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Asset Management in Planning and Operations

A Peer Exchange

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Prepared by
Patricia Hendren

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Transportation Research Board
500 Fifth Street, NW
Washington, DC 20001
www.TRB.org

Patricia Spellman, Production Editor; Kristin C. Sawyer, Proofreader; Jackie Kearney, Layout

Contents

Introduction

On September 7–8, 2004, the Asset Management in Planning and Operations Peer Exchange, sponsored by the Federal Highway Administration (FHWA), was hosted by the Transportation Research Board (TRB) Committee on Statewide Multimodal Transportation Planning (ADA10), Performance Measurement Committee (ABC30), and Transportation Asset Management Committee (ABC40). The peer exchange was organized jointly by representatives of TRB, the American Association of State and Highway Transportation Officials (AASHTO) Standing Committee on Planning, the Standing Committee on Highway, the subcommittee on Asset Management, and the FHWA.

Asset Management (AM) in planning and operations was selected as the peer exchange focus because of the expanding role of AM as a comprehensive approach to managing agency resources and transportation systems. In addition, the benefits associated with the application of AM principles underscored AM as an area of critical importance to the transportation field. The goal of the AM peer exchange was to gather additional information about the state of the practice and to identify research needs and potential areas for innovation.

Invitations to the peer exchange were extended to transportation organizations from across the country engaged in AM. Participants were selected from state and local transportation agencies to create a mix of organizations with regard to size, jurisdiction, and experience with AM.

INTRODUCTORY REMARKS

Lance Neumann, Cambridge Systematics, Inc., began the peer exchange with a brief overview of available AM resources and observations from state department of transportation (DOT) implementation of AM. The recently released AASHTO report *Transportation Asset Management Guide* (available online at http://downloads.transportation.org/amguide.pdf) was noted as a useful document that clearly defines AM, identifies key business principles, provides guidance on "good AM practice" in key functional areas, contains a self-assessment tool, and presents selected examples. An additional AM training resource discussed was the National Highway Institute (NHI) course based on the AASHTO *Transportation Asset Management Guide*. The course has been held five times since January 2004 and revisions are being considered to make the training applicable to a wider range of agencies. An interesting implementation lesson highlighted during two recent conferences, Asset Management: Moving from Theory to Practice and Performance Measures to Improve Transportation Systems, was the synergy between AM and performance measures. Both areas are evolving rapidly from concepts into applied management principles.

Next, Kirk Steudle, Michigan DOT, gave an update on the AASHTO subcommittee on Asset Management. Since starting in 1997, the AM effort in AASHTO has helped produce the AASHTO *Transportation Asset Management Guide*, and the Transportation Asset Management Community of Practice website (http://assetmanagement.transportation.org). The current mission of the subcommittee is to advance the AM state of the practice and to guide the evolution of AM into a standard for state DOTs. To accomplish this mission, the subcommittee has identified five goals:

1. Promote development of tools.
2. Communicate with and inform member states on how to use AM.
3. Assist member states in assessing and implementing AM.
4. Develop and document an understanding of AM and share with member states.
5. Develop partnerships with other organizations, for example, the American Public Transportation Association and the Association of Metropolitan Planning Organizations.

Peer exchange participants applauded the efforts of the AASHTO subcommittee but encouraged the inclusion of cities, counties, and metropolitan planning organizations in the effort to expand the adoption of AM practices.

Dave Geiger, FHWA Office Asset Management, discussed recent efforts to further integrate AM principles into existing FHWA offices. To support this initiative, seven papers were written that explored the relationship of AM to each of FHWA's major program areas, including planning, right-of-way, environment, infrastructure, safety, operations, and federal lands (http://www.fhwa.dot.gov/infrastructure/asstmgmt/positionpaper.htm). Mr. Geiger also reported on the FHWA-supported AM education efforts including NHI's AM course, Highway Economic Requirement System for State DOTs conference, new economic analysis primer, new course on system preservation, updates to PONTIS, and the documentation of data integration practices through case studies. The exchange of AM information and lessons learned continues to be a critical goal of FHWA.

Finally, Sue McNeil reported on recent TRB Asset Management Committee activities, including several calls for papers for the 2005 TRB Annual Meeting, identification of liaisons with other committees, and the planning of the next AM conference to be held in 2005. The goal of the TRB AM Committee is to provide training opportunities and to strengthen the connection between AM principles and other aspects of transportation planning.

REPORT ORGANIZATION

Peer exchanges offer a unique opportunity to engage in discussion, share experiences and lessons learned, and identify areas for additional advancement through research, technical assistance, and other activities. This report serves to document and further distribute the insights raised during the meeting.

To facilitate discussion, each participant was asked to answer the following set of questions before coming to the peer exchange:

1. How is your organization using asset management in decision making and resource allocation?
    a. Who are the primary users of asset management and how are they using it (staff level only, director, elected officials, etc.)?
2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?
3. Barriers to using asset management:
    a. Data problems/integration/collection?
    b. Percent of system or operation covered?
    c. Interagency cooperation?

4. Are you using asset management for nonhighway modes and how?
What improvements would you recommend in the implementation of asset management?
5. What improvements would you recommend in the implementation of asset management?
    a. Areas that need improvement?
    b. Future research?
    c. Data?

The participant answers to the AM questions are contained in Section 2, Participant Peer Exchange Material, along with a summary of the written responses. Section 3, Summary and Next Steps, presents the key themes discussed, notable agency accomplishments, and potential areas for innovation. Finally, the appendix contains a list of peer exchange attendees.

Participant Peer Exchange Material

PEER EXCHANGE QUESTIONS ON ASSET MANAGEMENT

Each participant was asked to answer the following questions before attending the peer exchange to facilitate discussion and the sharing of information:

1. How is your organization using asset management in decision making and resource allocation?
    a. Who are the primary users of asset management and how are they using it (staff level only, director, elected officials, etc.)?
2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?
3. Barriers to using asset management:
    a. Data problems/integration/collection?
    b. Percent of system or operation covered?
    c. Interagency cooperation?
4. Are you using asset management for nonhighway modes and how?
5. What improvements would you recommend in the implementation of asset management?
    a. Areas that need improvement?
    b. Future research?
    c. Data?

The participant responses follow and are summarized in Tables 5–9.

DISTRICT OF COLUMBIA DOT

1. How is your organization using asset management in decision making and resource allocation?

As of August 2004, the District of Columbia was in the last year of a five-year pilot AM/performance-based contract, DC Streets, with VMS, Inc. DC Streets is a contract to rehabilitate and maintain the District's 75 miles of National Highway System (NHS). The contract covers 14 work categories including surface repairs, bridge maintenance, mowing, litter and trash pickup, catch basin cleaning, lighting maintenance, street sweeping, and snow removal. The signal system is not included. DC Streets was the first urban performance-based asset preservation contract in the United States. An update on the contract was presented during the TRB Annual Meeting in 2004 (presentation slides are included in the Appendix).

For the balance of the D.C. system, a street-oriented system (SIS) based on 1990 FHWA pavement management system (PMS) requirements is utilized. The system has a fully developed geographic information system (GIS) link to allow mapping and the analysis of program decisions against other factors, projects, and programs such as lighting improvements, development activities, or utility investments. The AM system works off the SIS and makes an

initial attempt to allocate resources. The AM system favors maintenance activities. Data are collected by an automated distress survey van.

Tunnel, retaining wall, and culvert management systems and a PONTIS upgrade to enhance its usefulness to D.C. are being pursued. The goal is to connect all systems with the SIS through a unified, GIS-linked database. Future enhancements to allow what-if exercises, shifting between programs, will be processed manually. The effort to develop a unified database for all asset data (TEAMS) also has resulted in District of Columbia DOT upgrading its AM abilities.

Information from District of Columbia DOT's AM efforts also has been used to respond to questions raised during public hearings. The following examples are from a public oversight hearing held on February 10, 2004.

> **Question:** In the area of *Percent of streets rated good or excellent on the Pavement Quality Index* your target was 72 percent and your actual result was 75.54 percent. That's good news. How are we doing so far in FY 2004?
>
> **Answer:** We completed 30 blocks (2.91 miles) in FY 2004. The annual rating is done in the fall; a partial rating will not be reflective for continuous pavement deterioration.
>
> **Question:** Who actually rates this particular measure?
>
> **Answer:** Data are collected by a consultant using the *Digital Pavement Imagining System*, a state-of-the-art technology that collects continuous images of pavement surface.

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

The asset manager proposes a six-year list of projects to the four geographic ward-based teams who work with the District of Columbia DOT transportation planners, the public, and utility companies to determine the actual program. The list of projects is updated yearly. Currently, bridge maintenance funds are allocated to bridges with the worst conditions, but a preventative maintenance program is being developed. Tunnels are largely maintained through the VMS contract with a full-scale tunnel inventory, including all appurtenances, nearly complete in a separate effort.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

It allows a rational approach to resource allocation and a defense against politicizing the program.

3. Barriers to using asset management

3a. Data problems/integration/collection?

The information technology personnel are in charge of data but unfortunately are removed from the needs of the program. We collect data, but they are in control of the other aspects.

3b. Percent of system or operation covered?

In effect, 100 percent.

3c. Interagency cooperation?

Interagency cooperation can be challenging with the individuals running the development activities in D.C., because they do not understanding the constraints and competing demands on District of Columbia DOT funds. Cooperation with the National Park Service is both challenging and rewarding, as is the more limited interaction with the 15 to 20 agencies here in the District that express opinions about projects depending on the project location and scope. Utility cooperation is probably the most unrelenting and least rewarding of the project challenges, never as high profile as dealing with a federal agency but the one almost always guaranteed to cause problems throughout the process.

4. Are you using asset management for nonhighway modes and how?

N/A.

5. What improvements would you recommend in the implementation of asset management?

Data integration, what-if tools, and communication methodology.

MARYLAND DOT

1. How is your organization using asset management in decision making and resource allocation?

Overview

In Maryland, we manage our highway assets through a series of funds under our system preservation program and through our maintenance operating budget. Our system preservation program includes a wide variety of funds intended to reduce accidents, relieve congestion, enhance urban roadways, provide improved access for pedestrians and bicyclists, and provide for adequate structures and pavements all through system preservation of existing assets. Our maintenance operating budget is intended to maintain all existing roadway assets through preventive and corrective maintenance activities.

The Maryland State Highway Administration (MDSHA) does not use a single tool to manage these programs. Instead, each system preservation program is managed independently

using a variety of tools. Program managers work each year to establish operational plans that will attempt to achieve overall program objectives. Each year the program managers meet together with the MDSHA administrator in a working meeting to present their needs for managing their respective programs. During this meeting, tradeoffs between programs are discussed and debated. Currently, MDSHA does not have the capability of objectively evaluating the benefits and consequences of tradeoffs other than the use of good engineering judgment and past performance, although some of the programs include tools to predict the consequences of various funding allocations.

Program Approach

A brief overview of some of Maryland DOT's more structured programs is summarized below:

- Large Structures. Project-based system driven by needs. Use PONTIS and an in-house developed system to rate bridge and structure condition. The ratings from these systems are used to identify project needs. The projects are prioritized based on structural and functional needs and are rolled up into a multiyear program.
- Urban Revitalization. Project-based system driven by community requests. Use a scoring system that consists of a wide range of factors to quantify project benefits. Projects are prioritized based on the scoring system and rolled into a multiyear program.
- Drainage. Project- and life-cycle-based system driven by needs and age. A fairly extensive inspection program has been ongoing for several years to establish drainage improvement needs. An annual program is established based on identified needs and routine operations necessary to maintain adequate life cycles for drainage facilities.
- Congestion Relief. Project-based system driven by needs. Problem intersections and roadway sections that warrant minor improvements to improve capacity and relieve congestion are identified on an annual basis. Various alternatives to relieving congestion for each potential project are considered by a panel of engineers. A panel of experts is used to predict the benefit of applying each alternative. Candidate projects are prioritized based on cost and benefit and then rolled into a multiyear program.
- Safety. Project-based system driven by needs. Critical accident intersections and roadway sections that warrant improvements to reduce the occurrence of accidents are identified on an annual basis. Various alternatives to reduce accidents for each potential project are considered by a panel of engineers. A panel of experts is used to predict the benefit of applying each alternative. Candidate projects are prioritized based on cost and benefit and then rolled into a multiyear program.
- Pavement. Network-based system driven by optimization. An in-house developed system is used to evaluate various funding strategies to maintain and improve the pavement network. The system utilizes an optimization approach to maximize program benefits while operating under budgetary and policy constraints. An investment strategy is developed to establish outcome- and output-based targets for District offices. District offices attempt to develop resurfacing programs that will achieve these targets using an in-house developed project selection tool. In addition, preventive maintenance targets that are used to develop annual crack sealing and surface treatment programs are established by the system.
- Maintenance Operating. Budgets are established based on recent funding levels and estimated needs to meet statewide objectives for signs, pavement marking, lighting, drainage,

roadway appearance, pothole repair, and snow removal. Performance measures are monitored quarterly to make adjustments in funding allocation levels to ensure that targets are met.

Tools

Several tools have been developed within MDSHA through the development of these programs that allow data to be shared. Much of our system data are contained within our agency GIS, which is only accessible to GIS users and requires some knowledge of the system to be utilized fully. A variety of other tools have been developed on the agency Intranet that allow for access to construction history data, pavement and bridge condition information, bridge inventory information, and traffic and accident data. The majority of these tools are database systems that allow for user queries and data reporting, however, some of the systems are text and graphic reports that are updated on a regular basis.

We recently have formed an Integrated Design System team that is working on integrating planning, design, construction, and maintenance activities through common systems statewide. The overall goal of this initiative is to share data during the full life cycle of a project so that we can work more efficiently and make better decisions (i.e., capturing in a history file maintenance improvements as they happen).

Business Planning

MDSHA recently has revised the agency business plan, which now is linked more strategically to performance-based outcomes in our system preservation program. The plan includes objectives that directly affect how we manage assets and how we have established priorities. For example, some of the objectives challenge us to reduce accidents and congestion, to maintain adequate pavement and bridge conditions, and to maintain functional condition levels for other assets such as signs, drainage systems, lighting, and pavement markings. The business plan includes outcome-based measures as objectives and then more output-oriented strategies that are typically the product of program delivery (e.g., number of miles resurfaced).

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

The primary users of our systems are staff-level engineers who use the various tools available to make asset improvement decisions. The products of these tools (e.g., reports, predictions) have been used to convince department leaders and legislators of the need to invest in Maryland's highway infrastructure. This year we were successful in securing a multiyear revenue increase as a result of our ability to demonstrate the consequences of deferring much needed improvements.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

Over the past several years, our system has improved or at least maintained network-level condition levels using the programming process described above. We have used our systems on

two occasions over the last four years to justify funding increases to transportation executives and legislatures.

3. Barriers to using asset management

- Gaining buy-in from our district offices. It has been difficult to get our districts to use a performance-based system that includes targets. They often are not able to fund the projects that they feel warrant the greatest needs and have, at times, been frustrated with the approach to managing our assets.
- Maintaining data collection to adequately track condition measurements for all of our assets. We invest heavily in pavement and bridge data collection efforts but have not invested enough in data collection efforts to monitor other roadway assets. With shrinking operating budgets and dwindling human resources, this has been a challenge.
- Keeping up with new technology has been challenging as our internal procurement rules prevent us from easily upgrading to new and improved systems.
- Integrated data across assets are only truly happening in our GIS system, which is only used by a small percentage of asset management users.
- Conducting tradeoff analysis has been difficult without good prediction tools for all of our assets. It has been difficult to get some of the more traditional asset programs to change they way they manage their program.
- Competing business plan objectives have made it more challenging to achieve desired outcomes using our AM systems. For example, we have one objective to reduce work zone congestion while we have another objective attempting to increase pavement quality through longer work zone closures.

4. Are you using asset management for nonhighway modes and how?

We use AM principles for facility management and fleet management; however, these assets are managed independently. We do not manage other modal agency assets through system preservation (we do work with interagencies in project planning).

5. What improvements would you recommend in the implementation of asset management?

5a. Areas that need improvement?

- Need to understand more fully how tradeoff analyses can be conducted in a state agency.
- As asset management is more fully adopted, we need to identify the need for data collection protocols, especially for those assets that have not been traditionally monitored.
- Establishment of a methodology to determine minimum data collection needs to support an AM system.
- Examples on how network-level planning can be delivered in a program through the use of performance targets.

MICHIGAN DOT AND THE MICHIGAN ASSET MANAGEMENT COUNCIL

1. How is your organization using asset management in decision making and resource allocation?

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

Michigan DOT uses the five-step resource allocation and utilization process (Figure 1):

1. Policy goals and objectives,
2. Planning and programming,
3. Program delivery,
4. Quality information and analysis, and
5. System monitoring and performance results.

The information is used at all levels of the department from staff in the field to upper management.

The Transportation Asset Management Council (TAMC) follows this same process but has been in existence for only two years. They have adopted a specific mission statement and goal statement. They are also in the second year of gathering condition data on the federal-aid eligible system. This information is reported to the State Transportation Commission and the Michigan legislature.

Mission Statement: Advising the State Transportation Commission on a statewide AM strategy and the necessary procedures and analytical tools to implement such a strategy on Michigan's highway system in a cost-effective, efficient manner.

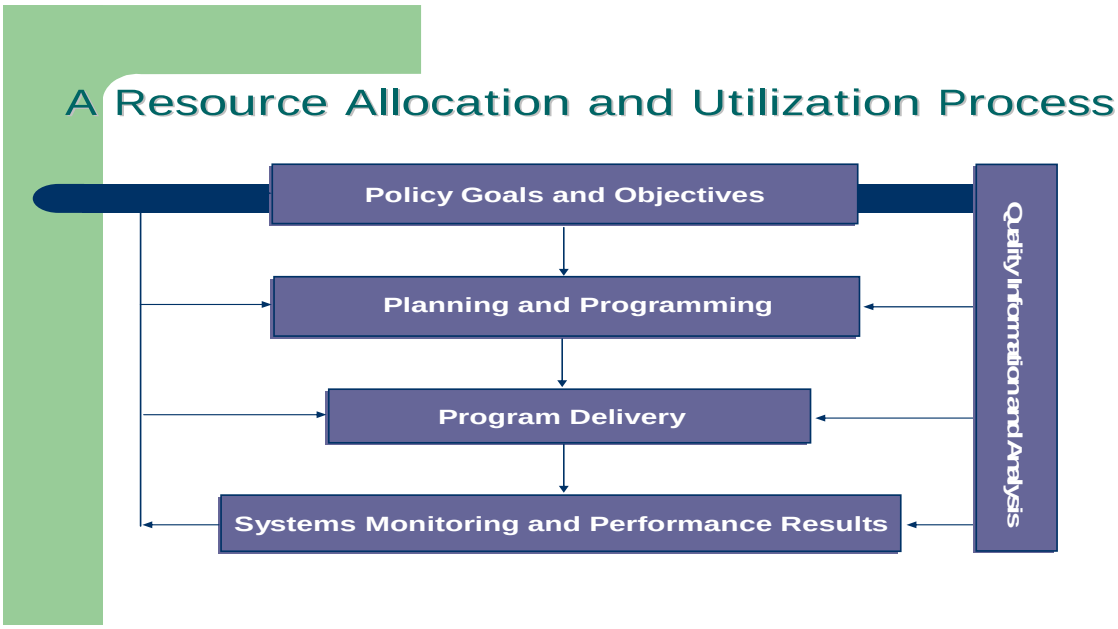

FIGURE 1 Michigan DOT resource allocation and utilization process.

Goal Statement: The TAMC will expand the practice of AM statewide to enhance the productivity of investing in Michigan's roads and bridges through coordination and collaboration among state and local transportation agencies by

1. Surveying and reporting the condition of roads and bridges by functional classification categories for the state and regional planning areas,
2. Assessing completed and planned investments in roads and bridges by the various transportation agencies of the state,
3. Supporting the development of appropriate AM tools and procedures, and
4. Providing education and training on the benefits of developing road improvement programs through the use of AM principles and procedures.

Our expected outcome is an AM process that is used and communicated easily and that leads to a road network that is managed by function.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

Before the adoption of AM principles the department followed a "worst-first" approach. Now we use a mix of pavement fixes that balances investments between short-, medium-, and long-term with the current condition of the road. With the change to AM, Michigan DOT has reduced the number of poor pavements by more than 11 percent since 1996. The average remaining service life has increased by 26 percent (Figure 2).

We have established very specific goals for both highways and bridges.

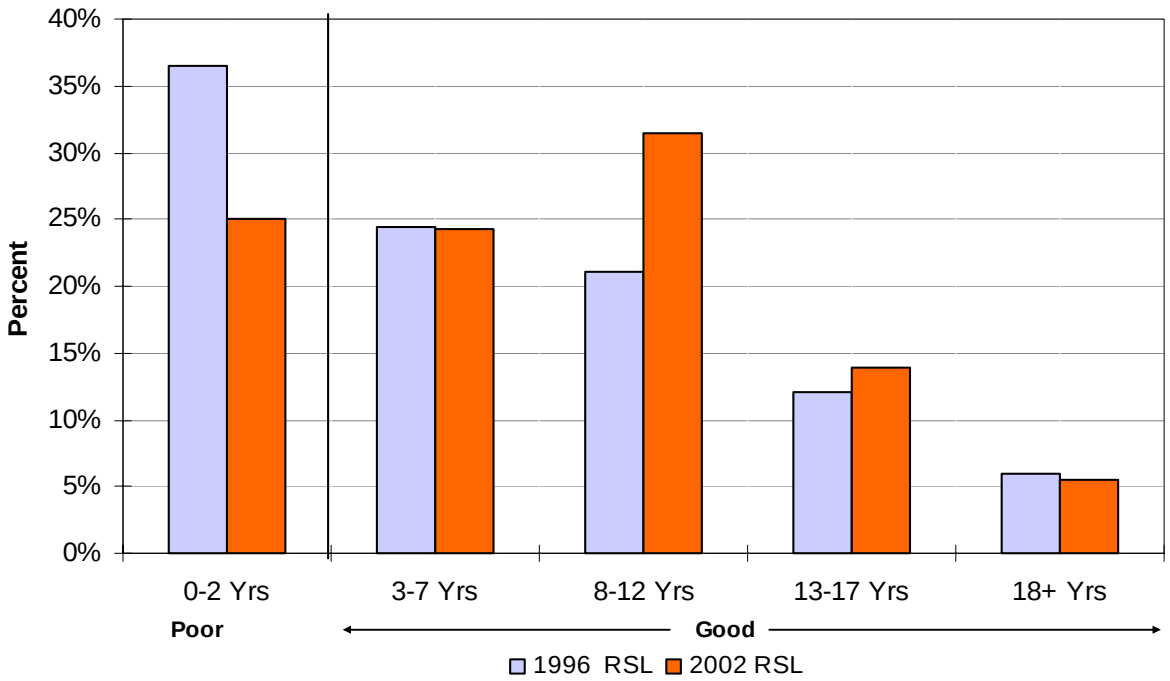

FIGURE 2 System improvements, 1996–2002.

Program Targets, Percent Rated "Good"

The heart of our process is our cash flow model (Table 1) and our call for projects process. Our cash flow model provides an evaluation of the amount and type of road and bridge projects that can be built with a given funding amount. It calculates the expected expenditures and revenues for seven to 10 years. The model allows management to estimate the impact of:

- New revenue sources,
- Changes in cost of projects, and
- Changes in the timing of federal-aid reimbursements and lagged effects of expenditures.

It also provides us with a tool to talk to the governor and the legislature about financial expectations and the resulting conditions.

We use a Call for Projects process as a cooperative process to determine which roadways should be reconstructed, rehabilitated, or receive capital preventive maintenance. These decisions are made by the Michigan DOT regional offices and the statewide planning staff. The selections are reviewed by a multidisciplinary project screening team. This team is made up of planning, construction and technology, Lansing development, and region staff.

We have a Road Quality Forecasting System (RQFS) to predict future system condition based on alternative investment scenarios. Forecasts from RQFS are used to assess project selection and fix type in determining whether a particular strategy will meet the systemwide condition goals. Once the type of fix for a particular section of pavement is decided, and associated design life is identified and used in designing the pavement structure, we track the delivery of the program and the resulting changes in pavement condition. If necessary, we make changes. We repeat the analysis at least on an annual basis.

As we looked closely at our program, it was becoming clear that our progress toward our goals was not proceeding at the anticipated pace. So, we needed to make an adjustment (Figure 3). We also adjusted our preservation funding to keep pace with inflating project costs.

Road Preservation Investment Level and Pavement Condition (Freeway and Non-Freeway) in Kent County, Michigan

The Kent County Road Commission's (KCRC) experience in AM began in 1995 with an annual process of surveying pavement conditions on the primary road system for a new PMS. That effort significantly expanded the organization's ability to assess needs on a systems level and to forecast the impact of various investment alternatives. As a result, KCRC stepped up its investments in system preservation, and the effect of that decision is illustrated in Figure 3.

TABLE 1 Cash Flow Model

Highways	**Bridges**
95% of trunk line freeways 85% of trunk line non-freeways	95% of trunk line freeways 85% of trunk line non-freeways

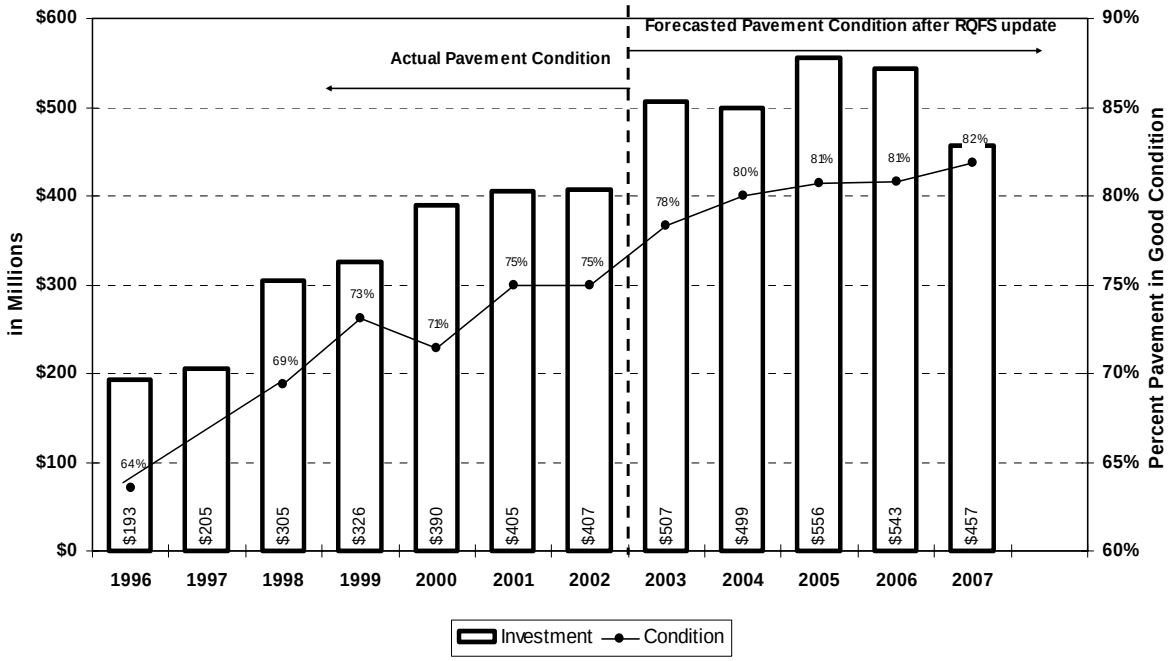

FIGURE 3 Road Quality Forecasting Progress.

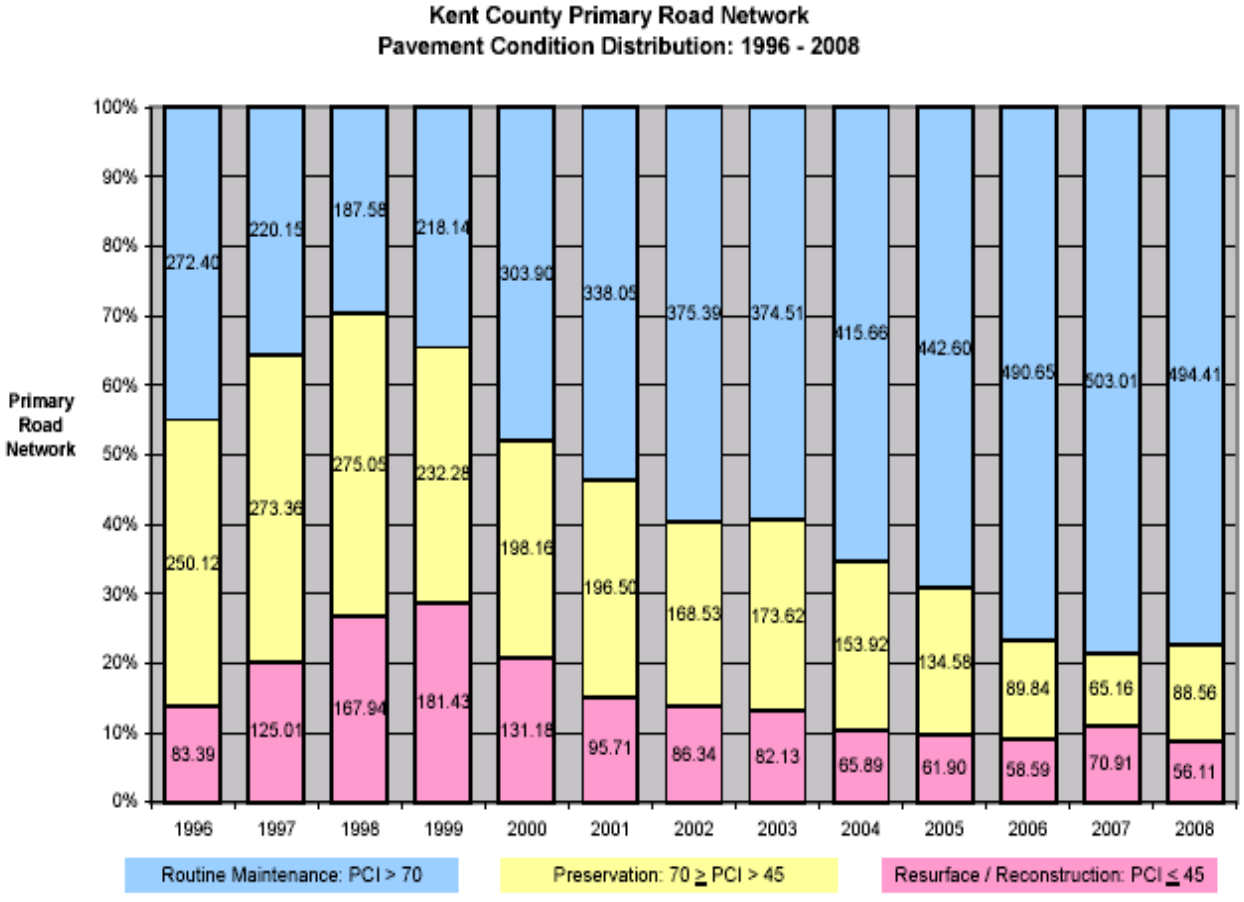

FIGURE 4 KCRC five-year improvements.

Since 1995, KCRC has more than doubled annual investments in its overlay and seal coat program. With the information generated by the PMS, KCRC has the ability to forecast the effect of its investment decisions. Figure 4 demonstrates that ability and shows improving conditions on the primary road system due to increased investment in system preservation. This trend continues through 2008 with projects included in KCRC's current five-year improvement program.

3. Barriers to using asset management

With regard to TAMC, the biggest barrier was a lack of trust between the department and the County Road Association. This was overcome when Michigan DOT and the Genesee County Road Commission decided to enter into a joint pilot project. This project was so successful it led to the department and the County Road Association introducing a bill to create TAMC. The Council comprises representatives of the state, cities, counties, township, MPOs, and regional planning agencies.

Today the Council is facing several barriers to successfully implementing AM on a statewide basis. The first is that there are 619 separate agencies that manage some portion of the highway system in Michigan of which 62 percent own less than 25 miles of roads. Twenty percent of the agencies own 92 percent of the total assets, while 80 percent of the agencies own only 8 percent of the assets. Some agencies manage as few as three miles or less. At what level does it no longer make economic sense to engage in a full-blown AM process? How do you make the process simple enough for very small agencies to engage in it?

A second barrier for the Council is that only 45 percent of all agencies in Michigan are using a PMS.

4. Are you using asset management for nonhighway modes and how?

At Michigan DOT, our investment strategies include multimodal considerations. The framework provides the necessary flexibility to coordinate with the projects and needs of other transportation modes adjacent to and crossing the highway systems.

5. What improvements would you recommend in the implementation of asset management?

5a. Areas that need improvement?

- University civil engineering courses need to incorporate AM into their curricula.
- To make AM more effective for local governments, it must reflect a comprehensive approach within the entire right-of-way. This would include water, sewer, and utility management into the process. If you don't do this you can be faced with a situation where you have just resurfaced a road and three months later the power company comes along and cuts into your pavement significantly reducing your service life (e.g., Lansing, Michigan DOT, Capitol Loop).

5b. Future research?

- Is there a certain size of system at which this process is *not* cost effective? Do cities with fewer than 10 miles of road need this elaborate of a methodology?
- Rates of deterioration need to be made more specific to local or regional conditions. In Michigan, we have a lot of lake effect snow that affects deterioration rates in different ways.

5c. Data?

- A paring down of data that is needed for agencies to do AM effectively. What is the minimum data you need?
- Sharing of information internationally.

SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS (SEMCOG)

1. How is your organization using asset management in decision making and resource allocation?

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

SEMCOG is attempting to use AM concepts to help develop our long-range transportation plan. We have developed policy goals and objectives, identified deficiencies, and estimated available capital and operations funding for the next 25 years. Having a process to help decide the mix of improvements that will help us reach as many of our objectives as possible, consistent with the amount of funding we have available, is what we are attempting to develop.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

We believe that implementing an AM process will help develop options for elected officials to consider when making decisions on capital programs. The analysis should be able to show them the long-term impacts of their current decisions and be one more piece of information for them to consider in decision making.

We have begun collecting data on pavement conditions for all of the federal aid–eligible roads in southeast Michigan consistent with the Michigan TAMC directive. We will begin to review this data to see if the region's pavements are showing improvement, if local agencies are making investments consistent with the data that has been collected, and if not why not.

3. Barriers to using asset management

There are a number of potential barriers to overcome, including

- What data to collect,
- How to collect it,

- What software to use,
- What part of the system should be covered,
- Who should do the ratings, and
- How will the data be reported?

4. Are you using asset management for nonhighway modes and how?

Not yet, but would like to integrate transit and non-motorized assets into database eventually.

5. What improvements would you recommend in the implementation of asset management?

- AM theory should begin to be taught as part of engineering curricula.
- Especially need a way to communicate to small cities and counties.
- Need more and better training opportunities, maybe one for DOTs, one for large counties, and one aimed at smaller cities and counties.
- Options—one size does not fit all.
- Future research should include types of roads (e.g., gravel roads). Is there some minimal amount of data that needs to be collected to be able to say something about the system?

MISSOURI DOT

1. How is your organization using asset management in decision making and resource allocation?

Missouri DOT uses data from its AM system in most areas of decision making. Our planning framework combines data on the physical condition of system assets with operational data including safety data, capacity information, traffic volumes, and level of service to develop needs. Priorities are developed cooperatively by districts, central office, and planning partners to develop the Statewide Transportation Improvement Program (STIP) in the categories of taking care of the system, safety, regional and emerging needs, and major projects (system expansion).

Other major uses of AM data include funding allocation to districts, funding needs projections, performance data used for predicted system conditions, and department performance tracking.

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

Data are used by all levels of Missouri DOT, from upper management for purposes that include funding distribution decisions, projected funding needs, and organizational performance measures to location-specific decisions by district field staff.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

The development of the relational database combined with a standard location reference system has allowed much easier query of data and more consistent results. Planning at district and central locations is more consistent and reliable. Many operations associated with programming, project selection, needs determination, and prioritization can be automated.

One of the biggest benefits is the ability to perform what-if scenarios to predict system conditions based on assumed changes in funding levels or distribution factors.

3. Barriers to using asset management

3a. Data problems/integration/collection?

The key to AM is the development of a standard location reference system. Historic data take many forms, and conversion to the new system is slow and complex. Many errors were encountered during conversion, and these were blamed on the new system, thus causing a lack of trust in the resulting data. Data are massive and virtually impossible to check 100 percent.

3b. Percent of system or operation covered?

One hundred percent of state highway system is covered, but off-system (city and county facilities) is limited. This becomes an issue when developing safety systems where it is important to account for all accidents on public roads or, for example, where traffic volumes are unavailable from city streets for traffic demand models.

3c. Interagency cooperation?

It is difficult to convince other agencies of the necessity to use a common reference system if they are simply supplying data to the system and not retrieving it. If there is no direct benefit to them, there is little motivation to change existing systems. This is especially true of local law enforcement agencies collecting accident data.

4. Are you using asset management for nonhighway modes and how?

Not at this time; however, the reference system was developed to allow inclusion of data from other modes in the future.

5. What improvements would you recommend in the implementation of asset management?

5a. Areas that need improvement?

Training in the area of AM rather than in the more conventional disciplines, such as pavement management, bridge management, etc.

5b. Future research?

Little seems to be known about, or at least agreed on, how to equate the value of one type of improvement versus another. For example, what is the benefit to the overall system of improving roads over bridges? Research on the prioritization process for overall needs should be undertaken.

5c. Data?

States just starting AM should spend a great deal of time evaluating the data necessary to make the decisions for their business. However, data are expensive to collect and maintain, and care should be taken not to include data in the database just because "we always have" or because "we can" if it does not provide a benefit equal to or greater than the cost of collecting, converting, or maintaining it.

JACKSON COUNTY, MISSOURI

1. How is your organization using asset management in decision making and resource allocation?

AM is used to improve decision making from a quick fix to a pro-active process; to generate sound decisions to guide where, when, and how to spend a limited budget; and to reduce maintenance cost by maintaining verses replacing. An estimated cost savings of more than $10,000,000 has been realized since AM was implemented in 1991.

Jackson County uses the following tools in AM to improve the decision-making process:

- Efficiency analysis: Jackson County AM will evaluate the overall relationship between total cost of system, service, and total benefits. This tool helps management look at the impact of their decisions on the network during budget planning.
- Evaluation process: Jackson County AM provides information the choice of the best course of action, such as identification, analysis, and assessment of the pavement performance, cost, and impact of alternative courses of action and determination of the absolute value of a particular project.
- Forecasting tools: Assist Jackson County to determine expected performance, impacts, and cost likely to occur under each possible alternative.

Other notable aspects of Jackson County AM system are

- The county's preventive maintenance AM gives recommendations for applying a series of preventive maintenance treatments over the life of the facility to minimize life-cycle cost. Treatment selection is based on a pavement performance and optimization model. Jackson County set aside about 60 percent of their maintenance budget just for prevention maintenance.
- The AM system is integrated with maps that assist counties in viewing asset conditions across other geographical areas and includes referencing information such as traffic, zoning, facility condition, R/W, utilities, etc.

- The county's AM provides project- and network-level information to help with general planning, programming, and policy decisions.
- Data collection frequency is based on the type of asset, age of asset, rate of deterioration, cost, and Government Accounting Standards Board Statement 34 (GASB 34) requirement. Different types of distress, extent, and severity data are used for high-volume and low-volume roads.
- Most of the existing AM systems available today are not able to calculate a new condition index based on maintenance activities performed by maintenance divisions every day such as routine, preventive, and corrective maintenance. The result is incorrect information sent to managers regarding the existing conditions of facilities. Our AM will update the existing condition index as daily maintenance is applied, enabling managers to make decisions based on current information.
- Performance modeling and optimization modeling is used to select the most cost-effective maintenance options. Maintenance selection is based on life-cycle costs, performance model, rate of deterioration, and cost–benefit ratio.
- Our system uses an optimization model plus benefit, cost, fund availability, facility type, rate of deterioration, and cost of failure to assign priority.
- The true power of Jackson County AM is its ability to permit the asset manager to quickly examine the consequences of different strategies in terms of overall network conditions, backlog of needs, and future needs (i.e., what-if analysis).

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

- Public works directors use AM to identify and prioritize maintenance and rehabilitation projects, to monitor the performance of those repairs and strategies, to determine the impact of funding decisions on the future condition of the network, and to estimate funding needs.
- Elected officials use the output of AM to justify budget requests pertaining to infrastructures, to weigh requests for public facility dollars against completing request for other uses of the fund, and to justify to their constituents why a specific road or street was or was not repaired.
- Maintenance managers use the AM to identify potential projects, to prioritize facility repair needs, and to prepare multiyear repair programs. Maintenance managers use AM to determine what work was done, when it was done, who did it, what resources were used, and how much was completed. AM is used to take a request, manage and group work orders, and assign crews. AM is used to search for data; feature inventory; generate reports; and determine material, equipment, and labor needs for each maintenance activity. AM is used to evaluate maintenance performance and production, to determine costs and materials needed, and to predict maintenance needs and cost for a given budget.
- Finance directors use their AM for financial reporting, to maintain an inventory of exiting asset, to track historical cost information, to prepare GASB 34 report, and for asset valuation.
- Utility companies use their AM to schedule planned utility work prior to facility construction.

- Risk managers use the AM to get information about the history of the road, bridge, or sign during certain litigation situations.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

- Improves county program quality;
- Improved information and access to the information;
- Improves communication;
- Provides a way to analyze the consequences of various funding levels;
- Provides sound basis for allocating resources;
- Enhances public works credibility with elected officials, top management, and the public;
- Eliminates duplication of effort;
- Quickly and efficiently analyzes objective data for planning, scheduling, resource allocations, and budgeting; and
- Backs up or justifies facility improvement program to legislators (See Table 2 for a cost savings summary).

3. Barriers to using asset management

At the beginning, Jackson County had barriers—fear of exposure, resistance to change, funding, and technical issues.

3a. Data problems/integration/collection?

In order to ensure that an AM fits the organization:

- It is important that the agency carefully plans what data and information it wants the AM to provide.
- It is important that the agency carefully plans the level of resources it wants allocated to the entire process.

TABLE 2 Cost Savings Summary

Past Methods (1992)	**Current Methods**
70% of all roads in poor and fail condition	75% of all roads are in are in fair to excellent condition
102 people work in maintenance division	70 people work in maintenance division
520 accidents every year	250 accidents every year
800 complaints every year	300 complaints every year
Always have budget problems	Transfer $1,000,000 every year from maintenance to Capital Improvement
5% of total maintenance budget is used for preventative maintenance	60% of total maintenance budget is used for preventative maintenance

- At the beginning the county used a single database that discouraged users from using the system, information sharing was cumbersome or impossible. Proper integration of information systems is critical for successful, comprehensive asset management. A single database may not be practical.

3b. Percent of system or operation covered?

One hundred percent of the transportation network.

3c. Interagency cooperation?

At the beginning, other agencies in Jackson County did not want to use the AM system, because they were not involved in the decision-making process and the system did not meet their needs. Today Jackson County has an integrated AM system, and all users are involved in the decision-making process.

4. Are you using asset management for nonhighway modes and how?

(No response provided.)

5. What improvements would you recommend in the implementation of asset management?

- To form an agency AM steering committee that includes every section in the agency where AM will have an impact.
- Develop a road map for AM. The road map will define agency goals and objectives, users of the system, user needs, level of sophistication of the system, and implementation plan.
- Training. Explain cost and benefits of AM to all users.
- At the beginning explore the options for funding the system development, select the level of sophistication for the system, determine the type of facilities to be included in the system, and identify resources that are necessary to put the system into action.
- Trial implementation. It is important to evaluate AM capabilities on a small area of the facility network, testing the software before implementing the systems on the entire network.
- Careful planning is needed before the implementation has begun.
  - Educate and train throughout the agency, and
  - Improve communication among those affected by the system.
- Factors to consider during implementation:
  - Who will maintain and update data?
  - Required resources,
  - Internal staffing,
  - Funding for data collection,
  - Funding to support the facility repair programs, and
  - Funding for equipment and training.

5a. Areas that need improvement?

Most existing AM systems available today are facility information management, not AM systems; they provide condition data, cost data, and subjective priority, but they do not have analysis tools and forecasting tools. Other elements that are missing from AM systems include

- Facility condition updates as daily routine maintenance is applied;
- Integration tools;
- Agency size, budget, skill not considered;
- Cause of facility problems;
- Road functional classification;
- Tools that combine forecast of costs and conditions; and
- Methods of assigning value to assets.

5b. Future research?

More research needed in the following areas:

- Performance modeling;
- Prediction tools for performance, budget, condition, maintenance action, and failure modes;
- Risk assessment;
- Analysis tool for optimization;
- Life-cycle cost analysis;
- Remaining life estimation;
- Asset valuation;
- Tradeoff analysis;
- What-if analysis;
- Update condition index of facility as daily maintenance is applied;
- Structural evaluation; and
- Treatment selection.

OHIO DOT

1. How is your organization using asset management in decision making and resource allocation?

Ohio DOT uses AM to identify, evaluate, and maintain its transportation assets in a steady-state manner. Annual condition assessments are reviewed, and these trends are used to predict future asset conditions. The projected conditions are compared to adequacy thresholds to identify lane miles or assets that are deemed deficient. Funding is allocated to the 12 decentralized districts to address the deficient conditions in an effort to maintain the assets at a steady state over time. Performance measures are used to monitor the effectiveness of the AM process and to adjust

management strategies or resource levels. Several documents, listed below, illustrate examples of Ohio DOT's AM process.

Organizational Performance Index (monthly, internal document)
http://intranet.dot.state.oh.us/opi/

The organizational performance index (OPI) monitors the monthly performance of all 12 districts in several key areas of construction management, contract administration, equipment and facilities, finance, information technology, plan delivery, quality and human resources, system conditions, traffic safety, and highway maintenance. These scores are used to monitor several programs and to standardize services across districts. OPI exception reports and action plans are discussed during monthly executive management meetings. Many of these performance measures are used to evaluate annually management and staff.

GASB 34 (annual)
http://www.dot.state.oh.us/finance/GASB34.htm

The performance of Ohio's assets also is reflected in the annual financial reports. Ohio uses the modified approach with minimal standards of 75 percent acceptable lane miles of pavements and 85 percent acceptable square footage of bridge deck area. These standards are less than the internal management standards applied in the OPI.

2004–2005 Business Plan (biennial)
http://www.dot.state.oh.us/BusinessPlan0405/default.asp

The business plan is a required biennial document the department must file with the Ohio General Assembly under the state law that created Ohio DOT's Career Professional Service. The business plan represents the underlying objectives that the DOT's management team is to accomplish in the biennium. From the business plan come the action plans for members of Ohio DOT's Career Professional Service. The Ohio DOT business plan presents current district performance and sets future targets used by the OPI for pavement, bridge, and maintenance conditions.

State of the Transportation System Report (biennial)
http://www.dot.state.oh.us/sos00/default.htm

The State of the Transportation System Report was first produced in 1996 to share with transportation stakeholders a report on the health of the state transportation system. This report has served as an annual report card of the state transportation assets. Much of this report is now integrated into the biennial business plan.

District Multiyear Work Plan (annual)
http://www.dot.state.oh.us/divplan/SysPlan/workplan.htm

Each of the 12 district offices is responsible for annually developing a District Multiyear Work Plan for pavement and bridge preservation and highway maintenance. This plan is developed by

multidisciplined teams including participants from planning, production, highway management, and finance. The District Multiyear Work Plan is a fiscally constrained plan to identify and predict the future conditions for the priority system (interstate and four-lane divided NHS highways), urban system (remaining incorporated state highways), and general system (remaining unincorporated highways).

The District Multiyear Work Plan includes identifying projects and conditions for

- 10 years priority system pavements,
- 6 years general system pavements,
- 6 years bridges,
- 4 years urban system pavements,
- 1 year routine highway maintenance, and
- 1 year safety projects.

This process is now integrated with the Ellis project tracking program (Figure 5). This program tracks all capital construction projects, their development schedules, and finances. As new projects are entered into Ellis, the affected highway sections are identified and the pavement condition forecasts are adjusted to show the improved conditions. Bridges are individually identified to show the correction of any of four major deficiency areas. Any subsequent changes to project delivery schedules revise the future projections and are reflected in real-time performance monitoring reports. Ellis uses district-specific degradation rates to degrade pavements condition projections for segments with no scheduled rehabilitation projects.

Funds Allocation Process (biennial, internal document)
http://intranet.dot.state.oh.us/finance/Manuals/Funds%20Mgmt.pdf

The Funds Management Committee is an advisory body created by the director in March 2001 to make fact-based recommendations on how the department can best allocate available funding based on the condition and needs of Ohio's transportation network.

Funding recommendations for all highway capital programs are based on one overriding goal—allocate money in a manner that drives down transportation deficiencies statewide until we reach a desirable state, and then maintain it over time.

Governor's Jobs and Progress Plan
http://www.dot.state.oh.us/JobsAndProgress/

The Governor's Jobs and Progress Plan is a 10-year program to address Ohio's most pressing congestion, safety, and rural access needs.

Access Ohio (30-year plan updated every 5 years)
http://www.dot.state.oh.us/planning/File%20Directory/AccessOhio.htm

ACCESS OHIO 2004–2030 is Ohio's statewide transportation plan. It includes a comprehensive analysis of existing transportation conditions and a 26-year projection of the needs and recommendations for Ohio's multimodal transportation system, including roads, bridges, bicycle, and pedestrian trails, rail systems, and air and water ports.

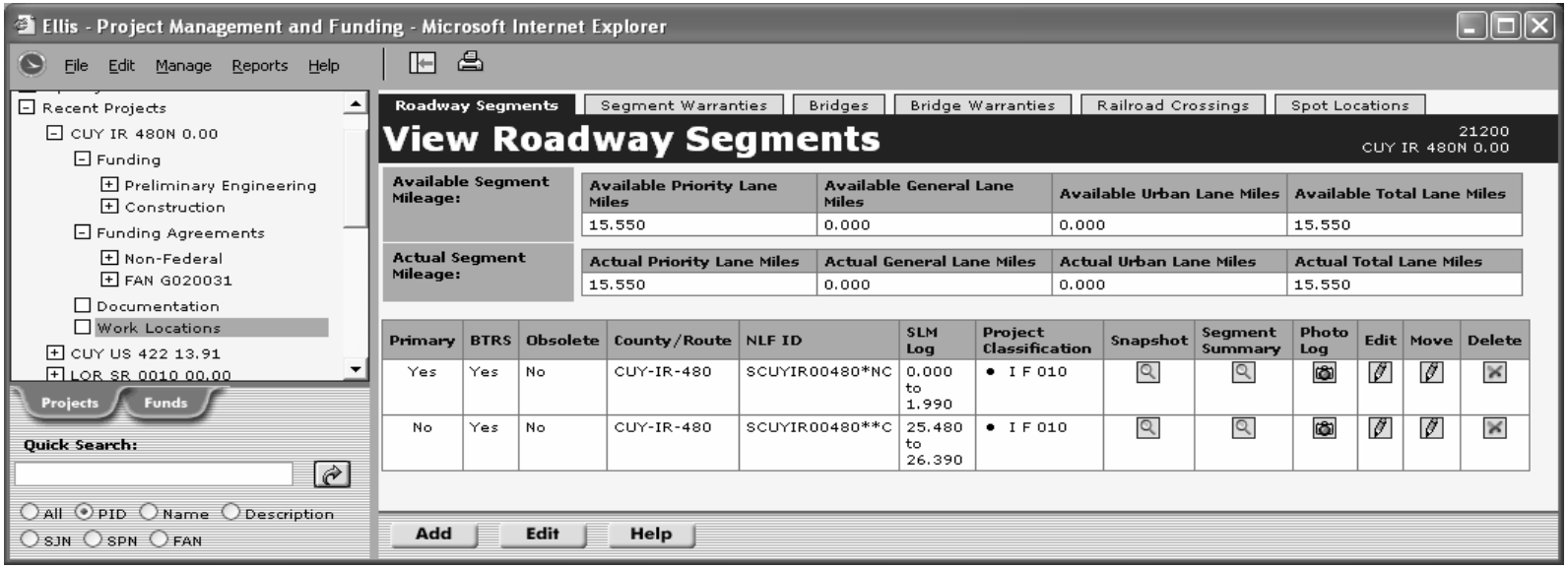

FIGURE 5 Ellis project tracking program.

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

The Ohio DOT is a state agency of 6,300 employees who are decentralized into 12 district offices with 88 county outposts. Ohio is a home rule state with 17 MPOs and 88 county engineers; 1,309 townships; and 942 corporations.

The department is organized internally at the district level into four key areas—planning, production, highway management, and finance—that report to the district deputy directors. The central offices set policy, provide training, and perform quality assurance reviews.

Each of the transportation reports described under Question #1 are directed towards different transportation stakeholders. These stakeholders are identified below.

OPI: director, executive management team (includes assistant directors, deputy directors and district deputy directors), planning staff.

District Multiyear Work Plan: executive management team, planning, design, maintenance teams.

GASB 34: state auditor, finance.

2004–2005 Business Plan and State of the Transportation System Report: governor, legislature, director, executive management team, planning, design, maintenance, finance, major program coordinators, personnel, and MPOs.

Funds Allocation Process: director, executive management team, finance, planning.

Governor's Jobs and Progress Plan: governor, legislature, director, major program coordinators, planning, finance, and MPOs.

Access Ohio (30-year transportation plan): governor, legislature, director, major program coordinators, planning, finance, MPOs, and general public.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

Before embarking on the current AM strategy, the priority system pavements were becoming increasingly deficient each year. These deficiencies included nearly 20 percent of the total lane mileage of interstate and four-lane divided highways. These deficient roads each had pavement condition ratings below 65 and many experienced high rates of annual deterioration. Using AM strategies, the percentage of deficient lane miles has been reduced to only seven percent and will remain at a steady state, below 10 percent deficient, each year.

The overall average pavement condition rating has increased most dramatically for the priority system pavements. These pavements represent 25 percent of the state highway lane miles. They handle 56 percent of the total vehicle miles of travel on the state system and also carry 70 percent of the truck travel (See Figures 6 and 7).

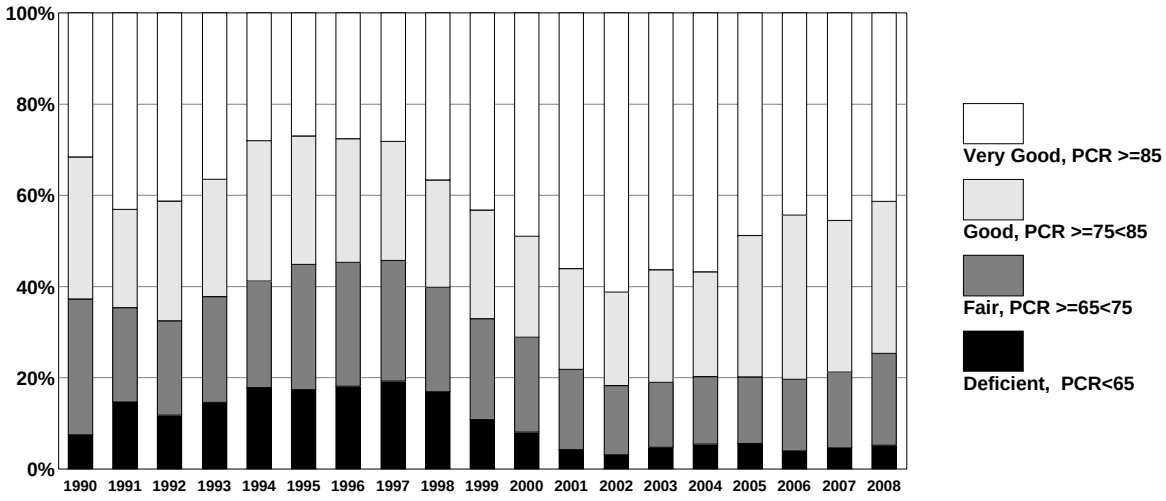

FIGURE 6 Priority system pavement conditions (statewide lane miles).

Bridge conditions are assessed by four major deficiency categories (Figure 8). General appraisal describes the overall condition of the structure and involves the most costly rehabilitation requirements. Floor condition is an evaluation of the substructure of the bridge deck and is second in cost to repair. Wearing surface describes the riding surface of the bridge, and paint condition is a measure of paint applied to structural members to reduce corrosion. Over the past six years, there has been a reduction of statewide bridge deficiencies that is similar to improvement trend experienced for pavements. Sound AM practices have resulted in observable improvements across the state.

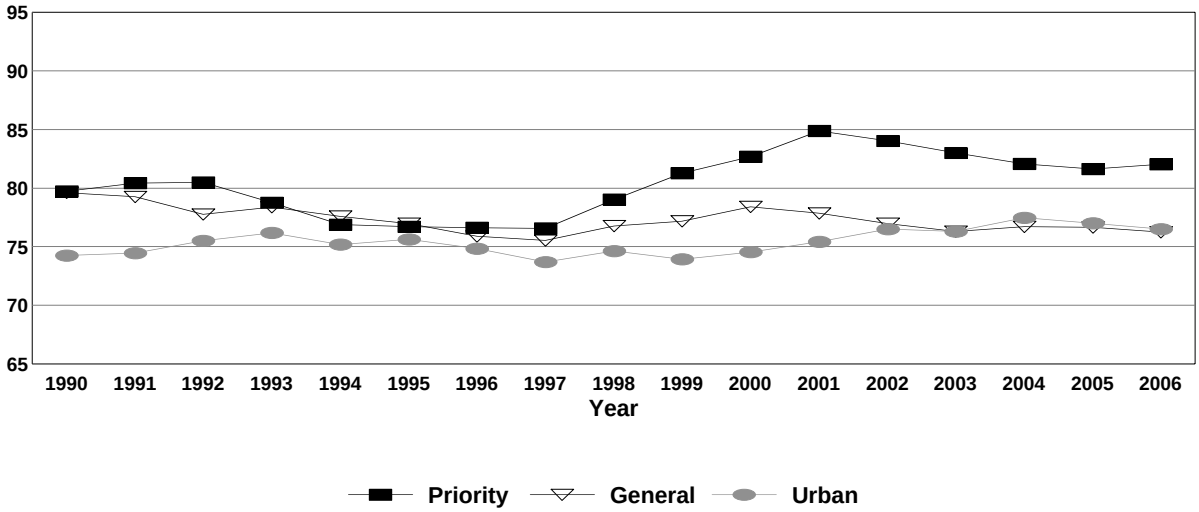

FIGURE 7 Bridge pavement conditions statewide (weighted average PCR).

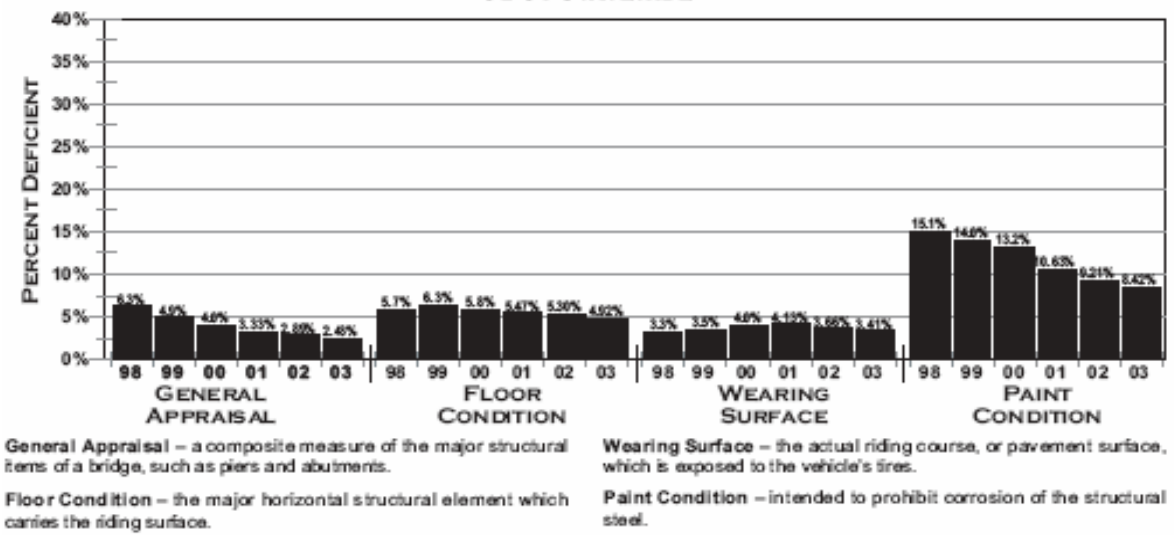

FIGURE 8 Bridge deficiencies assessment for Ohio.

3. Barriers to using asset management

3a. Data problems/integration/collection?

Ohio DOT began using dynamic segmentation tools from GIS to initially integrate AM data. Even with this tool, many files were not compatible because of different referencing notations. The Base Transportation Referencing System (BTRS) was created, and several of the departmental legacy systems were brought in compliance with the BTRS standard. As a result, road inventory, traffic count, pavement condition, bridge condition, vehicle crash, capital project, and other data are now integrated through a common BTRS link identifier and mileage log point. A continuing challenge is related to the fact that the base roadway network is not static, and data that was logged historically may no longer match the current roadway network. A road inventory modernization effort is underway to explore solutions to better deal with spatial and temporal highway data.

The high level of collaboration included in the district multiyear work plans has resulted in extensive corporate knowledge of system conditions. Previously, pavement and bridge data were reserved for those who collected it, small offices that analyzed it, and a few designers who used it. Now, the asset data are shared across the organization and are familiar topics for planners, maintenance personnel, management, and external stakeholders. Ohio DOT is continuing efforts to review and improve this AM process throughout the department.

3b. Percent of system or operation covered?

One hundred percent of bridges are inspected annually. These inspections include state-owned bridges and bridges owned by the local governments. One hundred percent of state-owned pavements are inspected annually. Local pavements for all federal aid–qualifying routes have been inspected and will be repeated on a three-year cycle. Traffic data are updated on a three-year cycle. Ohio DOT buildings and rest areas are inspected annually.

3c. Interagency cooperation?

The Ohio Revised Code has several laws that identify responsibilities for keeping the state highway information up to date. The data are used for distribution of state gas tax dollars to the 88 counties; 1,309 townships; and 942 corporations. Ohio's 118,00 centerline miles of roadways are made up of 20,000 centerline miles of state-maintained highways; 30,000 centerline miles of county highways; 43,000 centerline miles of township roads; and 25,000 centerline miles of municipal roads. Ohio DOT cooperates with 17 MPOs and other state agencies, including the Ohio Department of Public Safety, the Ohio Highway Patrol, the Ohio Rail Commission, and the Ohio Turnpike Commission.

Major capital and capacity improvement projects are governed by the Transportation Review Advisory Council (TRAC) http://www.dot.state.oh.us/trac/. TRAC policies have created a criterion-driven, fair, and open evaluation process for identifying major capacity projects of greater than $5.0 million (See Table 3).

Preservation of existing highways is paramount. Transportation efficiency, economic development, and safety factors are used to identify statewide needs and priorities. The separation of routine preservation projects from major new projects has helped the department to maintain continual focus on preserving existing facilities in a steady-state fashion without external political pressure.

4. Are you using asset management for nonhighway modes and how?

AM principles have been applied to the lands and buildings area to assess and predict the condition of Ohio DOT offices, county garages, rest areas, and water treatment facilities. Statewide general aviation facilities are inventoried and runways inspected annually. A stand-alone PMS is used to assess runway and taxiway conditions. Transit buses, light rail facilities, and rolling stock are inventoried and inspected annually. Information from these condition assessments is used to select capital replacement projects.

For local programs, Ohio DOT has performed pavement condition ratings on all federal aid–qualified highways regardless of jurisdiction. This information is shared with the local governments and will be updated on a three-year cycle. Ohio DOT operates a small cities program to fund pavement capital improvement projects for cities outside of an MPO that have populations between 5,000 and 24,999. Additionally, Ohio DOT funds local bridges through its municipal bridge program.

5. What improvements would you recommend in the implementation of asset management?

5a. Areas that need improvement

Data integration and dynamic segmentation are two key issues for AM. Most agencies individually collect many of the needed attributes for asset management. The roadway inventory or road-logs that have been maintained for decades can serve as a foundation for attaching condition attribute data. Data for pavements and bridges often are kept by their respective departments, and project data and traffic volumes are products of the design and planning departments. AM involves the integration of these data sets along with business rules to model

TABLE 3 TRAC Project Evaluation Matrix

Goal	Factors	Maximum Score
Transportation Efficiency	Average Daily Traffic: Volume of traffic on a daily average.	20
	Volume to Capacity Ratio: A measure of a highway's congestion.	20
	Roadway Classification: A measure of a highway's importance.	5
	Macro Corridor Completion: Does the project contribute to the completion of a Macro Corridor?	10
Safety	Accident Rate: Number of accidents per 1 million miles of travel during 3-year period.	15
Transportation points account for at least 70% of a project's base score.		**70**
Economic Development	Job Creation: The level of non-retail jobs the project creates.	10
	Job Retention: Evidence that the job will retain existing jobs.	5
	Economic Distress: Points based on the severity of the unemployment rate of the country.	5
	Cost Effectiveness of Investment: A ratio of the cost of the jobs created and investment attracted. Determined by dividing the cost to Ohio for the transportation project by the number of jobs created.	5
	Level of Investment: The level of private-sector, non-retail capital attracted to Ohio because of the project.	5
Economic Development points account for up to 30% of a project's base score.		**30**
Additional Points		
Funding	Public/Private/Local Participation: Does this project leverage additional funds that allow state funds to be augmented?	15
Unique Multimodal Impacts	Does this project have some unique multimodal impact?	5
Urban Revitalization	Does this project provide direct access to cap zone areas or brownfield sites?	10
Total Possible Points including Transportation, Economic Development, and Additional Categories		**130**

changes in conditions over time. The lack of standard definitions and schema for transportation data results in custom solutions for each agency. Improving the standardization of data formats and definitions for transportation-related data would promote better interchange of data between functions and enable developers or third-party vendors to write generic applications to be used by many agencies. Some standardization currently exists, such as Highway Performance Monitoring System (HPMS), and research is currently underway on TransXML http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+20-64 that may increase standardization of transportation data formats.

5b. Future research

Automated data collection, such as intelligent transportation systems (ITS) data, crash data, or the real-time traffic speeds as shown on Zipdash http://www.zipdash.com/ hold promise for the

collection of real-time data. However, real-time data in this form are often of limited use to transportation planners. Methods to warehouse data and to transform it so that recurring conditions and trends can be identified would make this dynamic information better suited for AM purposes.

5c. Data

Continuing transportation developments such as ITS and the lack of standardization of legacy asset inventories have resulted in many forms of data serving similar purposes. Pavement condition data are frequently incompatible between agencies and limit transferal of business processes and benchmarking. Some specialized data, such as HPMS, is limited to samples because of collection requirements. Breakthroughs in standardization and automated or shared data collection can reduce the overall cost of needed data. External sources, such as cellular phone GPS http://www.nextel.com/about/enterprise/wbs/packaged_apps_tran.shtml and satellite data may soon become economical ways to collect data across many jurisdictions.

Management processes are just as important as the data that drives them. Improved performance measures, funding mechanisms, and operational business rules will pay dividends in the future.

OREGON DOT

1. How is your organization using asset management in decision making and resource allocation?

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?

The Oregon DOT has used several stand-alone programs for some time now for use in allocating program funding based on condition rating and economic impact. Those include

Bridge Management System: Originally developed internally as an SQL database with Bridge View as the front end. We are now transitioning to PONTIS.

PMS: Developed internally and uses deflection data for condition rating.

Landslide/Rockfall Rating System: Originally used the Oregon Rockfall Hazard Rating System but transitioned into a condition–economic impact system with a GIS front end.

Maintenance Management System: An SQL database used to inventory and record maintenance repairs and costs.

The department has identified more than $27 billion in highway assets (not including right-of-way) residing in 61 components (See Table 4). The data for these components are stored and retrieved from 48 different databases and programs. The inventory and condition of most of these components, except bridges, pavements, and ITS equipment, is incomplete.

TABLE 4 Oregon DOT Approximation of Highway Assets as of September 30, 2004

Asset	Units	Replacement Value
Roadway		
Roadway (miles)	20,755.81	
Unpaved Lanes (miles)	646.70	
Drainage Installations (number)	97,238.00	
Flashers and Beacons (number)	1,180.00	$5,900,000
Ditches (miles)	8,216.00	$528,894,800
Rest Areas (number)	75.00	
Fence (miles)	1,726.40	$136,730,880
Striped Lines (miles)	26,582.44	$8,556,058
Major Signs: More than 20 Square Feet (number)	13,588.00	$300,080
Minor Signs: Less than 20 Square Feet (number)	146,230.00	$2,379,825
Illumination Units (number)	15,605.00	
Legends (number)	28,611.00	$7,152,750
Traffic Signals (number)	1,243.00	
Concrete Barrier (miles)	661.00	$132,972,000
Metal/Wood/Cable Rail (miles)	1,717.70	$110,574,800
Attenuators (number)	177.00	$708,000
Delineators/Mileposts/Mailbox Supports/Other (number)	306,860.00	$9,175,800
Major Structures (number)	7,944.00	
Pavement Markers (number)	681,701.00	
Sno-Parks (number)	105.00	
Buildings (number)	1,005.00	
Horizontal/Vertical Drains (lin feet)	168,062.60	
Geo-Environmental		
Fish Passage Structures (ea)	700.00	$150,000,000
Culverts (ea)	50,000.00	$1,000,000,000
Material Sources (ea)	900.00	$10,000,000,000
Retaining Walls (ea)	10,000.00	$250,000,000
Storm water Facilities (ea)	300.00	$15,000,000
Slopes/Repairs (ea)	1,200.00	$800,000,000
Wetlands (acres)	200.00	$7,000,000
Bridge		
Bridges (NBI)	2,680.00	$9,500,000,000
Construction		
Pavements (lane miles)	17,844.00	$3,800,000,000
Traffic		
Traffic Signals	1,227.00	$154,000,000
Detection Loops	30,000.00	$150,000,000
Ramp Meters	110.00	$8,250,000
Intersection Flashers	81.00	$2,400,000
Hazard Beacons	1,429.00	$1,400,000
Major Signs	15,700.00	$23,600,000
Minor Signs	163,250.00	$81,600,000
Sign Supports		

(*continued*)

TABLE 4 (*continued*) **Oregon DOT Approximation of Highway Assets as of September 30, 2004**

Asset	Units	Replacement Value
Roadway Lighting	21,000.00	$178,500,000
Tunnel Lighting	9.00	$9,000,000
Variable Message Signs	47.00	$4,700,000
VMS Supports	47.00	$4,700,000
Cameras	130.00	$1,300,000
Weather Stations	61.00	$1,800,000
Highway Advisory Radio	16.00	$500,000
Snow Zone Signs	7.00	$500,000
Ice Detection	4.00	$100,000
Oversize Vehicle Warning Signs	9.00	$300,000
Call Box	2.00	$20,000
Weather Warning Systems	5.00	$200,000
Total		**$27,088,214,993**

The department is now launching a new initiative to fully develop and integrate all systems to develop a Total Asset Management program. A recent letter from the director of Oregon DOT stated that management of the highway system was the agency's highest priority and core function. Figure 9 illustrates the potential AM structure at Oregon DOT.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

The concept of condition rating tied to the financial strategy using bridges, pavements, and landslides has made it much easier to negotiate with stakeholders regarding program funding. With a fully integrated system, tradeoff analyses will be made to manage funds between programs in a more systematic and defensible way.

3. Barriers to using asset management

Human resources and FTE ceilings. The organization, until recently, has been focused entirely on delivering the Capital Improvement Program, which did not leave enough resources to manage the system. As components aged, and were repaired or replaced, it became apparent that a systematic approach would be needed, and FTE would have to be realigned to fit the need. This has been done.

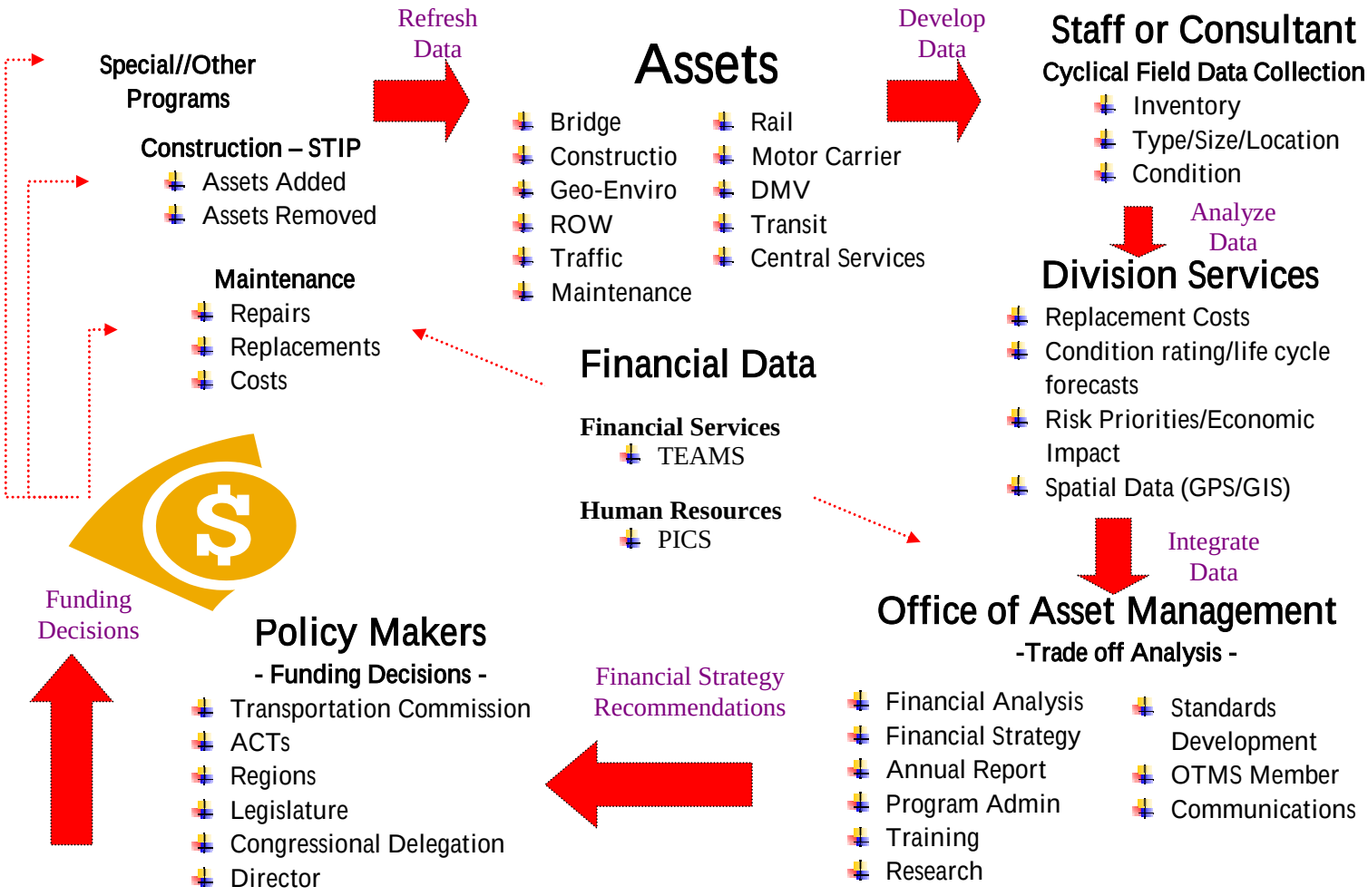

FIGURE 9 Oregon DOT asset management information and data flow.

4. Are you using asset management for nonhighway modes and how?

Yes, to some extent. These include

Fleet Management: We use a fixed-asset system and scheduled depreciation based on type and usage of the rolling stock for maintenance and replacement.

Facilities Management: We use commercial software Fac Center 7 by Tri Riga to schedule building inspections, record condition ratings to drive the preventative maintenance program. We have about 1,200 buildings in the inventory.

Information Technology Management: We use the commercial product Remedy Asset Management to manage our replacement schedule of computer hardware and software, telecommunication devices, inventory, and for contract management and purchasing needs.

5. What improvements would you recommend in the implementation of asset management?

5a. Areas that need improvement?

Partnering with other state and local agencies to take advantage of economies of scale and creativity. DOTs have the greatest contact with the greatest number of local and state governments because of the linear nature of the highway assets.

5b. Future research?

Economic impacts as a factor in priority rating. Not just the cost–benefit ratio and inflation index but the more intangible, such as the cost for delay of the motoring public and freight mobility when a highway is closed for staged or emergency repairs and the cost to communities that become isolated and have long detour routes during closures. Costs for environmental mitigations due to changes in regulatory rules that may be made in a replacement cycle.

5c. Data?

Data warehousing and availability and more consistent national data standards.

PENNSYLVANIA DOT

1. How is your organization using asset management in decision making and resource allocation?

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governor, etc.)?

Our department has been using statewide performance measures for decision making and resource allocation for a number of years. However, our management systems are legacy systems that have only limited predictive modeling capabilities that limit our ability to fully use AM principles in making tradeoff decisions. Our bridge management system is being rewritten to improve these capabilities, and our roadway management system and maintenance management system will follow shortly thereafter.

In the interim, some relatively simplistic predictive analyses based on the statewide condition of our assets are leading to some departmentwide tradeoff decisions for our construction program. An increased proportion of our spending for improvements and preservation is being directed to our bridges.

The departmentwide goals, based on standard performance measures, set for our tactical four-year business plan cycles are adapted by our districts for the management of the highway and bridge assets in their area.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

Tactical planning, for Pennsylvania DOT assets, now based more on performance measures and the more-simple asset analyses, is helping to direct our resources in a more effective manner. Just the use of performance measures draws more attention and internal focus on making improvements.

3. Barriers to using asset management

3a. Data problems/integration/collection?

- Older legacy management systems have a wealth of condition information but have limited predictive functionality.
- Older legacy systems are "silo-" oriented and do not allow good tradeoff decisions.
- Our new financial management system is not fully integrated yet with the AM systems.
- Some important factors for tradeoff analyses (such as congestion, land-use, safety, etc.) do not yet have meaningful data elements to model needs and to use for comparison to hard asset conditions.

3b. Percent of system or operation covered?

Because of limitations noted in Question 3a, only pavements and bridges would have sufficient meaningful data to make good decisions if modeling capabilities were present.

3c. Interagency cooperation?

Pennsylvania DOT works closely with our many planning partners (e.g., MPOs) in developing our capital improvement programs. Because good predictive analysis information is not available, especially for the local assets, it is more difficult to use a rational, needs-based distribution of spending.

4. Are you using asset management for nonhighway modes and how?

No.

5. What improvements would you recommend in the implementation of asset management?

Meaningful tradeoff analyses for nontraditional asset factors, such as congestion, safety, etc.

Meaningful and easy-to-collect measures and goals for nontraditional asset factors, such as congestion, safety, etc.

WISCONSIN DOT

1. How is your organization using asset management in decision making and resource allocation?

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governor, etc.)?

Highway focus because nonhighway modes are covered in Question 4.

State Highway System, Improvement Program (Resurfacing through Reconstruct, plus Capacity Expansion)

Background

- Wisconsin DOT has developed the "metamanagement system" that uses inventory data and information on pavements, bridges, safety, and congestion to identify highway deficiencies, a range of appropriate responses [project scope], and an estimated cost for each alternative. The definition of deficiencies and responses is driven by goals, policies, and priorities set within financial constraints defined by the legislatively approved budget.
- During each biennium, the metamanager is used to do a complete needs analysis for the system over the next 8 to 10 years. The metamanager also is used as the basis for Wisconsin DOT's long-range plan.
- The department maintains an ongoing 6-year improvement program, and improvements scheduled in the program are accounted for in the needs analysis on a location- and time-specific basis.
- The department has two improvement subprograms and determines the split of resources between them. The two subprograms include the following: the Backbone Rehab Program, funding improvements on our Backbone Highway System (which is a 1,550-mile system of multilane highways linking all of our major population and economic areas) and the 3R program that provides funding to each of Wisconsin DOT's eight districts to improve the non-Backbone infrastructure within their districts.

- Capacity expansion projects of any significance are approved by the legislature and are funded from a separate appropriation for so-called major projects.

Uses

- **Resource Allocation:** The funding distribution of priority needs between the Backbone System and 3R directly determines the split of resources dedicated to the two systems. The Backbone Rehab program is managed centrally, with district input on project scope. The funding distribution of priority needs across the districts directly determines the distribution of 3R funding that each district receives. Changes between biennia are phased in over a three-year time period. A group of performance measures is set to ensure that the districts use their allocation of funding to address priority needs with an appropriate scope. A district peer review process is used to monitor and explain any significant deviations.
- **Capacity Expansion:** The significant capacity expansion projects identified in the long-range plan determine the set of projects the department considers for the major project program. Subject to legislative approval, the department attempts to use meta-manager-produced information on safety and capacity deficiencies to set priorities for major projects.
- **Budget Preparation:** The department uses the meta-manager to estimate the cost of improving or maintaining system conditions, uses that information in the preparation of a biennial budget proposal, and can later indicate if the desired infrastructure goals were achieved.

State Highway System–Maintenance Program

- Location referenced improvement projects are shared with the maintenance area so that maintenance decisions are made with knowledge of any improvements scheduled in the near future.
- A pavement maintenance management system has been developed to provide guidance to the districts, but does not control district maintenance budgets and decisions. The system uses information from the meta-management system as input, and further integration and development of the systems is a goal for the future.
- A data-based system is being developed to estimate the costs of achieving a range of goals for maintenance in distinct areas (pavements, roadsides, culverts, etc.). A field survey process is in place to determine condition in each of these areas. The goal is to develop a system that allows the legislature to determine the maintenance budget based on legislative desire to achieve specific goals. The department will be in a position to be accountable for the maintenance conditions actually achieved versus those promised.

Local Highway System

- All local jurisdictions are required legislatively to submit pavement condition data to the department. Use of the PASER PMS or a more sophisticated system is encouraged by the department but not required. The department has created a web-based GIS system for local jurisdictions to submit and utilize their pavement condition data. The system links pavement condition data with other inventory data on local roads that the department maintains.
- The department works with local jurisdictions through the Local Roads and Streets Council to address a range of local program issues. AM is a priority for the department and for

the council. A budget proposal under consideration for the upcoming biennium would link increases in local aids payments to documented use of an AM system at the local level. The proposal would be phased in over time to allow all local jurisdictions to achieve its' requirements regardless of their current level of sophistication.

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

- Budget justification. A significant real budget increase for state highway improvement was justified based on need because of information generated by our AM system.
- Program management. AM principles provide the framework for managing district accountability for resource utilization. As expected, infrastructure condition improved after the budget increase noted above. The last two budgets have not provided increases sufficient to offset inflation. Our goal has become to maintain conditions, and we have done so.
- Project scope. AM principles have created a better understanding of the relationship between project- and system-level optimization and have led to greater emphasis on system as opposed to project goals.
- Program flexibility (culture). District allocations are now seen as fluid. Before our AM process, a district's allocation could realistically only increase. Now, linking resource allocation to statewide priority allows allocations to increase and decrease in absolute terms without bringing revolt. One district's allocation fell 20 percent.
- Priority on data. Operating budget and staff reductions have pressured district resources significantly, but priority has been put on data collection given its' importance in AM and improvement program decisions. This did not occur without some argument at the district level, suggesting that data definitely would have received lower priority were it not for our AM process. This would have hurt many aspects of department operations.

3. Barriers to using asset management

- Data integration. Before embarking on our AM efforts, Wisconsin DOT spent three years developing and implementing a more flexible location control system and providing linkages to update and ensure accuracy in location control information on key databases. This step was essential and very resource intensive.
- Internal acceptance. The AM process began with a vision similar to that now achieved, but its' implementation began small and grew from budget development, through resource allocation, to project scope and finally performance measures. Overall, this took approximately 10 years. District understanding and trust was essential. The system was developed and implemented in concert with a group of district managers in order to achieve the understanding and trust required. The process not only saw an evolution in modeling but also led to the gradual cultural shift that will be essential for long-term success. The real test will be the ability of the system to endure and evolve over time.
- Maintenance versus improvement. The maintenance and improvement programs are managed by different divisions within the department. They also are funded by separate appropriations. This limits our ability to implement appropriate maintenance versus improvement tradeoffs at the project level.

- Location-specific maintenance data. Wisconsin DOT is, to date, unable to create data on what maintenance treatments are performed. Having this data available would improve AM decision making in both the maintenance and improvement realms.

4. Are you using asset management for nonhighway modes and how?

Wisconsin DOT has a PMS for airport pavements. Information the system produces on conditions and needed improvements is used to guide decisions and forms one of the pieces of information used to justify funding applications to the Federal Aviation Administration.

5. What improvements would you recommend in the implementation of asset management?

- The field needs to increase greatly our empirical knowledge on how differing pavement and bridge treatments, taken at differing points of infrastructure condition, impact future performance and cost.
- Much greater knowledge and modeling ability is needed regarding the impact of specific ITS improvements on system operating characteristics, so that a complete range of capacity-related alternatives can be compared.
- We need to increase our ability to forecast the safety-related impacts of alternative roadway and bridge improvements.
- It would be useful to know more about the costs versus the benefits of more and more sophisticated AM systems. Where is the point of diminishing returns? What is the optimal point? Can a small local jurisdiction get 85 percent of the benefits for 35 percent of the cost of the optimal? If a government has *x* dollars per mile to invest, what should it do to get the maximum bang for the buck?

MINISTRY OF TRANSPORTATION OF ONTARIO (MTO)

1. How is your organization using asset management in decision making and resource allocation?

1a. Who are the primary users of asset management and how are they using it (staff level only, director, governor, etc.)?

Over the past three years, the MTO has developed an Asset Management Business Framework "To-Be" Model (AMBF), which sets out the basic framework for the development of AM within the organization. It is a blueprint of the organization's core business made up of processes, activities, linkages, and roles and responsibilities.

These items are "calendarized" to our annual investment cycle and show data and information flows and map out the intended use of management systems. The MTO AM model has five major integrated and iterative steps:

1. Setting the context,
2. Identifying needs,

3. Evaluating solutions,
4. Pursuing funding, and
5. Delivering programs.

The MTO is now in the process of implementing the AMBF and incorporating AM concepts into its existing business processes. The basic objective of the AMBF is to help the MTO "make the right investments at the right time."

The AMBF emphasizes concepts such as the importance of considering needs and developing programs across different asset and work categories, rather than considering each category in isolation; the use of performance measures to help characterize the state of the Ministry's assets; and the importance of using quality data and systems to support decision making.

The following are AM tools currently under development:

- **Economic Analysis Tool:** The AMBF was developed under the assumption that the MTO would use an economic analysis tool for evaluating the costs and benefits of project alternatives. This tool, the Priority Economic Analysis Tool (PEAT) is currently under development and will be reviewed in September 2004.

PEAT is a project-level economic analysis tool that will address gaps in the MTO's existing management systems. It will enable users to analyze rehabilitation and improvement projects for highways, intersections, and bridges using an economic approach that considers both agency and road user costs. The tool also will enable economic analysis of ferry projects based on agency costs. PEAT will help the MTO answer the following questions:

Which projects should be included in the capital program for the current period?

If there are two (or more) mutually exclusive alternatives for a project, which should be selected?

To answer the first question, PEAT will calculate the benefit–cost ratio for "Do It Now" versus "Do It Later" alternatives. The "Do It Now" and "Do It Later" alternatives are specified in terms of 1) an existing transportation facility; 2) a rehabilitated or improved facility; and 3) when the facility would be rehabilitated or improved under each of two alternatives.

PEAT will be developed as an Excel workbook compiling the best practices of established economic analysis models and will incorporate a formula-driven design with minimal use of hidden macros. User-defined functions will be used where appropriate to streamline the design of the workbook and to ensure maximum flexibility for future updates and enhancements to the tool.

- **Noneconomic Criteria:** Economic evaluation is only one set of information that needs to be considered when evaluating and selecting between alternatives. MTO also is determining what non-economic criteria should be considered in the decision-making process and how these will be used in an evaluation process. Examples of noneconomic criteria include but are not limited to community impacts, environmental impacts, consistency with growth management plans, construction timing, and others. The evaluations will be applicable to all highway assets including pavements, structures, lighting, guiderails, etc., and also to maintenance, preservation, rehabilitation, and expansion needs.
- **Tradeoff Matrices:** Building on the criteria developed above and using performance measure targets, matrices will be created that can be used to facilitate tradeoff analysis between a variety of project types (physical condition, safety, operational) and also between asset types

(bridges, pavements, ITS, ferries). Tradeoffs will be done at a network (program), regional, corridor, and project level.

- **Corridor Investment Plans:** Building on the corridor investment plans developed by the AM team, the MTO is now developing a corridor investment plan format and template that details the investment decisions on a corridor over a 25-year period. This includes rehabilitation, reconstruction, emergency work, nonroutine and routine maintenance, and the associated soft costs such as design along with property acquisition costs for all highway assets along a corridor. The plans also will detail the performance of the corridor, condition (bridge and pavements), safety, and operational based on the proposed investments. The corridor investment plans will then roll up to a regional corridor investment plan and then ultimately roll up into a network investment plan.

The corridor investment plan will be automated and will work within the ministry's existing operating system, in either Microsoft Excel or Microsoft Access. It will have the capability of producing various reports, including an evaluation report summary, a summary of the corridor, regional and network corridor investment plans, and a summary and analysis of performance measures (i.e., percent highways and bridges in good condition by year).

2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?

- AM has influenced our funding agency to take a results-based approach to infrastructure management, and they will now be requiring all ministries within the province with capital assets to report this way, following MTO's lead for AM on highways. MTO and others now are being requested to develop three- and 10-year infrastructure management plans.
- Increased justification for investments by describing both economic and non-economic benefits, how investments contribute to network condition, and performance and life-cycle costing will be available.
- Increased ability to quantify overall infrastructure debt and future deficit based on various funding scenarios.
- Ability to track asset value for both management and financial accounting purposes.
- Infrastructure management systems being updated to support AM methodology (25-year time period of analysis, multiple alternatives, predicting future condition and performance, determining outcomes of investment).
- More consistent analysis of investment across the organization by using common tools and methodologies (all within a common decision-making framework).
- More comprehensive tradeoff analysis at project and program level, within and across transportation modes.

3. Barriers to using asset management

3a. Data problems/integration/collection?

- Data problems: data not current, not referenced geographically, not available (because of system shutdown for updates), data gaps, too much data in some cases and not always clear why this data is being collected, not enough data in some cases, (e.g., predicting asset condition over time for bridges, safety, mobility).

- Data integration: several silo systems, some systems linked but not all links are functional. MTO currently is finalizing an RFP be advertised in the new year for the development of a replacement inventory system and integrated database of bridge, pavement, and traffic data to support the needs of AM and other applications that require data from different data sources within MTO.
- Data collection: organization eager to collect various types of data (e.g., roadside assets) before proper consideration of what data will be used for, how to keep current, costs to maintain, what system will be used for data storage, etc.
- Interfunctionality of legacy systems is difficult because of development architectures creating interface issues.

3b. Percent of system or operation covered?

- MTO data covers 100 percent of the provincial highway network; however, the province also provides some funding and is looking at additional programs to fund municipal road networks. Information on municipal networks is not available currently, and the province is now introducing initial principles of AM and inventory/needs data to municipalities.

3c. Interagency cooperation?

- MTO has many external stakeholders that support AM.
- Our funding agency for capital, the Ministry of Public Infrastructure Renewal, has fully accepted the AM approach to infrastructure management and would like to follow our lead in developing a framework for all provincial infrastructure. The first major step in this direction is their implementation of results-based planning and the requirement for the submission of a three- and 10-year infrastructure plan from all government sectors with capital assets.
- The Ministry of Finance (MoF) has been a strong supporter of AM, specifically with the development of the asset valuation methodology. For the 2002–2003 fiscal budget, MTO provided an opening balance and deterioration charge for tangible capital assets. This was the first time Ontario reported on its assets this way. MoF was a crucial team member during the development of the methodology, supported the calculation of the asset value, and assisted with the reporting aspects.
- The provincial auditor was involved with reviewing the opening balance and depreciation charge reported in the 2002–2003 budget. The audit concluded with an acceptance of the methodology and approval to continue indefinitely with the method into the future.
- Our funding agency for operating funds (basic maintenance, pothole patching, bridge washing, snow and ice control), the Management Board Secretariat, has been briefed on AM and how operational funding can save capital funding with preventive type treatments, or how a cut in operational funds decreases asset remaining life and asset value. However, the importance and recognition of this link between the two funding agencies has been difficult because of other governmental fiscal pressures.
- The Ministry of Northern Development and Mines administers funding for capital construction for the MTO in the northern part of the province as an economic development agency. They are involved and make final decisions on project and corridor programming issues in northern Ontario. They support the results-based planning process and are aware of the AM initiatives at MTO.

4. Are you using asset management for nonhighway modes and how?

- Currently we have a consultant on board to determine how to evaluate the benefits and costs (both economic and non-economic) for nonhighway assets such as airports, ferries, and road and rail transit alternatives.
- Our desired end-state is to incorporate these types of capital investments into the broader AM decision-making framework for all transportation assets. We also want the ability to perform tradeoffs between highway and nonhighway mode investments. These tradeoff matrices are currently under development.

5. What improvements would you recommend in the implementation of asset management?

5a. Areas that need improvement?

- Communications: can't just be at the initial project kickoff and then die off. Must be clear and consistent throughout the development, implementation, and sustaining phases of the AM project. Need dedicated resources for this to successfully occur.
- Change management: directly linked to communications. AM changes the work that many people do, and they need to understand why there is a change occurring, the benefits or advantages, that it is inevitable and that they have help and they're not alone. This also cannot just be an initiative at a project kickoff but must be throughout the life of the project.
- Executive support: must be strong and visible throughout the life of the project.
- Intra-agency support: for AM to be successful, it has to be supported across the organization, not just within a small core group office. It needs regional people to fully support its development and implementation, to act as a core group member geographically situated within a region. It has to be owned by a larger group.
- Accountability: managers and staff must be made accountable for developing and implementing AM deliverables. Include these responsibilities within performance management plans.

5b. Future research?

Development of operational improvement performance measures that are reliable and useful beyond simple accident rate information.

5c. Data?

- Resourcing of data acquisition and analysis is often time consuming and expensive. Automated methods of acquiring data and updating data would be beneficial.
- Further education of regional staff on the importance of consistent and accurate data acquisition in order for AM systems to be functional and credible.

SUMMARY OF PEER EXCHANGE MATERIAL

The participant responses are summarized in Tables 5–9.

TABLE 5 Question 1 Answer Summary

	1. How is your organization using asset management in decision making and resource allocation? **1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?**
District of Columbia DOT	District of Columbia DOT maintains its share of the NHS through an AM/performance-based contract. For the remainder of the system, District of Columbia DOT uses a street-oriented system (SIS) to evaluate programming options and make initial resource allocation decisions. The asset manager proposes a six-year list of projects to the four geographic ward-based teams who work with the District of Columbia DOT transportation planners, the public, and utility companies to determine the actual program.
Maryland DOT	Information used in the prioritization of projects for multiyear program.
Michigan DOT and Michigan Asset Management Council	Department decisions are guided by several AM tools including cash flow model, RQFS & Bridge Condition Forecasting System, call for projects (corridor approach, capital preventative maintenance strategy), and Five-Year Road & Bridge Program. TAMC was recently created to further guide AM efforts in the state. AM information used at all levels of the department from staff in the field to upper management.
Michigan, SEMCOG	AM concepts used to guide the development of the agency's long-range transportation plan including the identification of policy goals, objectives, deficiencies, and funding estimates for the next 25 years. SEMCOG is currently designing a process to select a mix of improvements that will accomplish set objectives within funding constraints.
Missouri DOT	Missouri DOT uses data from its AM system in most areas of decision making including development of the STIP, funding allocation to districts, funding needs projections, and future system condition and department performance estimates. Data are used by all levels of Missouri DOT from upper management to district field staff.
Missouri, Jackson County	AM is used to improve decision making from a quick fix to a pro-active process, to determine where, when, and how to spend limited budget and to reduce maintenance cost by maintaining verses replacing. AM used by public works directors, elected officials, maintenance managers, finance directors, utility companies, and risk managers.

(*continued*)

TABLE 5 (*continued*) **Question 1 Answer Summary**

	1. How is your organization using asset management in decision making and resource allocation? **1a. Who are the primary users of asset management and how are they using it (staff level only, director, governors, etc.)?**
Ohio DOT	AM used to identify, evaluate, and maintain its transportation assets in a steady-state manner. Annual condition assessments are reviewed and these trends are used to predict future asset conditions, allocate funds, monitor effectiveness of AM, and adjust management strategies or resource levels. Ohio DOT produces multiple AM documents that are used on multiple agency levels.
Oregon DOT	Several stand-alone AM programs are used including Bridge Management System, PMS, and Landslide/Rockfall Rating System. The department collects highway asset information in several databases but is working to integrate all systems into a Total Asset Management Program.
Pennsylvania DOT	Statewide performance measures used for decision making and resource allocation. However, management systems are legacy systems with limited capability to perform tradeoff decisions. Pennsylvania districts adopt the departmentwide goals and performance measures for the management of the highway and bridge assets in their area.
Wisconsin DOT	State Highway System Improvement Program is used to distribute funds, monitor performance, set priorities for significant capacity expansion projects, and estimate cost of improving or maintaining system conditions. On the local level, jurisdictions are required to submit pavement condition data and demonstrate the application of AM strategies.
Ministry of Transportation of Ontario (MTO)	MTO is currently incorporating AM into its existing business processes to "make the right investments at the right time." AM components currently being developed include economic analysis tool, non-economic criteria, tradeoff matrices, and corridor investment plans.

TABLE 6 Question 2 Answer Summary

	2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?
District of Columbia DOT	AM creates a rational approach to resource allocation and a defense against politicizing the program. Performance-based contract maintenance resulted in notable asset condition improvements.
Maryland DOT	Justification for two funding increases in the past four years. Notable system condition improvements.

(*continued*)

TABLE 6 (*continued*) **Question 2 Answer Summary**

	2. Benefits to using asset management: How has your system improved or your program changed due to the use of asset management principles and data?
Michigan DOT	AM tools enable Michigan DOT to demonstrate to the governor and the legislature the need for additional funding. With the change to AM, the percentage of pavement in good condition and remaining service life has increased.
Michigan, SEMCOG	Provides information to decision makers on the long-term impacts of selected programs (e.g., pavement condition data).
Missouri DOT	• Communicating AM to small cities and counties, • Relational database allows easier query of data, • Planning more consistent and reliable, and • Ability to perform what-if scenarios to predict system conditions.
Missouri, Jackson County	• Cost savings, • Higher percentage of pavement in fair to excellent condition, • Improved communication (access to information), • What-if scenarios, • Enhance public works credibility, and • Improved efficiency.
Ohio DOT	Notable pavement and bridge condition improvements.
Oregon DOT	Condition ratings have made it easier to negotiate with stakeholders regarding program funding.
Pennsylvania DOT	Tactical planning now based more on performance measures and more-simple asset analysis leading to a more effective allocation of resources.
Wisconsin DOT	• Justification for funding increase, • Framework for program management, • Resource allocation flexibility, • Prioritization of data, • Identification of needs, and • Project scope focus on system impacts.
Ministry of Transportation of Ontario (MTO)	• Results-based approach to infrastructure management, • Justification for investments, • Ability to quantify future funding scenarios, • Asset value tracking, and • Tradeoff analyses.

TABLE 7 Question 3 Answer Summary

	3. Barriers to using asset management:		
	3a. Data problems/ integration/collection?	**3b. Percent of system or operation covered?**	**3c. Interagency cooperation?**
District of Columbia DOT	District of Columbia DOT collects data but information technology personnel are in charge of the data.	100%	Coordination among interested parties (approximately 20 agencies) challenging due to a lack of understanding of the constraints and competing demand for District of Columbia DOT funds. Utility agency cooperation is especially challenging.
Maryland DOT	Gaining buy-in from district offices, maintaining data collection to adequately track asset condition, keeping pace with new technology, limited integrated data across assets, lack of tradeoff analysis tools, competing business plan objectives.		
Michigan DOT	Michigan DOT goal is to implement AM on a statewide basis but currently only 45% of all agencies in Michigan are using a PMS.		Highway system is managed by 619 different agencies making coordination difficult. The AM process needs to be made straight forward for very small agencies usage.
Michigan, SEMCOG	Data issues: selecting the type of data to collect, how to gather, what coverage, reporting format, rating standards.		
Missouri DOT	Conversion of historic data into a standard location reference system produced errors that reduced trust of the resulting database.	• 100% state system covered. • Off system (city and country facilities) limited coverage.	Difficult to convince other agencies of the necessity to use a common reference system if they are simply supplying the data to the system and not retrieving it.

(*continued*)

TABLE 7 (*continued*) **Question 3 Answer Summary**

	3. Barriers to using asset management:		
	3a. Data problems/ integration/collection?	**3b. Percent of system or operation covered?**	**3c. Interagency cooperation?**
Missouri, Jackson County	• Selection of data. • Resource requirements to implement AM. • Integration of AM system to accommodate multiple users.	100%	Agencies in Jackson County did not want to use AM until they were involved in the decision-making process.
Ohio DOT	• Data file compatibility. • Base roadway network not static making legacy data incorrect. • Communication of AM information throughout the department.	• 100% bridges. • 100% state-owned pavement. • Local pavement that qualifies for Federal aid. • Traffic data. • Department buildings and rest areas.	Ohio DOT cooperates with 17 MPOs and other state agencies, including the Department of Public Safety, Highway Patrol, Rail Commission, and Turnpike Commission as well as the TRAC.
Oregon DOT	Human resources and FTE ceilings previously restricted the application of a systematic management of the state's system. Due to human resources and FTE ceiling, the organization was restricted to a Capital Improvement Program focus that did not leave adequate resources to manage the system. AM information conveyed the need for a systematic approach and FTE would have to be realigned to fit the need.		
Pennsylvania DOT	• Legacy systems have limited predictive and tradeoff analysis capabilities. • Financial management system not integrated with AM system. • Limited data on difficult to measure elements (e.g., congestion, land-use).	100% of pavement and bridges.	Pennsylvania DOT works close with its many planning partners (e.g., MPOs) to develop the capital improvement program but AM not used for needs-based resource allocation.

(*continued*)

TABLE 7 (*continued*) **Question 3 Summary Answer**

	3. Barriers to using asset management:		
	3a. Data problems/ integration/collection?	**3b. Percent of system or operation covered?**	**3c. Interagency cooperation?**
Wisconsin DOT	• Resources required for data integration, • Internal acceptance across the state, • Separation of maintenance and improvement programs reduce ability to perform tradeoff analyses, and • Limited location- and time-specific maintenance data.		
Ministry of Transportation of Ontario (MTO)	• Data not current, not referenced geographically, too much in some cases or too little in others; • Data integration; • Data collection; and • Interfunctionality of legacy systems.	100% of the provincial highway network. Future may also include municipal networks.	MTO works with many external stakeholders who have been supportive of its evolving AM approach: Ministry of Public Infrastructure (capital funding agency), MoF (budget office), provincial auditor, and Ministry of Northern Development (administer of capital funds). However, clarifying the role of AM to the Management Board Secretariat (operating funding agency) has been challenging.

TABLE 8 Question 4 Answer Summary

	4. Are you using asset management for nonhighway modes and how?
District of Columbia DOT	N/A
Maryland DOT	Yes: AM principles used for facility management and fleet management; however, these assets are managed independently.
Michigan DOT	Yes: AM framework provides the necessary flexibility to coordinate with the projects and needs of other transportation modes adjacent to and crossing the highway systems.

(*continued*)

TABLE 8 (*continued*) **Question 4 Answer Summary**

	4. Are you using asset management for nonhighway modes and how?
Michigan, SEMCOG	Not yet, but SEMCOG would like to integrate transit and nonmotorized assets into database.
Missouri DOT	Not at this time, however, the reference system was developed to allow inclusion of data from other modes in the future.
Ohio DOT	Yes: offices, county garages, rest areas, water treatment facilities, aviation facilities, runways, transit buses, light rail facilities, rolling stock, and local pavement that qualifies for federal aid.
Oregon DOT	Yes: fleet management (schedules rolling stock maintenance and replacement), facilities management (preventative building maintenance program), information technology management (computer and telecommunication management).
Pennsylvania DOT	No.
Wisconsin DOT	Yes: PMS for airports.
Ministry of Transportation of Ontario (MTO)	Developing a benefits–costs approach to incorporate nonhighway assets (airports, ferries, and rail) into capital investment tradeoff analyses.

TABLE 9 Question 5 Answer Summary

	5. What improvements would you recommend in the implementation of asset management?		
	5a. Areas that need improvement?	**5b. Future research?**	**5c. Data?**
District of Columbia DOT	Data integration, what-if tools, and communication methodology.		
Maryland DOT	Tradeoff analysis tools, data collection protocols, methodology to determine minimum data collection needs, use of performance targets.		
Michigan DOT	• Communicating AM to small cities and counties. • Include AM in engineering curriculum. • How to make AM a comprehensive approach at the local level (e.g., include water, sewer, and utility management agencies).	• At what system size is AM not cost effective? • Identify rates of deterioration that reflect local or regional conditions (e.g., snow).	• What is the minimum data necessary for effective AM? • Sharing of information internationally.

(*continued*)

TABLE 9 (*continued*) **Question 5 Answer Summary**

	5. What improvements would you recommend in the implementation of asset management?		
	5a. Areas that need improvement?	**5b. Future research?**	**5c. Data?**
Michigan, SEMCOG	• AM training. • Include AM in engineering curriculum. • Communicating AM to small cities and counties.	What types of roads should be included in AM?	Sample data: How much data is sufficient?
Missouri DOT	AM training.	• Tradeoff analysis, and • Prioritization of needs.	Data is expensive to collect and maintain so proper selection of what data to include in a database is important.
Missouri, Jackson County	Most existing AM systems available today are facility information management not AM systems, they provide condition data, cost data, subjective priority—but they do not have analysis tools and forecasting tools.	Analytic tools for evaluating performance, budget requirements, maintenance schedules, asset value, tradeoffs, and what-if scenarios.	
Ohio DOT	• Data integration and dynamic segmentation. • Lack of standard data definitions and formats.	Real-time data collection and storage.	• Standardization and automated or shared data collection (e.g., cellular phone GPS). • Data management processes.
Oregon DOT	Partnering with other state and local agencies to take advantage of economies of scale and creativity.	Economic impacts as a factor in priority rating.	Data warehousing and availability and more consistent national data standards.
Pennsylvania DOT	Meaningful tradeoff analyses for nontraditional asset factors, such as congestion, safety, etc.	Meaningful and easy-to-collect measures and goals for nontraditional asset factors such as congestion, safety, etc.	

(*continued*)

TABLE 9 (*continued*) **Question 5 Answer Summary**

	5. What improvements would you recommend in the implementation of asset management?		
	5a. Areas that need improvement?	**5b. Future research?**	**5c. Data?**
Wisconsin DOT	• Understanding of how different pavement and bridge treatments impact future performance and cost. • Knowledge and modeling of ITS impacts on system operating characteristics. • Forecasting of the related safety impacts of alternative roadway and bridge improvements. • Expand knowledge of the relationship between costs and benefits of AM decisions.		
Ministry of Transportation of Ontario (MTO)	• Communicating role of AM throughout the development process especially in regards to changing MTO staff roles. • Maintaining executive support. • Creating interagency support. • Implementing manager and staff accountability.	• Development of operational performance measures.	• Data acquisition and analysis is expensive (time and funding). • Educating regional staff of the importance of consistent and accurate data.

Summary and Next Steps

The following is a summary of key themes, notable agency accomplishments, existing and future challenges, next steps, and existing resources identified through the participant-submitted answers and discussions.

KEY THEMES

The peer exchange participants represented a range of agencies with regard to size, jurisdiction, and experience with AM. However, even with these differences, several insights were repeated by multiple participants, suggesting that lessons can be shared among organizations. The key issues raised included the following:

- AM is becoming an accepted set of business principles and has moved rapidly from theory and concepts to implementation. AM is no longer limited to one area (e.g., preservation) but is applied to the entire multimodal transportation system. AM allows for fact-based decision making, accountability, and a performance-based management approach. AM provides guidance in answering, "If I have only one dollar to spend, where do I spend it?"
- Important elements to consider when initiating AM include the following.
  - AM is an incremental process; therefore, it is not necessary to wait for the perfect model or to address all assets at once. As one participant stated, "AM implementation began small and grew from budget development, through resource allocation, to project scope, and finally performance measures."
  - Pavement management is a common asset to address first.
  - Data are expensive to collect and maintain, so identify necessary elements carefully.
  - Performance measures are key elements to AM.
  - AM implementation will be slow, because it requires a shift in culture from series of project perspectives to a network perspective.
- AM challenges will vary according to agency size and jurisdiction. For example, smaller agencies struggle with the initial steps of establishing an AM system and collecting data, while larger agencies may have data but struggle with how to analyze and use the data (data rich and information poor).
- Agencies have successfully used AM information to justify funding increases.
- AM practices have resulted in notable system condition improvements.
- Agencies with more sophisticated AM programs are realizing significant benefits from predictive models (e.g., tradeoff and what-if analyses).
- An important benefit of AM is the ability to analyze trend data. One participating agency described how it used historical data to develop pavement deterioration curves and found conditions worsened quickly in the beginning, contrary to conventional wisdom.
- Exchange of AM information within the transportation field is critical; there is a need to share success stories.

NOTEWORTHY AGENCY ACCOMPLISHMENTS

During the two-day peer exchange, participants described several positive outcomes related to the adoption of AM principles and data.

- Michigan has established an Asset Management Council to advise the State Transportation Commission on a statewide AM strategy and to provide the necessary procedures and analytical tools for implementing such a strategy on Michigan's highway system in a cost-effective, efficient manner. The Asset Management Council is a noteworthy example of coordination and cooperation across multiple agencies (almost 700 agencies are owners of the public road system).
- DC Streets was the first urban performance-based asset preservation contract in the United States. The contract covers the District of Columbia DOT's share of the National Highway System and includes surface repairs, bridge maintenance, mowing, litter and trash pickup, catch basin cleaning, lighting maintenance, street sweeping, and snow removal. The project is an example of the benefits of a private–public AM arrangement.
- AM enabled several agencies to obtain additional funding.
  - Jackson County, Missouri, obtained a 30-percent "add back" to budget as a result of AM information.
  - Alaska documented the benefits of accelerating projects.
  - Maryland State Highway Administration used PMS to argue for funding.
  - Michigan DOT used an RQFS to justify an increase in pavement preservation funding. The state's pavement condition data demonstrated that the state was not making progress towards its goals at the anticipated pace.
  - Wisconsin DOT used AM data to justify a funding request that would result in current conditions being maintained.
  - AM information supported the need for a gas tax that was approved recently in Ohio.
- AM practices have produced notable system condition improvements.
  - The share of poor pavement in Michigan has been reduced by 11 percent since 1996, and the average remaining life has increased by 26 percent.
  - Jackson County, Missouri, has seen a shift from 70 percent of all roads in poor or fair condition in 1992 to 75 percent of all roads currently in fair to excellent condition.
  - The percentage of deficient lane miles in Ohio has been reduced to only 7 percent and is predicted to remain at a steady state, below 10 percent deficient, each year.
- Several participating agencies have begun to use or are developing tradeoff analysis capabilities.
  - MTO is developing tradeoff matrices that use both economic and non-economic criteria. The matrices will allow evaluation of a variety of projects (e.g., physical condition, safety, operational) and asset types (bridges, pavements, ITS, ferries). These analyses will address network, regional, corridor, or project level.
  - Missouri DOT indicated that one of the largest benefits from AM is the ability to perform what-if scenarios that predict system conditions based on assumed changes in funding levels or distribution factors.

EXISTING AND FUTURE CHALLENGES

Although the application of AM principles has progressed, the following areas were identified as essential to address in furthering the expansion and benefits associated with AM.

- Need for more sophisticated analytic tools to answer some of the following questions.
  - How to prioritize bridges versus roads?
  - How to weigh safety versus system preservation?
  - How to evaluate options across modes?
  - How can information on the impact of past investment be used to make better decisions in the future (especially when the tracking of actual expenditures is limited in some agencies)?
  - Can funding allocation across assets be optimized?
- Challenges associated with databases were raised numerous times during the peer exchange.
  - Legacy systems do not allow for predictive analyses.
  - Data are expensive to collect and maintain; however, sample datasets are not producing the same quality of information.
  - How can existing data be used best?
  - Data integration, emphasis on a GIS-based system to guide decisions.
- What are the best communication devices, and how do these vary according to the audience?
- Jurisdictional challenge: In some states, the majority of infrastructure is owned by local government, although the opposite is true in other states. Who has authority over infrastructure will have important implications for the AM approach that can be implemented. Need to remember the customer is not concerned about who owns the system, only its performance and cost.
- Institutional challenges:
  - How to implement a system AM approach in an environment with modal silos, separate funding programs, etc.?
  - How to maintain a consistent AM program in a changing political environment?
  - How to further increase agency and staff accountability?
  - How to improve working relationships with utilities?

NEXT STEPS

To address the challenges identified in the previous section, the peer exchange participants identified the following steps:

- Conduct research to address the issues listed under Existing and Future Challenges:
  - Lack of sophisticated analytic tools,
  - Database issues,
  - Identification of effective communication devices,
  - Jurisdictional challenges, and

  - Institutional challenges.
- Increase AM education efforts.
  - Additional peer exchanges;
  - Local Technical Assistance Program coordination;
  - Revise existing NHI training to address municipal, county, and regional agencies;
  - Develop additional training courses (e.g., AM introduction course for new employees, AM training for executives); and
  - Include AM course in graduate school programs.
- Further develop AM printed resources:
  - Document case studies (public and private);
  - Develop definitions for common terms used in AM; and
  - Provide examples of effective communication tools (graphics, reports, etc.) used currently.
- Community of Practice Website:
  - Develop a directory of AM contacts in AASHTO states, and
  - Provide more resources for MPOs and cities.

RESOURCES

During the peer exchange, participants discussed the following resources, which provide useful guidance on the application of AM principles and data for a wide range of agencies.

- FHWA White Paper series: Collection of seven papers that explores the relationship between AM to each of FHWA's major programs areas, including planning, right-of-way, environment, infrastructure, safety, operations, and federal lands.

- AASHTO Asset Management Community of Practice: http://assetmanagement.transportation.org.

- *Transportation Asset Management Guide* (completed in November 2002): Defines asset management, identifies key business principles, provides guidance on good asset management practice, and includes a self-assessment tool with selected examples.

- **NHI Training Course**: Based on the *Transportation Asset Management Guide* and aimed at state DOTs beginning asset management. Revisions are being considered to make course more applicable to municipal, county, and regional agencies.

APPENDIX

Peer Exchange Participants

James Bledsoe
Missouri DOT

Norris Bot
Ministry of Transportation of Ontario

David Clawson
AASHTO

John F. Deatrick
District of Columbia DOT

Leonard Evans
Ohio DOT

Kimberly Fisher
TRB

Stephen Gaj
FHWA, Office of Asset Management

King Gee
FHWA

David Geiger
FHWA

James Healy
New Jersey DOT

Patricia Hendren
Cambridge Systematics, Inc.

Mike Long
Oregon DOT

Sue McNeil
University of Illinois at Chicago

Daisuke Mizusawa
University of Illinois at Chicago

Lance A. Neumann
Cambridge Systematics, Inc.

Carmine Palombo
SEMCOG

Rob Ritter
FHWA

Harold Rogers
Pennsylvania DOT

Ali Roohanirad
Jackson County, Missouri

Gloria Sheperd
FHWA, Office of Planning

Peter Stephanos
Maryland State Highway Administration

Kirk Steudle
Michigan DOT

J.D. Stokes
Jackson County, Missouri

Paul Ward
Maricopa Association of Governments

Mark J. Wolfgram
Wisconsin DOT

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