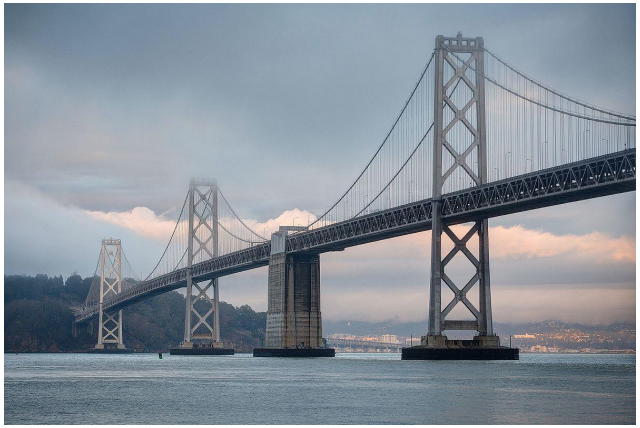
Decision Making Under Deep Uncertainty (DMDU) in Regional and Transportation Strategic Planning: A Pilot Study

Framing Visions and Informing Decisions



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TMIP Webinar

8 October 2020

U.S. Department of Transportation Federal Highway Administration

SCAG INNOVATING FOR A BETTER TOMORROW

SACOG

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Administrative Items

- **The** session will be recorded. The recorded webinar is available after the session at https://tmip.org/webinars.
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TMIP EMA Research Webinars

- TMIP has held three webinars as part of the TMIP Exploratory Modeling and Analysis (EMA) series*
  - ✓ Introducing the Exploratory Modeling and Analysis Tool (TMIP-EMAT) (Dec 18, 2018)
  - ✓ Using TMIP-EMAT for Exploratory Analysis (Nov. 13, 2019)
  - ✓ Testing and Results of TMIP-EMAT at ODOT (May 28, 2020)
- At our November 13th webinar, I recapped TMIP Exploratory Modeling and Analysis (EMA) research history and the future direction. One of the additional projects I noted is the joint research effort with our Planning Oversight & Stewardship Team (Harlan Miller). The research aims to demonstrate the value of additional decision support tools such as Robust Decision Making (RDM). Today's webinar is about this latest research project.

*Note: The webinar recordings are available at https://tmip.org/webinars.

TMIP Contact

If you have any questions or comments about today's presentation or TMIP, or if you are interested in sharing your experience, please contact me at sarah.sun@dot.gov.

Incorporating Uncertainty in Transportation Planning Activities:

Motivation and Experience from the Sacramento Region

Southern California Association of Governments (SCAG)

Incorporating Decision Making Under Deep Uncertainty (DMDU) Approaches in Transportation Planning Activities: A Pilot Study

Hsi-Hwa Hu

Manager, Modeling & Forecasting Department

Southern California Association of Governments

10/08/2020

www.scag.ca.gov

SCAG™

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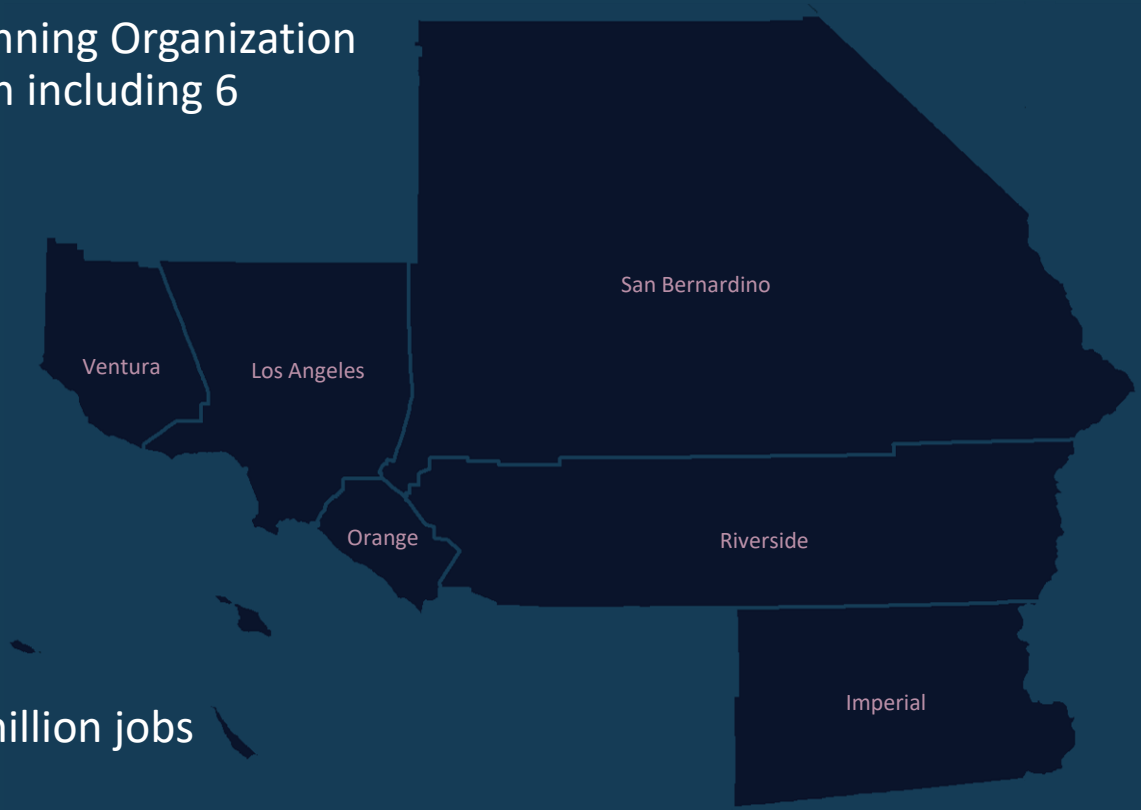
SCAG Overview

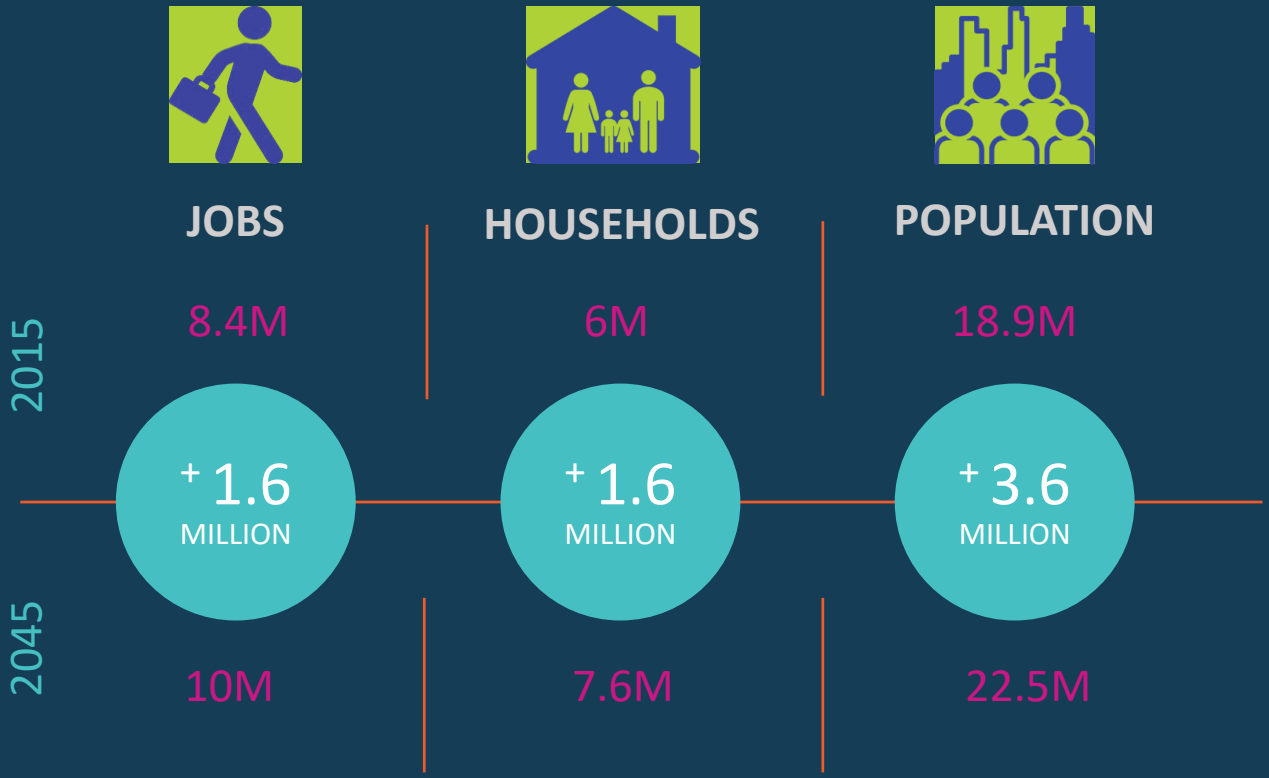
SCAG is the Metropolitan Planning Organization for Southern California Region including 6 counties:

- Ventura
- Los Angeles
- Orange
- San Bernardino
- Riverside
- Imperial



19.5 million people and 8.5 million jobs

Growth


JOBS
HOUSEHOLDS
POPULATION
2015
8.4M
6M
18.9M
+ 1.6 MILLION
+ 1.6 MILLION
+ 3.6 MILLION
2045
10M
7.6M
22.5M

Travel (before pandemic) - 2016

	ALL TRIPS	TO/FROM: WORK	TO/FROM: SCHOOL	OTHER
SINGLE OCCUPANCY VEHICLE	36.0%	70.7%	12.8%	31.2%
HIGH OCCUPANCY VEHICLE	51.7%	23.5%	61.8%	58.2%
TRANSIT	3.2%	2.7%	9.0%	1.6%
BIKE	1.3%	0.7%	2.5%	1.1%
WALK	7.8%	2.4%	13.8%	7.8%

Source: SCAG Activity Based Model

SCAG Regional Plan

- Long-range plan – RTP/SCS
  - Regional Transportation Plan (RTP)
  - Sustainable Communities Strategy (SCS)

- To reduce:
  - Congestion
  - Pollution, and
  - Greenhouse gas emissions

- SCAG 2016-2045 RTP/SCS was adopted last month

Planning Approaches: what we've been doing

- Solve issues caused by growth and reliance on cars
- Measure: VMT reduction

- Main Planning Strategies: Reduce VMT
    - Transportation Infrastructure
        - Transit, Walking/Biking
    - Land Use
        - Transit-oriented Development
    - Pricing, EV, Shared Modes, …

Future Uncertainty

- Technical advances in mobility
- Shared economy
- Goods movement and local land use change

- Above of all, changes due Pandemic
  - Employment / Economic
  - Travel behavior: Transit / Driving
  - Tele-activity:
    - work, shopping, medical, school, …


(Image from www.converge.today)

- Those uncertainties Interact each other

Challenge to Future Plan - Pandemic

- SCAG Next Plan: 2020 (19) – 2045(50)
- It’s a challenge for planners (or everyone) to understand the complexity of uncertainties

Our Motivation to Join This Project

- Learn this new methodology to better understand the uncertainty of future plan
  - pandemic impact
- Learn how TMIP-EMAT can support decision making for future plan
- Apply the methodology to analyze SCAG Plan
  - work with planners

Thank you

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This Project: a Pilot and Laboratory for DMDU Strategic Planning Tools

- *Is it possible to introduce new tools for strategic planning and modeling into MPOs? If so, how?*
  - Explore and illustrate the 'value proposition'
  - Engage in mutual learning with agency professionals
  - Provide tangible demonstrations
  - Determine best practice within existing planning agencies
  - Understand both technical and organizational issues

Transportation Planning is Hard…
…and getting harder

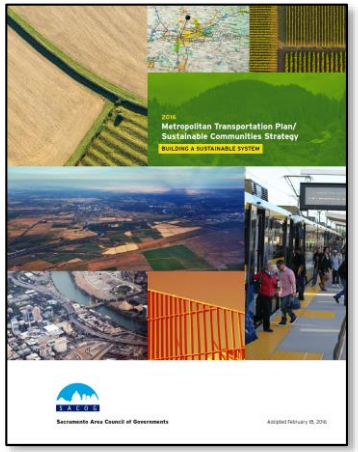
- **Only limited control over operating environment**
  - **So harder than military planning with entire objective being control**
- **Widening circle of stakeholders and interests at the table**
  - **Federal government; Local governments, agencies; State government; Business; Communities; Environmental and other NGOs…**
- **Many moving parts, concurrent activities, and interactions**
  - **Multi-modal transit planning; Systems engineering; Monitoring; Operations; Security; Consortium building; Political consensus development; Financing; Environmental planning; Economic planning; Management plan; Communications plan; Community engagement…**
- **And, importantly, old rules of thumb -- on technology, economy, society -- are increasingly less certain**

Metropolitan Planning Organizations (MPOs) Use Predictions to Craft Long-Range Plans

Multi-decadal forecasts of future conditions:

- Demographic
- Economic
- Technological
- Regulatory
- Behavioral

Regional Transportation Plan



- Transportation, housing, land use investments
- Related policies

Why Do MPOs Use Predictions?

- Prediction-based approaches
  - Required by law
  - Follow established practice
- Some audiences demand predictions
- Perceived lack of alternatives

Predictive planning rests on myriad assumptions

- All plans must make assumptions about the future
- Many assumptions are explicitly identified and planned for
- However, most plans also contain implicit or “hidden” assumptions
- These implicit assumptions can cause significant problems
- Assumptions exist because of the presence of uncertainty
- Uncertainty is not a failure of due diligence; it is inherent in looking over the long term
- In the presence of uncertainty, systematically identify explicit *and* implicit assumptions and ensure they are part of the planning process

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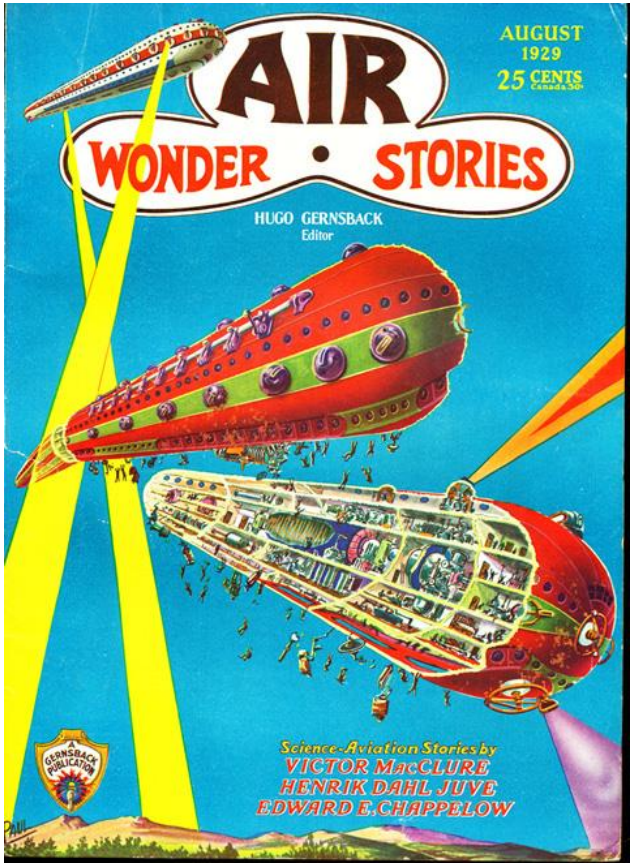
But what are we really interested in?

Predicting the future?

or

Understanding which short term decisions are consistent with our long-term goals across many plausible futures?



A Value Proposition: Produce Analyses that Address Two Categories of Issues

- The presence and consequences of 'deep' uncertainty: When we do not know – or cannot agree upon:
  - Predictions or probabilities of future values of important factors;
  - Underlying causal relationships between inputs and outcomes.
- The normative consequences of
  - Competing explicit and implicit visions (and interests)
  - Widely different assumptions and beliefs
  - Many more stakeholders represented than in previous eras

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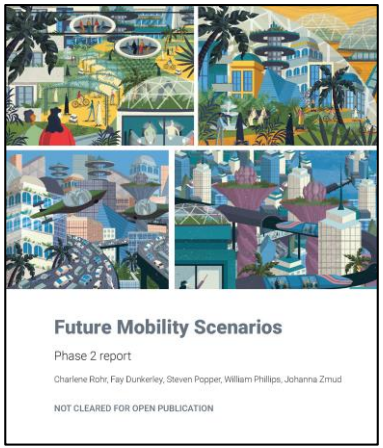
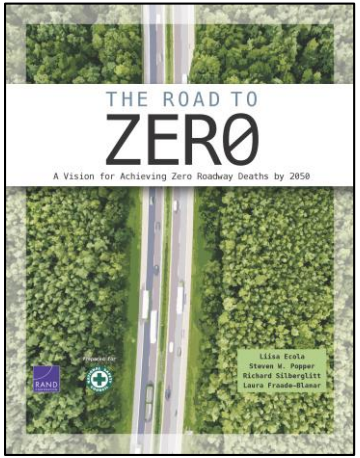
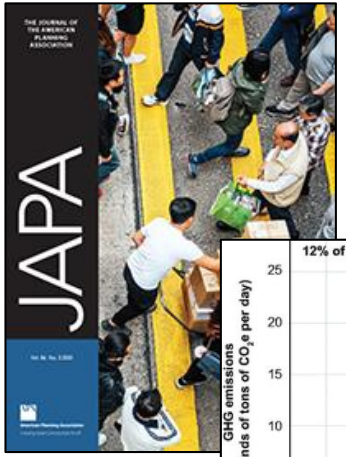
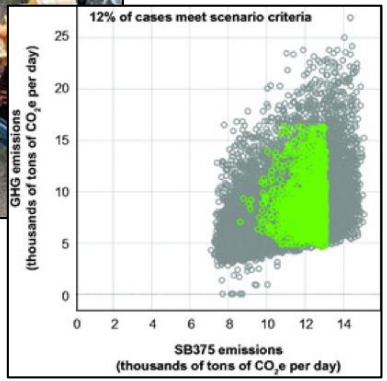
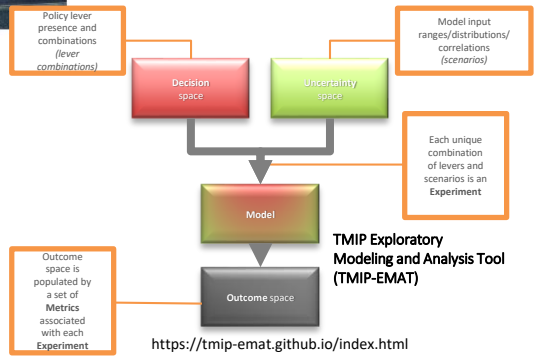
DMDU Tools for Transportation Strategic Planning have been Tested…











TMIP Exploratory Modeling and Analysis Tool (TMIP-EMAT)

https://tmip-emat.github.io/index.html

Pilot Study with SACOG

April 29, 2020 TMIP-EMAT Webinar

https://tmip.org/content/demonstration-robust-decision-making-sacog

Previous Cases of DMDU Use in MPOs Were Limited

- Models not fit for intended purposes
- Focused only on stress-tests not policy responses
- Not integrated into ongoing planning

Our Project Explores Use of a DMDU Method: Robust Decision Making (RDM)

- **Robust decision-making** (RDM) is an iterative, multi-scenario, multi-objective **decision** analytic framework that aims to:
  - Help identify potential **robust** strategies,
  - Characterize the **vulnerabilities** of such strategies, and
  - Display the **tradeoffs** among them.
- RDM rests on a simple concept.
  - Rather than use computer models and data as predictive tools,
  - RDM runs model thousands to millions of times to:
    - Stress test proposed policies against a wide range of futures, and
    - Uses the results to help decision identify policy-relevant scenarios and strategies robust across those scenarios.

How Does RDM Differ From Scenario Analysis?

Scenarios come in three types

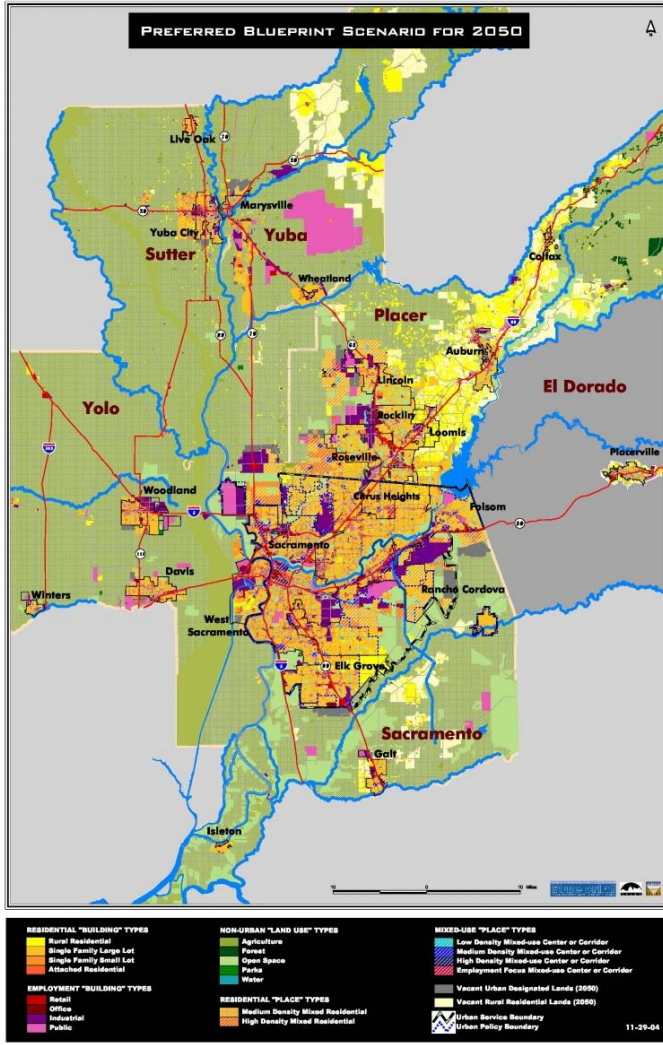
Explorative	Predictive	Normative
What might happen?	What will happen?	How might we reach our goals?

MPOs Generally Employ Normative Scenarios Within a Predictive Analysis

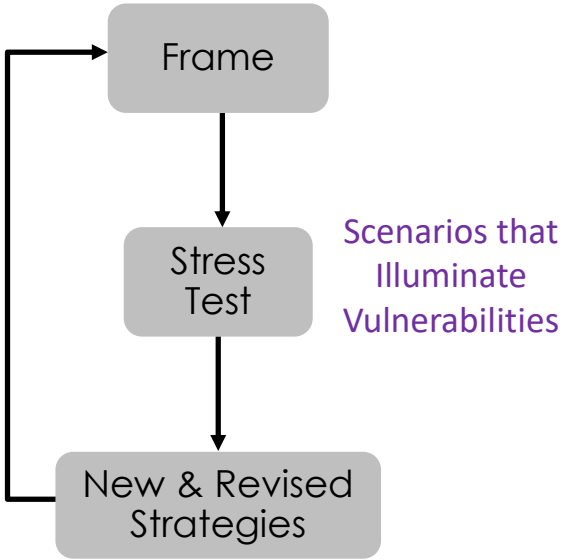
- Scenario testing with limited # of changes
  - e.g, land use/transportation network
- Less use of exploratory
- ‘Goldilocks’ results

RDM scans over many exploratory scenarios in order to:

- *Stress test plans*
- *Identify robust pathways to goals*



RDM Employs Exploratory and Normative Scenarios in an Iterative Analytic Process



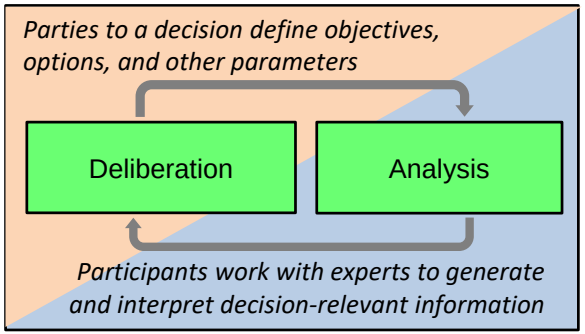
RDM Steps

- Frame the decision challenge, including:
  - What are we trying to achieve?
  - What actions might we take to achieve our goals?
  - What uncertainties affect our achieving our goals?
- Stress test proposed strategies over a wide range of futures
  - Identify most important factors affecting whether we meet or miss our goals
- Identify new or revised strategies that meet our goals over a wider range of relevant futures

DMDU Supports Process of "Deliberation with Analysis"

RDM and other DMDU approaches designed to support a decision support process call "deliberation with analysis"

- Stakeholder deliberate over problem framing
- Analysts produce decision relevant information products



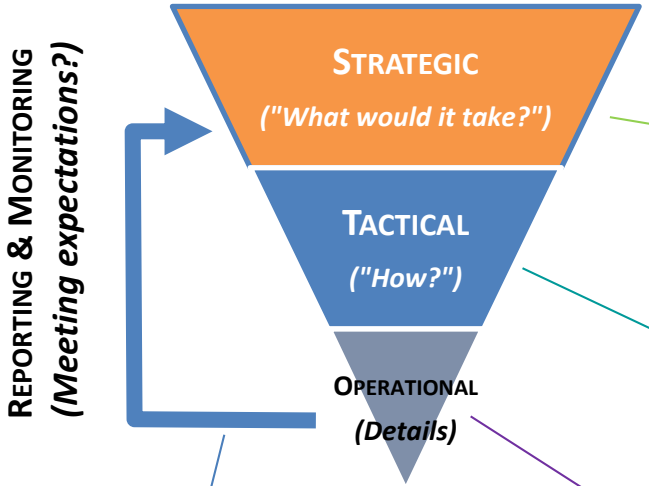
"*Deliberation with analysis most appropriate when the values of pluralistic participants may evolve in response to interactions with each other and the analytic products*"

National Research Council (2009)

Next steps: modeling

- Use exploratory model to cover additional relationships (congestion, adaptive pathways, etc.) yet preserve run times.
- TMIP-EMAT
- VisionEval

Strategic Models Provide Less Precision, But More Opportunity for Exploration



Exploratory/Strategic Models can help with long-term visioning/ policy/ resilience analysis but sacrifice detail. Example is this pilot work.

Tactical Models use fixed assumptions (e.g. a single economy, fixed fuel prices) to work out how to best implement allotted funding. Example is travel model.

Operational Models help with short-term implementation details (e.g. signal timing). Example is project-level analysis.

Reporting & Monitoring should reflect observed behavior (not modeled)

Next steps: engagement

- RDM envisions a new conversation among modelers, decision makers, and the public
- Identify barriers that might inhibit RDM adoption in transportation/land use planning
- Working to overcome
  - Trainings / skill building
  - Community of practice
  - Outreach to stakeholders

Thank you!

http://www.rand.org/pardee/
http://www.deepuncertainty.org

Questions? Advice? Thoughts?