JDSAT
Operations Research & Big Data Sciences

Probability Management

Accounting for Uncertainty in Business Decisions

Shaun Doheney
Chief Analytics Officer
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Chair, Resources & Readiness Applications
ProbabilityManagement.org

ABOUT THE PRESENTER

Mr. Shaun Doheney

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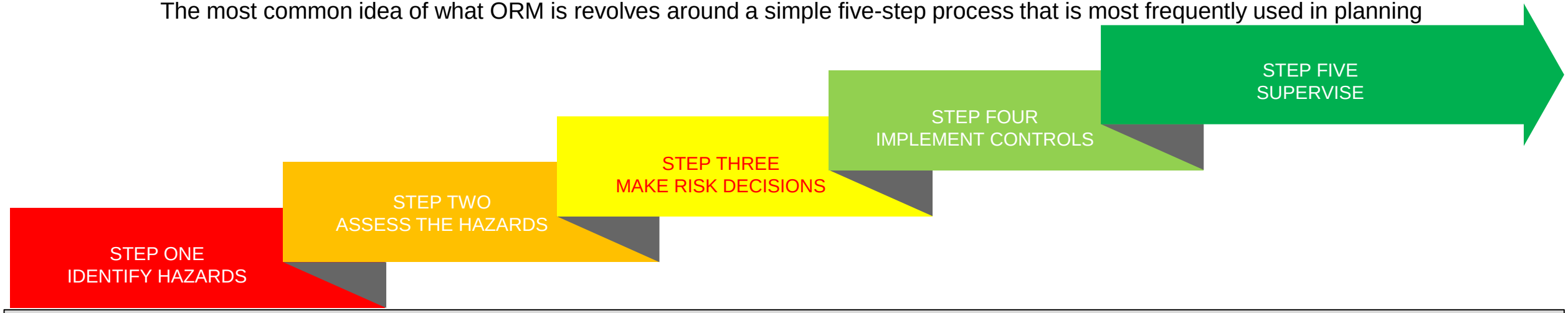
Chair, Resources & Readiness Applications

Probability Management

Shaun Doheney is the Chief Analytics Officer for JDSAT – a certified Service-Disabled Veteran-Owned Small Business specializing in Operations Research and Data Science. Shaun is also the Chair of Resources and Readiness Applications at ProbabilityManagement.org - a nonprofit devoted to the communication and calculation of uncertainty. He holds a B.S. in Mathematics from California State University, Long Beach, an M.S. in Operations Analysis from the Naval Postgraduate School, a Graduate Certificate in Data Analytics from George Mason University, is an INFORMS Certified Analytics Professional (CAP®), and is a PMI certified Project Management Professional (PMP ®). As a Marine Corps Lieutenant Colonel (Retired) and Marine Operations Research Analyst, he performed quantitative and qualitative analyses and evaluations across major DoD decision support processes. His past projects featured optimization, multiple-objective decision analysis, quantitative risk analysis, modeling and simulation, and survey design and analysis. His more recent work has focused on guiding adoption of analytic methods involving uncertainty associated with risk and readiness, as well as optimizing allocation of resources across operational scenarios to inform portfolio funding decisions over a multi-year horizon.

The Operational Risk Management Process

The most common idea of what ORM is revolves around a simple five-step process that is most frequently used in planning



Step 1. Identify hazards - A hazard is any condition with the potential to negatively impact mission accomplishment or cause injury, death, or property damage. Hazard identification is the foundation of the entire RM process. If a hazard is not identified, it cannot be controlled.

Step 2. Assess the hazards - For each hazard identified, determine the associated degree of risk in terms of probability and severity. The result of the risk assessment is a prioritized list of hazards, which ensures that controls are first identified for the most serious threat to mission or task accomplishment. Combine the severity with the probability to determine the risk assessment code (RAC) or level of risk for each hazard, expressed as a single Arabic number. Although not required, the use of a matrix, such as the one below, is helpful in identifying the RAC.

Step 3. Make risk decisions - A key element of the risk decision is determining if the risk is acceptable. This decision must be made at the right level by the individual who can balance the risk against the mission or task potential benefit and value. This individual decides if controls are sufficient and acceptable and whether to accept the resulting residual risk. If it is determined the risk level is too high, the development of additional or alternate controls, modifications, changes, or rejecting the course of action becomes necessary.

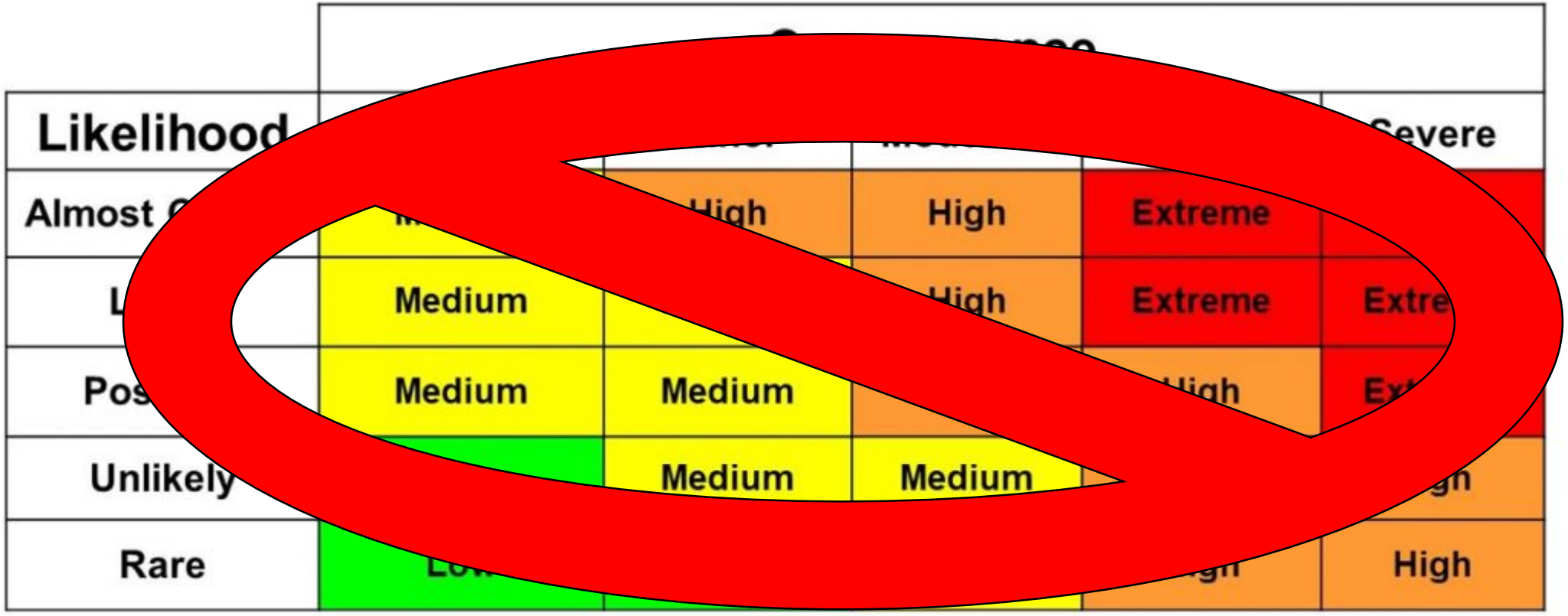
Step 4. Implement controls - Once the risk control decisions are made, the next step is implementation. This requires that the plan is clearly communicated to all the involved personnel, accountability is established, and necessary support is provided. Careful documentation of each step in the RM process facilitates risk communication and the rational processes behind the RM decisions.

Step 5. Supervise - Supervise and review involves determining the effectiveness of risk controls throughout the mission or task. This involves three actions: monitoring the effectiveness of risk controls; determining the need for further assessment of all or a portion of the mission or task due to an unanticipated change; and capturing lessons learned, both positive and negative.

Risk

What do we mean?

- a measure of the probability and severity of adverse effects (Lawrence 1976)
- the probability and consequence of an event causing harm to something valued (CJCSM 3501.01)



'Pay your age' promo causes chaos for Build-A-Bear

https://www.cbc.ca/news/business/build-a-bear-pay-your-age-1.4744480

- Children's toy seller Build-A-Bear was forced to halt a promotion that allowed customers to pay their age after the publicity stunt became too popular and led to safety concerns from long lineups.
- The retailer was touting a promotion online for weeks where a child could get a customized teddy bear for the same price as their age — a five-year-old child would pay $5 for the bear, for example. Normally, the bears cost well over $20 apiece, or more with accessories.
- With limited in store capacity, locations quickly filled up and management had to quickly deploy staff to marshal line ups outside. To control the crowds, doors were closed and in some locations mall security were called to maintain order.
- What contributed to this failure?
  - Poor assumptions.
  - Failure to anticipate demand.
  - Failure to develop contingency plans.

How the Phoenix pay system rose and fell

https://www.cbc.ca/news/canada/ottawa/phoenix-ottawa-timeline-1.3691812

- Canada's government payroll system is the largest in the country, covering 300,000 employees. The transition to a new system called Phoenix was announced in 2009 and began in February 2016.
- As soon as the system was launched it was clear there were problems. As many as 7,000 calls per day were received by the system help desk. Being sized for a maximum of 2,200 calls per day the help desk was quickly overcome.
- By July of 2016, the number of outstanding problems reported by government employees had reached a staggering 82,000 cases. An analysis of the problems by government staff and the IT systems provider found that the costs to address the ousting issues could be as a high as $50M[1].
- What contributed to this failure?
  - Poor assumptions.
  - Failure to anticipate demand.
  - Failure to have sufficient resources on hand to address launch glitches and problems.

1. https://www.cbc.ca/news/canada/ottawa/phoenix-pay-update-deadline-1.3751126

Why Do Projects Fail?

There are many forms of failure:

- schedule slippage;
- budget overruns;
- quality issues;
- products that don't meet the envisioned business need.

A common theme…

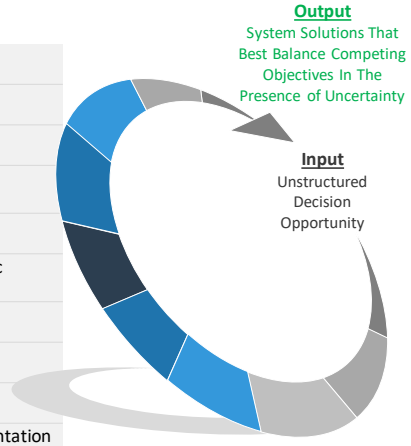
Not properly accounting for uncertainty.

Key Features of a New Risk Management Representation:

- **Open Standard Data:** The representation should use standard cross platform compatible data, and not require proprietary software to interpret. Additionally, the standard risk data being reported must be stored in a common schema, allowing analysts to quickly wrangle the data for model development.
- **Additive:** Using analytic tools, the arithmetic of chance becomes as simple as adding columns of data to get the risk of combined elements. Note that the columns capture the interdependencies between risks. You probably can't do the required calculations in your head, or even with a calculator. They can, however, be done easily with a laptop and Excel, or Python, or R, or [insert your favorite computational platform here].
- **Auditable:** The representation should have an audit trail with provenance. Is the source of the data being used authoritative? If it isn't auditable, there may be no way to know.
- **Agnostic:** The representation should be available in numerous non-proprietary formats such as Excel, CSV, XML, etc. and be accessible across software platforms.
- **Actionable:** The representation should enable calculations involving the chance of risks. Applications should be able to talk to each other, in that quantifiable results from one application can be easily incorporated into other analytical models, exercises, and war games.

Proposed Solution:

1	Frame Decision
2	Develop Objectives and Measures
3	Generate Creative Alternatives
4	Assess Alternatives and Deterministic Analysis
5	Synthesize Results
6	ID Uncertainty & Conduct Probabilistic Analysis
7	Assess Impact of Uncertainty
8	Improve Alternatives
9	Communicate Tradeoffs
10	Present Recommendation & Implementation Plan



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Accounting for Uncertainty by
Starting Small and Reinforcing Success

Probability Management

- ***Column Representation of Risk***
  - ✓ ***Cures the Flaw of Averages (explained shortly)***
  - ✓ ***Enables Rolling-Up Risk***
  - ✓ ***Interactive***
- The discipline of probability management represents the risk as a vector of realizations. These vectors can be rolled up to model the multiple types of risks in an uncertain environment.
- The approach does not require specialized software. The Open SIPmath™ Standard from 501(c)(3) ProbabilityManagement.org allows simulations in any environment to be networked by communicating uncertainties as arrays of Monte Carlo realizations called Stochastic Information Packages (SIPs).
- The free SIPmath Modeler Tools create interactive simulations in native Excel which run 10,000 trials or more per keystroke. The models created by the tools do not require macros or add-ins to run so they can be shared with any Excel user.

Uncertainty in the Iron Triangle – The Triple Constraints of Business

01

Time

Will the project be completed on time as planned at the start of the project?

02

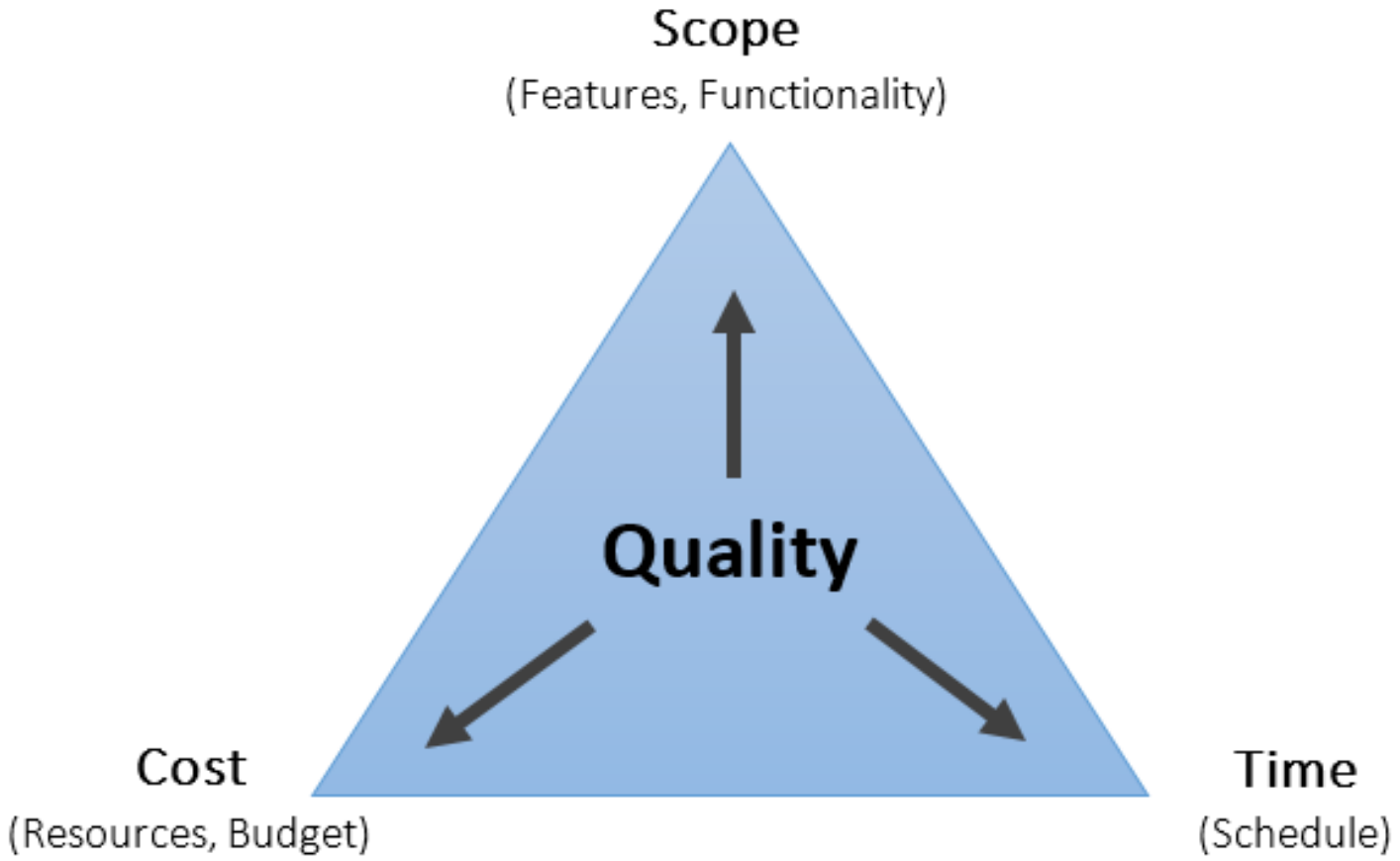
Cost

Will the project be completed within the allocated budget?

03

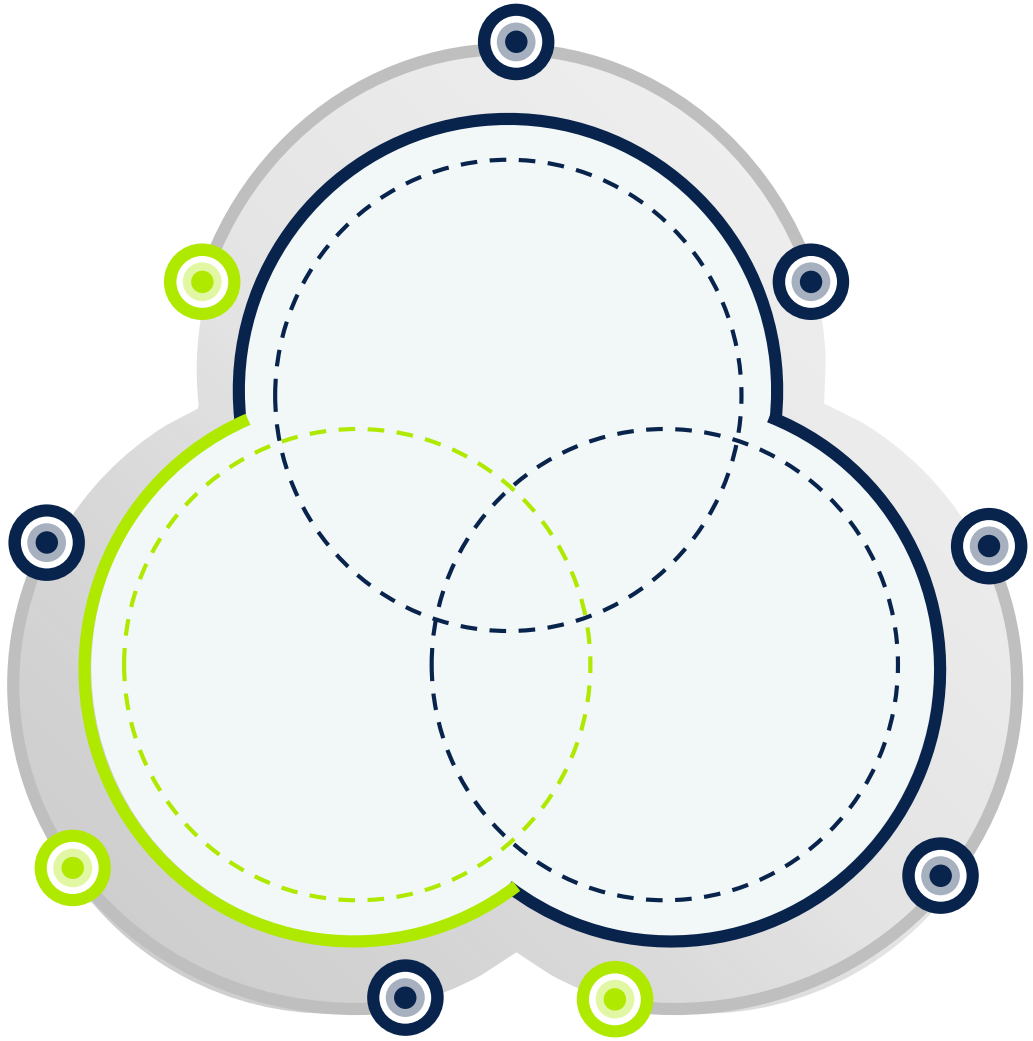
Scope

Were all the planned features implemented or not?



Iron Triangle — Triple Constraints of Project Management, https://medium.com/@harpreet.dhillon/iron-triangle-triple-constraints-of-project-management-e818e631826c

Good, Fast, or Cheap Pick Two



Scope

Were all the planned features implemented or not?

Cost

Will the project be completed within the allocated budget?

Time

Will the project be completed on time as planned at the start of the project?

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Good & Fast

Develop something quickly and of high quality, it will be very costly to do

Won’t be Cheap

Scope

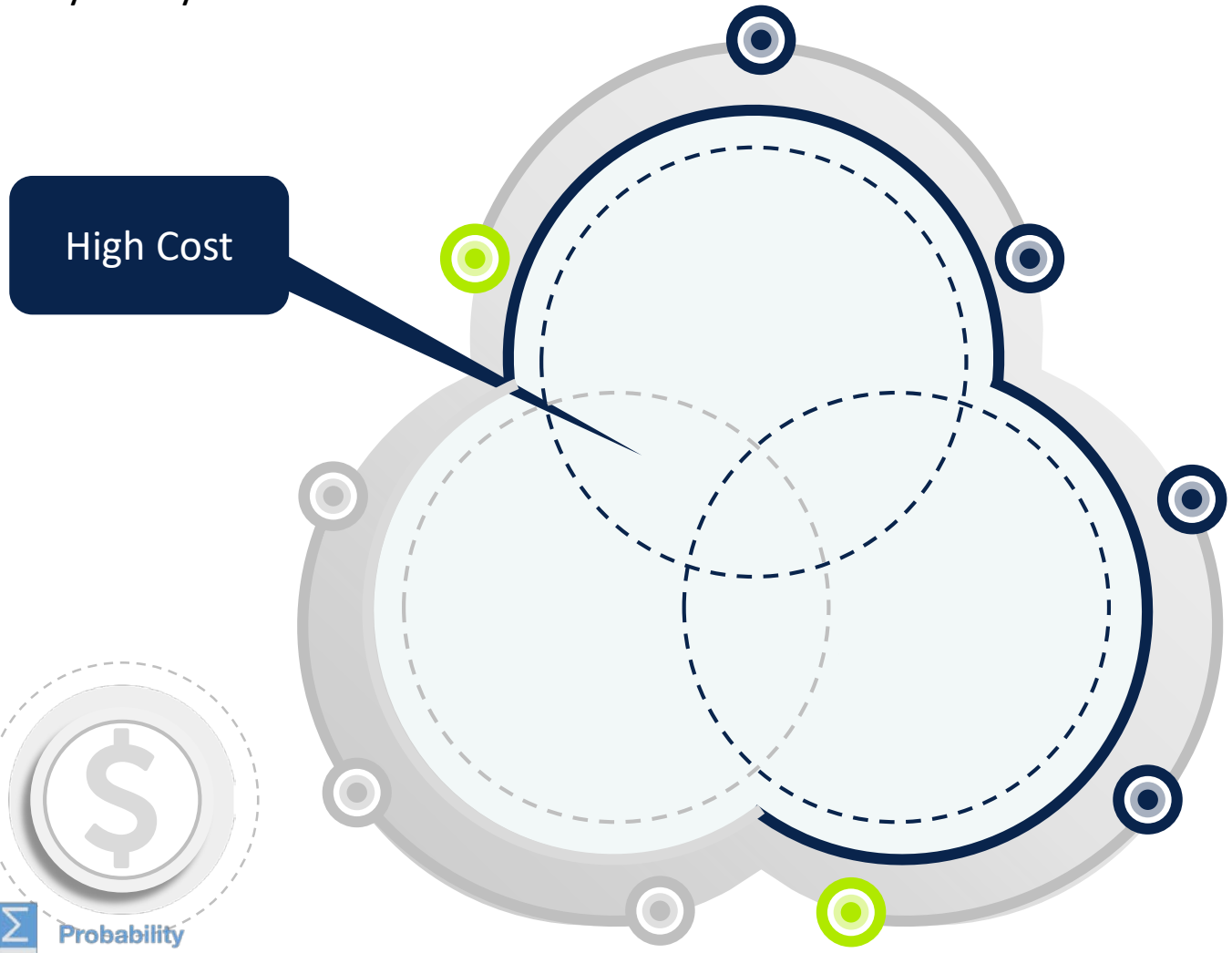
Were all the planned features implemented or not?

Cost

Will the project be completed within the allocated budget?

Time

Will the project be completed on time as planned at the start of the project?



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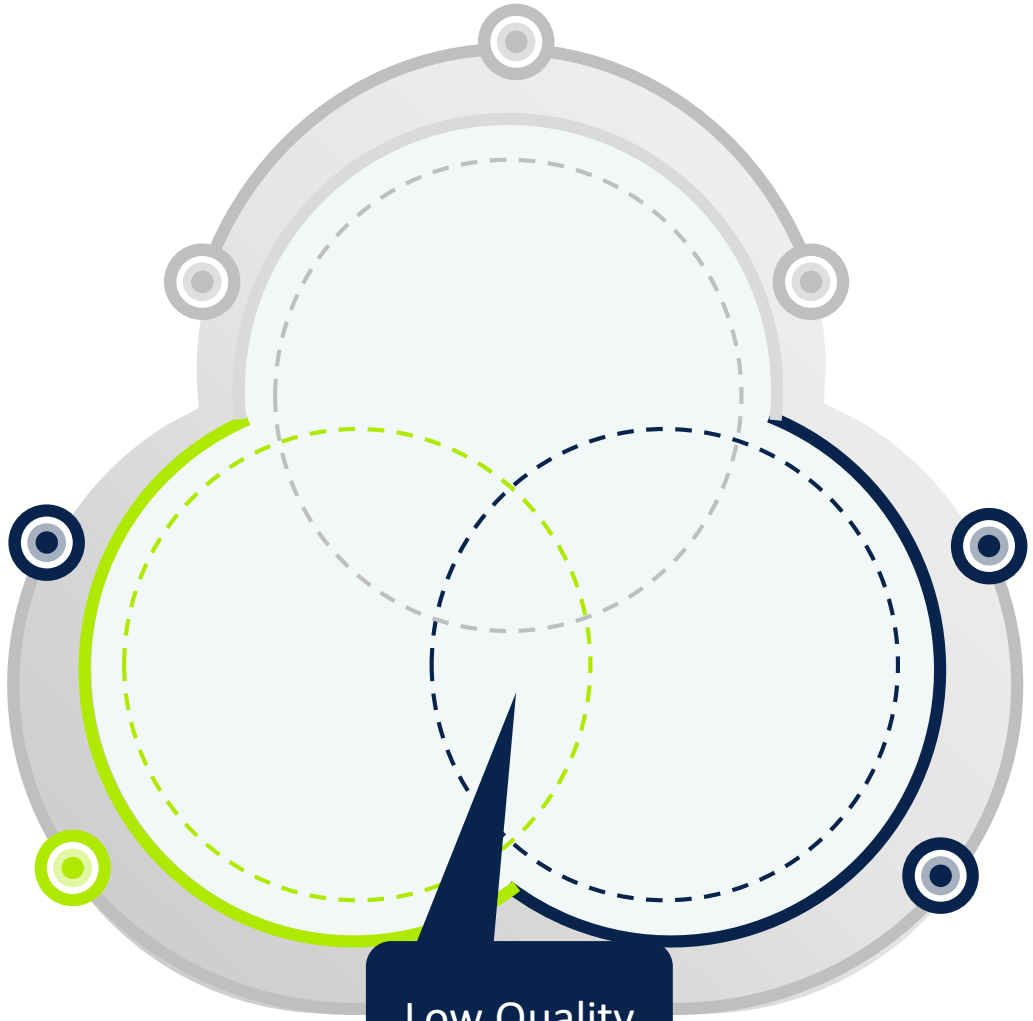
Fast & Cheap

Develop something quickly and cheaply, it will not be of high quality



Won't be Good

Scope

Were all the planned features implemented or not?

Cost

Will the project be completed within the allocated budget?

Time

Will the project be completed on time as planned at the start of the project?

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Good & Cheap

Develop something of high quality and low cost, it will take a long time.

Won't be Fast

Scope

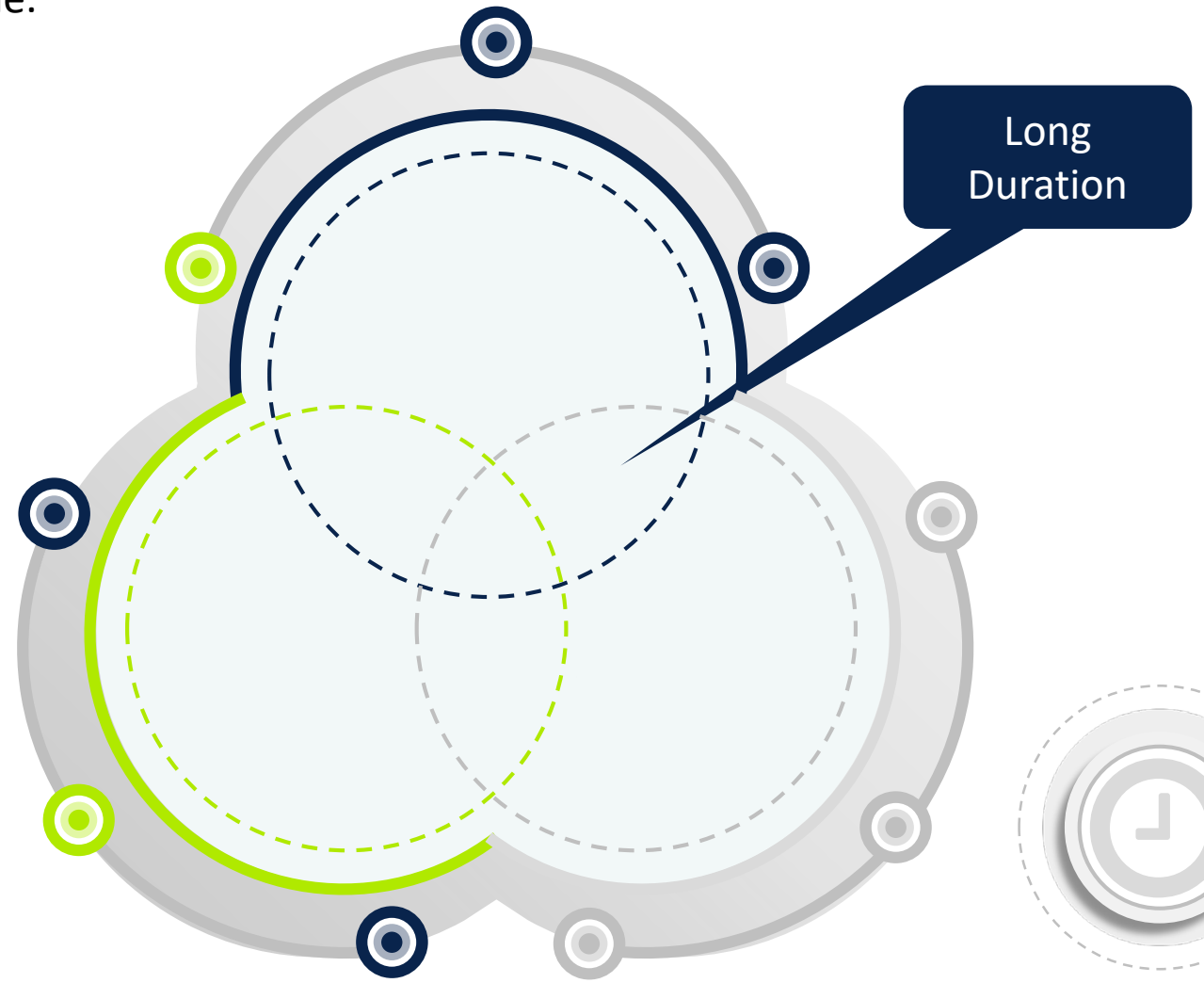
Were all the planned features implemented or not?

Cost

Will the project be completed within the allocated budget?

Time

Will the project be completed on time as planned at the start of the project?



Good, Fast, AND Cheap… Keep Dreaming

The Iron Triangle, https://www.f13design.com/the-iron-triangle/

The Iron Triangle isn't new; we've all heard of this before

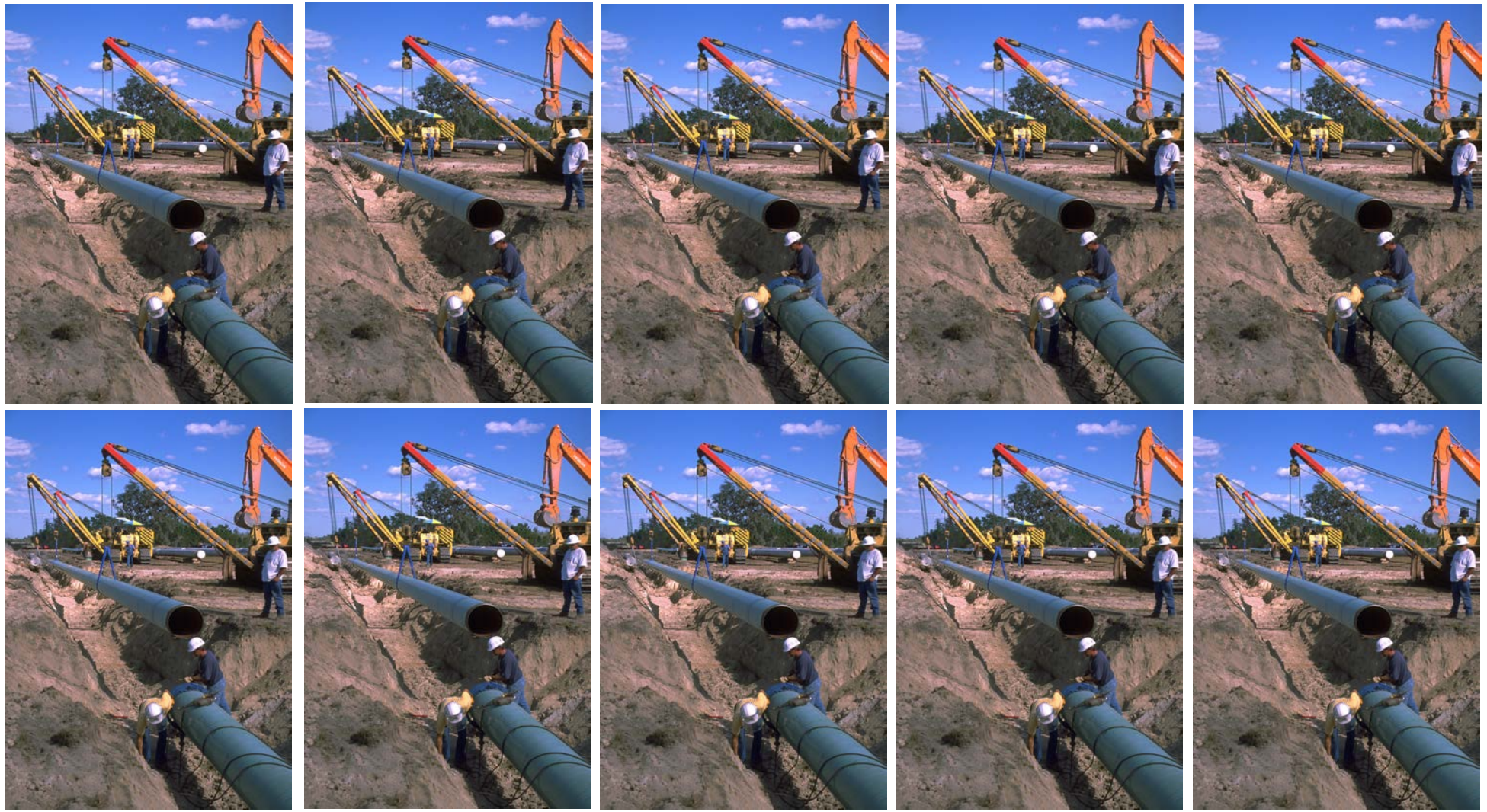
- **Has anyone here had a conversation with a client or customer hoping that we can and will achieve all three even if "just this once"?**

- **Has anyone recently witnessed a project:**
  - **… over budget?**
  - **… beyond schedule?**
  - **… fail to deliver a key feature?**

- **Then these ideas clearly bear reminding. But what's the solution?**

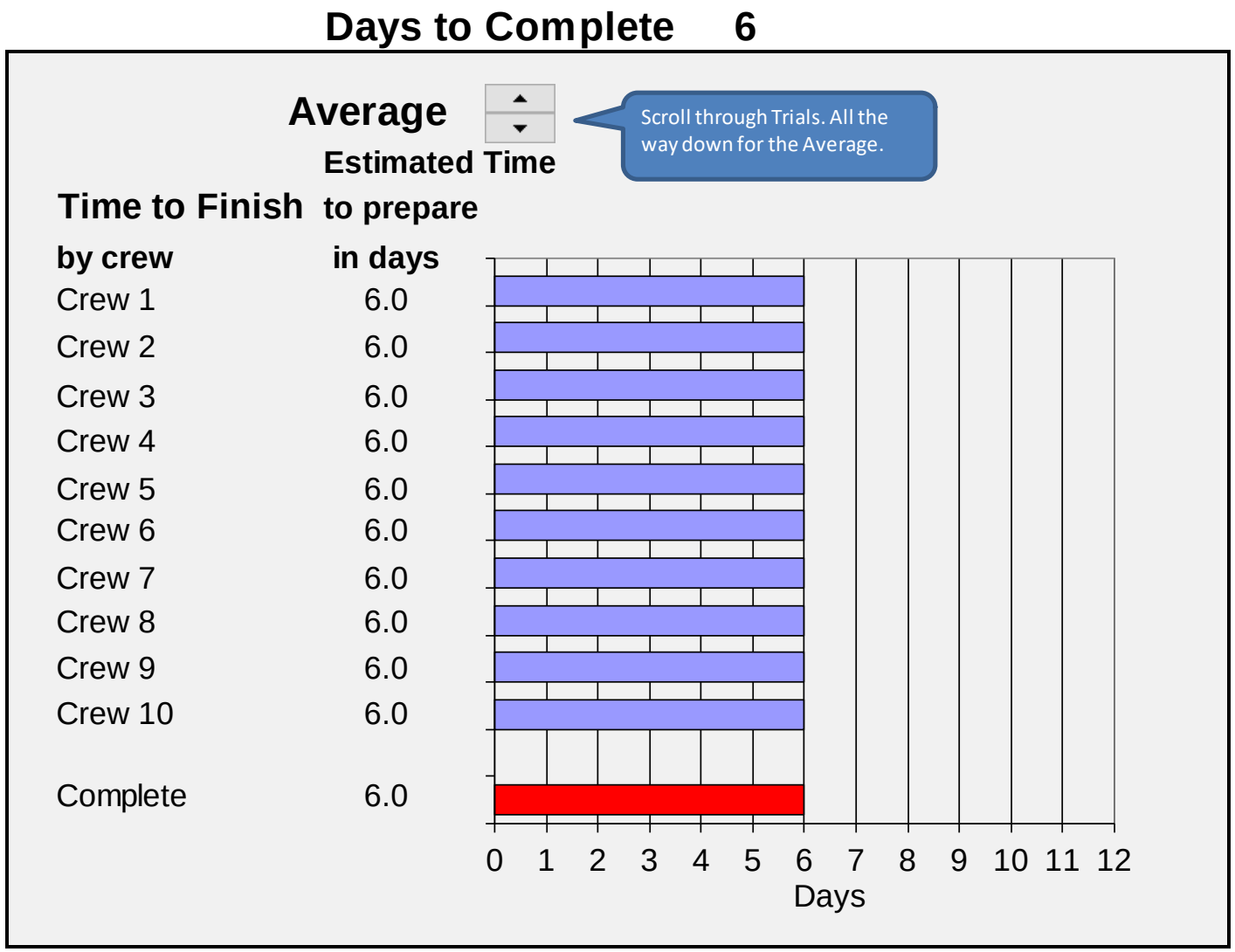
Ten separate pipeline construction projects must be completed

Each Crew will Work in Parallel and Take an Average of Six Days to Complete their Pipeline



When Will the Pipeline Infrastucture be Operational?

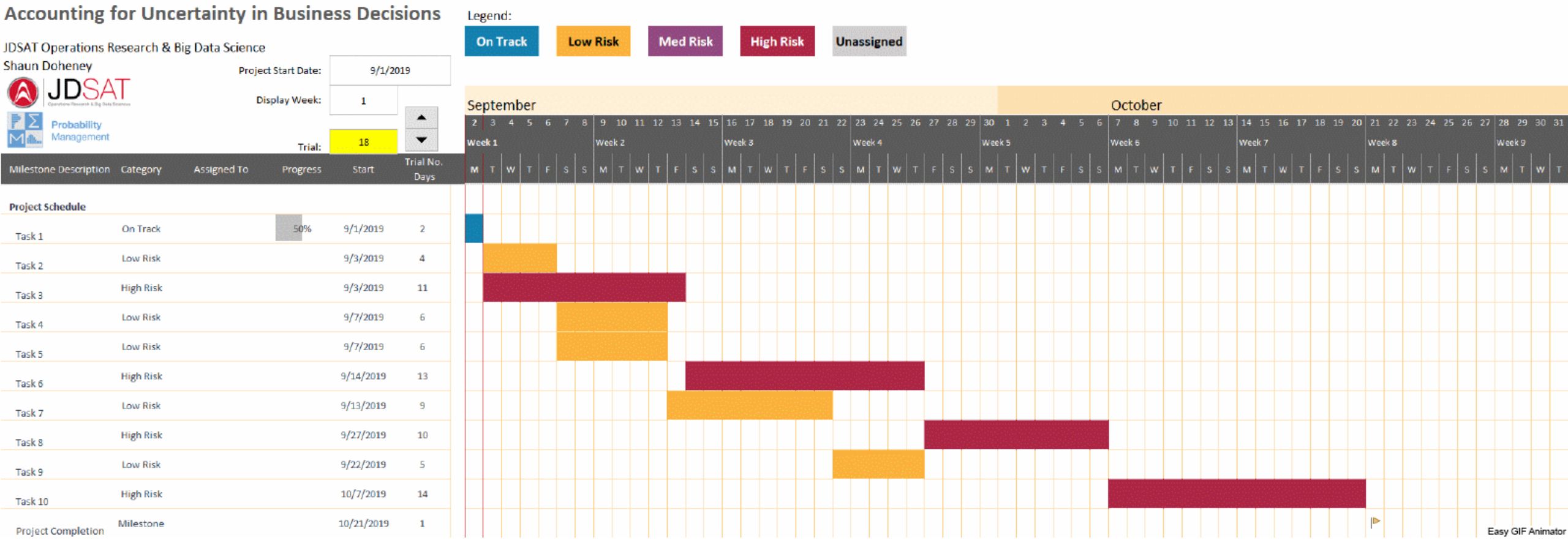
With apologies to Dr. Sam Savage, author of the Flaw of Averages



What is the probability the pipeline projects will be completed in 6 days?

a. 100%
b. 50%
c. 1 chance in 4
d. 1 chance in 10
e. 1 chance in 100
f. 1 chance in 1,000
g. 1 chance in 10,000

And that was when the tasks were done in parallel…
… What about for “normal” projects?



“Was that an FS, FF, SS, or SF activity?”

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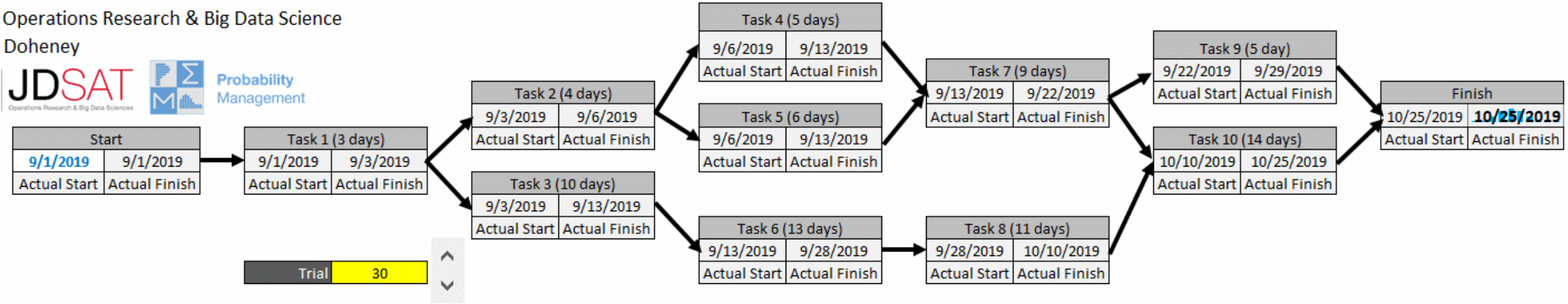
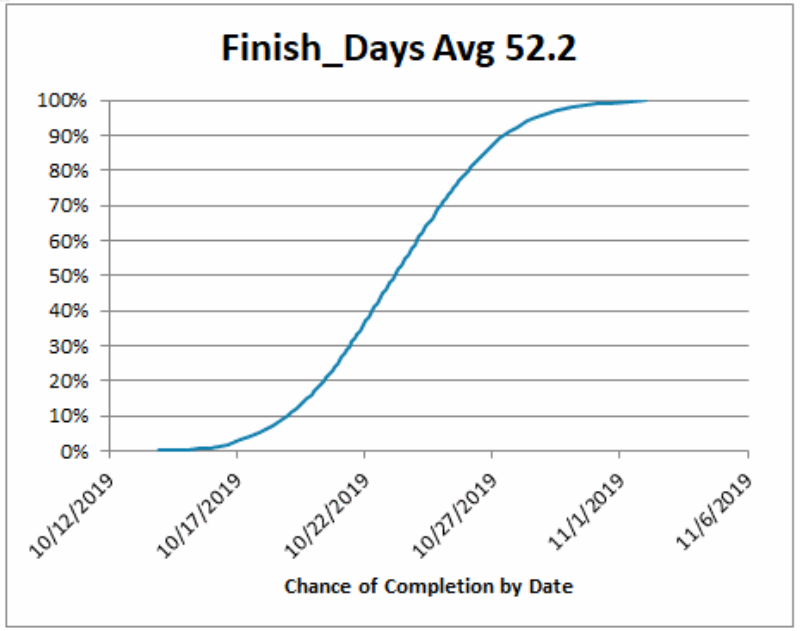
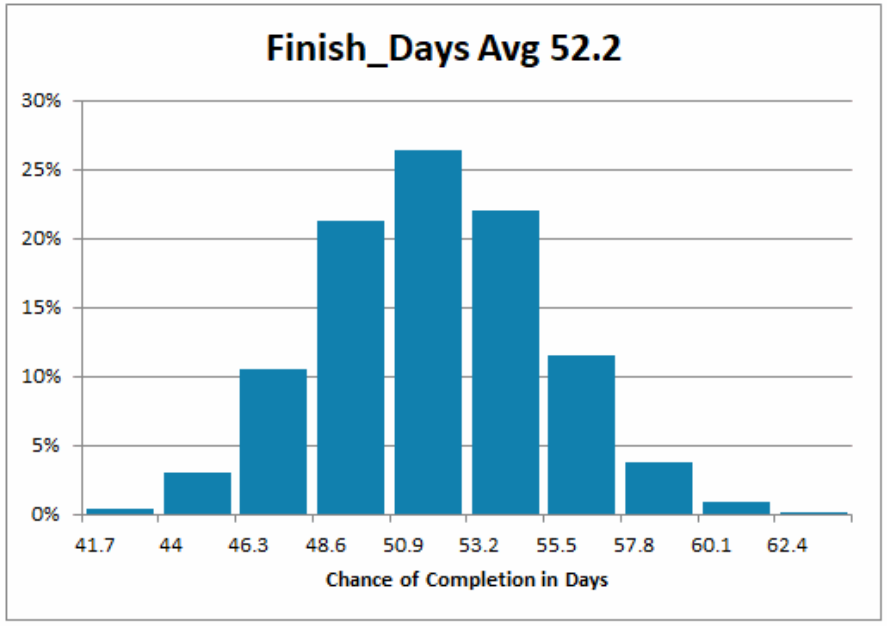


TASK	Predecessor	MIN	ML	MAX	Trial Result
Task 1		2	3	5	2.7
Task 2	Task 1	3	4	7	3.2
Task 3	Task 1	7	10	14	10.0
Task 4	Task 2	3	5	8	6.4
Task 5	Task 2	4	6	9	6.6
Task 6	Task 3	9	13	18	14.3
Task 7	Tasks 4 & 5	6	9	14	9.4
Task 8	Task 6	8	11	15	12.2
Task 9	Task 7	3	5	8	6.9
Task 10	Tasks 7 & 8	10	14	21	15.0
Finish_Days					54.21





Easy GIF Animator

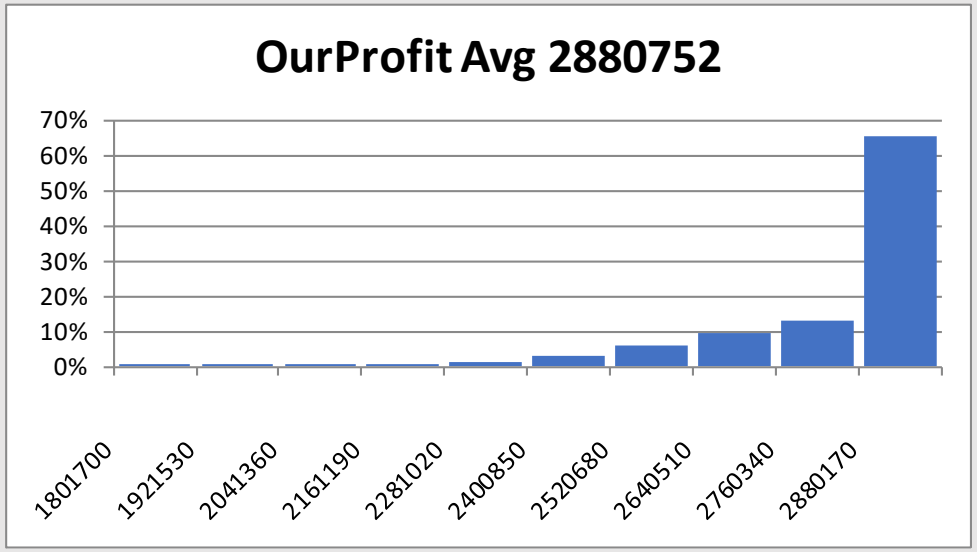
Estimating Uncertain Profit

You're the Chief Financial Officer for a manufacturing plant.

Your monthly profit is proportional to the monthly demand. The maximum capacity of your manufacturing plant is 1,000 units. If the demand is greater than 1,000 units, then any demand over your maximum capacity of 1,000 units will be satisfied by some other manufacturer, and therefore won't be profit for your production plant.

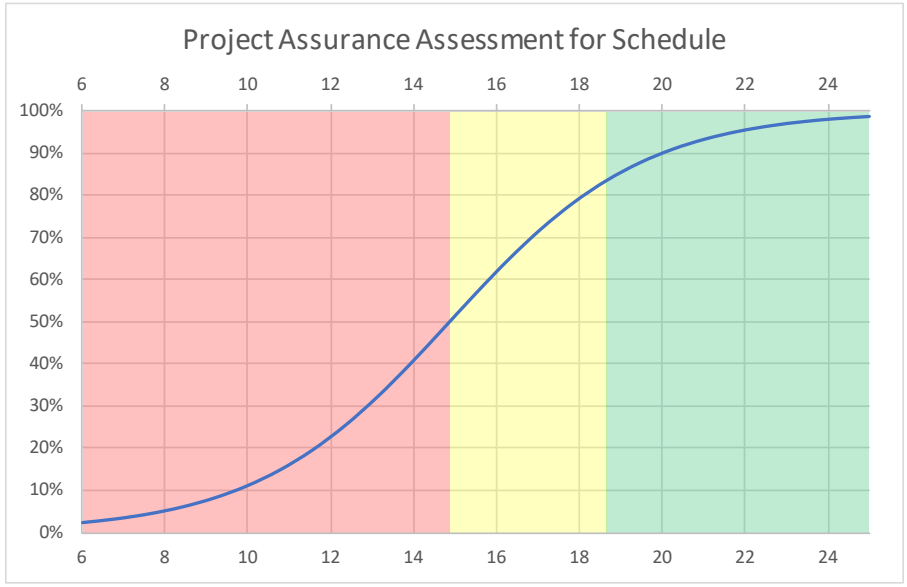
The monthly demand is uncertain, but the average demand is reliably estimated at 1000 units per month. At this level of demand, the montly profit is $3,000,000. The CEO comes in and says that he's trying to figure out if he can hire another employee and needs to know what the expected monthly profit will be for the next 12 months. Which of the following is true of the expected profit?

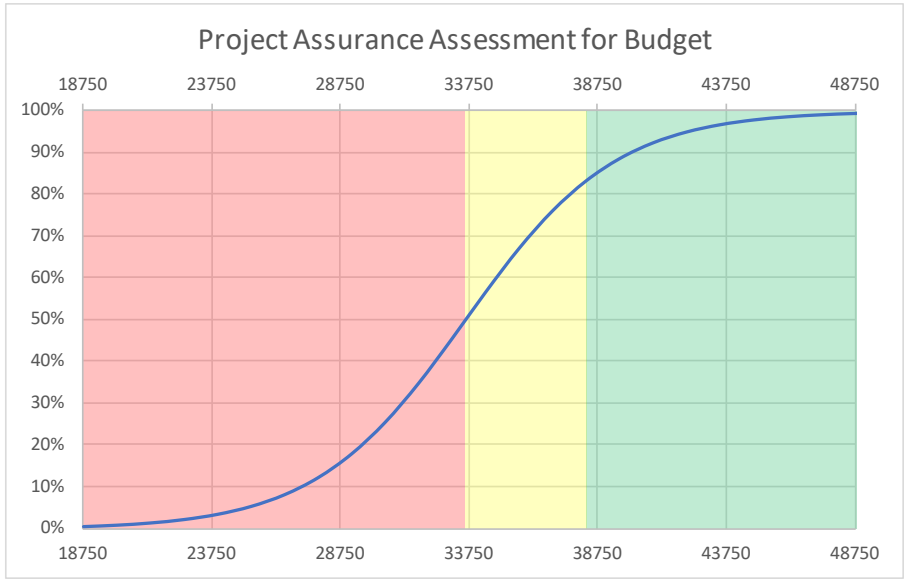
A. Expected profit can have any value.
B. Expected profit could be greater than $3,000,000.
C. Expected profit is equal to $3,000,000.
D. Expected profit is less than $3,000,000

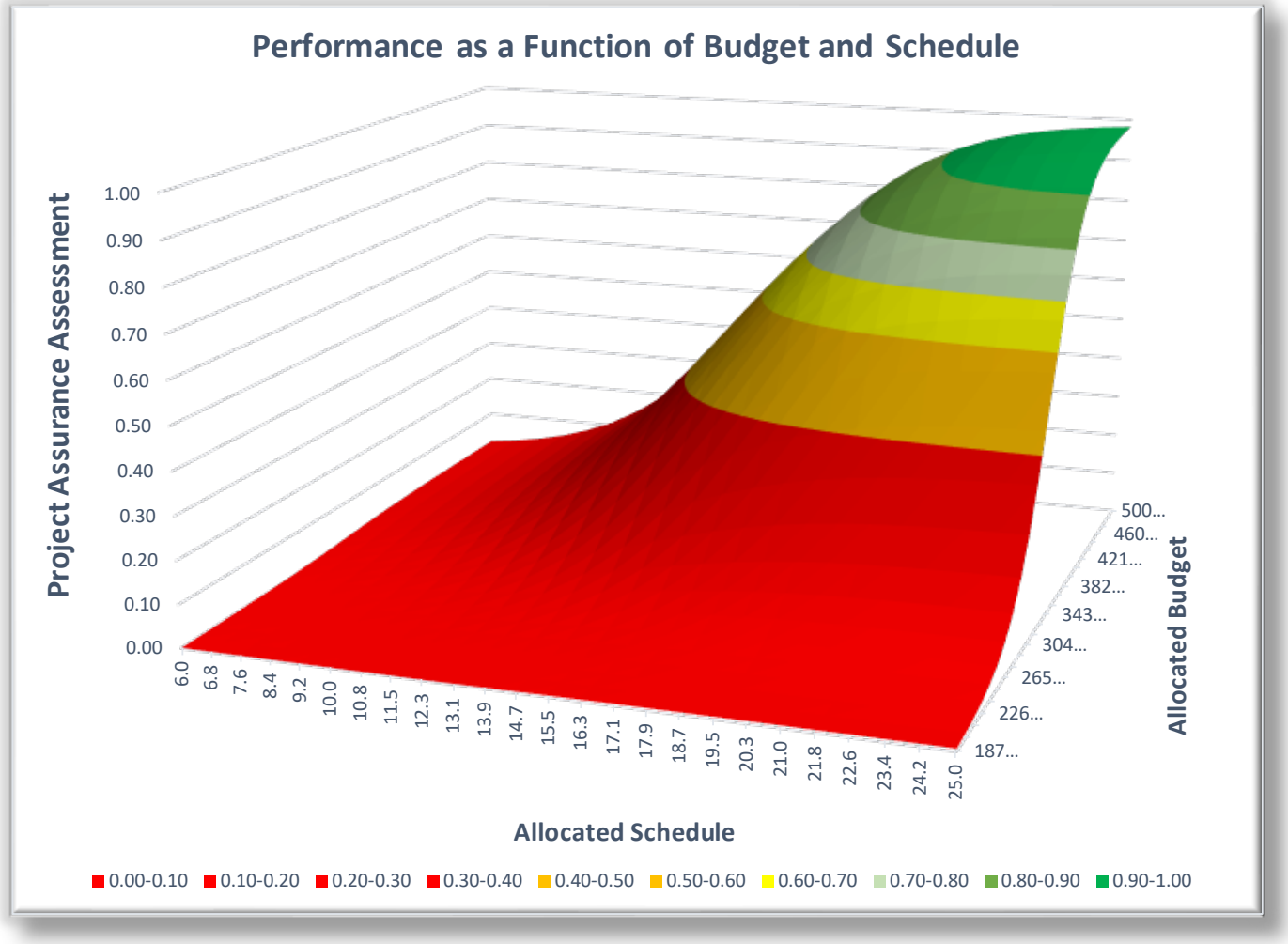


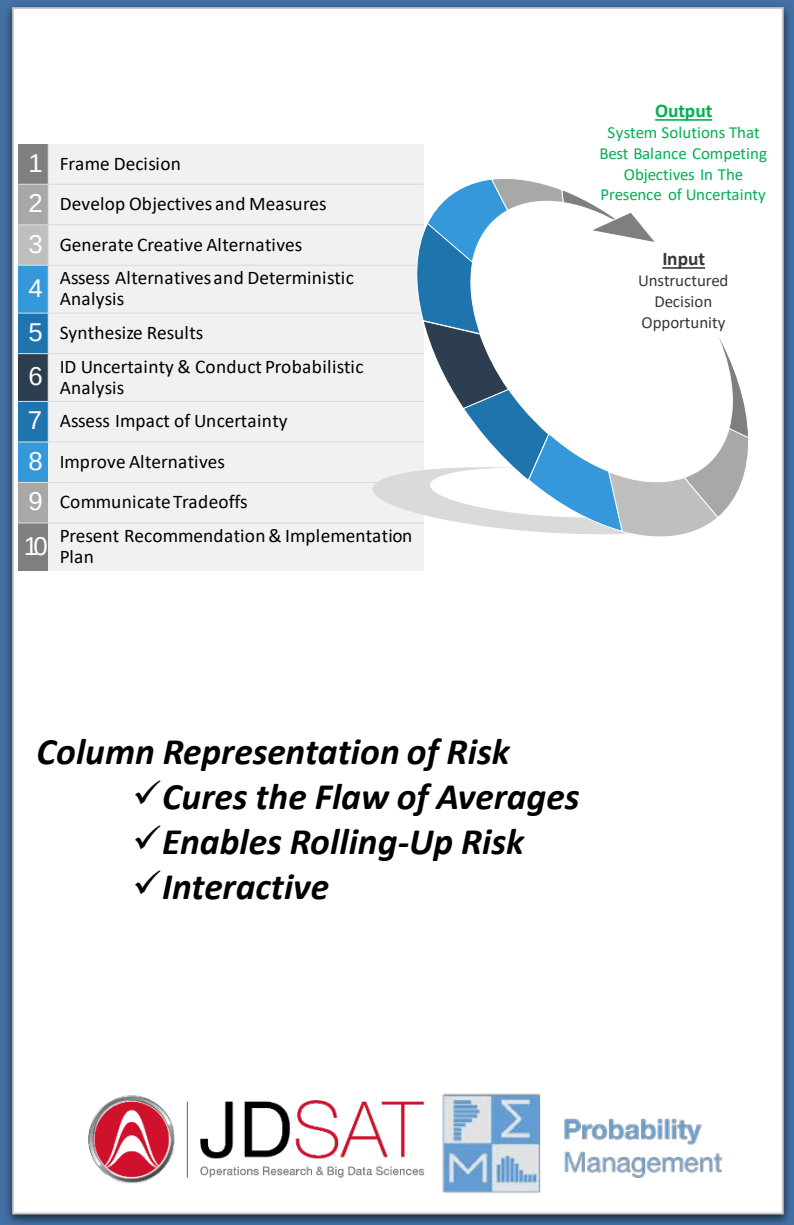
The chance that my profit will be | < | $ 2,750,000 | is | **20%**

Modeling the Iron Triangle – Cost, Schedule & Performance



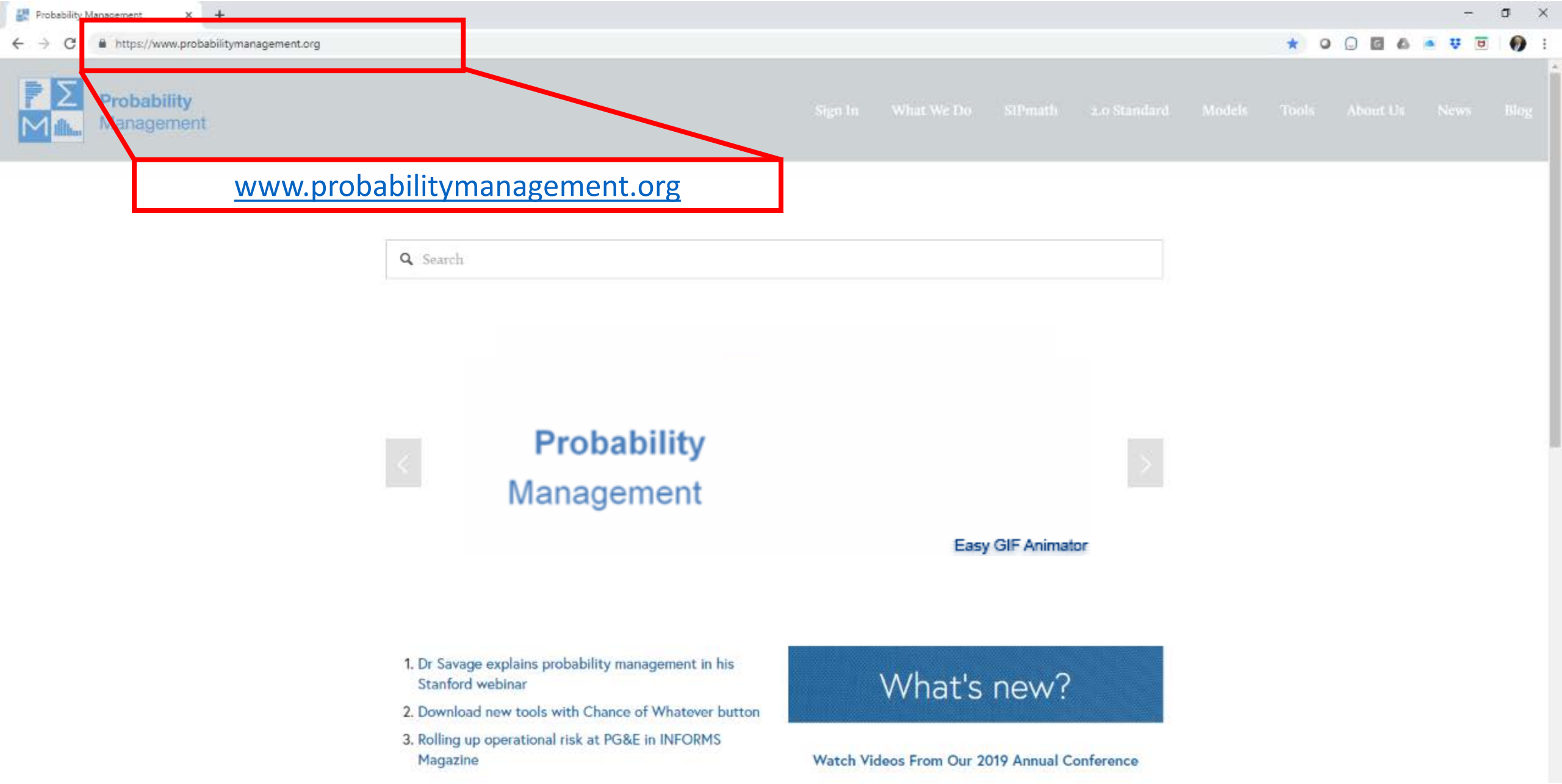






Conclusion:

- The risk management system should be able to aggregate the risk of multiple aspects while accounting for chance.
- To do so, business leaders should consider adopting column representations of risk that are additive, actionable, auditable, agnostic, and capable of accounting for chance.
- Column representations could provide decision-makers a comprehensive understanding of risk at all organizational levels, allowing for mathematically sound aggregation and true representation of risk.
- By starting small and reinforcing success, adoption can grow organically at little cost.
- This approach would bring incremental value for measuring risk in any organization at which it was adopted.



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Companion Models to Published Articles and Presentations

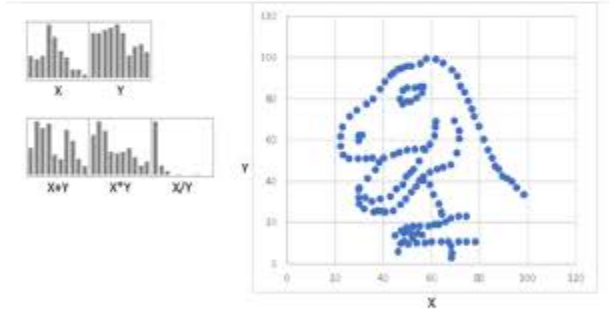
The best way to learn about probability management is to explore interactively.
NOTE: to experiment with the models below, you will need to enable content, if asked, and make sure that Excel is in Automatic Calculation mode.

Search

Datasaurus Arithmetic

Based on the Datasaurus data set of Alberto Cairo, which was based in turn on DrawMyData by Robert Grant. This model shows that SIPmath lets you do arithmetic with the most bizarre distributions imaginable.

Download Model (.xlsx)



None of My Successes Have Been Planned and None of My Plans Have Been Successful: Simulating Rags to Riches and Vice Versa

https://www.probabilitymanagement.org/tools-1

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New Enterprise SIPmath™ Modeler Tools

Search

Videos and Documentation

The SIPmath Modeler Tools leverage the native Excel Data Table function to bring interactive Monte Carlo simulation to all Excel users. The models built with these tools do not require the tools to run in Excel.

Other Simulation Tools

SIPmath™ Modeler Tools

ProbabilityManagement.org announces a paid Windows Enterprise version of our our SIPmath Modeler Tools for Excel. We still recommend that you download the Standard SIPmath Modeler Tools for Windows or Mac at no charge to get your feet wet. Then move up to the paid version when you need more performance, more support, and less guilt.

More Performance: See the chart below for a comparison of the standard and enterprise versions.

Our Standard SIPmath Modeler Tools are free when you register:

DOWNLOAD FREE TOOLS FOR WINDOWS (EXCEL 2010 AND NEWER)

DOWNLOAD FREE TOOLS FOR MAC (EXCEL 2016 AND NEWER)

The Enterprise Tools offer more features and technical support:

PURCHASE ENTERPRISE TOOLS ($500 - WINDOWS ONLY)

Read Sam's article in Analytics Magazine about the SIPmath Tools

Frequently Asked Questions

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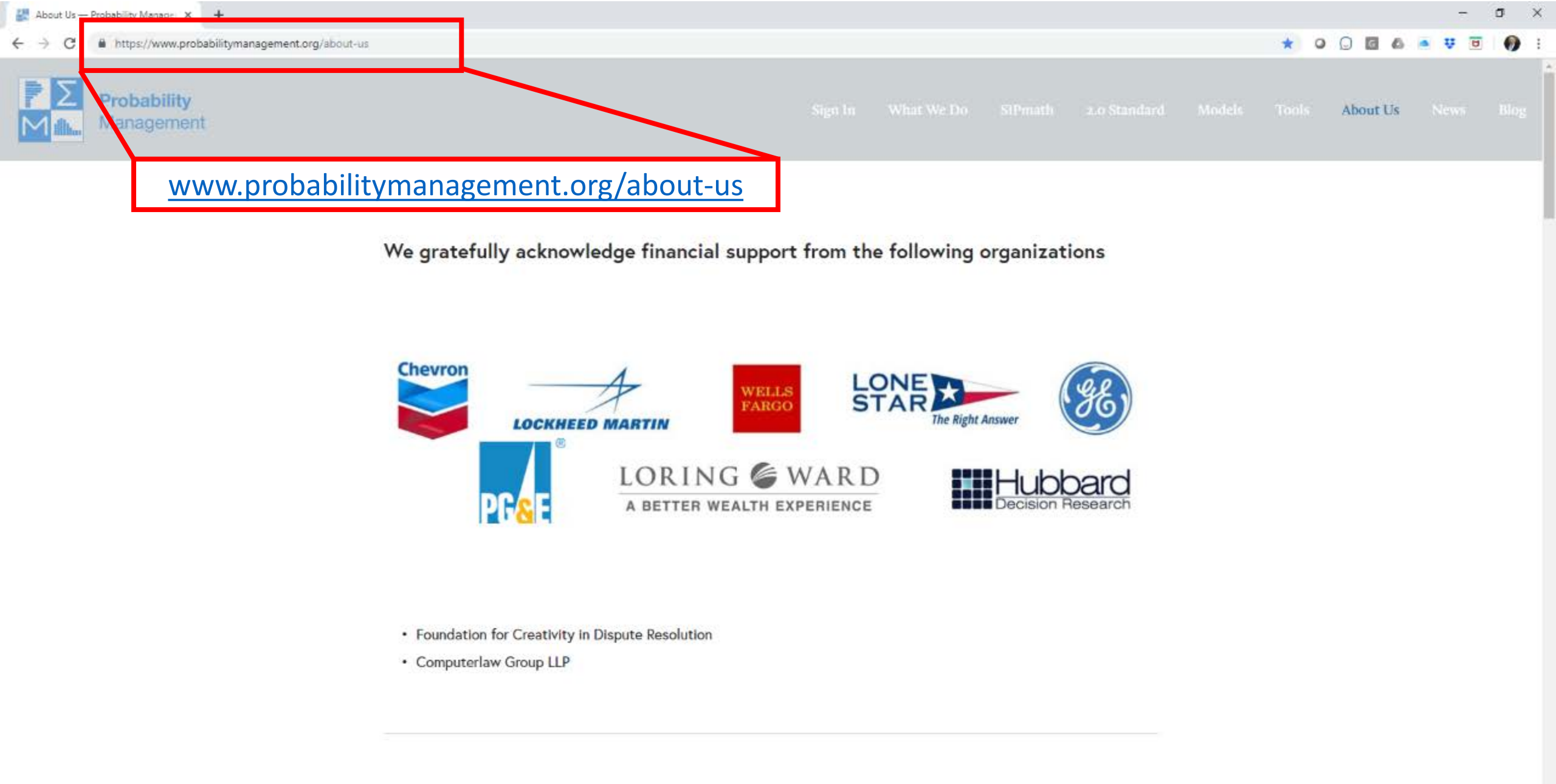

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Our team

Sam Savage

Executive Director

Author of *The Flaw of Averages* and Adjunct Professor of Civil & Environmental Engineering at Stanford University.

Harry Markowitz

Board Member

Nobel Laureate in Economics and Professor of finance at the Rady School of Management at the University of California, San Diego.

Michele Hyndman

Board Member

Fifteen years of communications consulting including 10 years as PR manager of the Stanford University School of Medicine Blood Center.

Tom Keelin

Chief Research Scientist

Founder and Managing Partner at Keelin Reeds Partners; former Worldwide Managing Director, Strategic Decision Group; Co-founder Decision Education Foundation.

June Klein

Bridget Cash

Melissa Kirmse

Dave Empey

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Chair of Secondary Education

West Oakland Middle School teacher with a background in Civil Engineering and Transportation Management.

Mary Claire Meijer

Executive Administrator

Supports the Executive Director and other team members. Multiple years of experience directing large volunteer staff.

Shaun Doheney

Chair of Resources and Readiness Applications

Chief Analytics Officer at JDSAT Operations Research and Data Science; Senior Operations Research Analyst; Data Scientist; and Marine Corps Lieutenant Colonel (Retired).

Doug Hubbard

Chair of Decisions and Measurements

President of Hubbard Decision Research and author of *How to Measure Anything*.

Shayne Kavanagh

Chair of Government Finance Applications

Shayne is the Senior Manager of Research for GFOA and has been a leader in developing the practice and technique of long-term financial planning and policies for local government.

Marc Thibault

Chair of Standards Committee

Project Planning Consultant, Author of *The Art of the Plan Blog*.

Keith Shepherd

Chair of Agricultural Applications

Principal Scientist at World Agroforestry (ICRAF) and Advisor to Innovative Solutions for Decision Agriculture (iSDA) with 40 years' experience in tropical land management.

Connor McLemore

Chair of National Security Applications

Connor McLemore is an Operations Research Analyst and Section Head at the Pentagon.

Brian Putt

Chair of Energy Practice

Consulting Decision Analyst. 41 years at Chevron (retired). Developed DA Practice and conducted probabilistic analysis of capital investment.

Matthew Raphaelson

Chair, Financial Applications

Retail banking executive for 25 years. Treasurer for San Francisco Conservatory of Music, and former board member for BAI, a banking industry association.

Steve Roemerman

Chair of Best Modeling Practice

Chairman and CEO of Lone Star Analysis, Inc.

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