

Decision Making Under Uncertainty¹

By Bob Prieto

Chairman & CEO
Strategic Program Management LLC

Introduction

This paper looks at the special case of decision making under uncertainty. The relationship between uncertainty and complexity is explored as is their joint relationship with large complex projects. The importance of getting these projects well founded from an ability to manage uncertainty is discussed and the aspects of these strong foundations is described.

Effective decision making under uncertainty is outlined and high reliability practices for decision making under uncertainty are tabulated. Additionally, it is suggested that we may have learned the wrong lessons from some of our most complex and most important projects delivered under high uncertainty and in the process hard coded a project management dogma that does not serve us under complexity or uncertainty well.

What is uncertainty?

Uncertainty consists of ambiguity, volatility and variability.

Ambiguity, an unquantifiable measure of uncertainty, may result from several sources:

- Inadequate view of external factors
- Uncertainty of cause and effect relationships
- Uncertainty inherent in means, methods and their effectiveness

The importance of stakeholder engagement and an increased focus on monitoring, measuring, tracking and understanding external project impacting factors cannot be overstated. Our project control resources are inward looking while uncertainty arises external to the project.

Tight coupling of tasks without effective buffers or adequate preparation for contingent execution ignores the uncertainties and variability inherent in all activities.

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Volatility is a constant source of uncertainty and is associated with unpredictable impacts or rates of change. It arises from unknown and often unknowable future events (Black Swans²) but often is perceived to arise from knowable but undealt with factors (Black Elephants³).

Variability is associated with a known range of potential outcomes but with the result itself being uncertain.⁴ This is aleatoric uncertainty as contrasted with the epistemic uncertainty of ambiguity.

***Aleatoric uncertainty** - statistical uncertainty representative of unknowns that differ each time we run the same experiment (Variability)*

***Epistemic uncertainty** - systematic uncertainty due to things one could in principle know but do not in practice. This may be because a measurement is not accurate, because the model neglects certain effects, or because particular data has been deliberately hidden (Ambiguity)*

Relationship of uncertainty to complexity

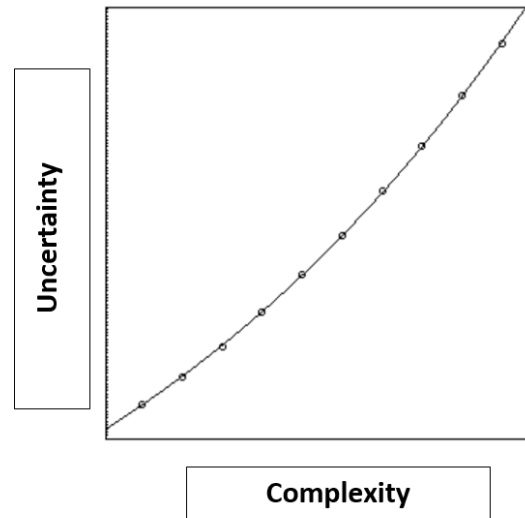
Large, complex projects face high degrees of uncertainty.

Stage-gate mentalities make it difficult for managers to take on risk, the very attribute which is often necessary when dealing with both complexity and uncertainty. The flexibility of response that uncertainty demands is constrained by traditional project inflexibility. Flexibility is about taking action while continuing to think. Adjusting as necessary.

² Black Swans Risks https://www.researchgate.net/publication/272507451_Black_Swan_Risks

³ Black Elephants https://www.researchgate.net/publication/343425486_Black_Elephants#fullTextFileContent

⁴ Rolling a dice. Result will be between 1 and 6 but we don't know which face will be on top.



When uncertainty and complexity are both high, maintaining flexibility and optionality until unknown unknowns have emerged provides for the best ability to make the right decision. This requires valuing conceptual slack, a heterogeneity of perspectives focused on maintaining a variety of viewpoints to protect against groupthink.

High uncertainty and complexity are a characteristic behavior of large complex projects. High uncertainty, even in less complex projects, still demands a level of flexibility beyond what traditional project management organizations provide for.

This contrasts with low uncertainty and complexity where standard project management and risk practices suffice.

Uncertainty fundamentally differs from risk which can be probabilistically assessed. Uncertainty represents an unknown future with equally unknown impacts. There is no information to support a calculation but there is enough insight to suggest that maintaining capabilities and capacities to address and deal with uncertainty is valuable.

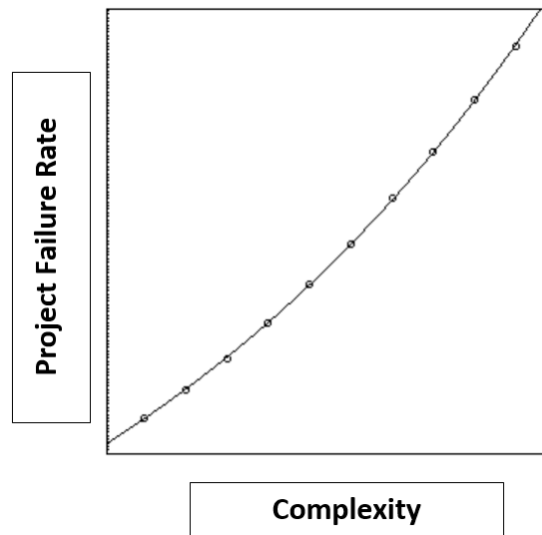
Relationship of complexity, uncertainty and large complex projects

The increasing complexity of projects necessitates a focus on better understanding increasing risk and uncertainty. Underestimating complexity results in a mismatch of risk and uncertainty.

Sources of complexity include:

- Technical complexity
- Financial/funding complexity
- Time

Complex projects have an inherently contingent nature of outcomes resulting from the multiplicity of interactions that are characteristic of such projects. There is a degree of unpredictability and unknowability despite our efforts to provide structure, control and risk assessment.



Uncertainty is a compounding factor in complex projects and is in itself integral with complexity. Uncertainty exists not just in the interactions within a complex project but often exists in the form of ambiguity in strategic business objectives (SBO) the project is to accomplish. Additionally, given the longer durations of many of these projects, it is not unusual to see these SBOs change in response to perceived changes in future uncertainty. The result is changed project requirements, scope, frameworks and potentially stakeholder relationships. Even means and methods experience added complexity as the goal posts are moved or even the game itself is changed.

If we are to understand uncertainty we must begin by measuring and tracking complexity, recognizing that complex projects have “unstable input-output relationships, changing system boundaries over time, and system behavior that is not (fully) depending on the past.”⁵

Effective decision making under uncertainty

Effective project management, especially under uncertainty, requires agility, an ability to react quickly to emergent risks and threats. Uncertainty may be foreseeable (risk) or unforeseen. Unforeseen uncertainty can arise from:

- Consequential, unthinkable events (Black Swans)

⁵ A. Nachbagauer, I. Schiri-boeck (2018)

- Flows/influences that act and interact through complexity⁶

Unforeseen uncertainty requires more flexible and emergent approaches than those associated with foreseeable uncertainty or allowed for with traditional project management and stage-gate processes.

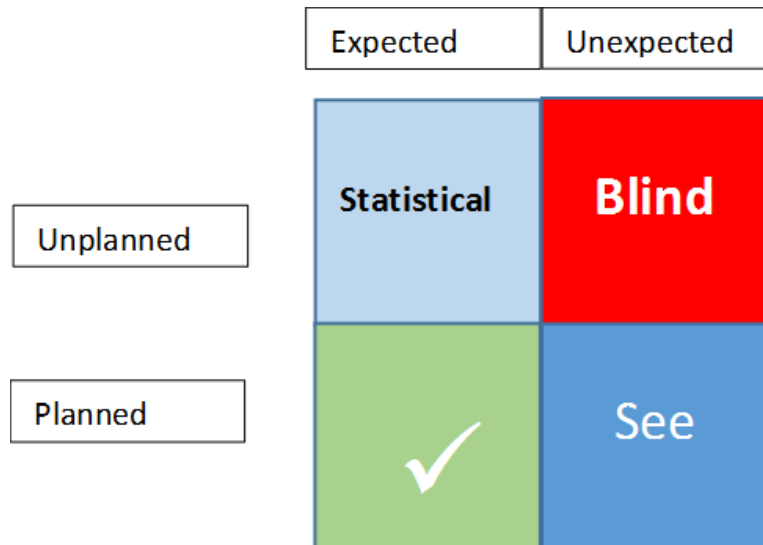
Effective decision making under uncertainty must begin with strong project foundations. These include:

- Clear, outcome appropriate, governance structures focused on organizational culture, capabilities, capacities and trust building
- Team alignment around strategic outcomes
- Shared, no-blame learning culture
- Consistent, open, transparent communication with always-on feedback loops
- Recognize that low probability high consequence events cannot be ignored (Black Elephants). Don't be risk blind.
- Acceptance that unknown unknowns exist and a commitment to discover them
- Assumption tracking
- Willingness to adapt to change. Build organizational and plan resilience incorporating adaption.
- Distributed authority to act with short decision paths when more aggregated views are necessary
- Concept of failing forward
- Understanding the value of time
- Recognizing planning as preparation but not necessarily the path
- Recognize that plans may make you blind to the unexpected in non-planned areas
- Valuing capabilities and capacities

Act and Adjust

At the sound of the batter hitting the ball, an outfielder's first step is towards the back of the outfield to ensure he can keep the ball in front of him. As he sees and begins to track the ball he adjusts his direction of travel. By then he is already moving and ready to respond.

⁶ Executive Insight, "Flows" in Large Complex Projects,
https://www.researchgate.net/publication/344306324_Flows_on_Large_Complex_Projects



These foundations must be allowed to act to prevent us from satisficing, selecting the first viable solution, when faced with a dilemma arising from uncertainty. Divergent views and challenge must be promoted while recognizing the need to move forward. The goal is an acceptable decision not an optimal one. Expertise and relevant experience must be given weight over role and rank. Maintaining organizational resilience is important so that we may adjust as required and recognizing that uncertainty often leads to a cascading set of unexpected events.

Decisions under uncertainty will have been more fully informed if the right foundations are already in-place and if the scans of changes in the environment have been rigorously carried out. Decision making under uncertainty is an area that will benefit from the capabilities of Big Analytics⁷.

Decisions under uncertainty benefit from the project manager and team’s mindfulness. Mindfulness is the ability to be fully present, aware of where we are and what we’re doing, and not overly reactive or overwhelmed by what’s going on around us. It is the result of the organizational resilience we have put in place beginning with strengthened foundations.

Sensemaking⁸ further reinforces the collective understandings and actions required under uncertainty.

⁷ Executive Insight, Proper Reliance on AI in Project Management, https://www.researchgate.net/publication/340949839_Proper_Reliance_on_Artificial_Intelligence_in_Project_Management_Key_Points#fullTextFileContent

⁸ Process by which people give meaning to their collective experiences

What are required features of large complex project management to address uncertainty?

We have successfully delivered large scale, extremely complex projects under high levels of uncertainty previously. Historical examples include the Manhattan Project, Polaris and Apollo. But many of the elements of success in delivering these complex projects under uncertainty seem to have been forgotten or at the very least under emphasized. We have abandoned flexible approaches to dealing with uncertainty.

Unknown unknowns are not knowable in terms of their probability, consequence or timing so preparation comes from the capacity, capability and agility we put in place.

In order to address uncertainty, management of these complex projects must:

- Ensure commonality and alignment of outcomes, objectives and strategic direction
- Recognize and acknowledge uncertainty
- Establish dedicated organizations to overcome bureaucracy with clear high level decision making rules that will be effective under uncertainty
- Put in place a strong open culture built on communication and sense of team
- Accept that all is not knowable at the outset of a project and recognize that parallel efforts, especially related to non-standard technologies or means and methods may be necessary (experimenting, prototyping, testing)
- Instill strong sense of team and trust, sharing knowledge and collectively learning from mistakes. Support with a no-blame culture and team focused monetized KPIs
- Recognize stakeholder and goal complexity and address up front. Manage in an “open” context
- Avoid subservience to established project management dogmas
- Recognize and support the duality of the project manager’s role – executing the plan while managing the unexpected
- Implement flexible, collaborative contract management
- Gather data broadly, continuously. Err towards knowing too much. Strong team based situational awareness.
- Avoid tendency to simplify complex situations. Encourage debate and devil’s advocate roles.
- Maintain conceptual slack in interpreting evolving events

- Restore flexibility and agility of project managers and project teams (antithesis of the stage-gate process)
- Recognize that complex projects, heavy on uncertainty, are journeys to an outcome rather than strictly bound by fixed plans.
- Plan for contingent execution
- Adopt the open nature of systems thinking (relationship to environment; complex problems; outcomes maximization; impact minimization) as contrasted with closed solutions and approaches of systems engineering (stage-gate; stakeholder minimization or management vs engagement; control)⁹
- Employ contracting structures that are designed for flexibility with a strong complementary emphasis on relationships. They may even need to provide for emergent outcomes.
- Maintain a predisposition to action over complacency
- Conduct meaningful after action reviews to inform future decision making under uncertainty

Going forward, in addition to these features we will need to:

- Measure and track project complexity
- Create an index for uncertainty

Table 1 describes some high-reliability practices for managing uncertainty in projects.

Table 1 High Reliability Practices For Managing Uncertainty In Projects¹⁰
Work with assumptions
Draw on all available expertise (multidisciplinary), internal and external to project team, to reduce uncertainties
Visibly recognize and reward openness and knowledge sharing
Project manager delegated all decision making powers from executive management within well-established but flexible decision making rules
Flexible
Staged conformance to established processes and procedures (action and improvement trump process)
Team encouraged to negotiate towards a workable action plan

⁹ Systems engineering, applied only at the later stages of the successful programs mentioned in this Executive Insight were credited for their success, ignoring the important foundational work that occurred applying systems thinking. This misinterpretation of success factors was institutionalized by Rand, McNamara and PMI.

¹⁰ Saunders et al (2016)

Table 1 High Reliability Practices For Managing Uncertainty In Projects¹⁰
Active questioning to discover what they did not know
Regular meeting and statusing to ensure current understanding of individual issues and aspects
Risk mind set to deal with ambiguity
Balance completeness of information with need to take action. Recognize that often fast response is worth more than correct response taken too late.
Intense but focused communication – simple, specific, selective
Address threats to effective decision making under uncertainty (organizational complexities; short term incentives)
Decisions based on strategic incrementalism (mission in mind as they address uncertainty in adaptive, flexible and inventive ways)
Empowerment of team without abdication of leadership. Recognition and utilization of informal networks
Visible, high touch leadership and management
Provide emotional stability

Summary

Effective decision making under uncertainty including reliability practices for such decision making are laid out. But perhaps the biggest unanswered question is whether we may have learned the wrong lessons from our most complex and important projects delivered under high uncertainty and in the process hard coded a project management dogma that does not serve us well under the complexity and uncertainty our most challenging projects face.

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About the Author



Bob Prieto

Chairman & CEO
Strategic Program Management LLC
Jupiter, Florida, USA



Bob Prieto is a senior executive effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering and construction industries. Currently Bob heads his own management consulting practice, Strategic Program Management LLC. He previously served as a senior vice president of Fluor, one of the largest engineering and construction companies in the world. He focuses on the development and delivery of large, complex projects worldwide and consults with owners across all market sectors in the development of programmatic delivery strategies. He is author of nine books including “Strategic Program Management”, “The Giga Factor: Program Management in the Engineering and Construction Industry”, “Application of Life Cycle Analysis in the Capital Assets Industry”, “Capital Efficiency: Pull All the Levers” and, most recently, “Theory of Management of Large Complex Projects” published by the Construction Management Association of America (CMAA) as well as over 700 other papers and presentations.

Bob is an Independent Member of the Shareholder Committee of Mott MacDonald. He is a member of the ASCE Industry Leaders Council, National Academy of Construction, a Fellow of the Construction Management Association of America and member of several

university departmental and campus advisory boards. Bob served until 2006 as a U.S. presidential appointee to the Asia Pacific Economic Cooperation (APEC) Business Advisory Council (ABAC), working with U.S. and Asia-Pacific business leaders to shape the framework for trade and economic growth. He had previously served as both as Chairman of the Engineering and Construction Governors of the World Economic Forum and co-chair of the infrastructure task force formed after September 11th by the New York City Chamber of Commerce. Previously, he served as Chairman at Parsons Brinckerhoff (PB) and a non-executive director of Cardno (ASX)

Bob serves as an honorary global advisor for the PM World Journal and Library and can be contacted at rpstrategic@comcast.net.