Applications of Asset Management in Programming and Budgeting
Peer Exchange

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16. Abstract

This report summarizes the results of the Applications of Asset Management in Programming and Budgeting Peer Exchange. The peer exchange was held in Elkridge, Maryland on August 15 and 16, 2007. The goal of the exchange was to facilitate a discussion between practitioners on existing practices, challenges, and issues. The exchange focused on the following six areas: 1) incorporating performance measures and targets in the programming and budgeting process; 2) the use of asset management systems to support the programming and budgeting process; 3) cross-asset analysis and programming; 4) the use of asset management principles in the prioritization of capacity expansion projects; 5) the application of asset management tools and techniques to assets other than highways; and 6) incorporating risk analysis techniques in the programming and budgeting process. This reports describes examples of current practices in each of these areas, summarizes common challenges associated with asset management implementation, and documents opportunities for future research aimed at addressing these challenges.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

Table of Contents

1.0 Introduction 1-1
1.1 Peer Exchange Format 1-1
1.2 Summary of Themes 1-2

2.0 Summary of Current Practices 2-1
2.1 Performance Measures and Targets 2-1
Current Practice 2-1
Challenges 2-3
2.2 Management Systems 2-4
Current Practice 2-4
Challenges 2-6
2.3 Cross-Asset Analysis and Programming 2-7
Current Practice 2-7
Challenges 2-7
2.4 Prioritization of Capacity Expansion Projects 2-8
Current Practice 2-8
Challenges 2-9
2.5 Application of TAM to Assets Other Than Highways 2-10
Current Practice 2-10
Challenges 2-11
2.6 Risk Analysis 2-12
Current Practice 2-12
Challenges 2-14

3.0 Recommended Follow-Up Activities 3-1
3.1 Future Research Opportunities 3-1
3.2 Potential Topics for Future Peer Exchanges 3-1

Appendix A – Agenda A-1
Wednesday – August 15, 2007 ..... A-1
Thursday – August 16, 2007 ..... A-2

List of Tables

Table 1.1 Peer Exchange Participants 1-2

List of Figures

Figure 2.1 Florida DOT's Performance Measurement System 2-2
Figure 2.2 Pavement Condition in Utah 2-2
Figure 2.3 Pavement Condition in Virginia – Interstates and Primaries 2-3
Figure 2.4 Analysis of Future Pavement Condition in Michigan 2-4
Figure 2.5 Analysis of Future Bridge Condition in Maryland 2-5
Figure 2.6 New Jersey DOT Funding Scenario Analysis 2-6
Figure 2.7 Use of Asset Management in Expansion Projects 2-9
Figure 2.8 Tracking Rest Area Roof Conditions 2-11
Figure 2.9 Michigan DOT's Modal Influence 2-12

1.0 Introduction

This report summarizes the results of the *Applications of Asset Management in Programming and Budgeting* Peer Exchange hosted by the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO). The peer exchange was held in Elkridge, Maryland on August 15 and 16, 2007.

The goal of the exchange was to facilitate a discussion between practitioners on existing practices, challenges, and issues. The exchange built upon the findings of the recent domestic scan on transportation asset management (TAM) and targeted the following six topic areas:

- Incorporating performance measures and targets in the programming and budgeting process;
- The use of asset management systems to support the programming and budgeting process;
- Cross-asset analysis and programming;
- The use of asset management principles in the prioritization of capacity expansion projects;
- The application of asset management tools and techniques to assets other than highways; and
- Incorporating risk analysis techniques in the programming and budgeting process.

1.1 PEER EXCHANGE FORMAT

Representatives from eight state departments of transportation, a metropolitan planning organization, and a turnpike authority participated in the peer exchange. Table 1.1 provides a list of participants. The first part of the exchange provided a forum for each participating agency to present their agency's work in the six topic areas listed above, focusing on areas where their agency has been successful, and highlighting challenges in other areas. The second half of the exchange was a facilitated session allowing for extended discussions of the challenges agencies face in applying TAM in programming and budgeting decisions and learning from partner agencies on how they address these challenges.

Table 1.1 Peer Exchange Participants

Participant	Organization
Ron McCready	AASHTO
Janet Oakley	AASHTO
Don Mauller	Arizona DOT
Rachel Falsetti	California DOT
Stephen Gaj	FHWA
Rob Ritter	FHWA
Butch Wlaschin	FHWA
Kirk Hutchinson	Florida DOT
Joseph Benedetta	Maryland DOT
Neil Pedersen	Maryland DOT
Jeff Smith	Maryland DOT
Ross McKeown	Metropolitan Transportation Commission
Kirk Steudle	Michigan DOT
David Kuhn	New Jersey DOT
Pamela Hatalowich	Pennsylvania Turnpike Commission
Ahmad Jaber	Utah DOT
Jeff Price	Virginia DOT
Megan Gaudet	Cambridge Systematics, Inc.
Joseph Guerre	Cambridge Systematics, Inc.
Ken Leonard	Cambridge Systematics, Inc.

1.2 SUMMARY OF THEMES

Although the participating agencies differed significantly in their experience, approach to programming and budgeting, and scope of their TAM efforts, several themes arose from the exchange.

- All of the participating agencies have established performance measures, set targets, and track progress towards them. However, the approaches used to set targets vary widely, and in some cases target values are not well understood in term of their technical soundness or the perception of the traveling public. Many agencies struggle with questions like: is a target of 80 percent of the network in good condition the "right" target?
- Several agencies have implemented management systems and use them to predict future performance. In most cases, this information is used to inform

budget discussions. However, final budget decisions are typically based on additional qualitative factors.

- Most technical analysis, budgeting, and programming is done within asset silos. Analysis across asset types is done implicitly rather than explicitly. While some agencies cited technical barriers to this type of analysis, the main barriers are organizational and institutional.
- All of the agencies described asset management efforts that included collecting data, measuring performance, and using analytical tools. However a direct link between these efforts and final programming decisions is less common.
- In all of the agencies decisions regarding preservation programs are made separately from decisions regarding capacity expansion programs. In addition, all of the agencies described the application of TAM concepts to their preservation programs. However, there were very few examples of the application of TAM principles to capacity expansion programs. The most common barrier cited in this area was the degree to which politics drive the prioritization of capacity expansion projects. There was a consensus among the participants that given the prevalence of politics in this process, the focus of future enhancements should be on providing decisions-makers with the data needed to support their decisions. For example, agencies should work to improve the understanding of the impacts of budgeting and programming decisions in terms of system performance.
- Most of the participating agencies are primarily focused on managing highway infrastructure. Therefore the bulk of the discussion focused on the application of TAM concepts to highways. However, a couple agencies discussed effort to implement TAM within other modes such as transit, ports, and airport. A common initial barrier to multimodal implementation is inconsistent nomenclature across modes. One strategy cited for overcoming this barrier is the creation of a steering committee with representatives from all of the participating modes.
- The most common risk considered during the programming and budgeting process is the risk of project overruns. In many agencies, increases in labor and material costs have surpassed scope creep as the main driver of this risk. Strategies sited for dealing with this risk include contingencies, tracking on-budget performance and improving accountability, implementing a risk mitigation program, and not specifying budget details in a program's out years (e.g., specify a program budget but not specific projects that will be implemented).
- Much of the discussion on opportunities for future research focused on the application of TAM concepts to other assets (beyond pavement and bridge to high-value roadside features) and other work types (beyond system preservation to operations and expansion).

2.0 Summary of Current Practices

The following section provides examples of current practices and a summary of key challenges associated with each of the six topic areas.

2.1 PERFORMANCE MEASURES AND TARGETS

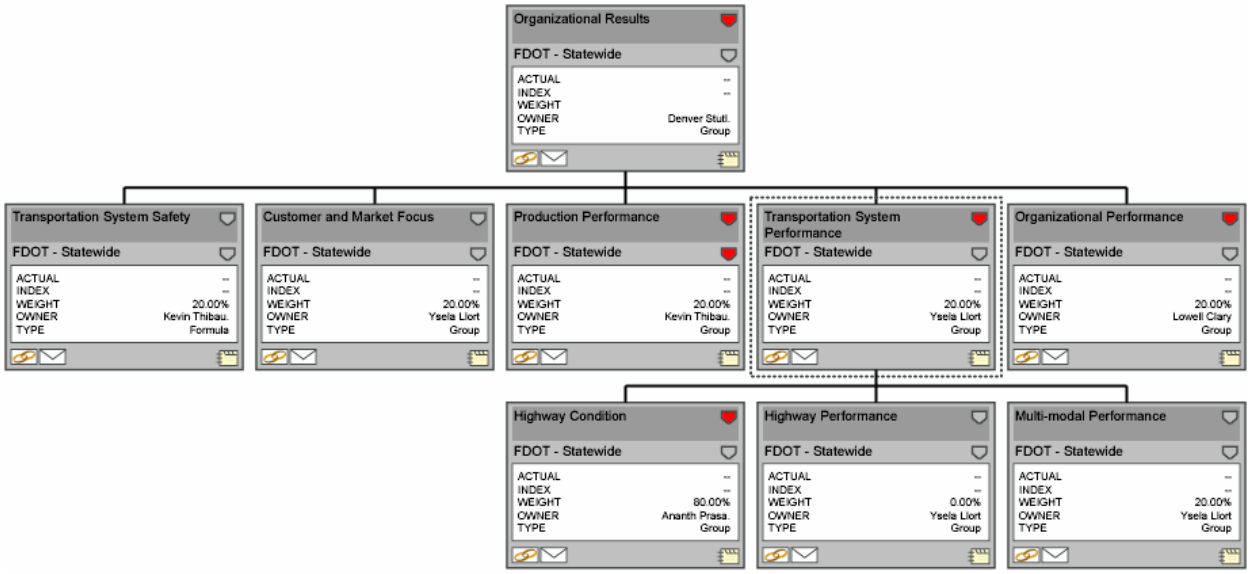
Performance measures help agencies understand the condition and performance of a transportation system. In addition, target values provide a means for agencies to track and communicate progress towards policy goals and objectives.

Current Practice

While all of the agencies at the peer exchange have defined performance measures and set targets, there are significant differences in terms of the types and number of measures reported by agencies, the mechanisms used to communicate performance results, methods used to set targets, and the degree of accountability for achieving the targets.

With regard to the number of measures used, Maryland DOT representatives presented the most. The agency's business plan includes 431 performance measures, 126 of which are in the key performance are of system preservation and maintenance. On the other end of the spectrum, some agencies have tried to consolidate their measures into one per asset (e.g., percent of pavement meeting department standards). The Florida DOT uses the performance measurement system illustrated in Figure 2.1. One of the features of this system is that it aggregates multiple measures into a series of indices. Users can review these indices or drill down into the details of the underlying measures. For example, the agency has defined a single transportation system performance index that is calculated by combining measures of highway condition, highway performance, and multimodal performance.

Figure 2.1 Florida DOT's Performance Measurement System

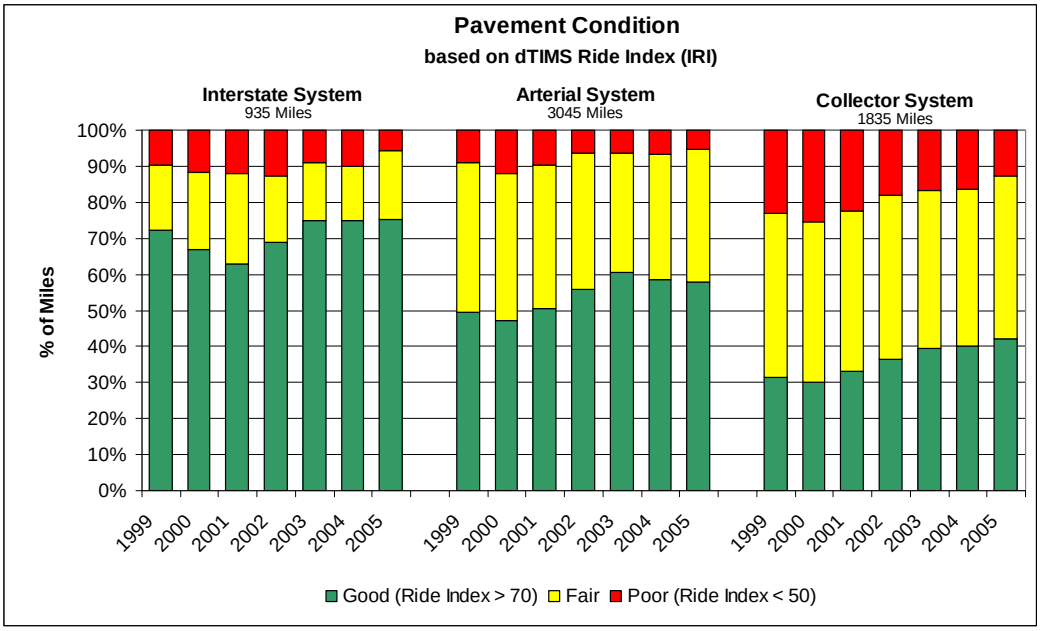


Source: Florida DOT.

Figures 2.2 and 2.3 present other examples of mechanisms used to communicate performance results.

Figure 2.2 shows pavement conditions in Utah. The figure provides information along three dimensions – time, condition (percent of miles in good/fair/poor) and functional class.

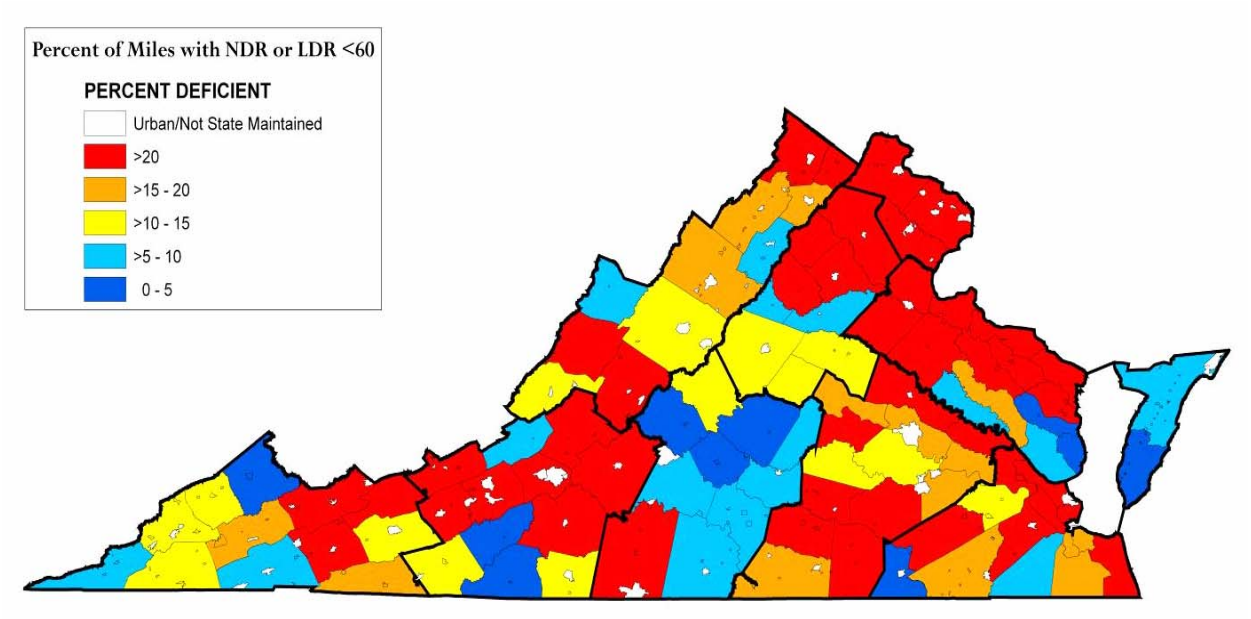
Figure 2.2 Pavement Condition in Utah



Source: Utah DOT.

Figure 2.3 shows the geographic distribution of pavement condition in Virginia for a single year.

Figure 2.3 Pavement Condition in Virginia – Interstates and Primaries



Source: Virginia DOT.

The approach to target setting varies widely across agencies. The process is often ambiguous, with targets set based on historical performance or expectations. In some cases, targets simply reflect the status quo.

The accountability for meeting the targets also varies between organizations. For example, the Florida DOT is held accountable by the State Legislature for reaching codified performance levels within its maintenance program. Other agencies provided anecdotal evidence that targets are not always expected to be reached; if targets are met it indicates the agency is receiving "too much" funding.

Challenges

The main challenges in the performance measurement area involve target setting. Many agencies struggle with establishing targets that are meaningful and easy to communicate. It is often difficult to understand whether or not a target reflects the "best" or "optimal" value from an engineering perspective and from the public's perspective. For example, does the traveling public perceive a difference between 75 percent of roads in good condition versus 80 percent?

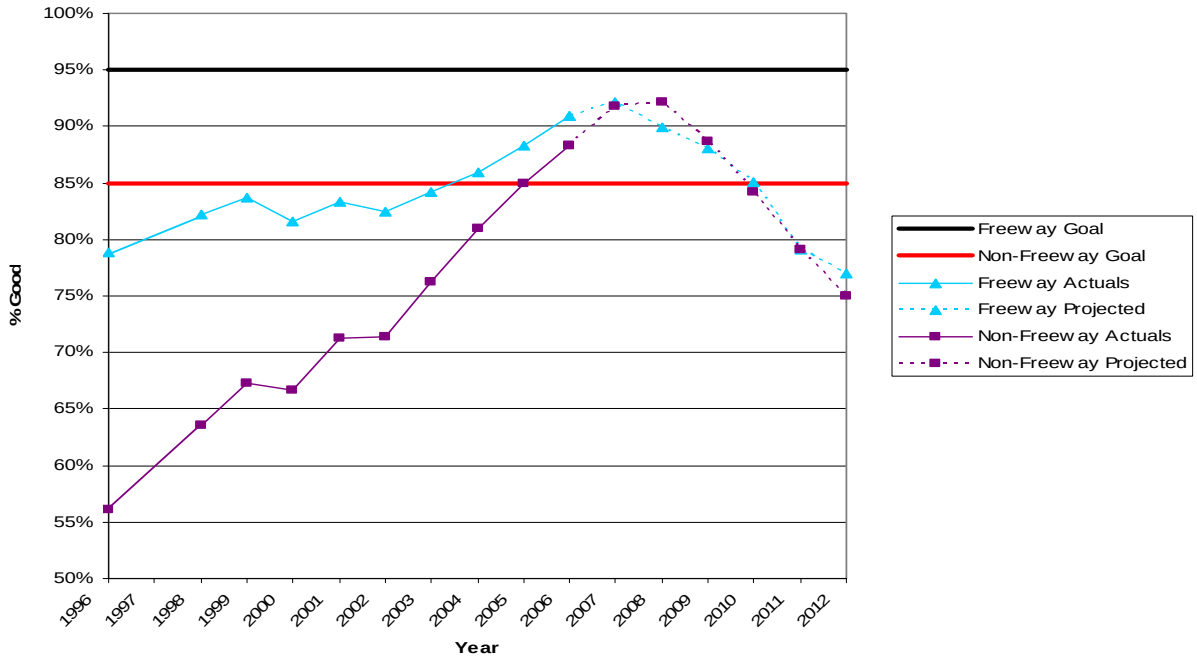
2.2 MANAGEMENT SYSTEMS

There are a variety of management systems and analytical tools designed to support TAM decisions. Participants were asked to discuss how their agencies use these tools to support programming and budgeting decisions.

Current Practice

All agencies at the peer exchange use some type of asset management systems. The vast majority of the work in this area has focused on pavement and bridge systems. In most cases, the agencies use these systems to manage and store inspection data. However several agencies also discussed how they use their systems to project future conditions based on funding levels. Figures 2.4 through 2.6 provide examples of this type of analysis. Figure 2.4 shows historic and projected pavement condition in Michigan. It indicates that conditions have steadily improved over time. However, based on the funding scenarios used in this analysis, they are expected to decline over the next several years.

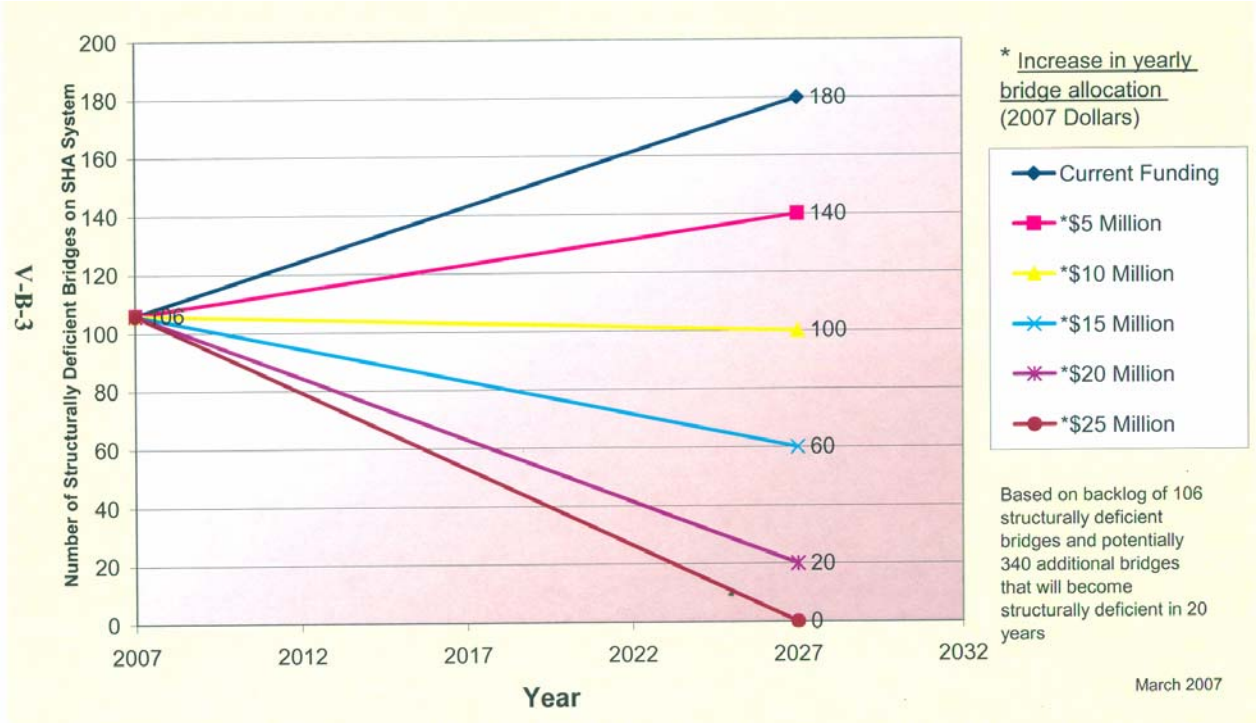
Figure 2.4 Analysis of Future Pavement Condition in Michigan



Source: Michigan DOT.

Figure 2.5 shows expected bridge conditions in Maryland over the next 20 years for multiple funding scenarios. It illustrates that at current funding levels, the number of structurally deficient (SD) bridges will increase over time. If the funding level were increased by $25 million per year, the number of SD bridges would be reduced to 0 by 2027.

Figure 2.5 Analysis of Future Bridge Condition in Maryland



Source: Maryland DOT.

Figure 2.6 illustrates another form of scenario analysis. In this case, the impact of increasing and decreasing current funding levels is shown for multiple program areas.

Figure 2.6 New Jersey DOT Funding Scenario Analysis

	Program Goals	BRC Option III (Improve +)	FY07	FY08	millions Scen B 25% decr	Scen C 25% incr	Scen D Maintain	Scenario E 50% Backlog reduction	Scenario F 100% Backlog Reduction (Total Need)	CIS
1	Bridge Preservation Goals	700	431	467	301	502	1016	1707	2542	1016
2	Roadway Preservation Goals	1000	360	414	270	451	284	417	817	467
3	Safety Management Goals	90	78	98	68	114	100	316	627	114
4	Congestion Relief Goals	550	255	266	250	418	330	502	750	418
5	Local Aid Goals	374	377	403	282	471	360	436	650	471
6	Multi-modal Goals	82	106	89	80	133	91	107	160.2	107
7	Quality of Life/Environmental Goals	70	29.6	42	22	37	30	36	44	37
8	Program Support Goals	41	26.4	25	19	33	26	32	39	33
	Capital Program Delivery Goals	416	238	231	178	297	320	508	805.2	380
	Grand Total	3322	1904	2040	1473	2457	2557	4063	6436	3044

Source: New Jersey DOT.

Challenges

Once of the main challenges in this area is to fully implement existing management systems so that they can be used for the type of analysis illustrated above. This requires customizing the models and algorithms used by these systems so that agencies have confidence in the results. For agencies that have already fully implemented the systems, the main challenge is to use the results drive programming and budgeting decisions. In many cases, the analysis of future conditions helps inform budgeting discussions. However, the final decisions are often based on a variety of other qualitative considerations. A final challenge for all of the agencies is to expand their use of analytical tools beyond pavements and bridges to other assets. This topic is explored further in a following section.

2.3 CROSS-ASSET ANALYSIS AND PROGRAMMING

The term "cross-asset analysis and programming" refers to investment decisions made across multiple asset types. For example, how much money should be allocated to the pavement program versus the bridge program; or what is the relative priority of proposed pavement project relative to a proposed bridge project?

Current Practice

Cross-asset analysis is not currently a focus of most of the participating agencies. In many cases, funding levels for program areas are set using a combination of historical funding levels, needs analyses, and political considerations. However, the California DOT (Caltrans) and the Utah DOT presented examples of cross-asset analysis.

Caltrans described how it uses cross-asset analysis to support the development of its 10-year State Highway Operations and Protection Program (SHOPP). The SHOPP covers work in the following areas – bridge, collision reduction, mobility (operations), roadside rehabilitation, and roadway rehabilitation. Caltrans has the flexibility to allocate funds to these areas based on needs and performance. The agency uses AssetManager NT to support this analysis. Using this tool, Caltrans can generate the type of graph illustrated in Figure 2.5 for all of the SHOPP areas. With this information, they can conduct a tradeoff analysis and determine 1) the preferred allocation of resources between the program areas, and 2) the performance targets that can be achieved with this allocation.

The Utah DOT presented another take on cross-asset analysis based on corridor analysis. As part of its programming process, the DOT generates a list of roadway and bridge projects along with their recommended timing. It then consolidates these projects based on corridors and "harmonizes" them. This harmonization effort consists of consolidating projects so that they can be completed at the same time. For example, a bridge rehabilitation project recommended for year five may be moved up to year three so that it can be done in conjunction with a pavement preservation project that was originally scheduled for year two. The goal of this harmonization effort is to minimize project costs and the disruption to the traveling public.

Challenges

One of the themes of the peer exchange was the lack of a clear link between an agency's asset management efforts and final programming decisions – e.g., the allocation of funds across programs and the final prioritization of projects within programs. The barriers in this area most often cited at the peer exchange were organizational and institutional. The organizational structure at many agencies is such that different assets are handled by separate groups. Given this structure, the analysis of different assets is largely conducted in isolation from one another. In addition, the allocation of resources to these silos is often based on historic

funding levels. A number of agencies are working to overcome these organizational barriers by using the results of the types of analysis described in the previous section to inform resource allocation discussions. This is an important first step in looking at the entire transportation network rather than individual asset types.

Other concerns included the lack of tools designed to support cross-asset analysis, difficulties involved with analyzing assets that have very different design lives, and trepidation in applying purely formulaic approaches to cross-asset management. Most of the agencies felt that expert judgment and local knowledge needed to play a significant roll in cross-asset decisions.

2.4 PRIORITIZATION OF CAPACITY EXPANSION PROJECTS

The principles of asset management transcend preservation activities and can be applied to the analysis of capacity expansion projects. For instance, capacity projects can be linked to policy goals related to congestion. Agencies can define objectives, establish performance measures and targets, use data and decision support tools to perform quantitative analyses, and prioritize expansion projects in order to achieve the congestion targets.

Current Practice

During the peer exchange, there was some confusion about the role of asset management for capacity projects as some of the agencies consider asset management to be synonymous with highway preservation.

In the agencies recognizing expansion work as part of their TAM efforts, such as Michigan and Utah, some systematic prioritization is performed. Figure 2.7 describes the benefit/cost approach used by the Michigan DOT to evaluate potential expansion projects.

Regardless of whether or not an agency includes capacity expansion in the scope of its TAM efforts, there are always significant political and public participation components to these decisions. Much of the discussion in this area focused on the need to provided elected officials and the public the best data and analysis available to inform their decisions.

Although preservation and expansion programming and budgeting are often done in relative isolation, some agencies identified a “fix-it first” policy that places a higher priority on persevering the existing network relative to expanding it. This policy manifests itself through program-level resource allocation decisions, in which preservation needs are addressed before expansion needs are considered.

Figure 2.7 Use of Asset Management in Expansion Projects

Source: Michigan DOT.

Another trend is the consideration of operations investments as a strategy for increasing capacity. Adding more lanes and roads is often not a practical option. Given this situation, there was wide agreement that capacity expansion discussions will continue to shift towards systems operations and management, with an initial focus on incident management. The Metropolitan Transportation Commission (MTC) and Caltrans are already moving in this direction. For example, in the San Francisco Bay Area design standards have been updated so that when a road is rehabbed there is a requirement that operations hardware (e.g., loop detectors, ramp meters, etc.) be installed.

Challenges

One of the challenges of applying TAM principles to the analysis of capacity projects is the concern regarding the use of "black box" tools to make high-profile investment decisions. This fear is prevalent given the wide range of people and interests involved in the decision-making process and the difficulty in quantifying all of the costs and benefits of expansion projects.

Another challenge in this area is effectively working with elected officials. Politicians play a vital role in the programming and budgeting process. In addition to providing a public perspective to investment prioritization, they have significant influence over the overall transportation budget. The perception of the participants was that elected officials are generally supportive of capacity

expansion projects, but less interested in preservation work. Therefore to help ensure that transportation is funded to the fullest extent possible, it is important to keep them involved in part of the decision-making – the capacity expansion part.

The major barrier to conducting tradeoff between preservation and expansion programs is the prevalence of funding restrictions. Often times funds are tied to specific types of work and agencies do not have the flexibility to transfer funds between programs. In addition, there is a perception that if agencies begin to make explicit tradeoffs between preservation and expansion investments based on benefit/cost considerations, preservation projects could lose out.

A barrier to broader analysis of operations alternatives is a lack of understanding of these strategies and their potential benefits.

2.5 APPLICATION OF TAM TO ASSETS OTHER THAN HIGHWAYS

Asset management principles are applicable to nonhighway assets. Extending asset management beyond highway assets can help many transportation agencies facing difficult decisions on how to allocated sparse resources across the entire transportation network.

Current Practice

All of the agencies at the peer exchange are working to apply TAM concepts to the analysis of pavement and bridge preservation strategies, budgets and programs. In addition, a few agencies described their efforts to expand the application of TAM to other highway assets (e.g., roadside and guardrail) and other modes (e.g., transit and airports).

The Florida DOT uses a Maintenance Rating Program (MRP) to develop performance-based maintenance budgets. This program covers five categories: roadway, roadside, traffic services, drainage, and vegetation aesthetics. Each category includes a number of asset types. For example, the roadside category includes sidewalks, fence, and unpaved shoulders. For each asset, the DOT has defined criteria for assessing its condition and a weight between 6 and 10 that reflects its relative importance in terms of the safety and preservation of the roadway system (e.g., guardrail has a weight of 8). Inspections are performed three times a year on a randomly selected sample of highway segments. The DOT uses the results of these surveys to support its maintenance budget request.

The Maryland DOT has also applied TAM concepts to nonhighway assets. For example, it maintains a detailed inventory and condition report of HVAC systems and roofs at rest areas. The agency uses a series of spreadsheets to track age, condition, anticipated work, location, etc. Figure 2.8 illustrates some of the information the DOT uses to manage rest area roofs.

Figure 2.8 Tracking Rest Area Roof Conditions

Dist.	Location	Age		Roof Age	Roof Warranty Years	Current Condition	Work Required
		Building Year	Roof Year				
6	I-68 Friendsville	1981	1981	26	Unknown	Poor	Replace
1	US 13 Pocomoke	1971	1971	34	Unknown	Poor	Replace
7	I-95 N Welcome Center	1971	1971	34	Unknown	Fair	Replace
7	I-95 S Welcome Center	1971	1971	34	Unknown	Fair	Replace
2	US 301 Bay Country	1994	1994	13	Unknown	Fair	Repair
6	I-68 Sidelining Hill East	1996	1996	11	No	Good	Repair
1	US 50 Sail winds	1998	1998	9	Unknown	Fair	Repair
7	Us 15 Emmitsburg	2005	2005	2	20	New Roof	Repair
5	US 301 Crain Highway	2006	2006	1	20	New Roof	-
6	Cove Overlook	2006	2006	1	20	New Roof	
6	I-68 Sidelining Hill West	2006	2006	1	20	New Roof	
7	I-70 South Mountain West	1981	1981	26	No	Fair	T
7	I-70 South Mountain East	1981	1981	26	No	Fair	T

Source: Maryland Department of Transportation.

In terms of expanding TAM to other modes, few participants have jurisdiction or influence beyond highways. One exception is the MTC, which has a transit priority process in which it considers preservation and expansion work. The agency has established regional targets for transit condition and recommends funding allocations based on these targets.

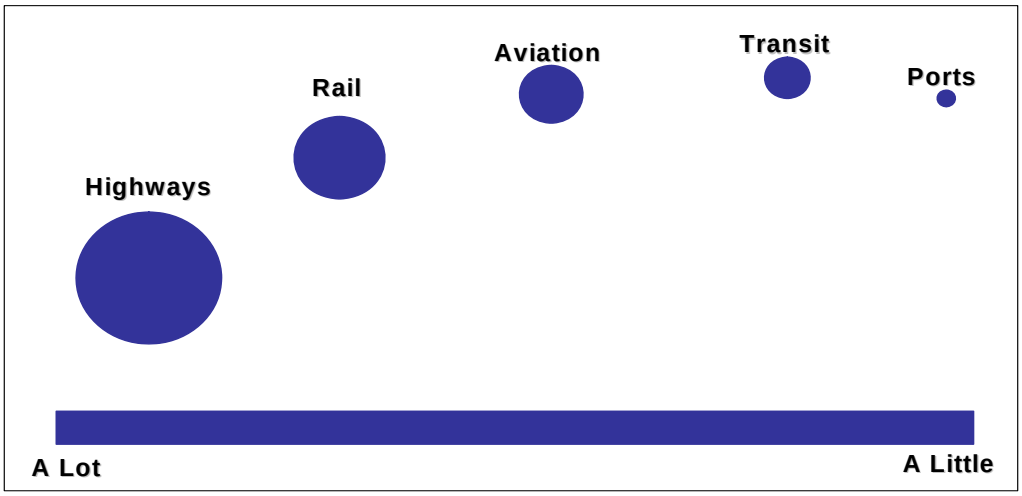
Other agencies, including the Maryland, Michigan, and New Jersey DOTs are working to coordinate investment decision with other modes and encourage TAM implementation. For example, the Maryland DOT has created an asset management steering committee with representatives from all major modes of transportation in the state – highway, rail, transit, port, and airport. The committee is working to establish a common understanding of TAM between the modes and to coordinate implementation efforts. The New Jersey DOT is moving in the same direction, although they are still very early in the process.

Challenges

A major technical barrier to expanding TAM beyond pavement and bridges is the lack of predictive deterioration models. There is little agreement on the expected service life of other assets. In addition, many agencies believe they do not have the data required to support these models even if they did exist.

A major origination barrier to expanding TAM to other modes is the lack of influence that many DOTs have in these areas. For example, Michigan DOT's influence on other modes is illustrated in Figure 2.9. Because the agency has direct responsibility for highways, asset management tools and framework are most developed in this area. In contrast, for rail the performance target is simply to keep the existing system operational and investment decisions are made by rail-dependent industries.

Figure 2.9 Michigan DOT's Modal Influence



Source: Michigan DOT.

Another challenge is defining consistent nomenclature across modes. Agencies working to expand TAM beyond highways have found that it takes a significant amount of effort to establish clear and consistent definitions and define performance measures that are meaningful to all groups.

2.6 RISK ANALYSIS

The term risk analysis can take on many forms. In terms of programming and budgeting, agencies are faced with the risk of cost overruns and the risk of asset failure. If a project costs more than anticipated, agencies can have difficulty delivering all of its programmed projects. When considering asset failure, the probability of the cause of event (e.g., earthquake), the probability of failure given the event (e.g., if there is an earthquake the chance the bridge will collapse), and the cost of a failure (e.g., economic impact to region) can be incorporated into programming decisions.

Current Practice

Mitigating the Risk of Cost Overruns

All of the agencies at the peer exchange addressed the risk of project cost overruns. Many agencies discussed how steep increases in labor and materials have replaced scope creep as the root cause of this risk. The following approaches were identified for mitigating the risk of cost overruns:

- Include contingencies in project estimates. Most participating agencies use contingencies when estimating project costs. However, the agencies acknowledge that more accurate cost projections would be preferable

because unnecessarily using contingencies reduces the number of projects an agency is able to program. Additionally, there is little consistency across agencies on how to set contingencies.

- Establish a culture of program management rather than project management. This provides agencies with the flexibility to transfers funds between projects as needed, while maintaining accountability for the overall cost of a program.
- Define performance targets for cost estimates. Several agencies have established performance measures used to track on-budget performance. Using these types of measures communicate the importance of cost performance to agency staff and help establish accountability. In addition, they can be used for diagnostic purposes to identify root issues.
- Include budget and scope milestones in the project development process. For example, in Arizona a project is not considered programmable until a scope and reasonable cost estimate have been developed. This practice decreases the uncertainly for projects included in the program.
- Providing fewer details in the out years of a program. One approach is to put a line item for type of work (e.g., pavement preservation) without listing specific projects. Another is to list projects or needs that will be addressed, without providing specific budgets.
- Implement a risk mitigation program. The MTC evaluates all projects in its program and assigns a level of risk based on dollar value and proposed timing. The agency then applies established risk management strategies that vary by level of risk.

Mitigating the Risk of Asset Failure

None of the participating agencies explicitly accounts for the cost of asset failure in its programming and budgeting process. However, the agencies identified the following approaches to mitigating this risk:

- Establish a program category that focuses exclusively on addressing a known risk. For example, the California DOT created a seismic bridge retrofit program following the Northridge earthquake.
- Enhance design standards. This approach was implemented in coastal regions in response to hurricanes Katrina and Rita. It enables agencies to account for risk early in the project development process and account for the cost of risk mitigation in a project's estimate.
- Consider risk as a criterion for project prioritization. For example, identify life-line corridors and assign a higher priority to projects along these corridors. (While no agency mentioned that this is currently being done, it was discussed as a viable option for risk mitigation.)
- Analyze network redundancy. For example, the MTC has assessed the impact a major bridge failure would have on the ferry system in the San

Francisco Bay area. The results of this analysis were considered when allocating funds to the ferry program.

Challenges

Several agencies discussed the danger of not considering risk until after a catastrophic failure has occurred. Even if the "cost" of failure were astronomic, the risk of occurrence could be miniscule. Thus, a purely formulaic approach may not result in the best use of limited transportation funds. However, the group did feel there is opportunity for the advancement of risk analysis in programming and budgeting.

Another barrier to risk mitigation is a lack of funding. For many high-priority assets, redundant capacity would be an ideal solution. However, this is not often feasible because many agencies are struggling to keep up with current capacity needs, let alone building in redundancies.

The group consensus was that there are substantial research needs in the area of failure risk. Specifically, in the areas of calculating the probability and monetary value of failure.

In terms of budget risk, the main challenge is the inconsistency in project costs. Updating inflation factors for material and equipment would yield more accurate project estimates.

3.0 Recommended Follow-Up Activities

The peer exchange participants identified the following opportunities for future research efforts and potential topics for future peer exchanges.

3.1 FUTURE RESEARCH OPPORTUNITIES

- Understanding targets from the public's point of view – e.g., how good do the pavements have to be?
- Develop deterioration models for assets other than pavement and bridge, and define the data required to model these features effectively.
- Develop guidance on how to calculate the probability of asset failure, estimate failure costs, and incorporate this information into the programming and budgeting process.
- Explore the implications of moving to a corridor-based approach to prioritization rather than program-level approach.
- Revisit the shift away from worst first strategies. For example, in terms of risk, the cost of the worst asset failing may be unacceptable.
- Compile information on operations strategies – what options exist, what are the benefits of these options, and how should these options be evaluated?

3.2 POTENTIAL TOPICS FOR FUTURE PEER EXCHANGES

- The management of highway assets other than bridge and pavement.
- Analyzing the impacts of projects on factors other than condition – e.g., safety and congestion.
- Outside of pavement and bridges, how much data is appropriate for effective asset management practice?
- Workshop that provides an opportunity for asset managers and maintenance managers to discuss crosscutting issues.

Appendix A – Agenda

Wednesday – August 15, 2007

12:00 PM	Opening Remarks	Kirk Steudle, Michigan DOT
12:15 PM	Participant Introductions	All
12:25 PM	Overview of the Workshop	Ken Leonard, Cambridge Systematics
12:40 PM	Experience in Arizona	Don Mauller, Arizona DOT
1:00 PM	Experience in California	Rachel Falsetti, CALTRANS
1:20 PM	Experience in Florida	Kirk Hutchison, Florida DOT
1:40 PM	Experience in Maryland	Neil Pederson, Maryland DOT
2:00 PM	BREAK	
2:20 PM	Experience at MTC	Ross McKeown, MTC
2:40 PM	Experience in Michigan	Kirk Steudle, Michigan DOT
3:00 PM	Experience in New Jersey	David Kuhn, New Jersey DOT
3:20 PM	Experience at PA Turnpike	Pamela Hatalowich, PA Turnpike
3:40 PM	BREAK	
4:00 PM	Experience in Virginia	Jeff Price, Virginia DOT
4:20 PM	Experience in Utah	Ahmad Jaber, Utah DOT
4:40 PM	Day 1 wrap-up	Ken Leonard, Cambridge Systematics
5:00 PM	ADJOURN	

Thursday – August 16, 2007

8:00 AM	Facilitated discussion	All

- Discussion of best practices and themes in the following areas:
  - Cross-asset analysis and programming
  - The use of asset management systems to support programming and budgeting
  - Incorporating performance measures and targets in programming and budgeting
  - The use of asset management principles in the prioritization of capacity expansion projects
  - The application of asset management tools and techniques to assets other than highways
  - Incorporating risk analysis techniques in programming and budgeting
- Barriers to success and how to overcome them
- Potential research topics, education opportunities, and follow-up activities

10:00 AM	BREAK	
10:15 AM	Discussion, cont.	All
11:30 AM	Conclusions and Next Steps	Ken Leonard, Cambridge Systematics Neil Pederson, Maryland DOT
12:00 PM		ADJOURN

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