Planning, Tracking, and Reducing a Complex Project's Value at Risk

Dr. Tyson R. Browning
Neeley School of Business
Texas Christian University

TysonBrowning.com

Based on the articles:

- Browning, Tyson R. (2019) "Planning, Tracking, and Reducing a Complex Project's Value at Risk," *Project Management Journal*, 50(1): 71-85.
- Browning, T. (2014) "A Quantitative Framework for Managing Project Value, Risk, and Opportunity," *IEEE Transactions on Engineering Management*, 61(4): 583-598.
- Browning, T., et al. (2002) "Adding Value in Product Development by Creating Information and Reducing Risk," *IEEE Trans. on Eng. Management*, 49(4): 443-458.

Dr. Tyson R. Browning

Professor of Operations Management
Neeley School of Business
Texas Christian University, Fort Worth, Texas, USA

- Educational Background
  - B.S., Engineering Physics, Abilene Christian University
  - S.M., Aeronautics & Astronautics, M.I.T.
  - S.M., Technology & Policy, M.I.T.
  - Ph.D., Technology, Management & Policy, M.I.T.
- Work Experience
  - Lockheed Martin Aeronautics Co., Honeywell Space Systems
- Research Emphases
  - Managing complex engineering projects and processes
  - System architecting, design, and development
  - Models and tools to support these efforts
- Industries
  - Aerospace, automotive, computer, software, utilities, railroad, military, government
- Co-Editor-in-Chief: *Journal of Operations Management*

Key Questions

- How do you measure progress in projects?
- How do you know if you're making enough progress (i.e., "ahead" or "behind")?
- How do your projects plan and track technical performance risk and opportunity?
- How do you trade off technical performance against project cost/budget and duration/schedule?

Initial Notes and Observations

- The result of product/system development (PD): a product "recipe,"* including a design that conforms to its requirements with acceptable confidence
- PD is
  - A creative, discovery process
  - Iterative, not linear
- In PD
  - Certainty is valuable
  - Uncertainties are costly—some more costly than others
  - Value is added by removing uncertainty and adverse impacts—i.e., by reducing the risk of an undesired outcome

*(Reinertsen 1999)

Problems with Earned Value Management (EVM)

- Deterministic view of cost and schedule
- Ignores uncertainty and risk
- Ignores quality/performance dimension
- Tracks “perceived progress” (Cooper 1993), ignores rework
- Inappropriately incentivizes:
  - Doing the easiest activities first
  - Starting activities prematurely → increasing risk of rework
- What type of “value” is really being “managed”?
  - Nothing about stakeholder value, value of information, or project Value at Risk (VaR)

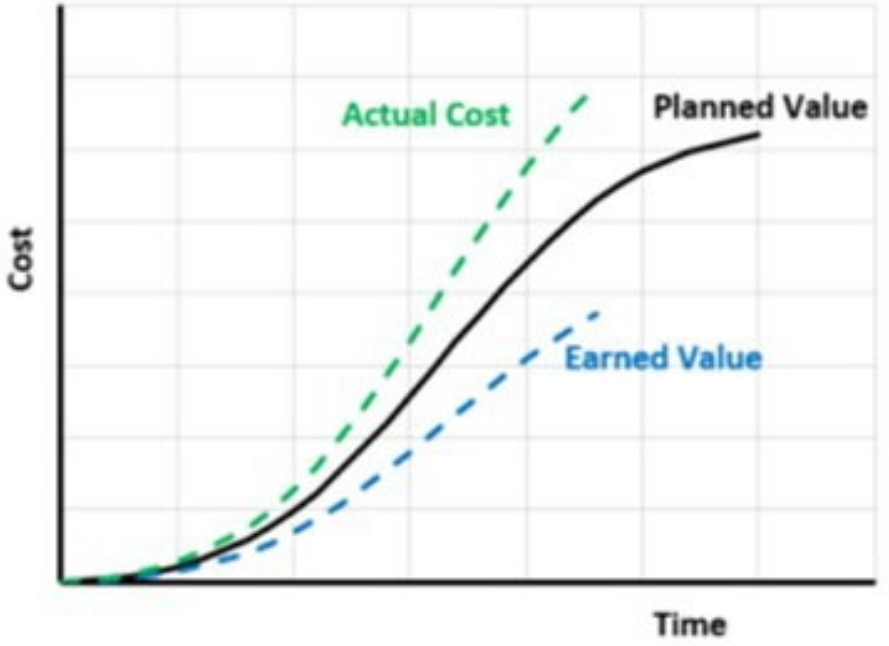


Image credit: projectengineer.net

Concept: Project Value

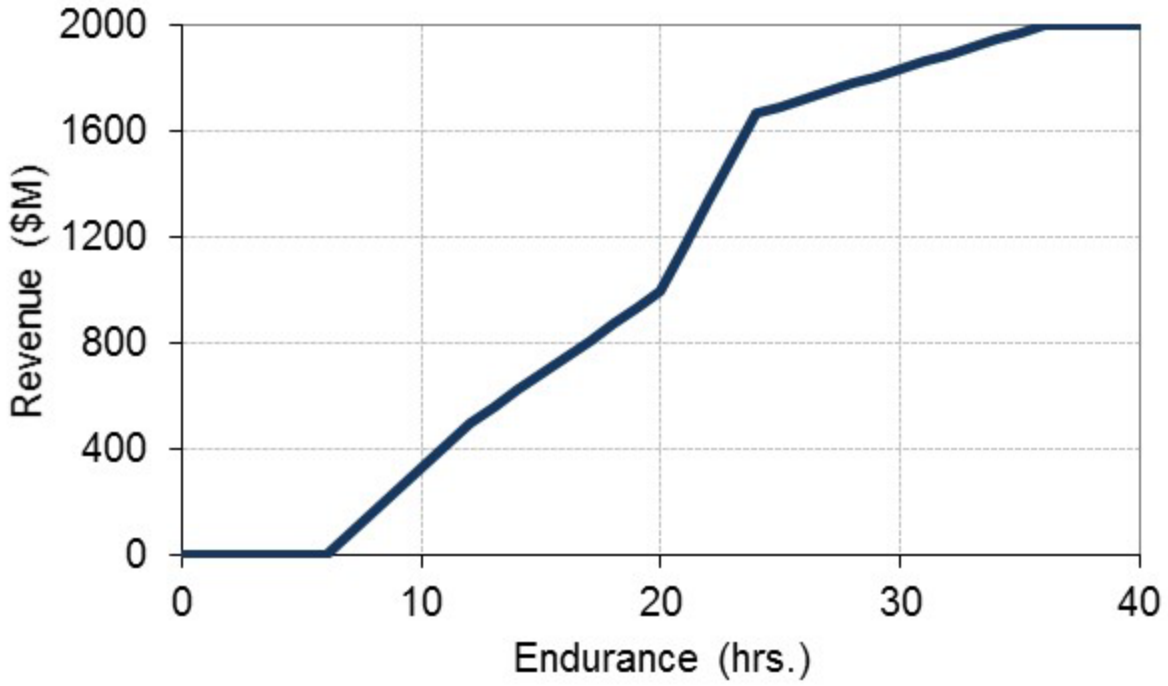
- Depends on what the project actually delivers
- Depends on stakeholders' preferences for a combination of attributes of the project and its results
- Stakeholders generally want
  - More of some attributes: features, functions, reliability, size, speed, availability, design aesthetics, etc.
  - Less of others: price, operating cost, weight, project duration, delivery time, etc.
- Project value is a composite of the relevant attributes
- Most of a project's value depends on a few (e.g., 5-10) key attributes
  - ***Project value attributes* (PVAs)**
  - Essentially the project's critical-to-quality (CTQ) characteristics

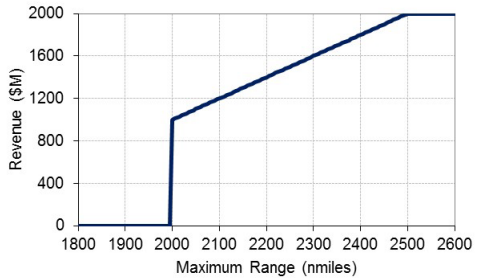
Determining PVAs

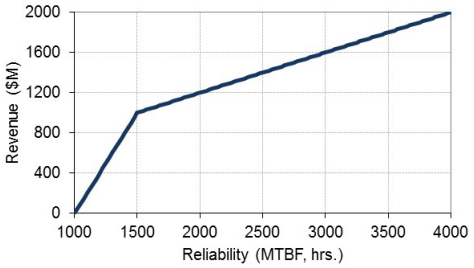
- Consider:
  - Key performance parameters
  - Stakeholder desires
  - Customer priorities
  - “Order winners”
  - Regulatory requirements
  - Competitive priorities
  - Akin to VOC, CTCs, CTQs, KPIs
  - The attributes that drive value
- Examples:
  - Functions/Features
  - Aesthetics
  - Speed
  - Power
  - Capacity
  - Reliability
  - Endurance
  - Lack of defects/bugs
  - Acquisition price
  - Operating cost

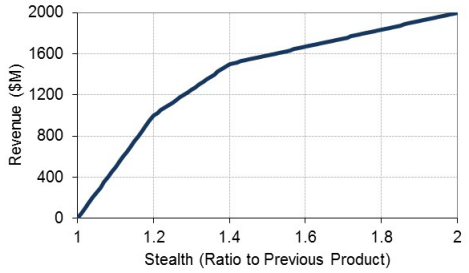
PVA Value Function: Drone Aircraft Example

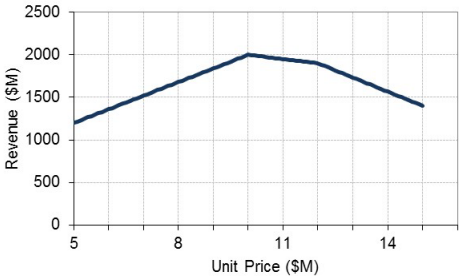
- How much value will a PVA outcome provide?
- May express in terms of revenue forecasts
- Endurance is a “larger is better” (LIB) PVA
- Assumes the product meets goals for other PVAs









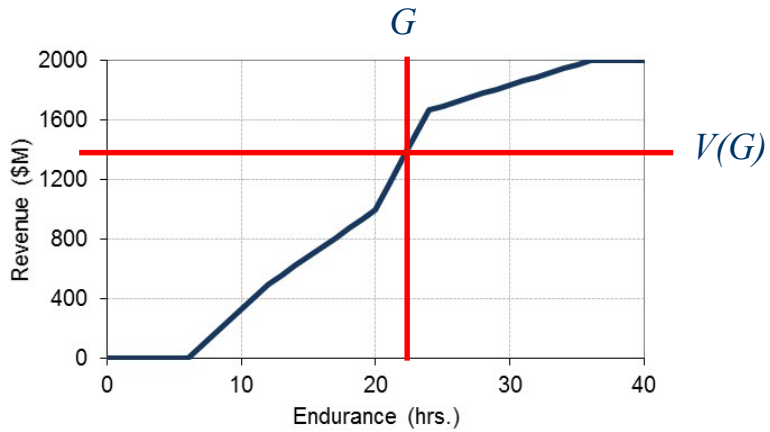


Four Types of Project Value

- At project completion:
  - Actual value
    - A project's final value at completion, based on how things turn out and where it ends up
- Prior to project completion:
  - Desired value
    - The value stakeholders (explicitly and tacitly) ideally desire from a project (may not be well articulated or understood)
  - Goal value (GV)
    - The value of a project that meets its chosen goals/targets/objectives/requirements
    - Goals can be different from stakeholders' ideal result (deliberately or not)
  - Likely value (LV) of an incomplete project
    - The estimated value of an incomplete project, given its projected outcomes

Project Goal Value (GV)

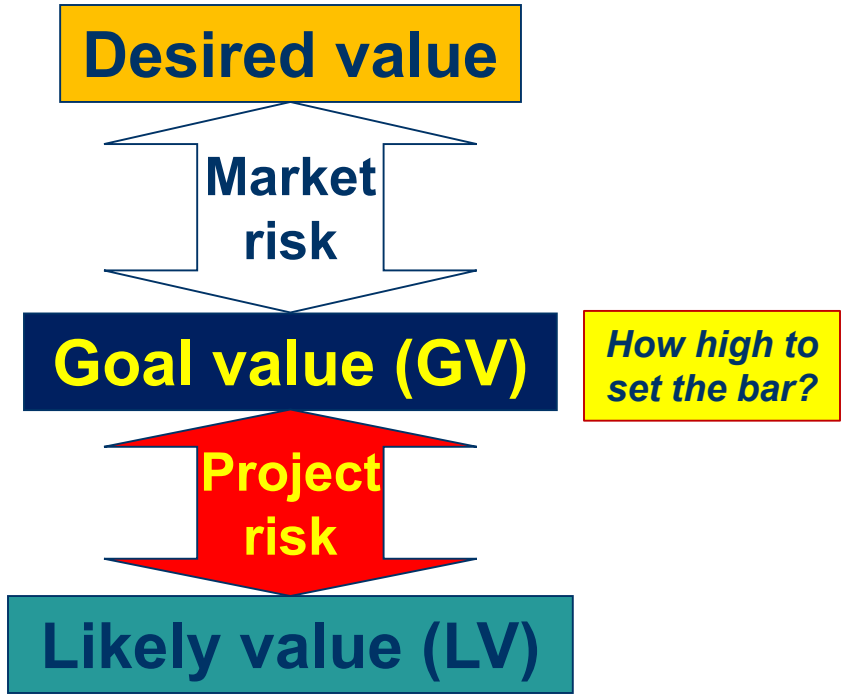
- A project sets a goal for each PVA.
- Meeting this goal provides some amount of value.
  - E.g., if our project develops a product with a particular level of PVA_1, it might sell d units at a price, generating revenue r
- Marketing and business developers regularly plan business cases around these types of projections.
- Overall project GV depends on a combination of the PVAs.



Project Goals (Partly) Determine Risk

- Project risk: generally about the risk of not meeting the chosen goals/objectives
- Market risk: generally about the risk of not choosing the right project goals/objectives

- Easy goals decrease project risk at the expense of market risk.
- More challenging goals decrease market risk at the expense of project risk.

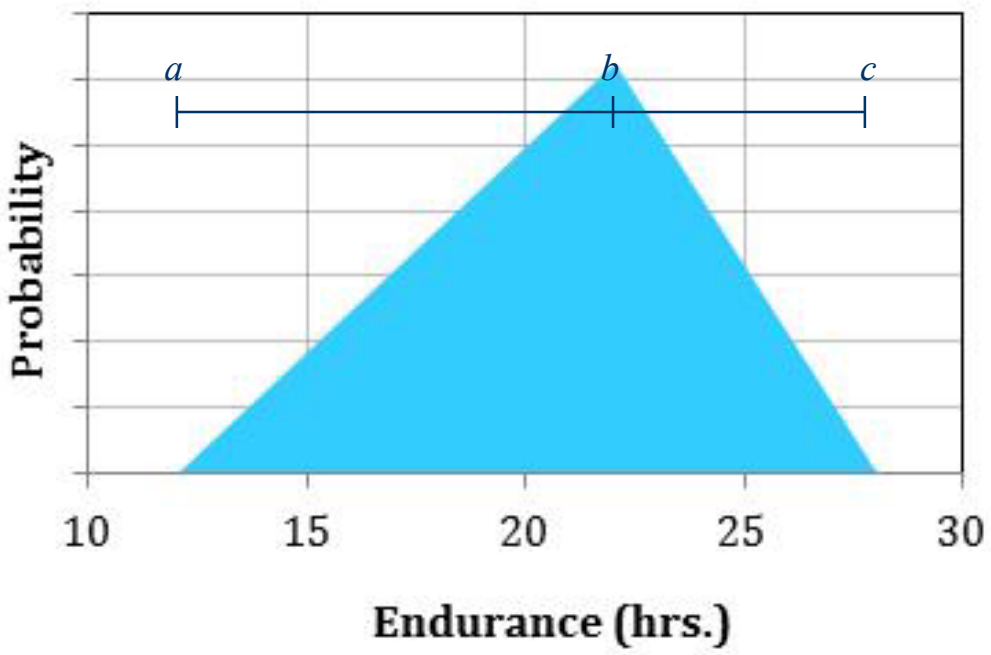


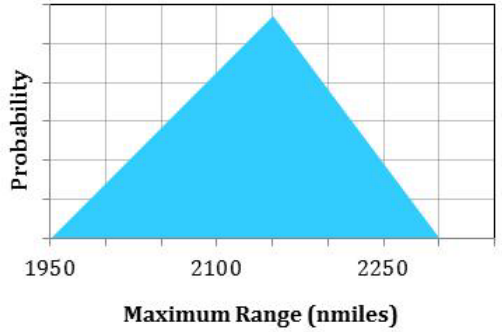
Concept: Project Capabilities

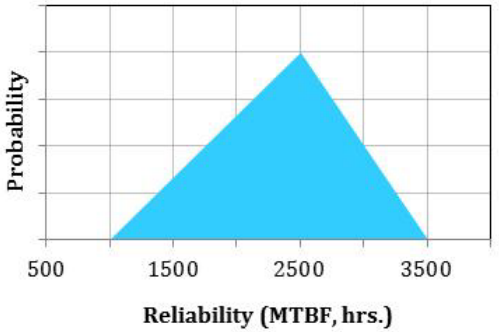
- Project capabilities depend on:
  - Available resources, technologies, expertise, skills, people, processes, and tools
  - Knowledge of potential paths towards the project's goals
  - Partner, supplier, and managerial capabilities
- Project capabilities determine the distribution of potential outcomes for each PVA, the ***project capability distributions*** **(PCDs)**
- Higher capabilities shift a PCD in a favorable direction.
- Uncertainty in the capability to achieve a PVA outcome widens a PCD.

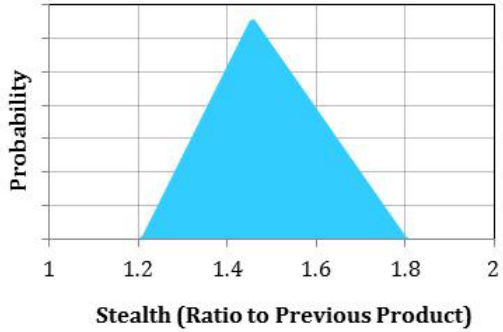
PCD Example: Drone Aircraft

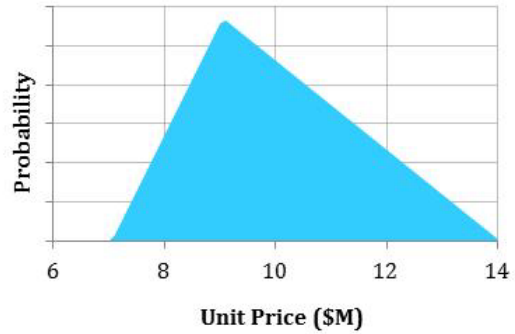
- What are the best-case, worst-case, and most likely potential outcomes?
- Consider all of the factors that affect the outcomes
- Consult as many diverse experts as practical
- Seek outlier opinions (with justifying rationale)
- Use a Delphi process if possible





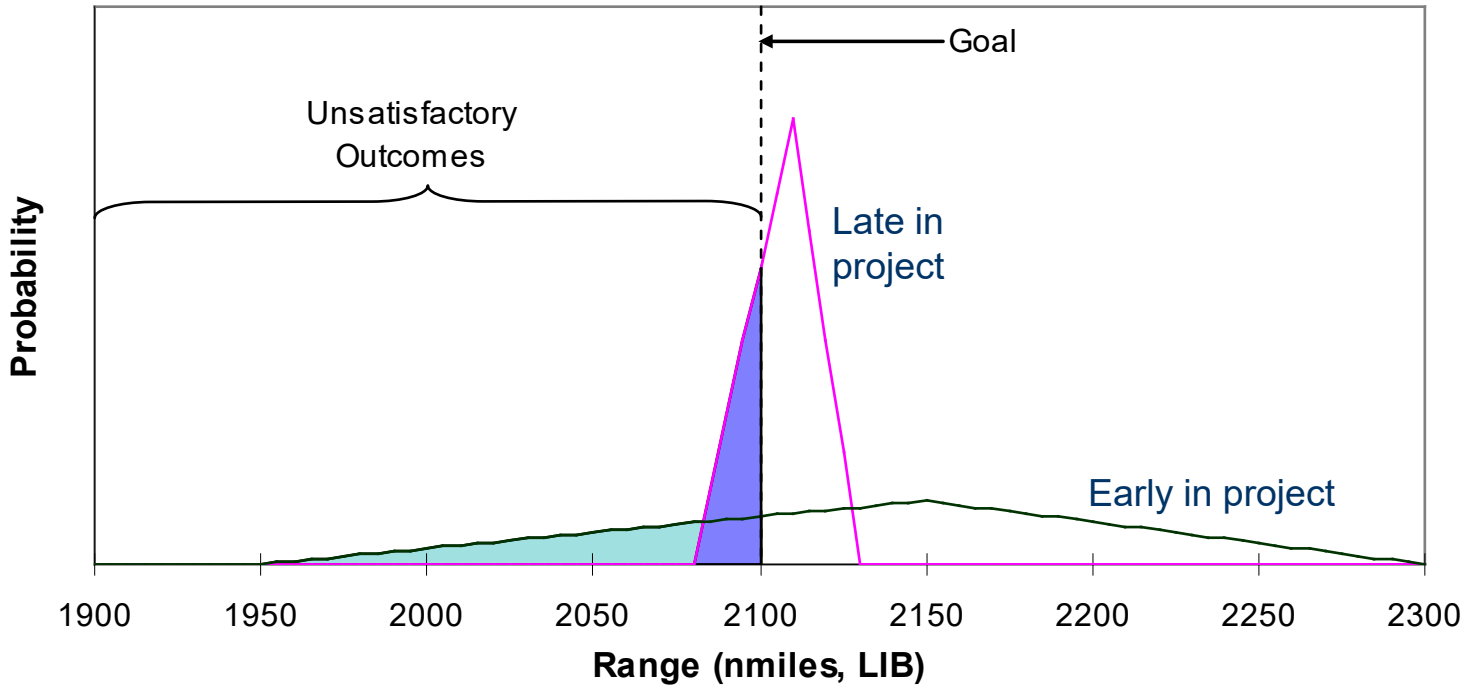






PCDs Capture Uncertainty in Reaching Goals…

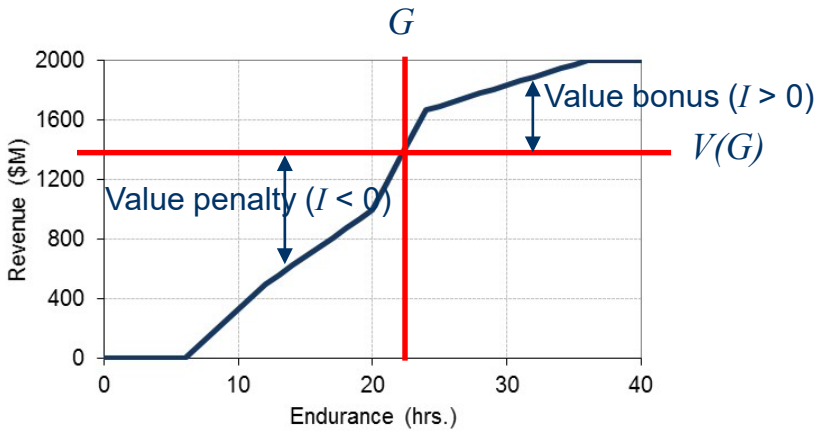
- However, for a given G, $P(G)$ can be the same for very different PCDs…
- So, monitoring uncertainty is insufficient: also weigh outcomes by their ***impact***!



Outcome Impact: A Value Bonus (or Penalty)

- A PVA outcome provides a bonus or penalty relative to its *GV*

- Example: Drone aircraft Endurance (continuous flight time)
  - Goal set at 22 hrs. => *GV* = $1,334M revenue
  - An outcome of 20 hrs. (missing the goal) => lesser revenue of $1,000M (a penalty of $334M)
  - An outcome of 24 hrs. (exceeding the goal) => greater revenue of $1,668M (a bonus of $334M)



Quantifying Risk, $\mathscr{R}$

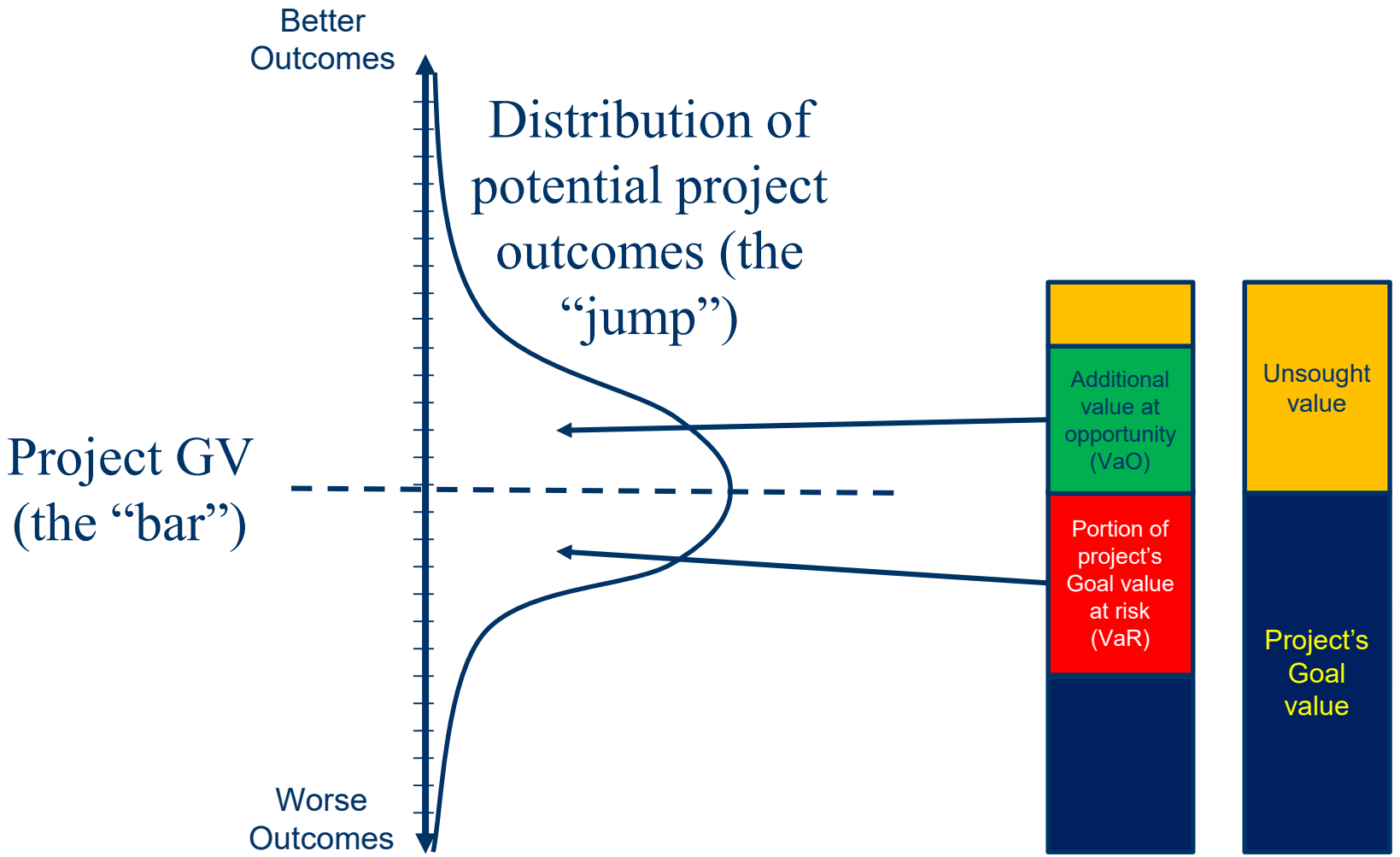
- Risk is a function of outcome uncertainty and adverse impact.
- Mathematically, $Risk = \sum_{\substack{\text{All adverse} \\ \text{outcomes}}} \left[P(\text{outcome}) \cdot I(\text{outcome}) \right]$
  - Adverse outcomes are the ones failing to achieve the goal.
  - Probability comes from PCD.
  - The value penalty is the impact.
- Overall risk is a composite of the individual PVA risks.

Meaning of $\mathscr{R}$

- $\mathscr{R}$ captures information about both uncertainty and its impact in a single, scalar variable.

- We can talk about it as the:
  - "Cost of uncertainty"
  - "Expected value loss"
  - The portion of the "**Value** (being put) **at Risk**" (**VaR**) by the prevailing uncertainty and its impact

Project Capabilities Partly Determine Risk



Designing a Project for Value, Tailoring for Risk

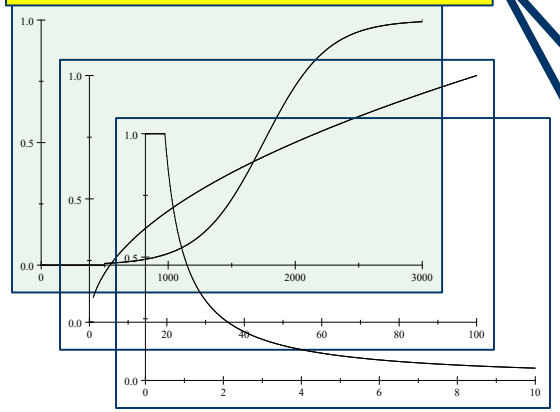
- The *likely value* (LV) of a project depends on:
  - Its set goals (How high is the bar?)
  - Its capabilities (How good is the jumper?)

- Because of set goals and uncertain capabilities, part of this value is:
  - At risk
  - At opportunity

- We can use the *project value, risk, and opportunity* (PVRO) *framework* to model these factors for project planning.

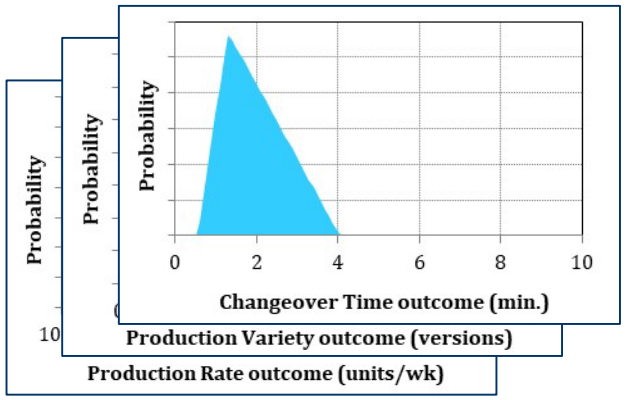
PVRO Framework Overview

PVA Value Functions



Project Goals

PVA Capability Distributions



PVA Goal Values

PVA $\mathscr{R}$

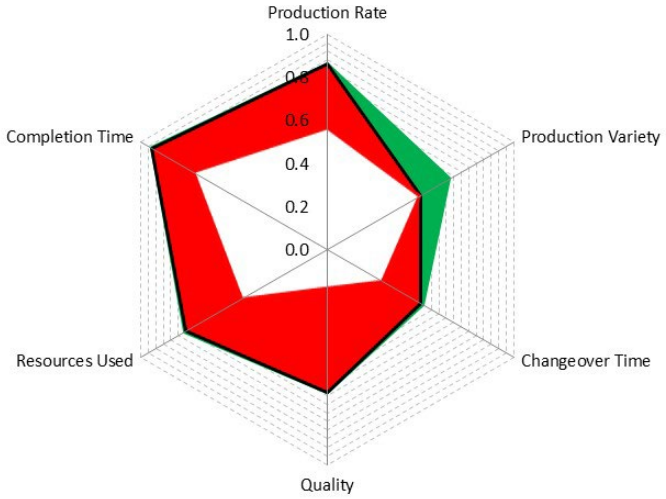
PVA $\mathscr{O}$

PVA Composite Model

Project *GV*

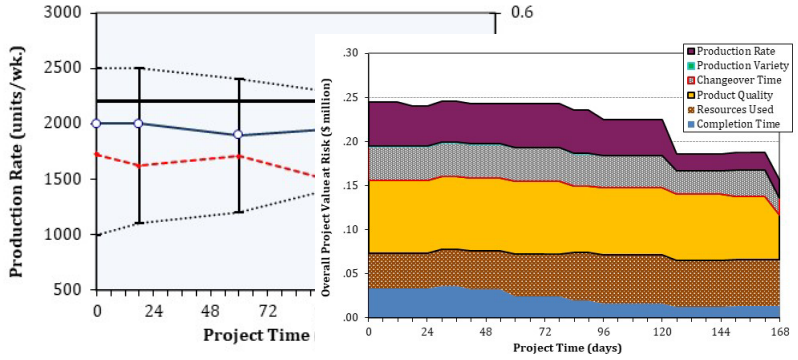
Project $\mathscr{R}$

Project $\mathscr{O}$

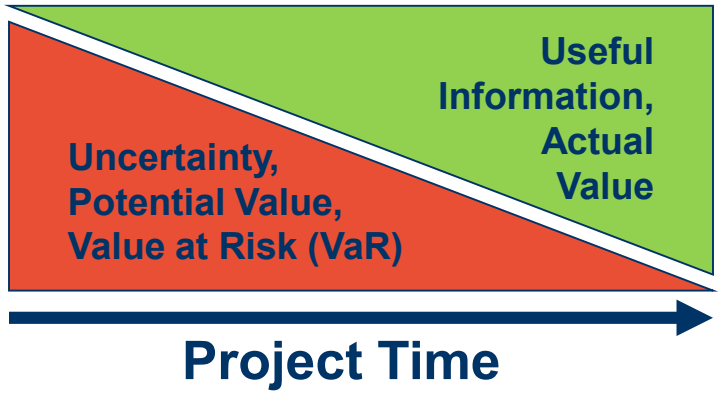


Project Planning

Project Monitoring and Control



What is Progress in Projects?



- As a project unfolds:
  - Project activities produce useful information…
  - That reduces uncertainty and (hopefully) risk…
  - And thereby adds value…
  - Or, viewed differently, removes "anti-value" (threats to value).

New Information Revises PCDs

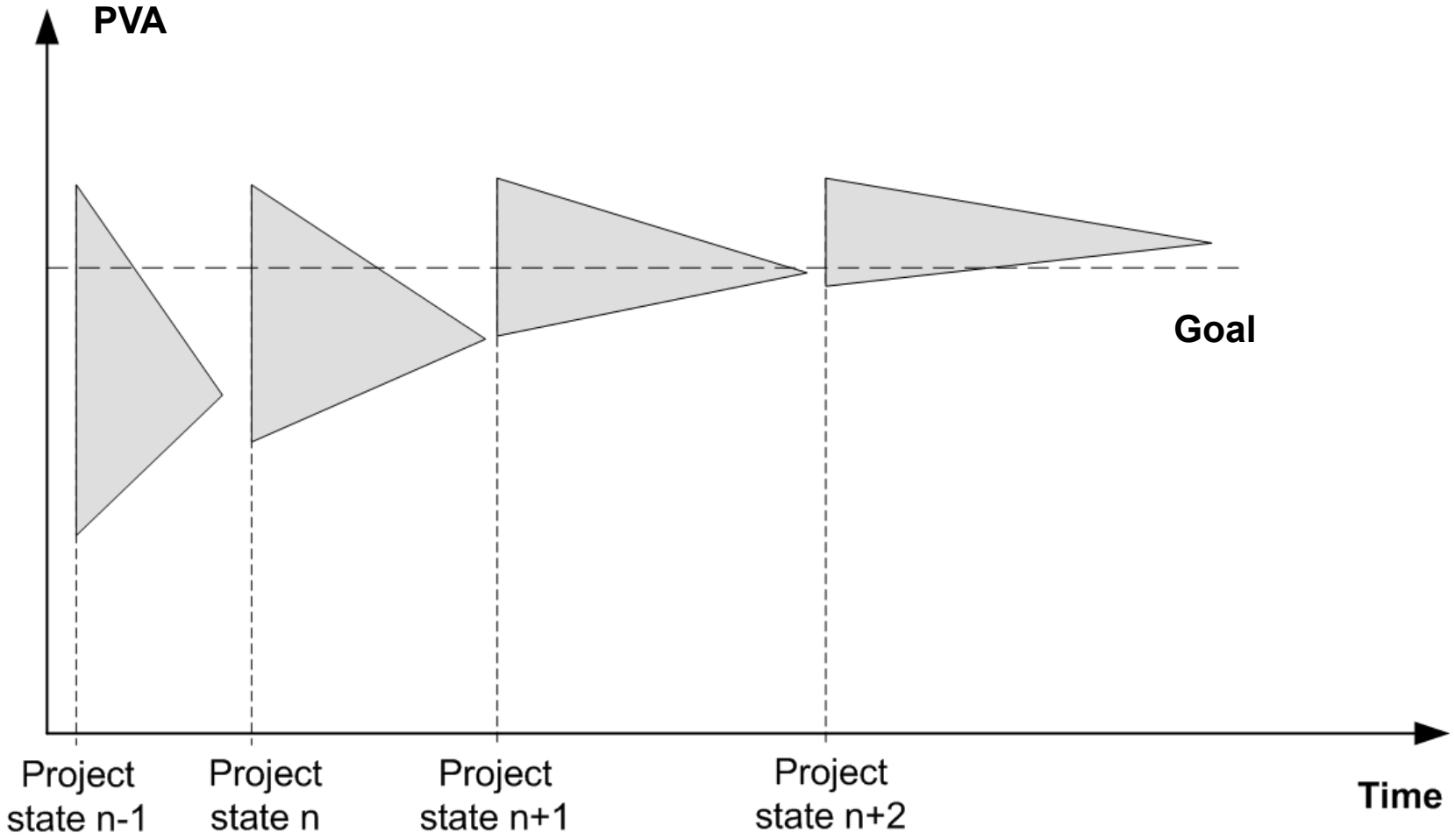
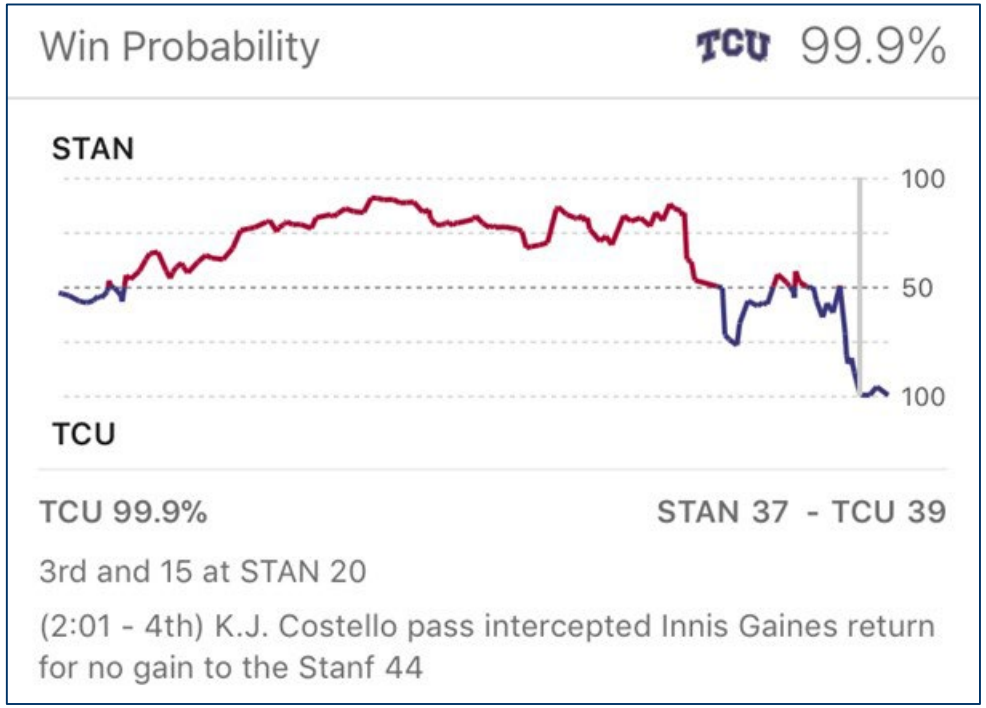


Figure ©IEEE (Lévárdy and Browning 2009)

Project Outcomes Change Over Time

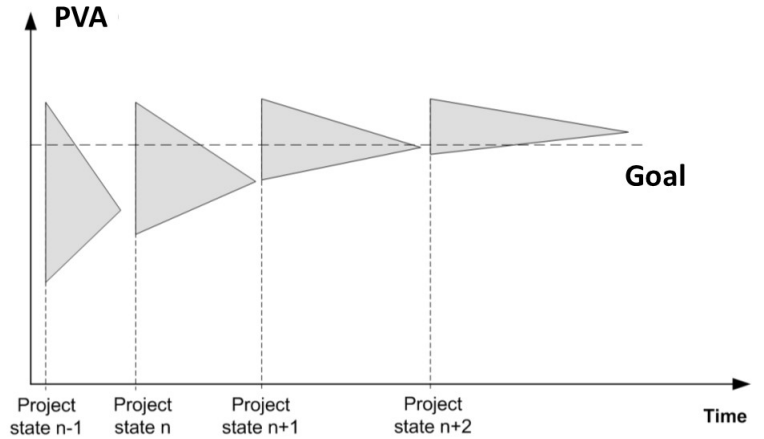
- Results of project activities change the probabilities of project outcomes.
- Focus on the results that change the PCDs.
- PCD evolution → $\mathscr{R}$ and $\mathscr{O}$ evolution



©2017 ESPN app

Is a Project Making Progress?

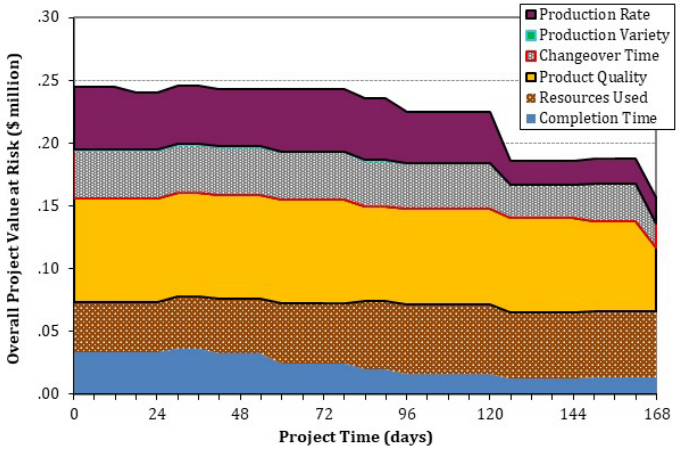
- What happens over the course of a project?
  - Uncertainty tends to decrease → PCDs get narrower
  - Design tradeoffs may change approaches → PCDs may shift
  - Management may reallocate resources → PCDs may shift



- As PCDs change shape and location, LV, $\mathscr{R}$, and $\mathscr{O}$ change.

- Any changes to project goals will also affect these factors.

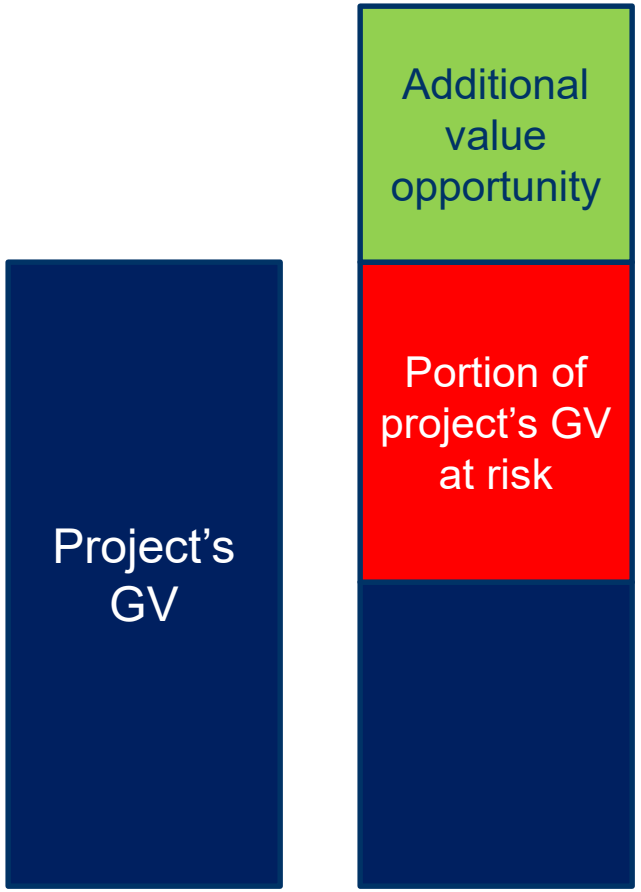
- The PVRO framework quantifies and monitors all of this.



Reducing a Project's VaR

- Value-adding work produces useful information that reduces the portion of the project's value put at risk by threatening uncertainties.

A project is the work done to eliminate the risk of not achieving its goals.



Implications: Managing a Project for Value

- Track not only the best current estimate of project value but also the uncertainty bounds around that estimate—and their implications for risk and opportunity.
- Real progress will produce useful information that reduces the portion of the project's value at risk.
- Chipping away the "anti-value" (threats to value) reveals a clearer image of the project's actual value.
- When the image does not look as desired, it is necessary to:
  - Alter the image; recast the project (change goals, raise or lower the bar)
  - Reallocate resources (emphasize work on one or more PVAs over others)

Managerial Insights

- Can help identify appropriate activities
  - To create appropriate information and reduce appropriate risks
  - Helps determine areas of ambiguity and a path towards breaking these down
- Helps focus on key performance attributes (PVAs) and early estimates thereof
- Emphasizes the importance of uncertainty and risk reduction in PD
  - Encourages designers to communicate in terms of “spread” and confidence
  - Decreases focus on “point solutions” (q.v. set-based design)
- Links activity results to the value they provide
  - Activities can be the basis for cost and schedule management
  - Enables cost, schedule, technical performance, risk, opportunity, and value tradeoff analyses
- Provides a scaffolding for organizational learning across projects

Conclusions

- Do Work → Produce Useful Information → Reduce Risk → Add Value

- Project management *is* risk management!
  - Every decision made by a PM should reduce the risk that the project will *not* provide stakeholder value.

A project is the work done to eliminate the risk of not achieving its goals.