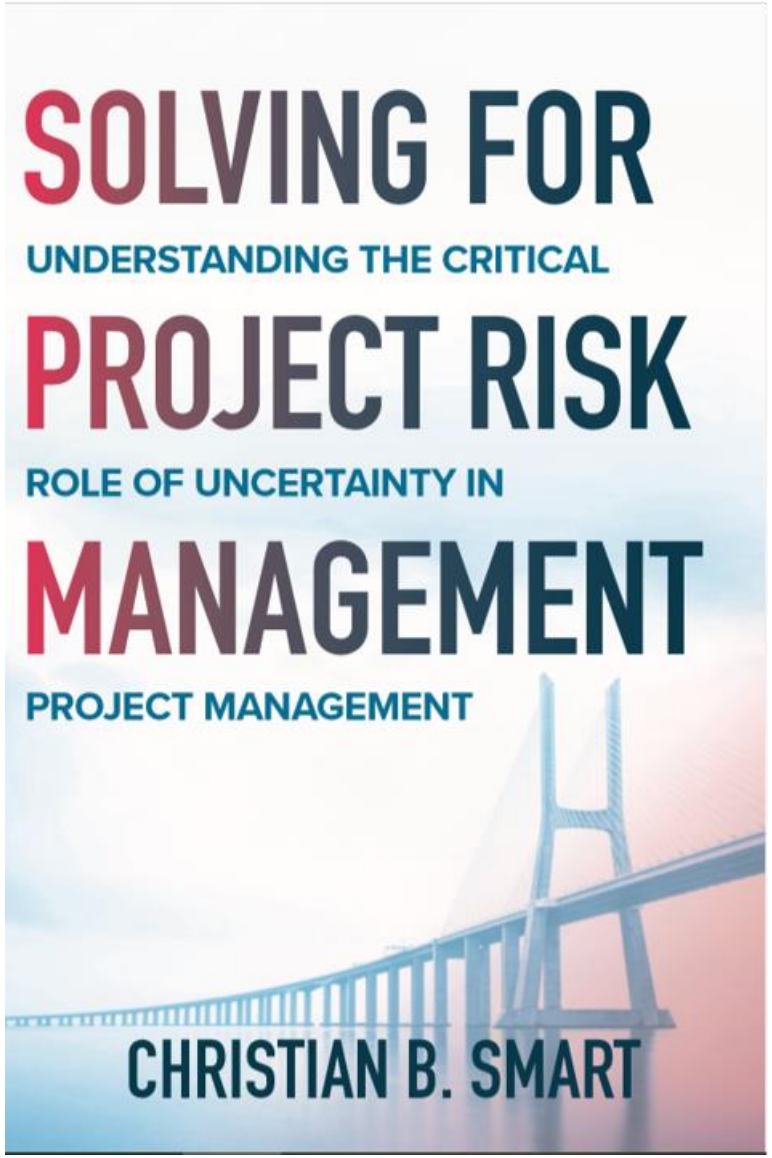
- Projects of all types, large and small, experience regular amounts of significant cost and schedule growth
- This growth is strong evidence not only of risk, but lack of proper risk management
- Risk is often considered just another a four-letter word

QUANTITATIVE RISK ASSESSMENT

- Projects need to conduct quantitative cost and schedule risk analysis
- The application of quantitative methods is fraught with obstacles

THIS PRESENTATION

- The focus of this presentation is one aspect of the book, which focuses on the need for quantitative risk assessment



Read Chapter 1 for free:
https://bit.ly/3ggPZK2

GALORATH

AGENDA

1

ANOTHER FOUR-LETTER WORD

Despite its critical role in project success, risk is often ignored

Projects need to consider risk

2

THE FLAW OF AVERAGES

Averages are not sufficient to measure the impact of uncertainty

We provide an example from the sport of baseball

3

QUANTITATIVE RISK MANAGEMENT

Qualitative methods such as risk matrices underestimate risk – need to quantify it

Risk and uncertainty can be measured by probability distributions

4

A COMPARISON

Inspired by an example by the late Dr. Steve Book, we illustrate how riskless point estimates underestimate likely cost

Plans based on averages are destined to be "behind schedule and beyond budget"

(Sam Savage, *The Flaw of Averages*)

COST AND SCHEDULE GROWTH

A LEGACY OF DISASTER

	Olympics	Software/ IT	Dams	NASA/ DoD	Rail	Bridges/ Tunnels	Roads
Average Cost Growth	156%	43-56%	24-96%	52%	45%	34%	20%
Frequency of Occurrence	10/10	8/10	8/10	8/10	9/10	9/10	9/10
Frequency of Doubling	1 in 2	1 in 4	1 in 5	1 in 6	1 in 12	1 in 12	1 in 50
Average Schedule Delay	0%	63-84%	27-44%	27-52%	45%	23%	38%
Frequency of Schedule Delay	0/10	9/10	7/10	9/10	8/10	7/10	7/10

1 **COMMON**

Multiple Industries Experience Significant Cost and Schedule Growth – Has Been a Problem for a Long Time

2 **FREQUENT**

70-80% of Projects Experience Cost and Schedule Growth

3 **HIGH**

Cost: 50% or More on Average (Mean)

Schedule: 30% or More on Average (Mean)

4 **EXTREME (FOR COST)**

Cost Growth in Excess of 100% Is a Common Occurrence in Most Projects (1 in 6)

GALORATH

Why Cost and Schedule Growth Occur

Numerous Reasons, Both Internal and External:

- Optimism
- Cost, Schedule, and Technical Misalignment
- Errors in Estimation
- Moore's Law
- Black Swans

"The Non-Secret of Good Cost [and Schedule] Estimating: Don't Drink the Kool-Aid"- Lawrence Goeller, OSD Cost Analysis Improvement Group

1 OPTIMISM

Innate bias - Planning Fallacy

Prospect Theory - Project managers are risk-seeking

2 COST, SCHEDULE, TECHNICAL MISALIGNMENT

Like a three-legged stool, all need to be consistent in order for a project to balance

3 MOORE'S LAW

Exponential growth in technology Paired with projects that take a decade or longer to complete means that either requirements are continually updated or the product is obsolete on delivery

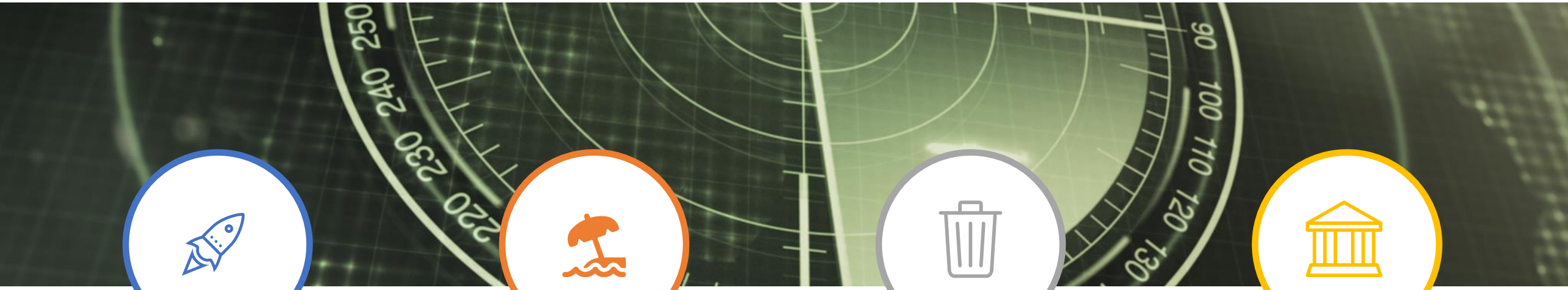
4 BLACK SWANS

Unpredictable, rare, unprecedented events that have a huge impact

5 LAKE WOBEGON

Project managers and their staff are not like the children of Garrison Keillor's fictional town – they are not all above average

EXAMPLES



JAMES WEBB SPACE TELESCOPE

Next generation space telescope

Highly complex but leadership was optimistic

MOSES

Venice's flood prevention project – has taken so long to develop that it is already obsolete

CALIFORNIA HIGH-SPEED RAIL

Designed to link LA and SF, but now will only connect two small cities, a mega project that is a mega waste

SYDNEY OPERA HOUSE

Began construction without a detailed plan in place, one of the highest cost increases and longest schedule in history

Engineering – Practical Risk Management

Focus on Quantitative Techniques

Charles Hitch, RAND, *An Appreciation of Systems Analysis* (1955)
Steven Sobel, MITRE, *A Computerized Technique to Express Uncertainty in Advanced Systems Cost Estimates* (1965)

Steve Book, Paul Garvey, Christian Smart, Douglas Hubbard, etc.

Uncertainty Is The Indefiniteness About an Outcome

Risk Is The Chance and Consequence of Bad Events

Economics – Theoretical Risk Management

Focus on Utility Theory, Measurable and Unmeasurable Uncertainty

J.M. Keynes, *A Treatise on Probability Theory* (1921)
Frank Knight, *Risk Uncertainty, and Profits* (1929)

Diverse group – e.g., Gerard Debreu, N.N. Taleb, John Kay and Mervyn King

RISK AND OTHER FOUR-LETTER WORDS

UNCERTAINTY IS OFTEN TREATED AS THOUGH IT IS SOMETHING TO BE AVOIDED

WE ARE BLIND TO RISK

Many project managers' attitude is like that of the Captain of the Titanic – before that ship's fateful voyage: "I have never been in accident…of any sort worth speaking about. I never saw a wreck and never have been wrecked."

COST AND SCHEDULE RISK ARE UNAPPRECIATED

I once hear a former NASA senior leader say: "Once a project is complete, no one remembers how much it cost or how long it took. All they remember is whether or not it worked."

This extreme emphasis on performance to the exclusion of cost and schedule leads to spending more, doing less, and taking longer

THE PLANNING FALLACY

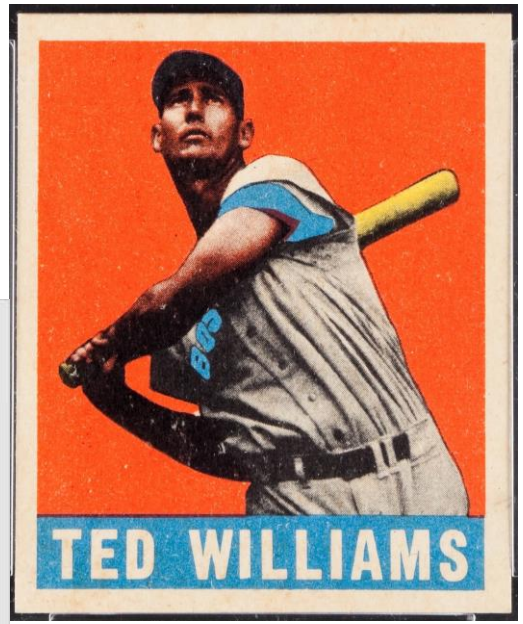
An innate bias noted by psychologist Daniel Kahneman

People plan for the best case possible

Leads to systematic underestimation of cost, schedule, and risk

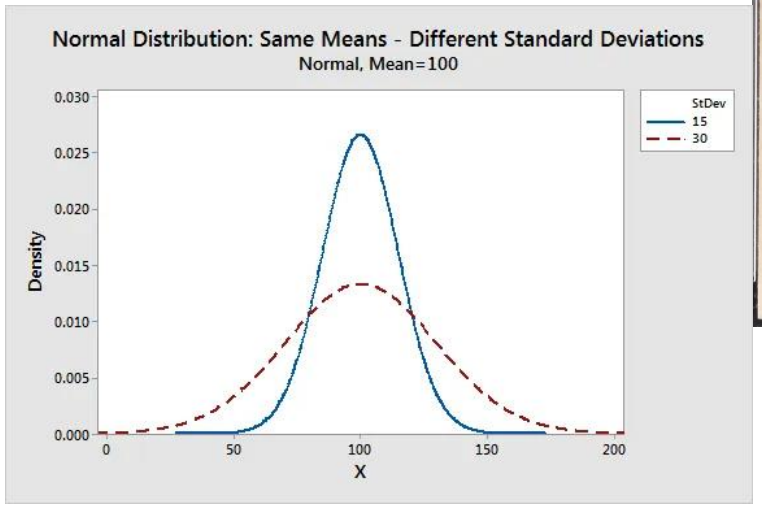
THE DISAPPEARANCE OF THE .400 HITTER

WHY AVERAGES CAN BE MISLEADING



BATTING AVERAGE

- Percent of plate appearances (not counting walks or hit-by-pitch) that result in reaching base safely
- Mark of an outstanding hitter is 30% or better (.300)



.400 HITTERS

- Decades ago, best hitters occasionally hit .400 or better in a season
- Last player to achieve that feat was Ted Williams in 1941

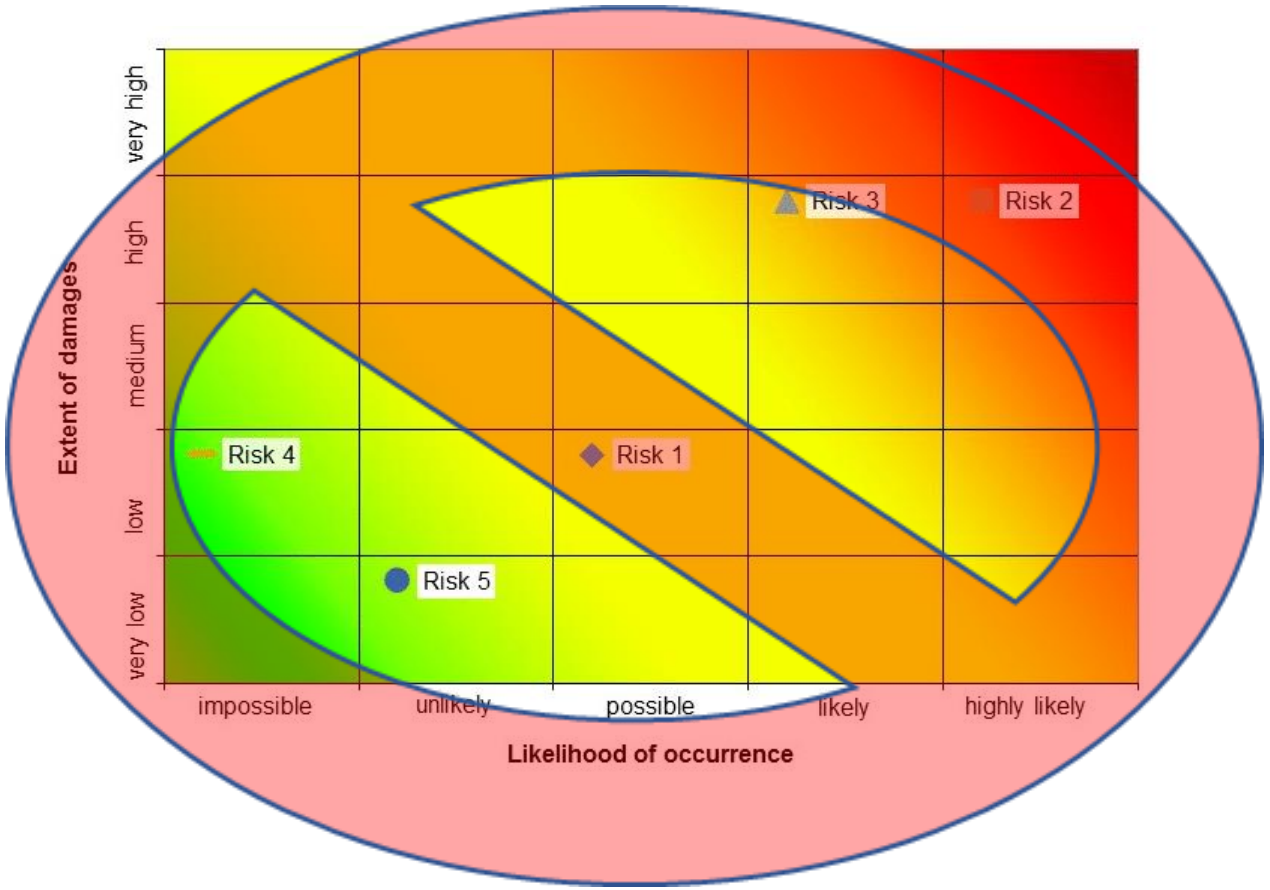
THE DIFFERENCE

- Average has stayed relatively constant over time, what has changed is that the standard deviation has decreased
- Chance of someone hitting .400 or better during the 1940s ~1 in 40,000
- Chance of someone hitting .400 or better during the 2000s ~ 1 in 125,000

We Need to Consider More Than Just the Average

RISK MATRICES UNDERESTIMATE UNCERTAINTY

They Should Not Be Used!



RISK MATRIX

- The use of risk matrices is a popular approach for modeling technical risk and is often applied to cost risk as well
- Two axes – likelihood and consequence
- However there are issues with this approach

UNDERESTIMATION OF RISK

- The inclusion of a few discrete risks significantly underestimates the full extent of uncertainty that programs face
- Numerous studies have shown that risk matrices underestimate risk
- Risk matrices are a quasi-qualitative method

CONCLUSION

- Risk matrices should not be used – true quantitative techniques should be applied to credibly analyze and assess risk

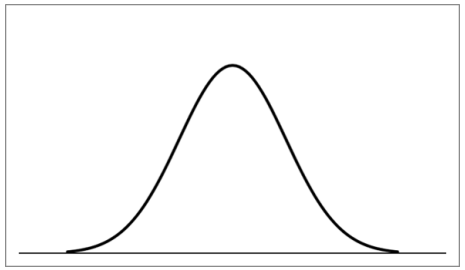
UNCERTAINTY IS A SHAPE

Four Commonly Used Probability Distributions

1

GAUSSIAN

The "Normal" distribution is commonly used but not applicable to cost and schedule (skew;fat tails)



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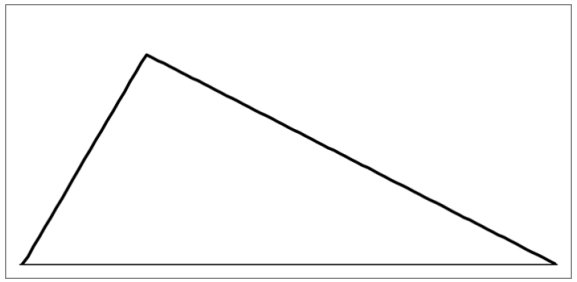
TRIANGULAR

Simple, but too simple
Has no tail
Can only model limited range



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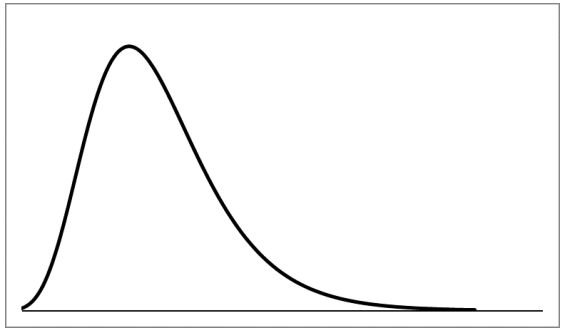
LOGNORMAL

Can model skew
Can model relatively fat tails
In-between thin tails and fat tails



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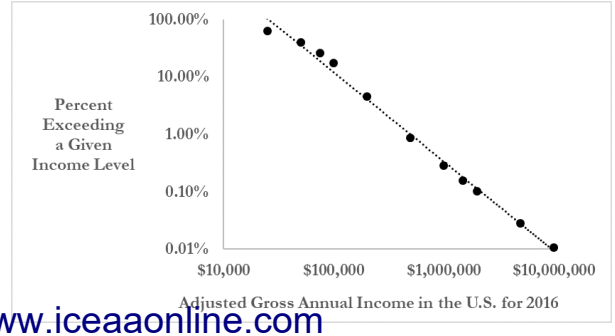
PARETO

80/20 Rule
Used to model extreme risks



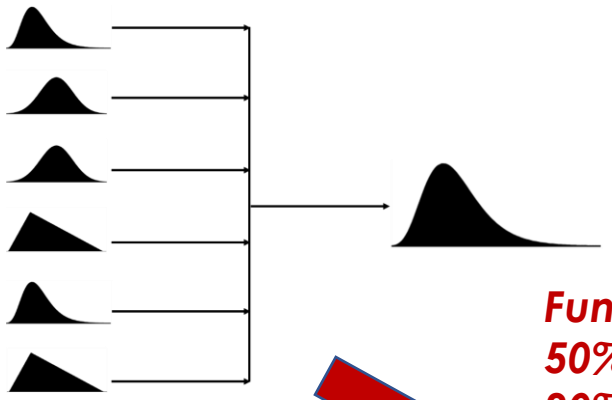
QUANTITATIVE COST AND SCHEDULE RISK IMPERATIVE

1

EXAMPLE

For the six WBS elements on the right with a mix of triangular and lognormal distributions

The sum of the median values is at the 20% confidence level of the total uncertainty distribution



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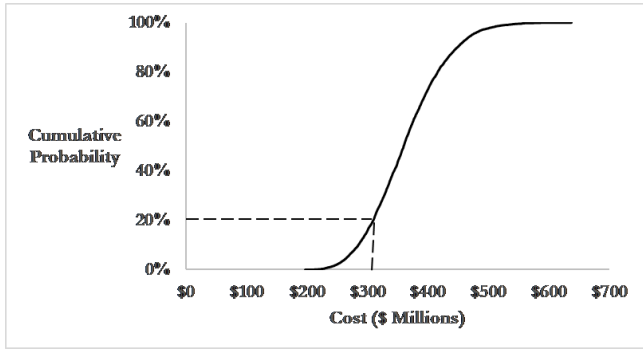
POINT ESTIMATES ARE POINTLESS

Funding to levels below the mean for WBS elements results in low confidence level funding for a system

Funding Each WBS Element to Its 50% Confidence Level Results in a 20% Confidence Level for the System



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CONNECTION WITH PORTFOLIO ANALYSIS

Just as with a WBS, funding individual projects below the mean results in a negative portfolio effect

Total organization is riskier than individual projects!

4

S-CURVES

Cost and schedule risk are typically displayed graphically as "S-curves"

Provides probability that cost/schedule will not exceed a specified value

Point Estimates Significantly Underestimate Cost and Schedule

ISSUES WITH THE CURRENT PRACTICE OF RISK ANALYSIS

RISK ANALYSIS FAILINGS

Even when quantitative risk analysis is conducted it is not implemented well

Variety of issues

RISK RANGES ARE NOT REALISTIC

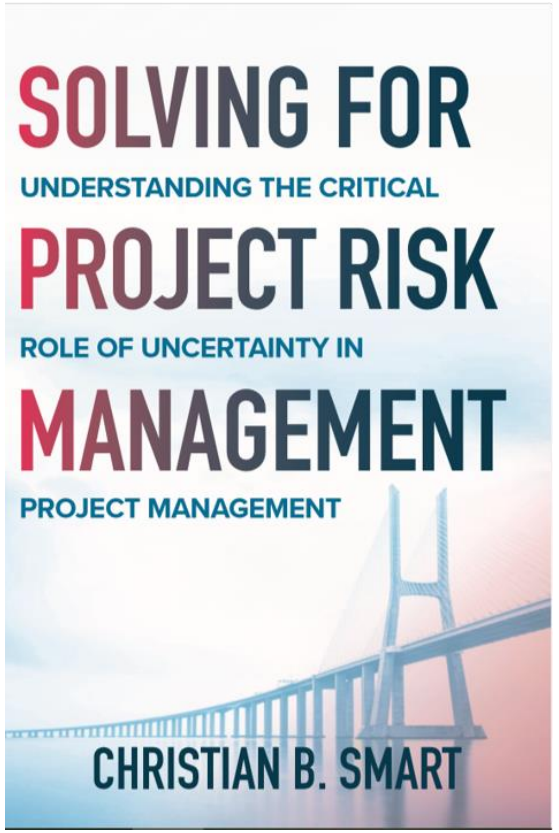
In practice, most risk analysis results in tight ranges that do not reflect the true potential for cost or schedule growth

PORTFOLIO ANALYSIS IS NOT CONDUCTED

Risk analysis is typically conducted at the project level – but not at the portfolio level

BEYOND S-CURVES

S-curve provide useful information, but do not provide critical information about the tails



These issues and more are addressed in my book, which is now available from Amazon, Barnes and Noble, and others
Read Chapter 1 for free: https://bit.ly/3ggPZK2

ABOUT THE AUTHOR

- Chief Scientist with Galorath Federal
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- Twenty years of experience with cost and schedule risk analysis, predictive analytics, probabilistic reliability analysis, and machine learning
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