Asset Management Ruminations

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Why Transportation Asset Management Has Nothing to Do With Systems to Manage Individual Transportation Assets

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I really didn’t intend to confuse you more

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What Is Asset Management

- FHWA office of Asset Management

  "Asset management is a business process and a decision-making framework that covers an extended time horizon, draws from economics as well as engineering, and considers a broad range of assets. The asset management approach incorporates the economic assessment of trade-offs among alternative investment options and uses this information to help make cost-effective investment decisions."

- AASHTO

  "Asset management is a systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines Engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision-making. Thus, asset management provides a framework for handling both short- and long-range planning."

- UK Asset Management Institute

  "The set of disciplines, methods, procedures and tools to optimise the whole life business impact of costs, performance and risk exposures of the company's physical assets."

TAM Definitions

- Commonwealth of Victoria, Australia

"Asset management is the process of guiding the acquisition, use and disposal of assets to make the most of their service delivery potential and manage the relate risks and costs over their entire life."

  - Steps
    - Needs analysis (demand analysis)
    - Economic appraisal (valuation)
    - Integrate with planning process
    - Budgeting (over entire life-cycle)
    - Pricing
    - Economic evaluation of acquisition and disposal options
    - Recording, valuation and reporting (condition/performance appraisal)
    - Management in use (maintenance management)

TAM Definitions Continue

- Lou Lambert (formerly with the Michigan DOT)
  - "Transportation Asset Management views infrastructure as an investment rather than a cost."
  - Using Lou's definition, what should be our criteria for determining how to allocate our financial resources?
  - In the public sector, how do we measure return on investment?

Important Difference Between Private and Public Sectors

The private sector internalizes user benefits and costs.

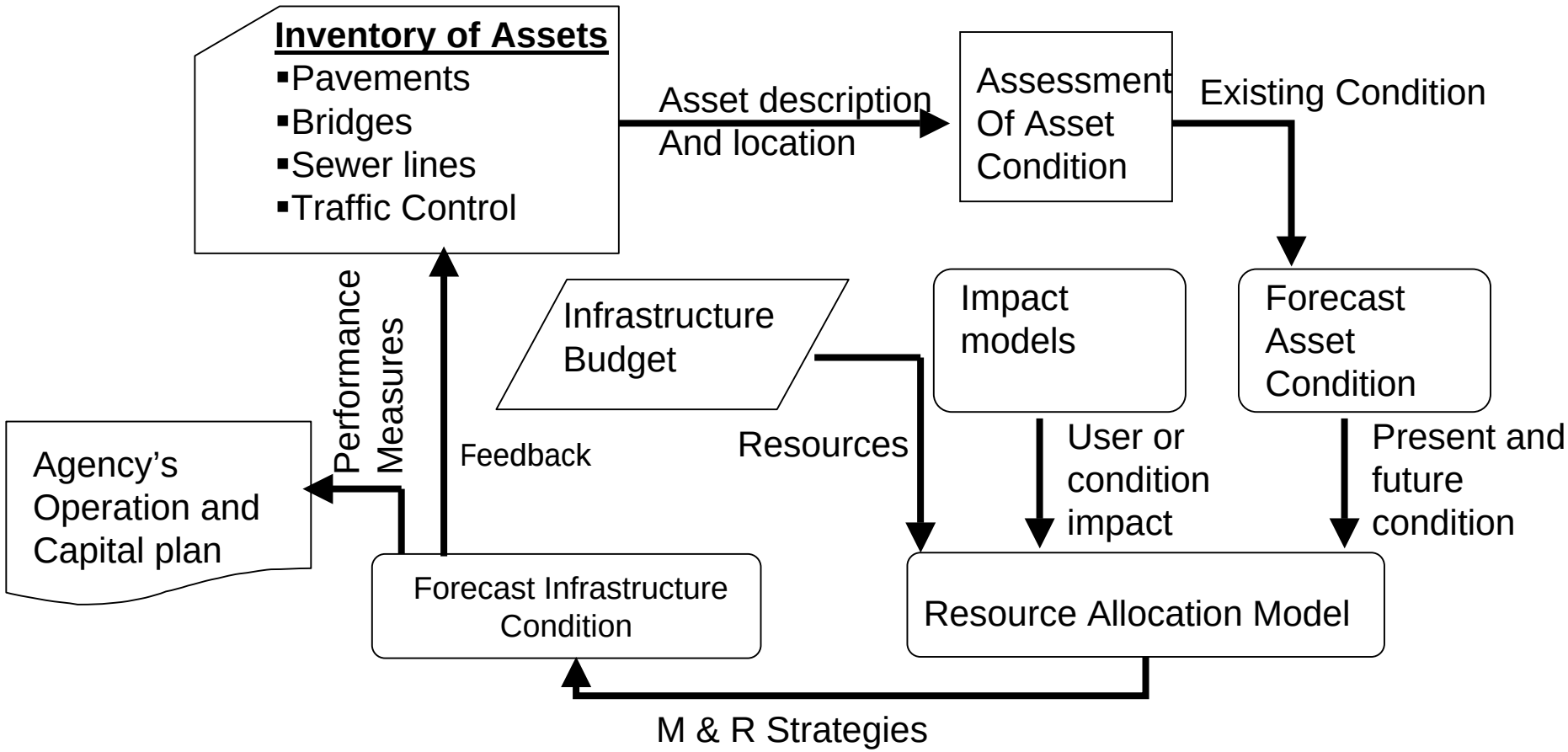
The public sector cannot internalize user benefits and costs. This results in sub-optimal solutions

Agency Optimum Example

Switching Gears

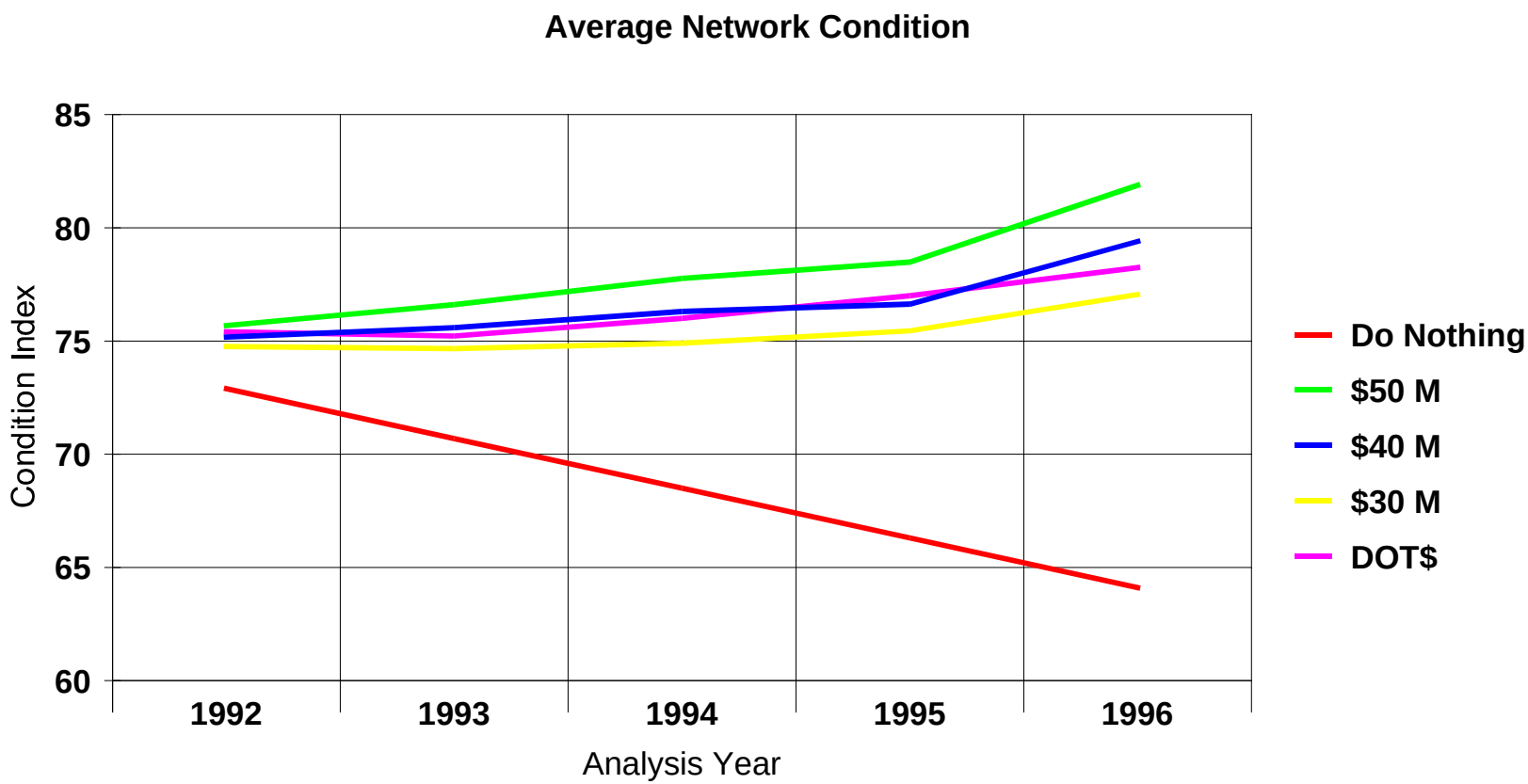
Lets look at how we use systems to manage individual assets

Technical Process for System Used to Manage an Asset

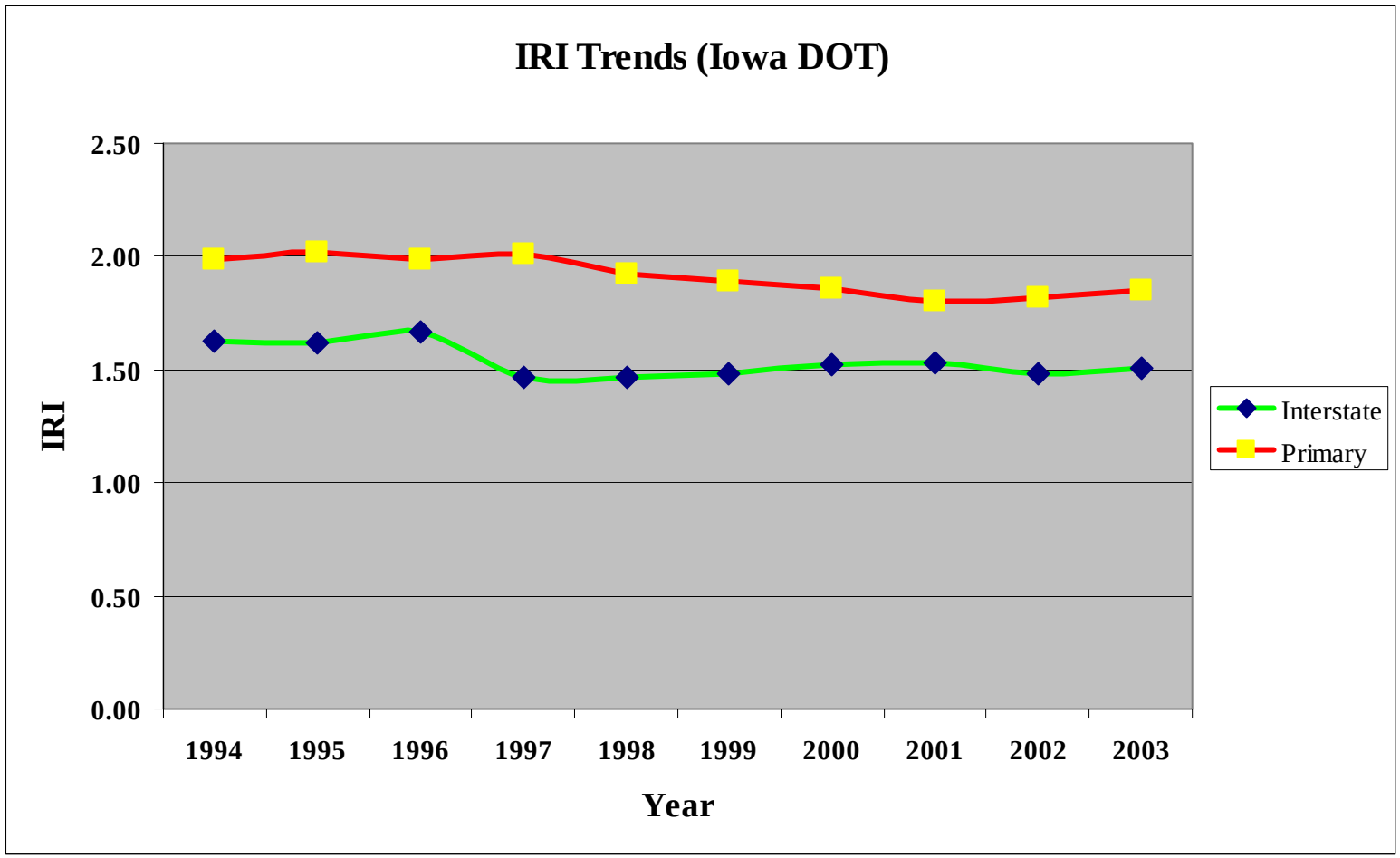


Performance Under Alternative Scenarios

Example of network level analysis



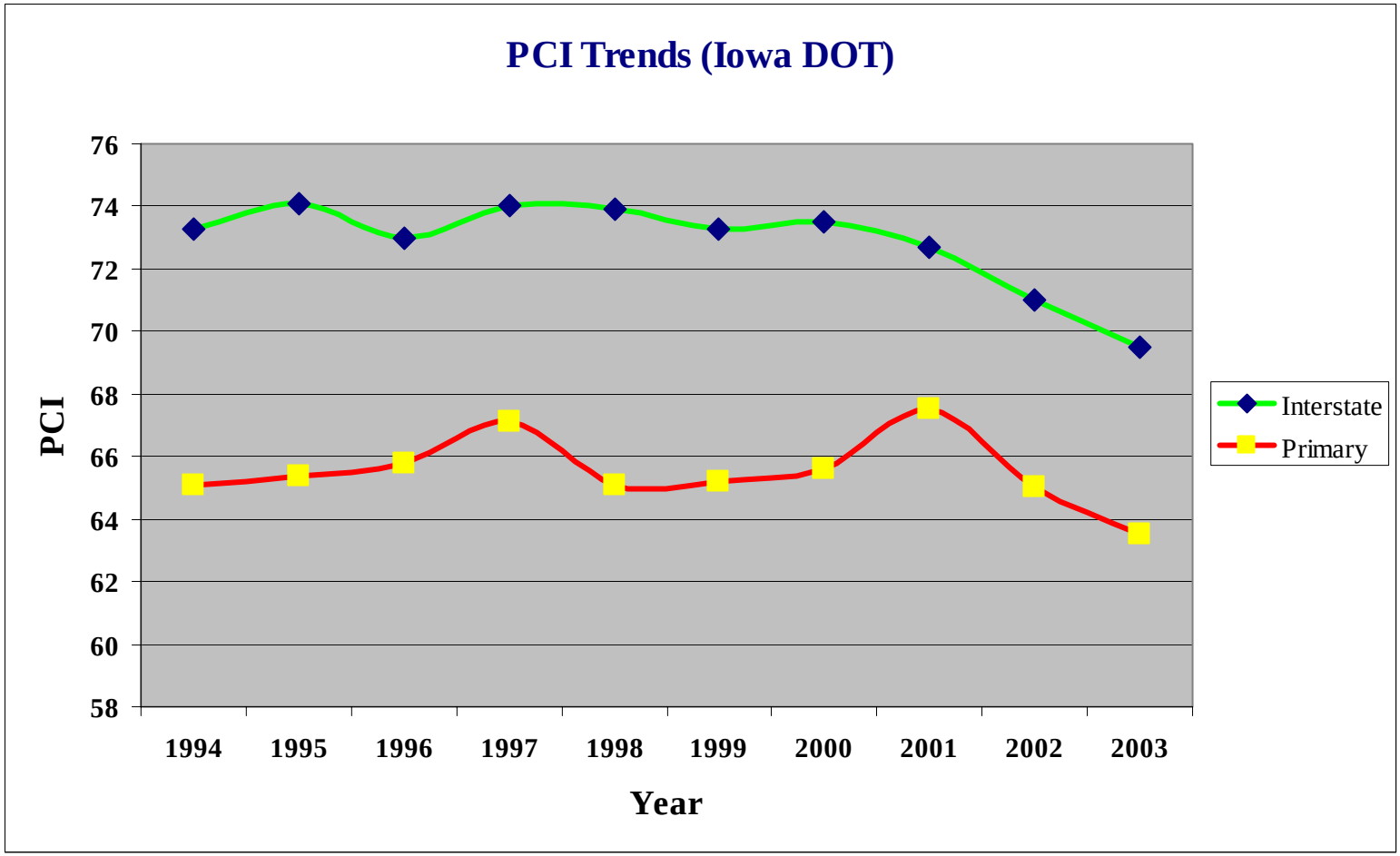
Pavement Performance Measures



International Roughness Index

Condition	iri (m/km)	in/mi
Good	1.50	95.00
Fair	2.68	170.00
Poor	3.95	250.00
Failed	5.52	350.00
Impassible	7.89	500.00

Pavement Performance Measures



PCI Equation

Jointed PC Pavements on the interstate
PCI = (-1.025063*age) - (0.225302*lifeused) - (0.125296*CRACK) + 102.238903

lifeused - ESALs since resurfacing divided by design or predicted lifetime ESALs
CRACK - cracking in sq.m per 800 meter test section

For full depth asphalt on the interstate
PCI = (-3.772517*age + (0.232149*basethick) - 4.044342*IRI + 23.073049

basethick - Base thickness in mm

Bridge Health Rating Severity weighting factor

Number of Possible Condition States	State 1 WF	State 2 WF	State 3 WF	State 4 WF	State 5 WF
3 Condition States	1.00	0.50	0.00		
4 Condition States	1.00	0.67	0.33	0.00	
5 Condition States	1.00	0.75	0.50	0.25	0.00

Current value of each element

Current element value = (quantity in Condition state x WF x FC)

WF = Weight factor for the severity of the deterioration as determine in table.

FC = Failure costs of the element (cost to rehabilitate or replace an element if it fails.

Core Element Condition & Extent Data

Element	Total Quantity	Units	State 1	State 2	State 3	State 4	State 5	Unit Failure Cost
Concrete Deck	300	Sq Meters	0	0	300	0	0	$600
Steel Girder	100	Meters	61	34	5	0	0	$3,500
Reinforced Concrete Abutment	24	Meters	24	0	0	0	0	$7,700
Reinforced Concrete Column	4	Each	4	0	0	0	0	$9,000
Joint Seal	24	Meters	0	0	24	na	na	$556

Bridge valuation calculation

Element	Calculation	Current Element Value
Concrete Deck	300 x 0.5 x 600	$90,000
Steel Girder	((61 X 1.0)+(34x0.75)+(5x0.5))x3,500	$311,500
RC Abutment	24 x 1.0 x 7,700	$184,800
RC Column	4 x 1.0 x 9,000	$36,000
Joint Seal	24 x 0.0 x 556	$0
	Total Current Value of Bridge	$622,300

Total valuation calculation

Element	Calculation	Current Element Value
Concrete Deck	300 x 600	$180,000
Steel Girder	1,000 x 3,500	$350,500
RC Abutment	24 x 7,700	$184,800
RC Column	4 x 9,000	$36,000
Joint Seal	24 x 556	$13,344
	Total Current Value of Bridge	$764,114

Bridge Health Index (Example)

$$H = \frac{\$622{,}300}{\$764{,}144} * 100\% = 81.4\%$$

Performance Measure

Osborne and Gaebler, Reinventing Government
If you don't measure results, you can't tell success from failure. If you can't see success, you can't reward it. If you can't reward success you are probably rewarding failure. If you can't see success, you can't learn from it. If you can't recognize failure, you can't correct it. If you can demonstrate results, you can win public support.

Performance Measurement

Tom Maze – The Soviet Union was very good at identifying performance measures and setting performance goals.
Performance measurement and goals by themselves are not enough.

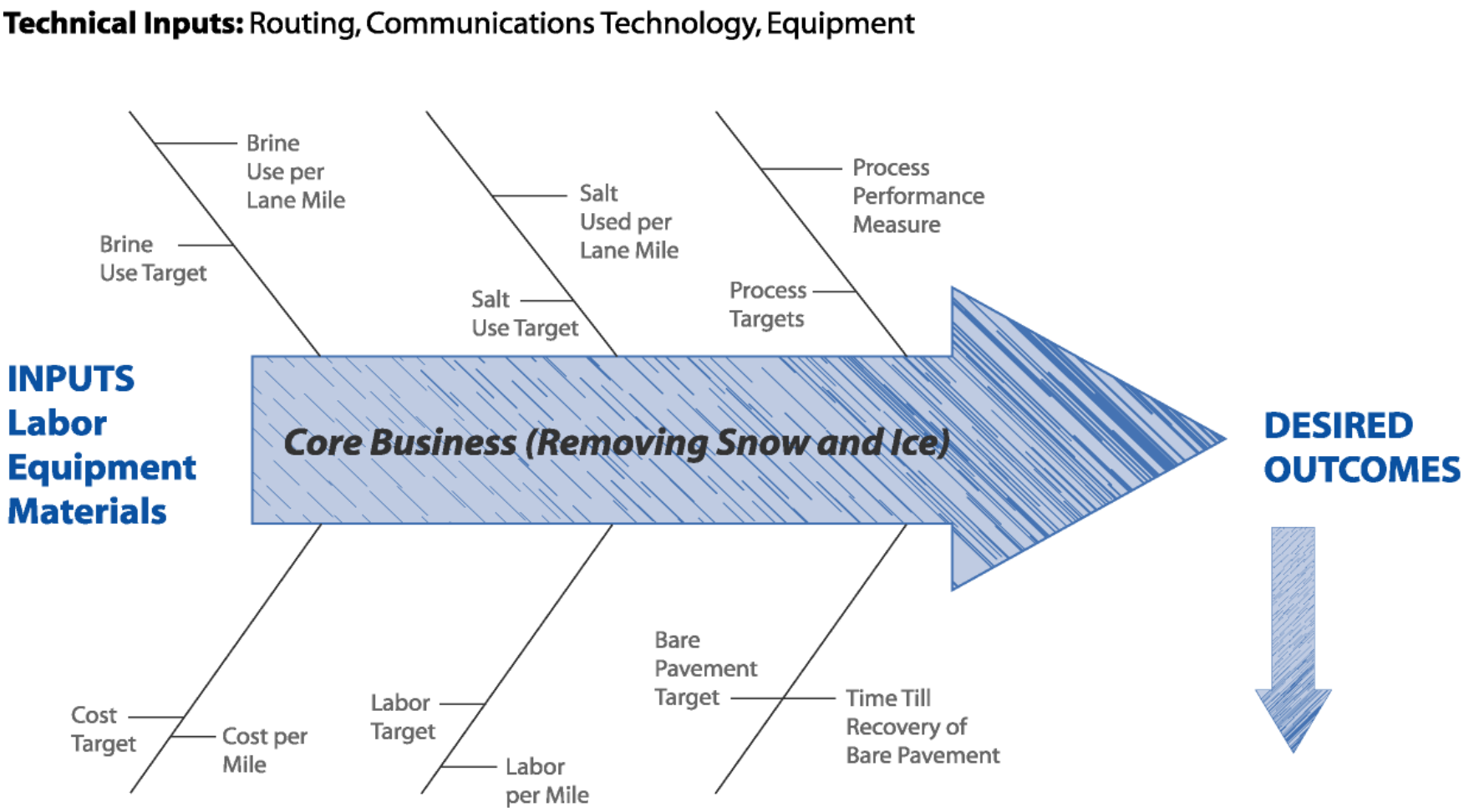
Defining performance

- Performance measurement needs to capture inventory, and condition - the “supply side”
  - Financial perspective indicators
  - Internal business and engineering indicators
  - Change and growth indicators
- Performance assessments also depends on usage - the “demand side”
  - Customer prospective indicators

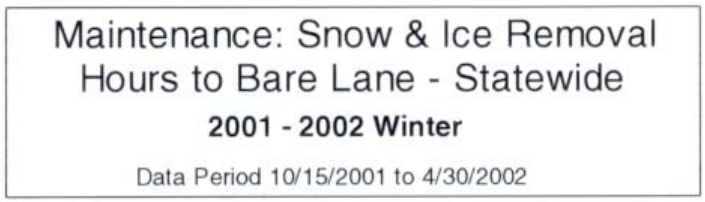
Performance Measurement Example – Understanding Desired Outcomes

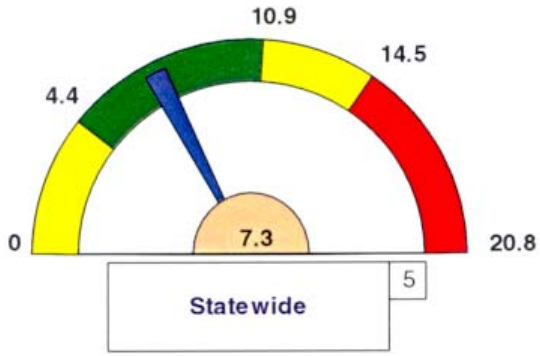
- What is the desired outcome for winter maintenance?
- What technical resources does a transportation agency have to achieve its objectives?
- What non-technical resources does a transportation agency have to achieve its objectives?
- What is a transportation agency's core business when it comes to winter maintenance?

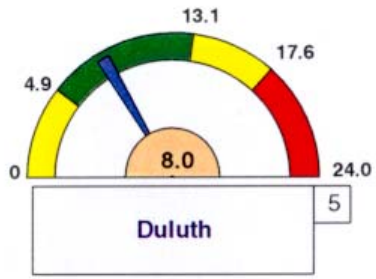
System Mapping Diagram

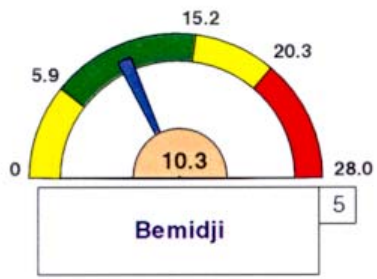


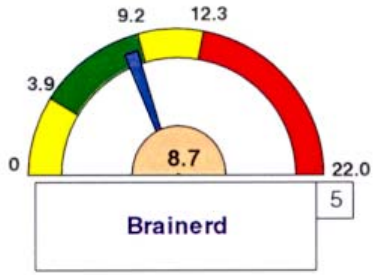
MnDOT Dashboard Examples

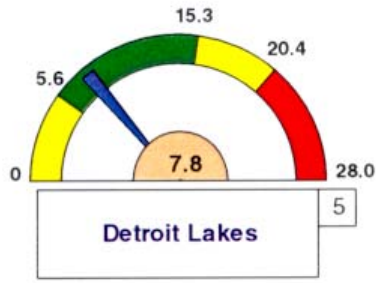


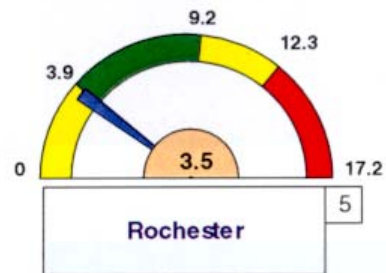


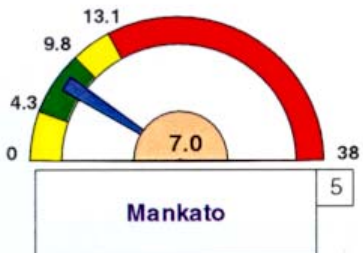


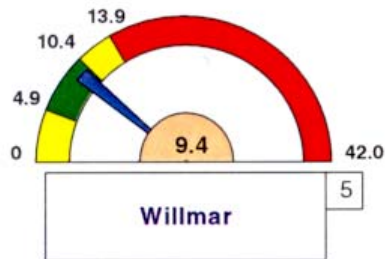


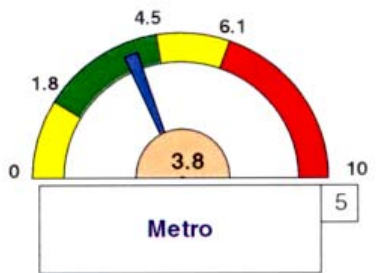








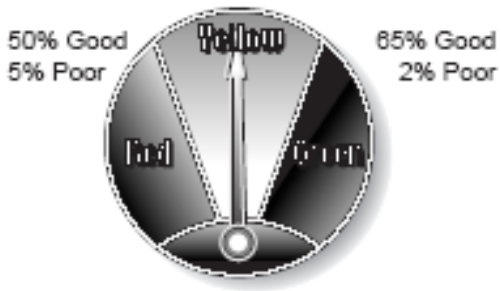




Example, MnDOT's bridge condition dash board

6-7-01

Bridge Condition
Trunk Highway Principal Arterials
Bridges 20 Feet and Over



Bridge Structural Condition

Targets for the Year 2017:

Structural Condition:	≥ 65% Good and 2% Poor
Geometric Rating:	≥ 50% Good and 5% Poor
Load Capacity:	≥ 50% Good and 0% Poor

Performance (January, 2000):

Structural Condition:	57.2% Good and 3.9% Poor
Geometric Rating:	46.9% Good and 6.1% Poor
Load Capacity:	42.2% Good and 0.1% Poor

Bridge Geometric Rating

Bridge Load Capacity

Source: Office of Bridges & Structures, Bridge Management Unit

How Do We make Trade Offs Between Performance Measure?

Issues with existing asset management process

- Existing methods seek to satisfy performance requirements while minimizing costs
- Existing methods do not address system growth or system abandonment
- There is no assurance that existing standards for performance are reaching desirable solutions
- No ability to measure the user impact of adjustment investment levels between alternative asset categories – supply side oriented
- Therefore, there is not means to measure return on investment!

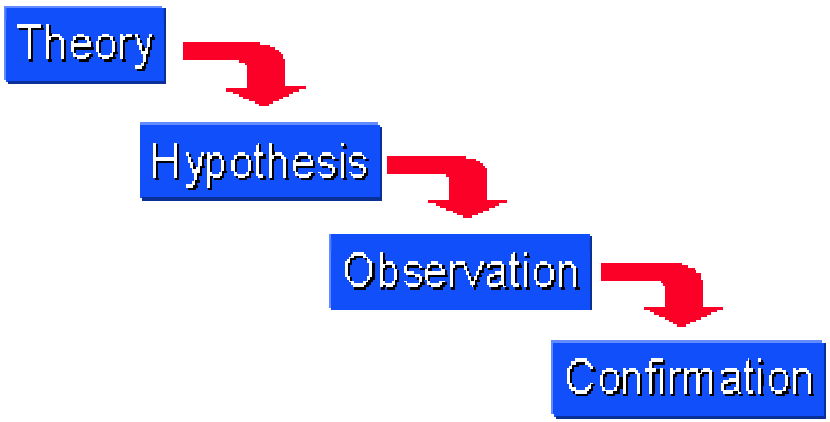
Issue

Some how asset management got confused with systems used to manage assets!!!

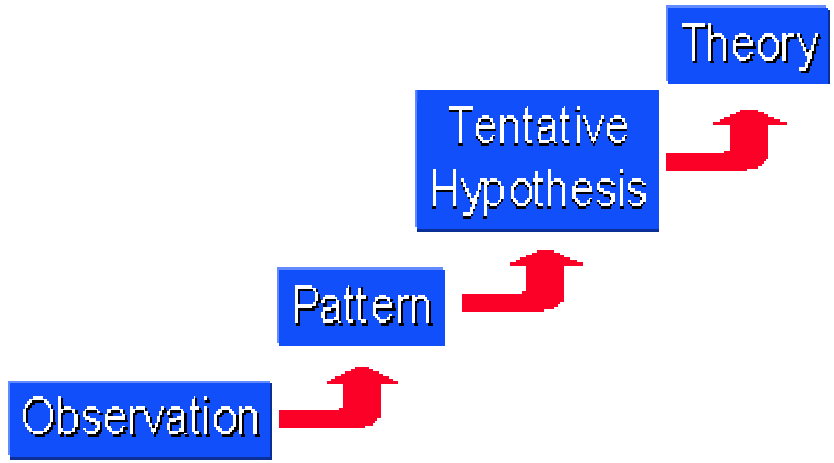
How did this happen???

Problem Solving approaches

Deductive Approach



Inductive Approach



How did we get to this point?

- The state-of-the-art took the inductive approach (the follow your noise approach)
  - Started with a conventional approach involving
    - Managing assets to performance standards
    - Minimizing internal costs
  - Look for best practices involving best decision making tools
  - Accumulate best practices into a state-of-the-practice
    - Declare victory

Alternative model for the development asset management

- Develop a theoretical model for asset management
  - Develop the science of asset management
- Develop practical models based on a sound theory
- Develop institutional processes which support approaches based on sound theory

Asset Management

- Maze Definition: The efficient allocation of resources between competing demands

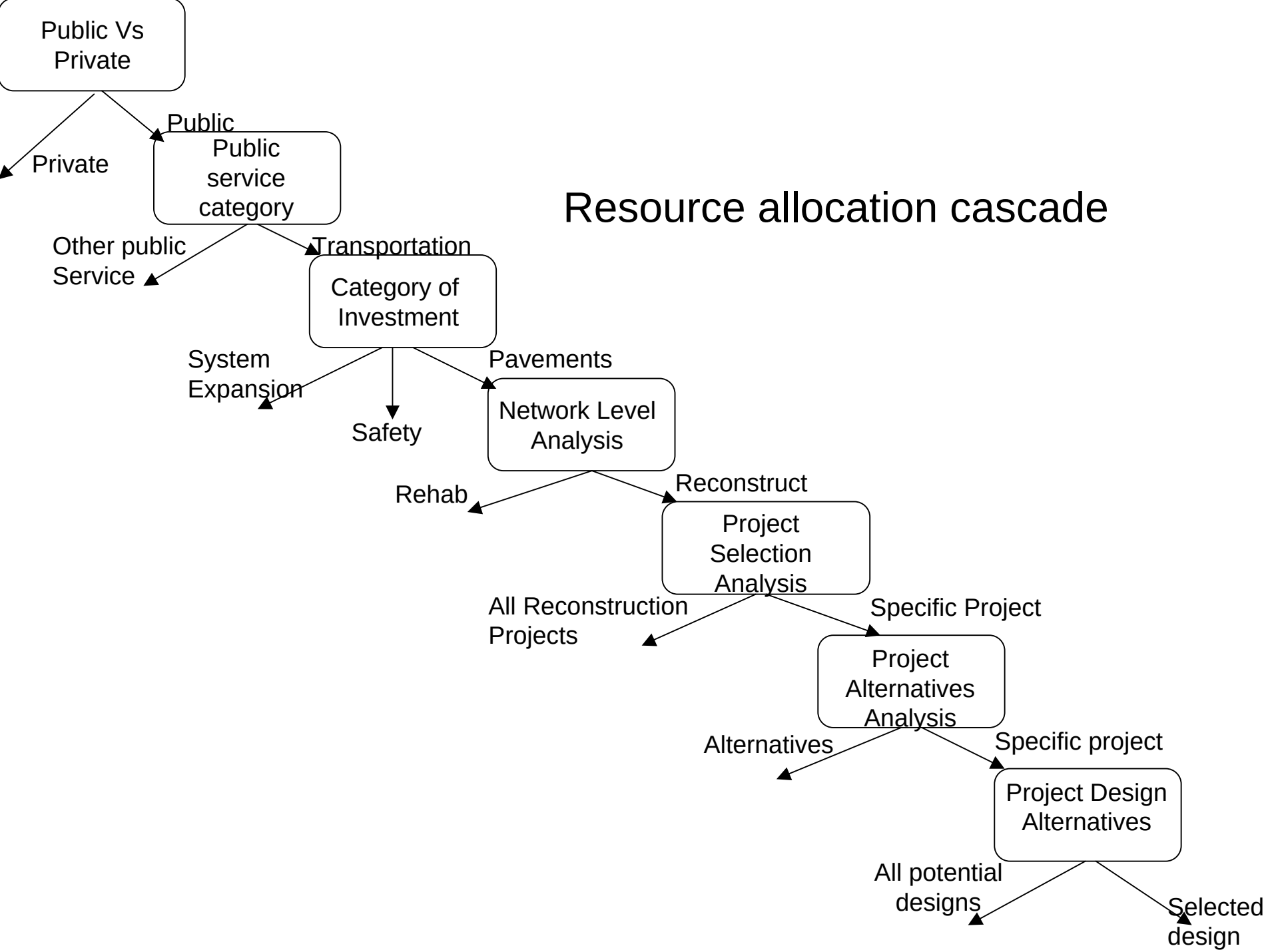
  <u>Requirements</u>

  – The allocating agency must have a free hand to move resources to most efficient use
  – The allocating agencies must give equal weight to internal and external costs and benefits

Resource Allocation Decision

- Level 1 – Public versus private
- Level 2 – Transportation versus all other public purposes
- Level 3 – Category of transportation service or asset
- Level 4 – Network level analysis
- Level 5 – Project selection
- Level 6 – Project alternative evaluation
- Level 7 – Project design selection
  - Maintenance resource allocation decisions are determined by level 7

Resource allocation cascade



Public Vs Private

- The public sector provides goods and services where delivery through the market is inefficient
  - The division becomes very murky

Stateline.org
Politics & policy news, state by state

THURSDAY, MARCH 4, 2004

States and public colleges consider new relationships

post-gazette.com
The interactive edition of the Pittsburgh Post-Gazette®

State eyes turning I-80 into toll road

PennDOT says funds needed for maintenance

History of private sector delivery in transportation

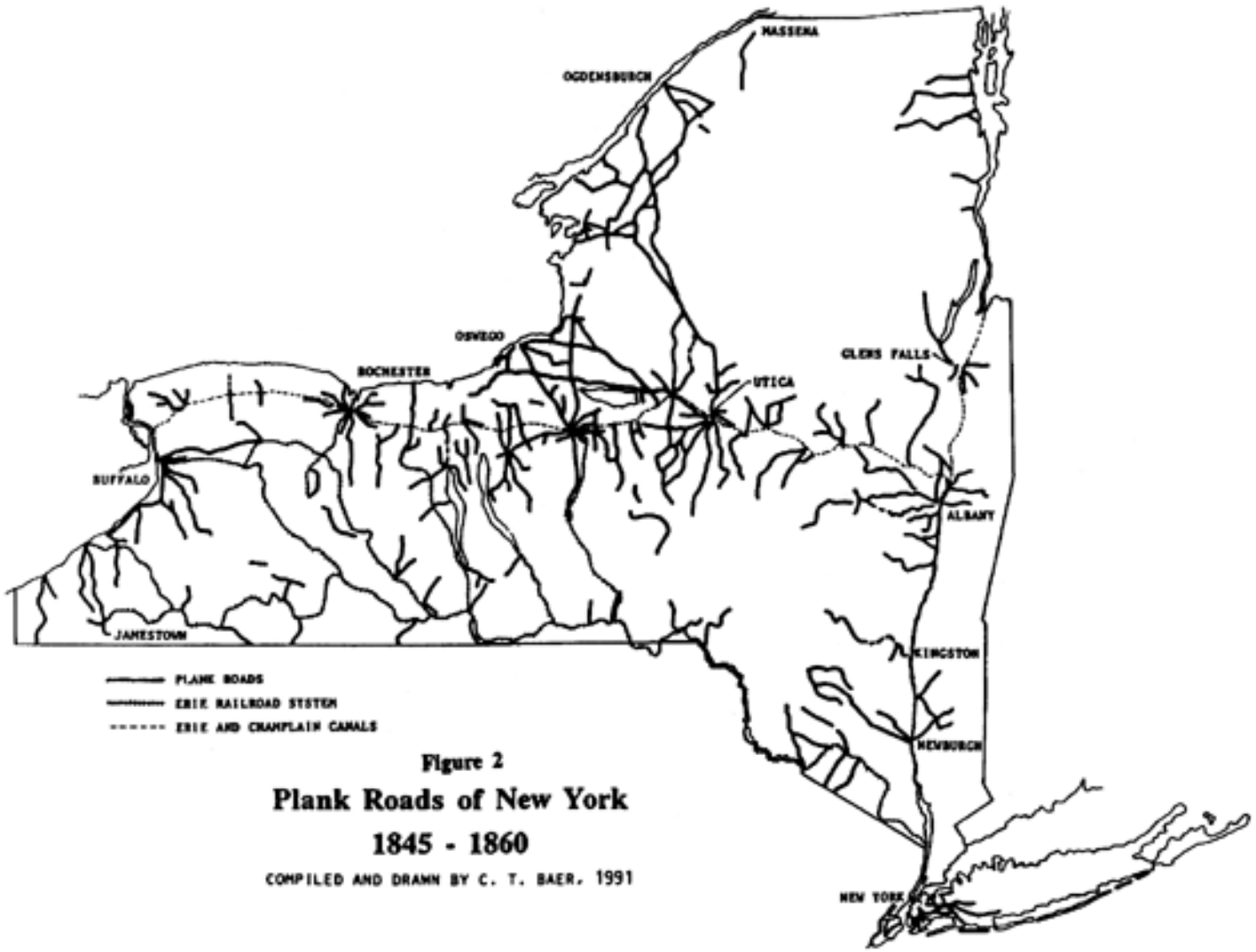


Figure 2

Plank Roads of New York

1845 - 1860

COMPILED AND DRAWN BY C. T. BAER, 1991

Question - Levels of resource (funding)allocation decisions

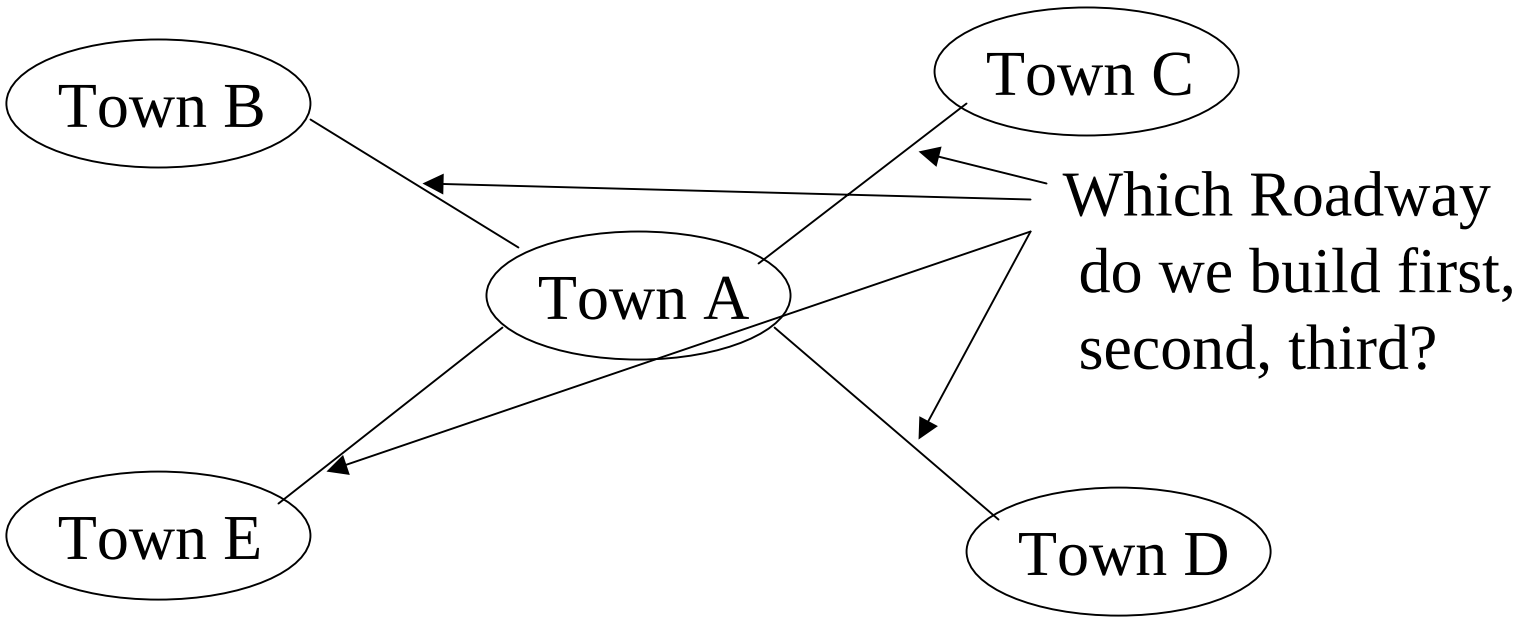
- How do we do we decide what category of investment to fund at what level?
  - Example – we can spend public funds on parks, roads, sewer, schools, etc.
  - Analogy – how would private company (GM) decide whether to invest more in making Geos or Cadilacs

Answer - Levels of resource (funding)allocation decisions

- At the margin (the last dollar invested in all investments) should earn the same return
  - Return on the last dollar invested highways should equal the return on the last dollar in water supplies.

Question - Given a level of resource devoted to category, which project do we invest in?

- How do we decide which project to invest in?



Characteristics of the decision – is non-mutually exclusive
Network level decision (planning level decisions)

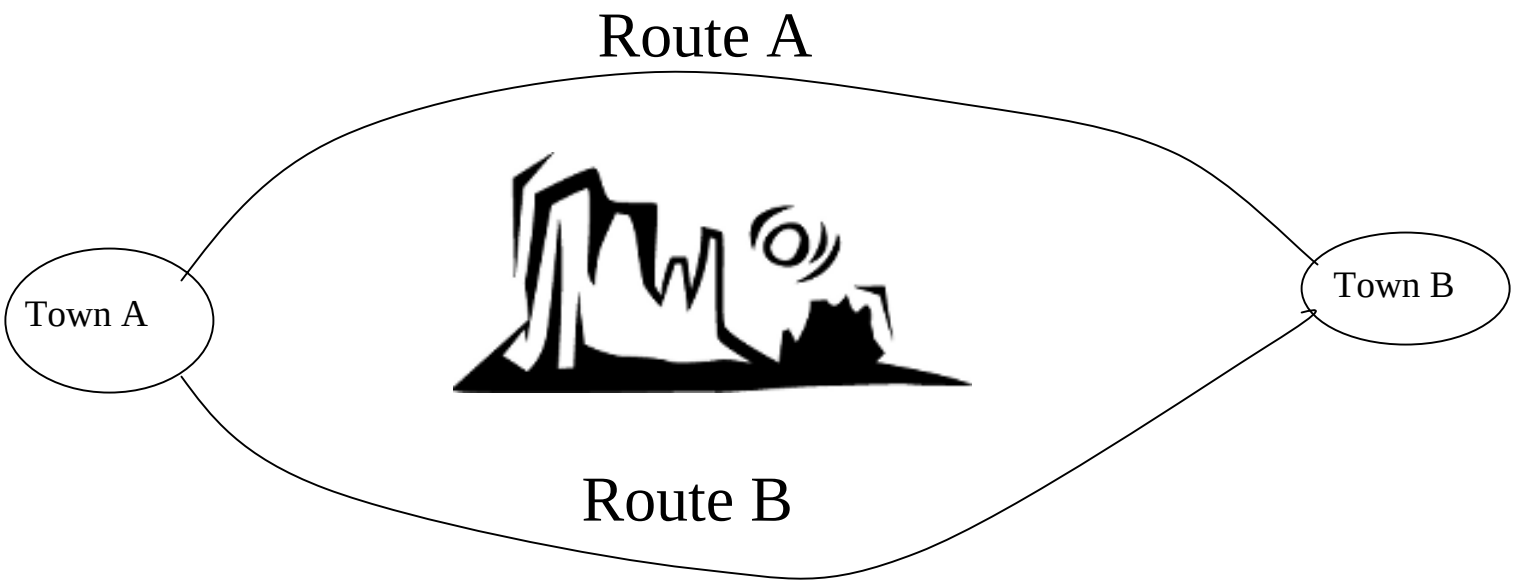
Answer - Given a level of resource devoted to category, which project do we invest in?

- Select projects starting with the greatest benefits to cost ratio (return) until
  - There are no more projects with benefit to cost ratios greater than one

    Or
  - You run out of resources

Question - Within a project how do we make choices?

- How do we decide to invest given multiple options for a project?



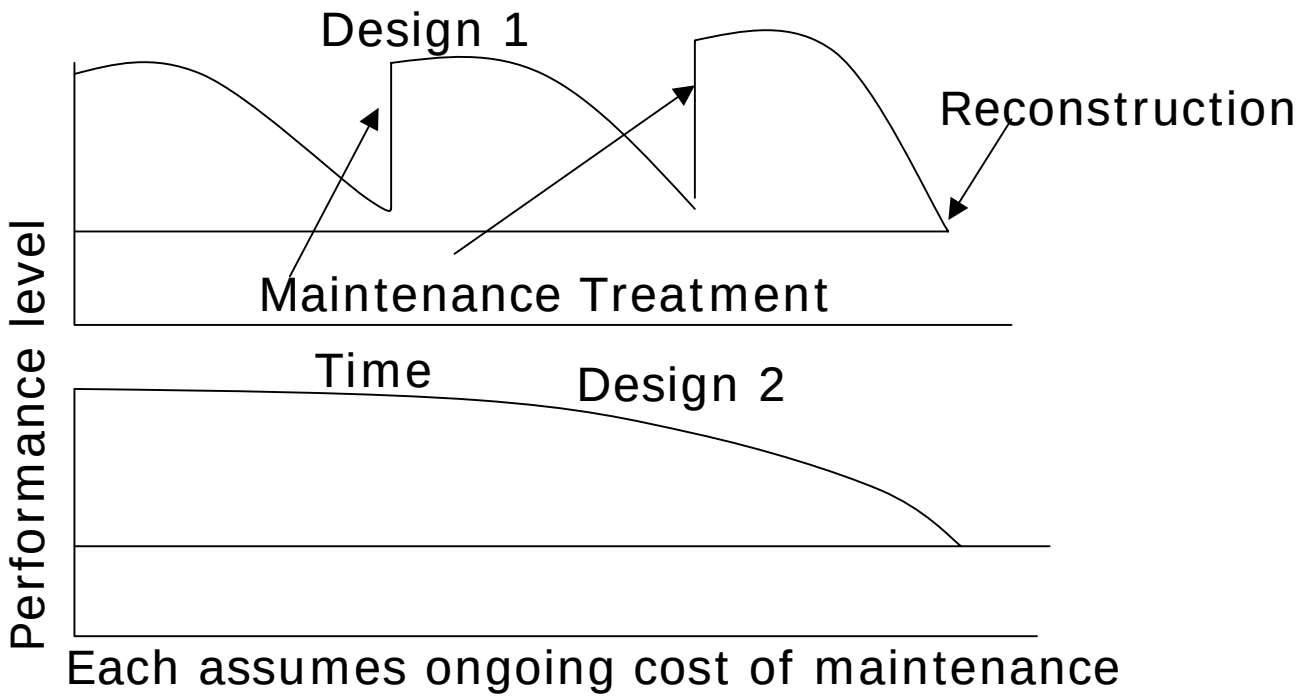
Characteristics of the decision – mutually exclusive
Project level decision (planning level decisions)

Answer - Within a project how do we make choices?

- We select the most expensive project where the incremental benefits exceed the incremental costs when compared to all other projects
  - Incremental benefits = incremental reduction in user costs
  - Incremental cost = increment facility related costs (including O&M) compared to the less costly facilities

Question - Within a design how do we make decisions

- Once we pick alignment A, how decided whether to use one pavement design or another?



Characteristics of the decision – mutually exclusive, benefits are essentially the same. Design level decision

Answer - Within a design how do we make decisions

- Assuming both designs offer the same benefits
- Select the design with the minimum life cycle cost
- The performance standard for the asset are made at this level

Question - Maintenance and Operations Decisions?

- After the asset is built how do we make comparisons between deferring maintenance and using the savings to build a new project?
  - Competition between O&M and capital decisions

Answer - Maintenance and Operations Decisions?

- O&M decisions have already been made as part of the design decision
- At the margin, O&M resource allocation decisions should be made based on the opportunity cost of decision
  - What are the costs associate with not performing the planned maintenance?

Summary of Decision Making Levels

- Public Versus Private – Level 1
  - Invest were the return is the greatest
- Public Sector Category – Level 2
  - The last dollar invested in each category should offer the same return
- Category of Investment - Level 3
  - The last dollar invested in each category should offer the same return
- Network level analysis – Level 4
  - Budget for category fixed
  - Non-mutually exclusive alternatives
  - Select treatments which maximize performance
- Project selection analysis – Level 5
  - Non-mutually exclusive alternatives
  - Select specific alternatives with greatest B/C ratio
- Project alternatives analysis – level 6
  - Mutually exclusive alternatives
  - Select option based on incremental B/C ratio
- Project design alternative analysis
  - Options offer the same user costs
  - Select based on minimum life cycle costs
  - Design to meet performance standard