Systems-oriented Requirements Development

(in an age of rapid, technology-driven evolution)

September 19, 2018

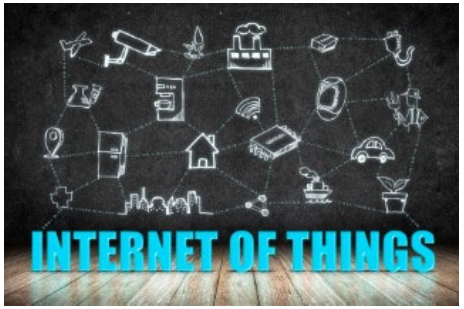
A discussion-oriented presentation

U.S. Department of Transportation
Volpe Center
Advancing transportation innovation for the public good

QUESTIONS:

1. How many of you know the detailed requirements for your program looking ahead five to ten years?

2. How confident are you about the relevance and acceptance of those future requirements–ten years from now?



The GL-10 prototype takes off in hover mode like a helicopter.
Credits: NASA Langley/David C. Bowman

Envisioning the future at the detail level . . .

- Air Traffic Management program development lifecycles are 5 to 15 years or more in some cases

- Technology advances and social change can render policy and infrastructure plans obsolete – or inappropriate – in just a year or two

What options do we have for efficient and effective requirements development given these challenges?

Your Thoughts?

How then do we plan for the unknown?

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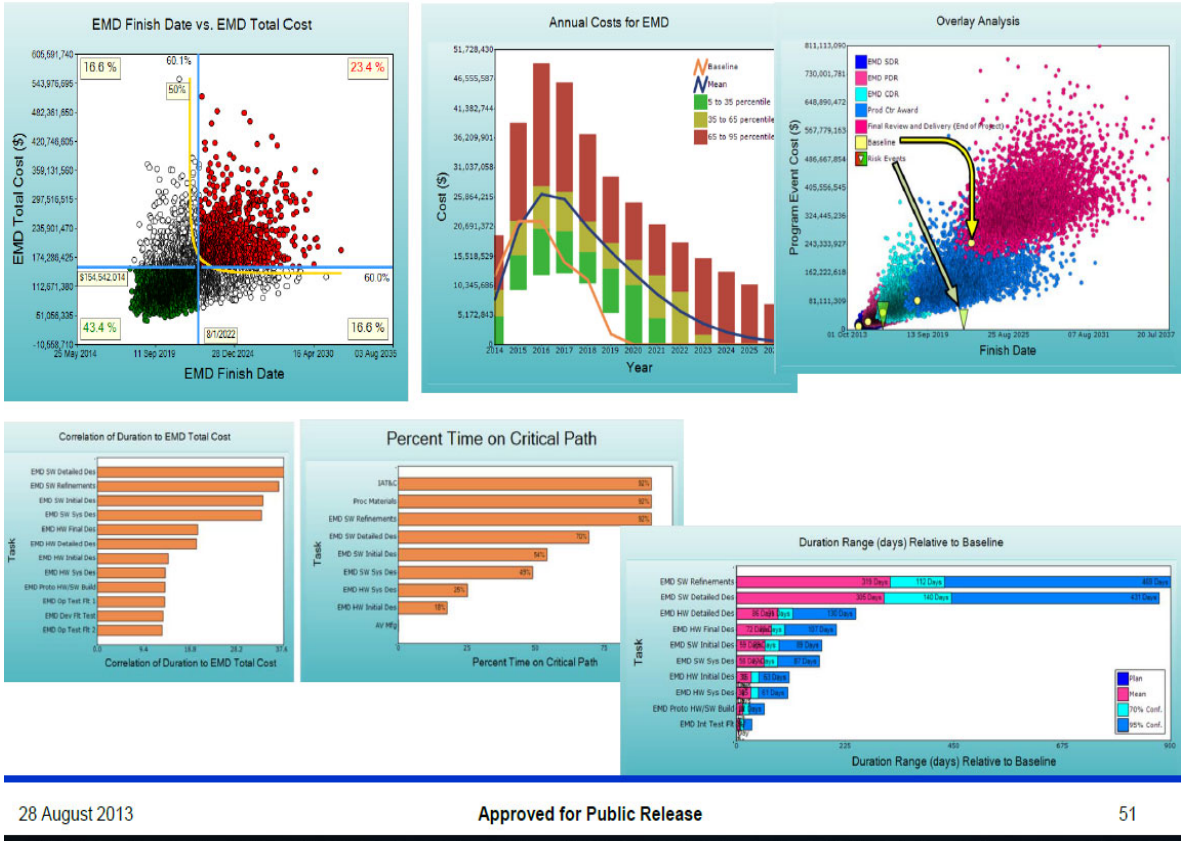
There is no one magic solution

- NASA's Fully Integrated Cost Schedule Model (FICSM)
  depicts program planning data on cost, schedule, and uncertainty (risk).

- It doesn't anticipate large scale change in social or system requirements however.

Typical FICSM Reports



Optimize Requirements Thoughtfully

- **No free lunch theorem** by Wolpert and Macready applies: "NFL theorems because they demonstrate that if an algorithm performs well on a certain class of problems then it necessarily pays for that with degraded performance on the set of all remaining problems" (Wolpert & Macready, 1997, p.69)

- **Examples?**
- **Airport Traffic Flows Altered by Uber and Lyft** - Mobility On Demand (MOD) and Mobility As A Service (MAAS) concepts have transformed traffic flows and revenue models at Boston's Logan Airport – creating new efficiency issues that were never envisioned

Wolpert, D. H. & Macready, W. G. (1997). No free lunch theorems for optimization. *IEEE Transactions on Evolutionary Computation*, *1*(1), 67-82. Publisher Identifier Item S 1089-778X(97)03422-X

Some Techniques That May Be Helpful

- Assume change will occur - use thought-based experimentation to test the flexibility and adaptability of your proposed requirements.
- Assess the entire system and enterprise when assessing flexibility and adaptability to future technical and social evolution.
  - Enterprise integration impact analysis
  - Complete stakeholder community engagement
  - Technology Refresh / System Replacement / System Disposal planning
  - Leveraging Organizational and Economic Capacity
- Embrace uncertainty using models designed to illustrate potential outcomes in the face of uncertainty (Monte Carlo, Decision Trees, Network Models, etc.)
- Review and reassess the requirements and the system regularly

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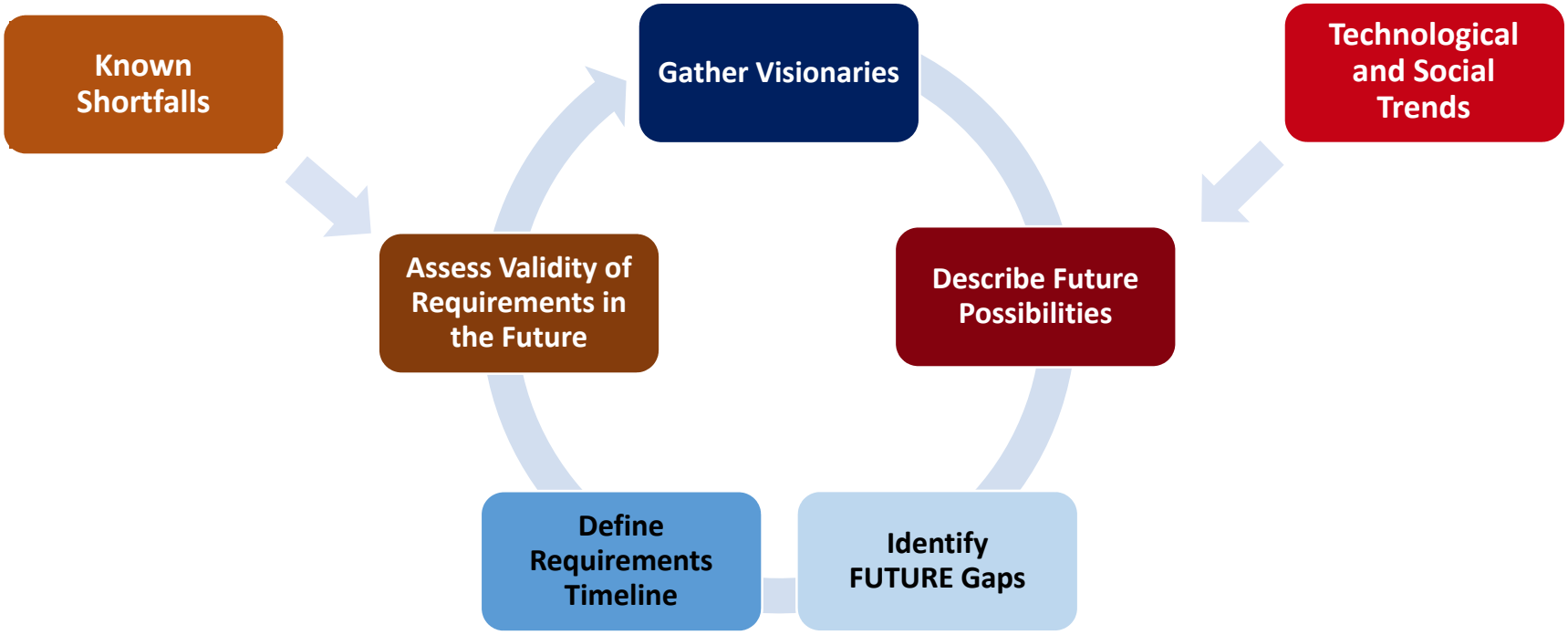

Plan for advancing the conversation

- What are your key take-aways?
- Is this a conversation worth continuing?
- Recommendations for keeping it alive?

Key points for consideration:

- Develop Requirements and Designs that anticipate and allow for radical change
- Engage a wide variety of stakeholders and visionaries in the future requirements collection process
- Reexamine and UPDATE the requirements regularly
- Evaluate requirements and design features across the complete program lifecycle – look beyond the operational functions
  - Operational suitability
  - Reliability
  - Serviceability
  - Maintainability
  - Financing
  - Technology Refresh/Update needs
  - Replacement by something different
  - Ease of functional evolution
  - Staffing and Support given “evolution”
  - Safety & Risk Implications of Change

Don’t hesitate to reach out to me

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