Scenarios Emergent: Supporting Robust and Flexible Plans Under Conditions of Deep Uncertainty

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Committee for a Study of the Future Interstate Highway System
TRB
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Scenarios Can Help Support Development of Flexible and Robust Plans

• Your committee tasked with:
  – Recommending actions needed to upgrade and restore the interstate highway system
  – Building on methodologies examined and recommended in the NCHRP report
• Under conditions of fast-paced and disruptive change, often useful to pursue flexible and robust plans
• New approaches for developing and using scenarios can:
  – Augment methodologies in NCHRP report
  – Help identify robust and flexible responses to deep uncertainty
In the early 1970s forecasters made projections of U.S energy use based on a century of data.

Believing forecasts of the unpredictable can contribute to bad decisions.
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In the early 1970s forecasters made projections of U.S. energy use based on a century of data

... they all were wrong
Optimizing to a single future: what if we’re wrong?

Source: http://www.hockscqc.com/articles/tunnelvision/tunnel-vision.jpg

Thanks to Pat Reed
Technology and Other Change May Make Forecasting Even More Difficult Over Next 50 Years

In many respects, transportation systems changed

* more from 1910 to 1960
* than from 1960 to 2010

What changes will the next fifty years bring?

Deep uncertainty occurs when the parties to a decision do not know, or do not agree on the likelihood of alternative futures or how actions are related to consequences.
Scenarios emergent
Robust and flexible plans
Engaging with these ideas
Traditional Planning Methods Work Well When Uncertainty is Limited

“Agree on Assumptions”

What will future conditions be?
What is the best near-term decision?
How sensitive is the decision to the conditions?

But under conditions of deep uncertainty:
- Uncertainties are often underestimated
- Competing analyses can contribute to gridlock
- Misplaced concreteness can blind decisionmakers to surprise
Under Deeply Uncertain Conditions, Often Useful To Run the Analysis “Backwards”

“Agree on Assumptions”

What will future conditions be? → What is the best near-term decision? → How sensitive is the decision to the conditions?

“Agree on Decisions”

Proposed strategy → Identify vulnerabilities of this strategy → Develop strategy adaptations to reduce vulnerabilities

Scenarios Often Chosen As Part of an “Agree on Assumptions” Process

- Scenarios provide power means to characterize deep uncertainty, helping to:
  - Expand range of futures considered
  - Avoid over-confidence

- But scenarios often developed as inputs to the analysis, risking:
  - Ambiguity, bias, and inconsistencies
  - Disconnect between scenarios and decisions
  - Surprise

*Challenge is choosing the best small set of decision-relevant scenarios from a multiplicity of plausible futures*
Within an “Agree on Decision” Process, Policy-Relevant Scenarios Emerge From Analysis

1. Run model to stress test proposed policy over many plausible futures

2. Generate large, multi-dimensional database

3. Use statistical algorithms to find interpretable (low dimensional) clusters of policy-relevant cases

4. Display as policy-relevant scenarios
Such Scenarios Proved Useful in Study of Terrorism Insurance

In 2007, US Congress debated re-authorizing U.S. Terrorism Risk Insurance Act (TRIA). RAND study and its scenarios:

- Cited on floor of US Senate by a proponent
- Called “insidious” by opponents
- Usefully informed Congressional debate

Note that this scenario:

- Remains consistent with official US Government forecasts, but suggests why other answers are (more than) possible
- Mixes uncertainty regarding states of the world with uncertainty regarding probabilities
- Mixes external and internal drivers

Scenario discovery identified these parameters as most important among over a dozen uncertain model parameters.
Outline

Scenarios emergent

Robust and flexible plans

Engaging with these ideas
What is a Robust Strategy?

Expected costs above least cost over many scenarios (% (Regret)

- Strategy C
- Strategy A
- Combine Strategies B & C
- Strategy B

Identify strategies that reduce vulnerabilities

Propose initial strategies

Identify vulnerabilities

Popper et. al (2009)
Robust Strategies Are Often Designed to Evolve Over Time in Response to New Information

Robust strategy consists of:

- **Near-term actions**
  - Shaping
  - Hedging
- **Signposts**
- **Contingent actions**

*Thanks to Laurna Kaatz*
Emergent Scenarios Helped Identify Robust and Flexible Plans for Colorado River Basin

In 2012 Bureau of Reclamation study, parties to the Colorado Compact:

- Generated consensus on potential risks to system
- Identified flexible contingency plan, with
  - High priority near-term actions &
  - Future actions contingent on how the future unfolds

Analysis identified Scenarios That Illuminate Vulnerabilities of Current River Management

Two key drivers of vulnerability for current river management plan:
- Fifty year average river flow
- Driest eight year period

Four policy-relevant scenarios emerge from analysis

Business as Usual

Two Adaptive

Transformative

Robust Responses to These Vulnerabilities Follow Adaptive Pathways

Vulnerability analysis for Colorado Basin generates four scenarios

- Business as Usual
- Two Adaptive
- Transformative

Adaptive Pathways Map describes potential paths through these scenarios
- Initial actions
- Signposts
- Contingent actions

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BASE POLICY
MODERATE POLICY
AGGRESSIVE POLICY

Potential paths
Signposts

Haasnoot, M., et. al. (2013)
Bloom (2015)
Robust Responses to These Vulnerabilities Follow Adaptive Pathways

Vulnerability analysis for Colorado Basin generates four scenarios

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Pathway A succeeds in two scenarios
Robust Responses to These Vulnerabilities Follow Adaptive Pathways

Vulnerability analysis for Colorado Basin generates four scenarios:

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Pathway B succeeds in three scenarios, but costs more.
Robust Responses to These Vulnerabilities Follow Adaptive Pathways

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Business as Usual

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Pathway C succeeds in all scenarios, but costs the most
Analysis Identify Probability Thresholds That Suggest Alternative Strategies

Map shows probabilistic expectations about the future that favor alternative strategies

Management best here

Transformative policies may be needed here
Outline

- Scenarios emergent
- Robust and flexible plans
- Engaging with these ideas
These Methods for Decision Making Under Deep Uncertainty Have Been Increasingly Employed

RAND and non-RAND engagements

See:
- RAND Water and Climate Resilience Center—www.rand.org/water

www.deepuncertainty.org
Assumption Based Planning offers one such qualitative process.
Ensuring the future of the US highway system may require:

- Embracing deep uncertainties facing transportation
- Robust and flexible plans
- Scenarios that emerge from analysis to help identify such plans

Quantitative and qualitative approaches exist to develop such scenarios and plans

Encourage policymakers to change the question from

“What will the future bring?”

to

“What steps can we take today to most assuredly shape the future to our liking?”

More Information

http://www.rand.org/pardee/
http://www.rand.org/methods/rdmlab.html
www.deepuncertainty.org

Thank you!