Why There Are No Infrastructure Asset Management Needs

Patrick Gurian
Drexel University
The Need

• Shortfall in infrastructure investment
• Collapsing bridges
• Bursting water pipes
• Polluted rivers
• Need to incorporate sustainability into our thinking

• But is this a research need?
Motivation for Presentation

- Can we defend this as an area of intellectual inquiry? (intellectual motive)
- How will competing disciplines view our stance? (strategic motive)
- Some evidence that a devil’s advocate can improve group decision making
Why there are no asset management research needs

• 1. It’s already been done
• 2. It can’t be done
• 3. It shouldn’t be done
#1 It’s already been done
The book has been written

- Managing assets is about making decisions
- We have Subjective Expected Utility Theory (SEUT)
  - a normatively correct system of decision making under uncertainty
- We have benefit-cost primers as well
Subjective Expected Utility Theory

• Enumerate options, uncertainties
• Assign probabilities to outcomes (preferable based on data but subjectively if needed)
• Utility function quantifies risk preferences and trade-offs among different attributes
• Systematically evaluate options and identify one with the highest expected utility—the preferred outcome
SEUT Framework

Condition Assessment → Condition Data → Performance Models (Integrated Assessment) → Attribute scores → Utility Function

Construction and Rehabilitation Actions

Evaluation and Decision Making
Example (Gharaibeh et al. 2006)

Conditions of different asset classes are valued by a utility function:

$$
\max_{x_t^i} U = \sum_{t=1}^{T} \prod_{i=1}^{I} (Kk_i u_t^i + 1) \\
\text{subject to } 0 \leq x_t^i \leq h_t^i \quad \forall \ i \in I, \ t \in T
$$

Find allocation corresponding to maximized utility:
What SEUT offers us

• A means to deal with uncertainty (probability)
• Elicitation procedures to assess preferences regarding risk and tradeoffs among different attributes
• Procedures for identifying what we need to know
  – What matters and what doesn’t
  – What information is worth acquiring
A common reaction

• Does anybody actually use this stuff?
• We have a normatively correct system but it is under used
  – It should be taught in high school
• This is more an educational issue than a research issue
Education and Training

• We need forward thinking managers and consultants
  – How effective are asset management workshops at TRB, WEF, ASCE?
How do we reply?

• To apply the framework need
  – Model inputs
  – Options and interrelationships
• System identification
System Identification

• How do we divide up the system?
  – Which interrelationships to model in an integrated fashion and which to treat as boundary conditions?
  – How will our efforts yield general knowledge (i.e., be research)? Can we identify good practices and common trends?

• How do we forecast performance of existing technologies?
  – Existing data is scattered

• Working new technologies into the system
  – Get inputs from pilot studies, other sources as appropriate
Who should do this research?

- Need for long term commitment
  - Not 3 year grant cycle
- How general will results be?
- Will consultants and owners be better placed to do this?
- How do we integrate skills of academia?
Performance Benchmarking

• AWWA is undertaking this for water industry
• There are likely opportunities to deepen/broaden this effort
• International Infrastructure Observatory
  – Pool data across different managers
  – Find out what is generally applicable and what isn’t
  – Improve performance estimates
  – Identify benchmarks and best practices
• We are doing this to some extent, but are we getting the information that is needed to those who need it?
Getting the information to those who need it: I-35

• 1996 Grand River Bridge structural failure due to gusset plates
• In the absence of a national system to benchmark performance of cohorts of comparable assets...
• "MnDOT reports that none of its employees were aware of the failure of the Grand River Bridge," the legislature's report states. "The Federal Highways Administration [sic]...should take steps to ensure that information on bridge deficiencies is shared with MnDOT and other state departments of transportation in the future."
  – Cho and Van Hampton, ENR May 22, 2008
#2 It can’t be done
Recap

• SEUT theory provides a framework for infrastructure management
• Need applied research and consulting to provide objective data where possible
Another Perspective

• First of all SEUT is NOT universally accepted
  – People’s behavior violates SEUT all the time
• Second even if there is a system that doesn’t mean it’s being used
Social sciences side of AM

- The failure to adopt SEUT opens up all kinds of social science research questions
- Descriptive/positive side of asset management
What we know already

• Infrastructure projects do not necessarily perform as advertised (Flyvbjerg et al. 2005)

• Infrastructure projects are often not selected based on benefit-cost analysis (SEUT) (Docherty et al. 2007)

• You might think these suggest the need for further research…
Why these are not tractable research questions

• Infrastructure systems are large, expensive systems
• We can not feasibly control conditions or conduct multiple experimental trials
• We observe only the one set of outcomes
• Without a control how can we validate our management model
What would we have to do to make it research?

• Research – generally applicable knowledge
• Would need both depth and breadth
• Something like an international infrastructure observatory PLUS social studies of decision processes at a statistically representative number of asset managers
#3 It shouldn’t be done
Technocrats vs. Politicians

- As we integrate across asset systems we will inevitably come up against basic questions of what type of society we want to have:
  - Sprawl vs. high density housing
  - Public transit vs. automobiles
  - Green roofs vs. lowest first cost
- These decisions are not made on a solely engineering basis
How do we engage public values in our work?

• Old system: throw our analysis over the engineer-politician divide and let them deal with it
• This was tried in the domain of risk assessment
  – We gave up
  – What is a value-free assessment of carbon emission impacts of infrastructure design?
• Now speak of involve interested and affected parties and an analytic-deliberative process
  – Whatever this is it’s not a controlled experiment
Validation

• Descriptive: Possible to develop but would require large scope of effort to identify generally applicable information.

• Prescriptive: Does “validation” even have meaning? How do you show that as a result of your efforts decision maker has achieved a result more in line with decision maker’s preferences?
Summary

• A basic framework for asset management has been developed
• Efforts to develop generally applicable information
  – would need to be very broad ranging,
  – would be difficult to validate,
  – would need to involve a broad range of interested and affected parties to develop recommendations that are reflective of societal values.
Discussion Points

• Do we have the educational programs and workshops we need for asset management?
• How well are we doing at collecting, compiling information and learning from what we are already doing? How can we do better?
• To what extent do management plans of public, technocrats/engineers, and politicians diverge? Is this divergence harmful and can it be reconciled?
• Who should do this research and how?