

Transportation Asset Management Research

HIGHWAY FATALITIES
 Remaining Service Life
 Surface Roughness
 Congestion Mitigation
 v/c ratio
 Bridge
 Health
 Crash Rate
 Jobs!
 Freeway speed
 Air quality
 Community Impacts
 Travel Time
 Historic Bridges
 Remaining Service Life
 Economic Development

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Research & Development – Transportation Asset Management (TAM)

Historical Background

- 1997 Integration of Different Program Areas
- 2004 Development of Framework for Asset Management Project Selection
- 2008 Methodology for Trade-off Analysis in Asset Management

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Recently Completed Research

A Methodology for Trade-off Analysis in Asset Management, SPR 3110

December 2008

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Spheres of TAM Trade-off Analysis

Sphere 1 -- Network-level trade-offs using network-level data;

Sphere 2 -- Network-level trade-offs using project-level data;

Sphere 3 -- Project-level trade-offs using project-level data.

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Spheres of TAM Trade-off Analysis

	Project-level Trade-offs	Network-level Trade-offs
Project-level Data	Sphere 3 Within each program area, often life-cycle based	Sphere 2 SPR 3110 Main Focus
Network-level Data	Not Applicable	Sphere 1 Future Research

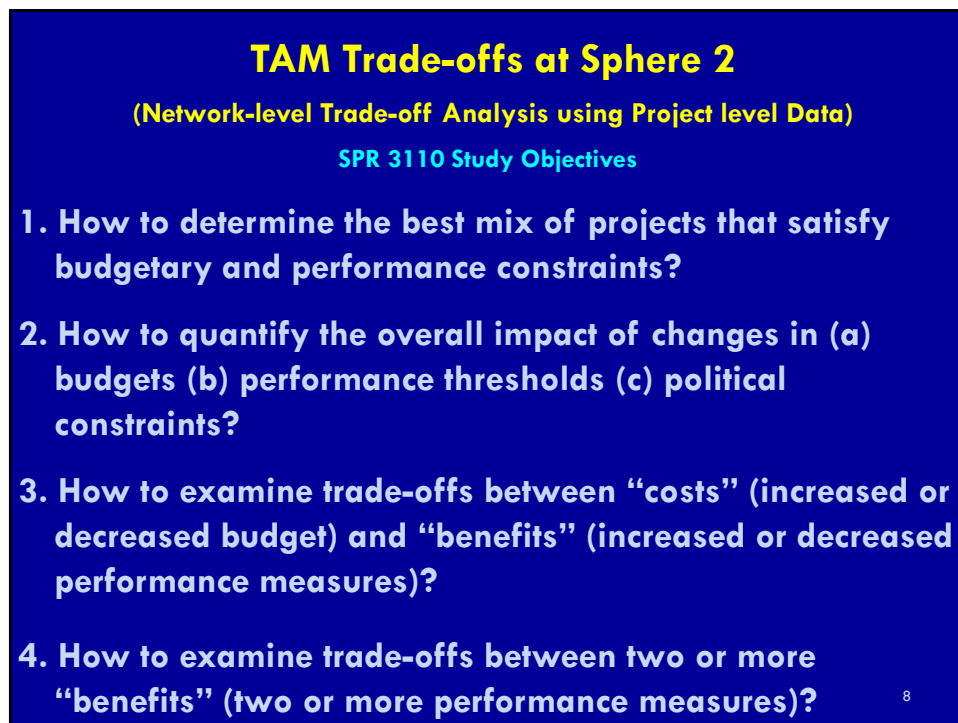
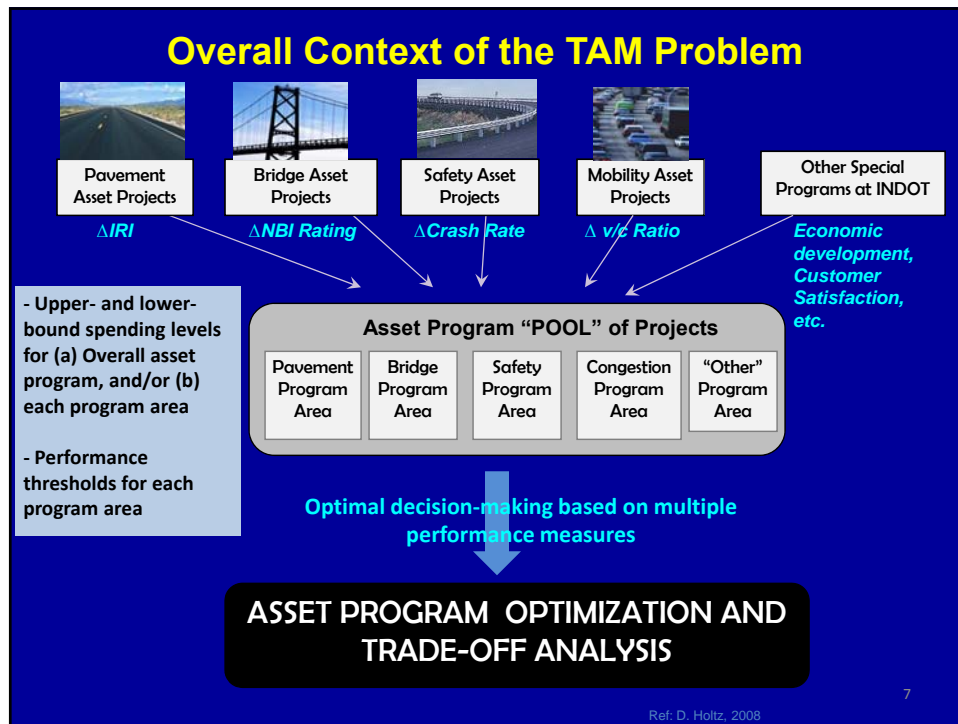
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TAM Trade-offs at Sphere 2

(Network-level Trade-off Analysis using Project level Data)

SPR 3110 Study Objectives

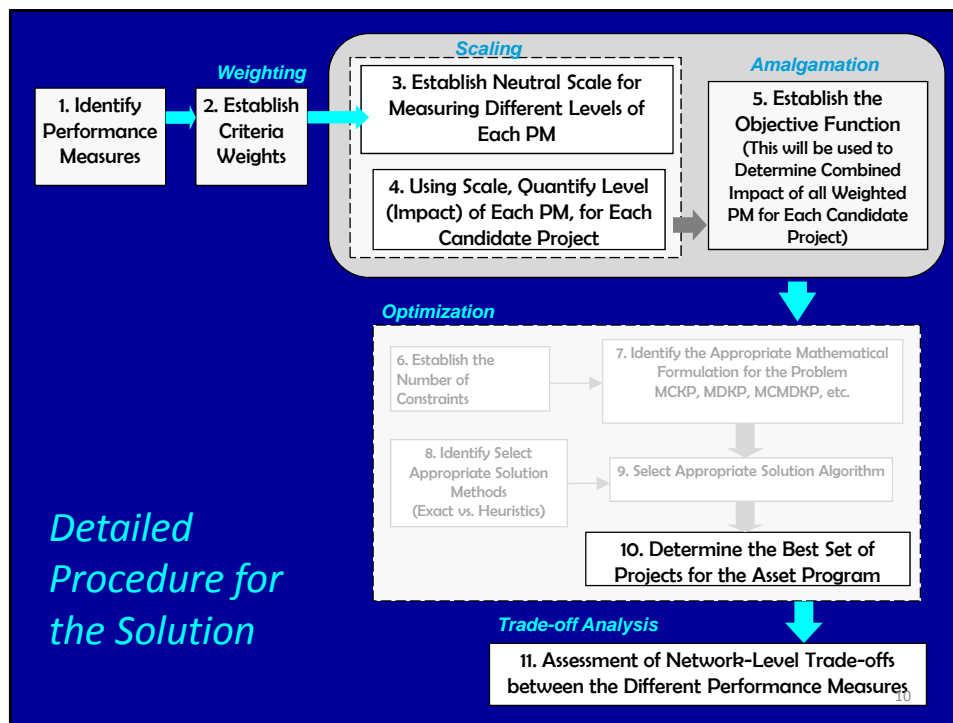
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Can these questions be answered, really?

- **Ideally ...**
 - Same performance measure across all Program Areas, OR
 - Different performance measures but they have
 - same units, dimensions, or scale
 - same level of importance to the Asset Manager
- **But idealism is not reality**
 - Hence there is a need for
 - Weighting and scaling the different performance measures
 - Amalgamating the weighted and scaled performance measures to yield combined impact of each candidate project

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The Solution Procedure – in a Nutshell (1)

Pavement Project A	
Bridge Project B	
Pavement Project C	
Safety Project D	
Congestion Project E	
Safety Project F	
.	
.	
Project <i>J</i>	

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The Solution Procedure – in a Nutshell (1)

Performance Measures (raw values)

	System Preservation	Safety Impacts	Mobility Impacts	...	PM <i>K</i>
Pavement Project A					
Bridge Project B					
Pavement Project C					
Safety Project D					
Congestion Project E					
Safety Project F					
.					
.					
Project <i>J</i>					

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The Solution Procedure – in a Nutshell (2)

Performance Measures (scaled values)

	System Preservation	Safety Impacts	Mobility Impacts	...	PM K
Pavement Project A					
Bridge Project B					
Pavement Project C					
Safety Project D					
Congestion Project E					
Safety Project F					
.					
.					
Project J					

Note: AM can carry out weighting before or after scaling

Research report provides several alternative scaling techniques

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The Solution Procedure – in a Nutshell (3)

Performance Measures (amalgamated values)

	System Preservation	Safety Impacts	Mobility Impacts	...	PM K	Total Impact of Project j
Pavement Project A						I_1
Bridge Project B						I_2
Pavement Project C						I_3
Safety Project D						I_4
Congestion Project E						I_5
Safety Project F						I_6
.						.
.						.
Project J						I_j

Research report provides alternative techniques for amalgamation

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The Solution Procedure – in a Nutshell (4)

Performance Measures (amalgamated values)

Projects	System Preservation	Safety Impacts	Mobility Impacts	...	PM K	Total Impact of Project j
	Pavement Project A					I_1
	Bridge Project B					I_2
	Pavement Project C					I_3
	Safety Project D					I_4
	Congestion Project E					I_5
	Safety Project F					I_6

Project J					I_j	

Optimization to identify the “best” projects

Research report provides mathematical frameworks for the optimization

The Solution Procedure – in a Nutshell (5)

Performance Measures (amalgamated values)

Projects	System Preservation	Safety Impacts	Mobility Impacts	...	PM K	Total Impact of Project j
	Pavement Project A					I_1
	Bridge Project B					I_2
	Pavement Project C					I_3
	Safety Project D					I_4
	Congestion Project E					I_5
	Safety Project F					I_6

Project J					I_j	

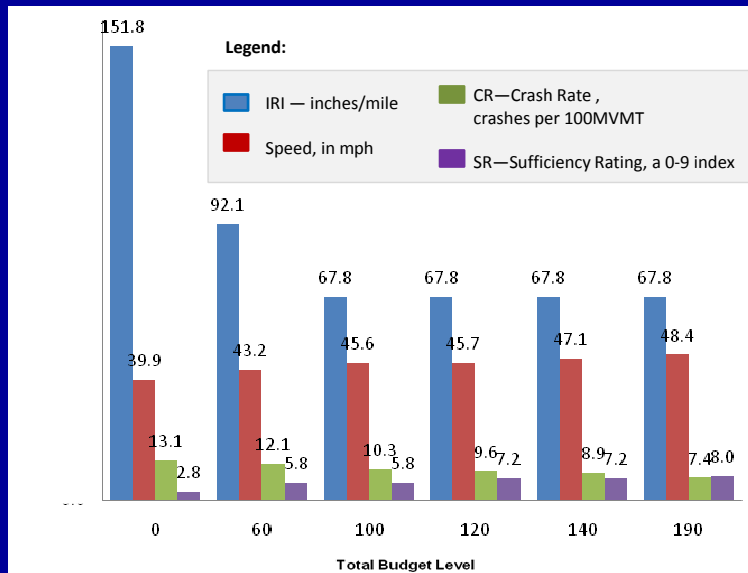
Trade-offs between budgets, performance levels and thresholds, risk, etc.

Research report provides mathematical framework for the trade-off analyses

Application Example of TAM Trade-offs at Sphere 2

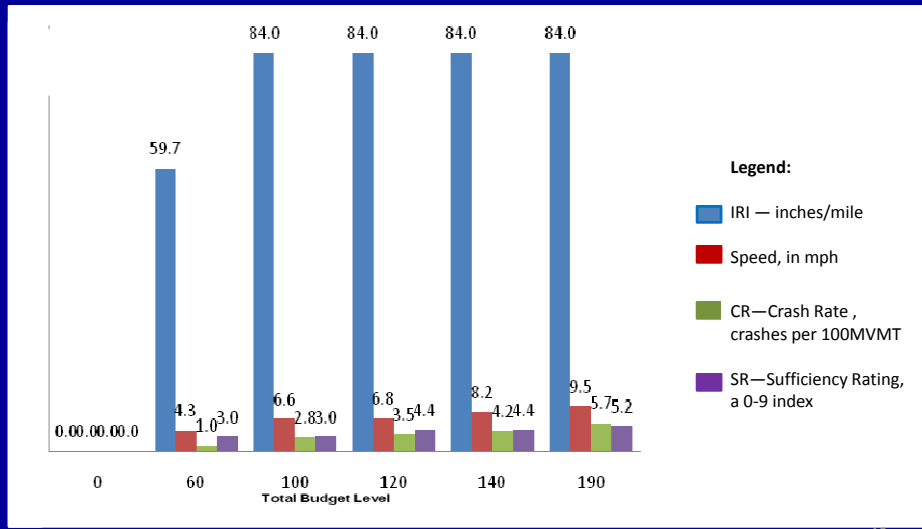
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Tradeoff Analysis 1A: Change total budget levels and find out the influence on AVERAGE values of performance measures



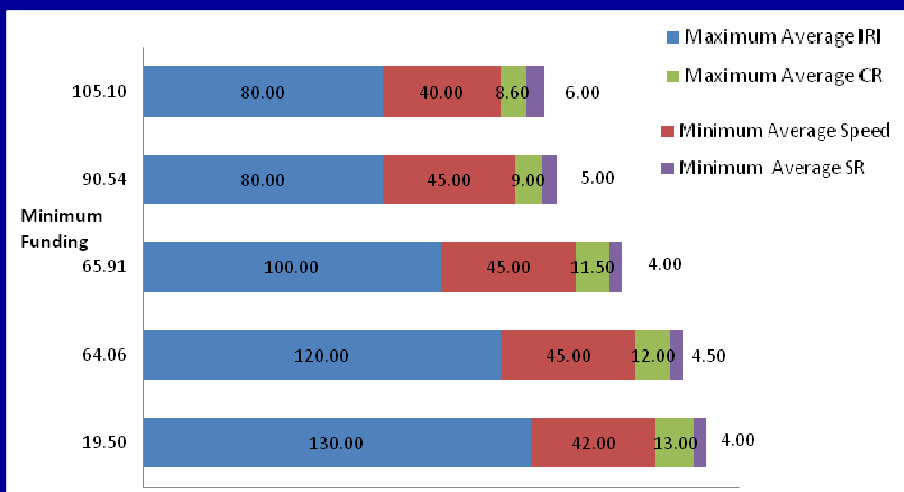
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Tradeoff Analysis 1B: Change total budget levels and find out the influence on the CHANGE in values of performance measures



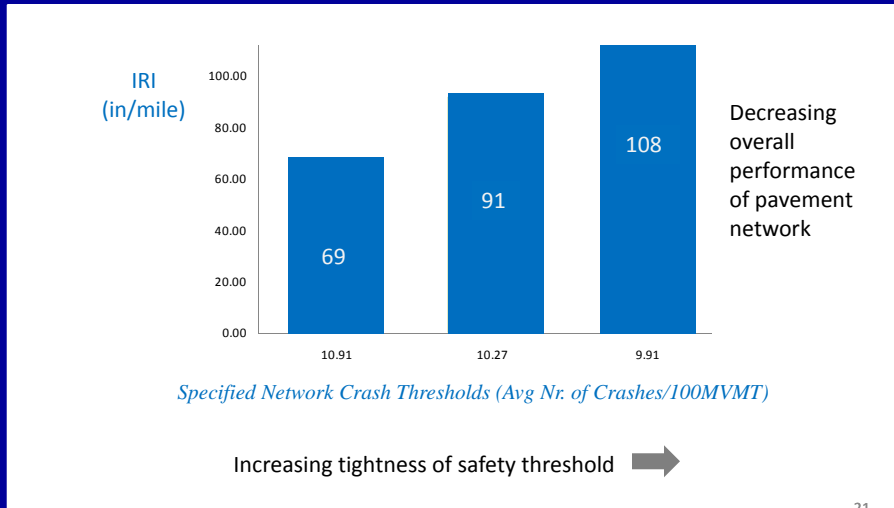
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Tradeoff Analysis 2: INDOT wants to know the cost needed to meet its performance targets for pavement smoothness, safety, etc.



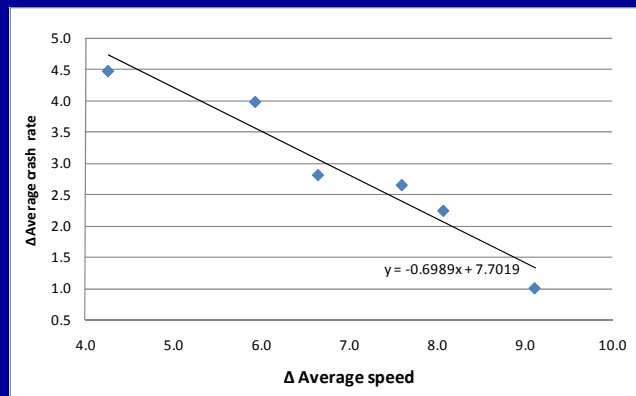
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Tradeoff Analysis 3: INDOT wants to know how much of one performance measure can be sacrificed for a given amount of another (total budget is fixed)



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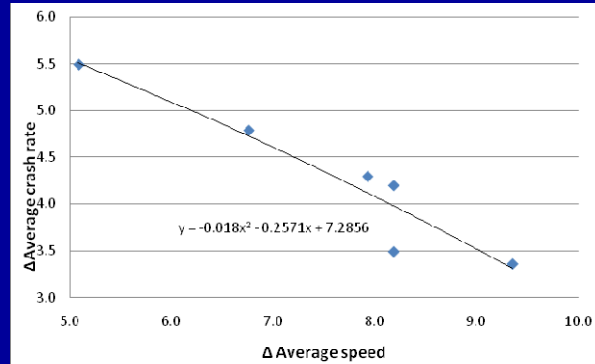
So, how much of one performance measure must INDOT “sell” in order to “buy” a certain amount of another performance measure



Gradient of line = Marginal Rate of Substitution = 0.6989 ≈ 0.7
 Meaning: A decrease of 7 Crashes/100MVT can “buy” a 10-mph speed increase

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Tradeoff Analysis 4A: INDOT wants to know the PROS and CONS of shifting budget from one program area to another



Safety Budget (\$M)	40	45	55	35	30	25
Congestion Budget (\$M)	30	25	15	35	40	45
Δ Average speed (mile/hour)	8.1841	6.7571	5.0819	7.9299	8.1841	9.3569
Δ Average crash rate (Crashes/100 million VMT)	4.1982	4.7862	5.4939	4.2942	3.4905	3.3603

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Implementation Suggestions

- **Decision support for Central Office or Districts:**
 - How to compare “apples and oranges” in order to select our projects fairly? Example: Do we do that safety project or that pavement project instead?
 - What will be consequences (performance impacts) for each funding level?
 - How much do we need to achieve a given network-level performance? For each district?
 - What will be the merits and demerits of shifting funds across program areas? Across districts?

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Implementation Suggestions (continued)

- **Permit investigation of past trends in expenditure and performance:**
 - Example: For each district, how much we spent on safety?
 - How much safety improvement was earned?
 - Is the trade-off value consistent across the districts?
 - Consistent across the years?

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Future Research in TAM

- TAM Trade-offs at Sphere 1 (Network-level trade-off analysis using network-level data)
- Extension to a multi-modal context
- Further investigation of past trends in expenditure and performance
- Enhanced mathematical formulations and solution algorithms to ensure quick analysis for large-sized problems
- Automate the AM decision-making and trade-off analysis processes

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