KEY FINDINGS FROM THE FIFTH NATIONAL WORKSHOP ON TRANSPORTATION ASSET MANAGEMENT

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16. Abstract

The Fifth National Workshop on Asset Management was held in Atlanta and Seattle in September and October of 2003. The focus of the workshop was to share real experiences from real transportation professionals who were implementing aspects of asset management.

This report summarizes the conference proceedings and extracts best practices from the material presented.

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Introduction

The Fifth National Workshop on Asset Management was held in Atlanta and Seattle in September and October of 2003. The focus of the workshop was to share real experiences from real transportation professionals who were implementing aspects of asset management. To that end nearly all of the presenters were experienced professionals.

The workshop had general sessions on the first day. At that time three local governments and three state governments shared their experiences in at each site. This was followed by breakout sessions which went into more depth on six topics:

1. Getting Started: How have agencies taken the first steps toward asset management? What was their motivation and what did they do?

2. Local Government Experiences: Many local governments have made much progress toward asset management. Their resources, constraints and objectives are often very different from state DOTs. What have they done?

3. Asset Management as a Communications Tool: One of the often-cited benefits of asset management is improved communications within an agency, with policy makers and with the general public. How have agencies used and benefited from this aspect of asset management.

4. Private Sector Experiences: Many private organizations have moved far in implementing asset management programs. What can the public sector learn from their experiences?

5. Tools: Many tools exist to assist in decision-making processes. What are they and how can they be best used?

6. Data Integration: Data rich and information poor is a common complaint of transportation managers. How can data from various seemingly incompatible sources be combined to produce useful information?

The following chapters are organized around these six subjects. They attempt to report the experiences shared at the workshops.

Chapter One
Getting Started

"You call. We haul"

No single method exists for implementing asset management. Agencies differ in terms of their needs, the complexity of their systems, their resources, their political climate, and the maturity of their management processes. To a substantial degree, each must assess itself and find the best route to implementation. Typically, the first steps toward implementation will involve some realization that a need for change exists. It may be management frustration with the status quo; it may be a fiscal crisis, or near crisis; or it may be some prodding from legislative bodies. Whatever the source, nothing will happen until people within the agency find a reason for change.

Another typical step is actually taking a first step toward change. Sometimes the first step is the hardest because it involves figuring out what needs to be done and identifying actions that will move the organization in that direction. The steps that have been taken by implementing agencies have varied markedly, but those who have been successful have found the step(s) that is most appropriate for their special set of circumstances.

Finally, from the experiences shared at the workshop, it is possible to draw some general observation regarding best practices about getting started. These observations are not an outline for implementation, but simply some issues, concerns, and comments that a would-be implementer should consider.

Best Practices – Getting Started

- Technology can serve as an effective driver for advancing asset management in an agency.
- Organizational culture may be one of the most significant obstacles to advancing asset management in an agency.
- There is no one particular agency model that would serve as the panacea in moving forward with asset management.
- Agencies that are taking substantive steps to do good asset management differ in their use of the modified approach for GASB 34 reporting.
- Those agencies that evaluated the Self Assessment Tool developed by the National Cooperative Highway Research Program (NCHRP) found it helpful in identifying gaps in their present approaches to asset management or endorsed it as a useful starting place for agencies interested in beginning asset management.

Incentives

"You call. We haul." were the words used by Hillsborough County, Florida, a large urban county, to describe how their agency did work before implementing asset management. It captures the frustration expressed by many managers who searched for a better way of managing their assets and their agencies. This frustration was one of the major incentives behind the agency's decision to adopt asset management within the County. Responding to an incentive is clearly the first step in getting started with a program.

Another often cited incentive for agencies considering asset management programs is the agency's difficulty in meeting the transportation needs of the public. A representative from Hart County, Georgia expressed this concern. He noted that the cost of maintaining roadways varied markedly depending on what was done and when it was done. Asset management provided him with a plan to do less costly treatments when they were still effective.

Gwinnett County, Georgia, one of the fast growing counties in America, initiated asset management based on the need for more organization. Fifteen years ago, the county did not have an inventory of its transportation assets. It literally did not know what it owned. The inventory was the starting point for asset management.

Washington State and Wisconsin DOTs both moved toward asset management in an effort to better communicate with legislative bodies. Both have had difficulty in answering basic questions on the impact of changes in funding levels or in explaining what funding was needed to support expected services.

Cole County, Missouri, cited two reasons for moving toward asset management. The first was the agency's dependence on the experiences and memories of its workers. As those workers aged and retired, the county's management information systems were literally walking out the door. Asset management is a tool that could be used to capture some of that information before the workforce retired. The second reason, which is frequently reported by other agencies, was the agency's need to comply with the recommendations under GASB Statement 34. The new accounting rules highlighted the importance of assets and provided an opportunity to improve management procedures while meeting the reporting requirements.

King County, Washington, and the Wisconsin DOT are two other agencies that moved toward asset management in part because of the requirements of GASB 34.

Finally, a number of agencies got a nudge to adopt asset management from their legislative bodies. This was the case in Michigan where an act of the legislature required both the state DOT and all local units of government to adopt asset management procedures. In Michigan the initiative was in response to a lengthy battle over the distribution of transportation revenues. The legislature saw asset management as a tool

that would force most claimants to state revenues to use similar measures of need and similar management practices. This would simplify the legislature's decision-making process and help to ensure that the revenues are being used most effectively.

Vermont was another state in which the legislature mandated the use of asset management. In this case, the mandate applied only to the state DOT. It was an effort to ensure that resources were being used well and to make the decision-making process more apparent to the legislature.

Whether the prod was from the outside in the form of legislative action, or from the inside in the form of a desire to improve the management of the agency, each agency identified an incentive that initiated them to take the first step toward asset management. Without this motivation, agencies are slow to adopt new practices; largely because people who are content with the status quo do not initiate change.

First Steps

Finding the incentive tends to produce champions. Most speakers said that the support of top management was essential. Some also pointed out the need to have some champions at every management level throughout the organization.

Vermont DOT creatively used a common first step, establishing a steering committee, as a way of building support and finding more champions for the program. Because its steering committee started with volunteers and quickly became recognized as the committee that was achieving results and having an influence over the direction of the agency, it became the only committee in the agency's history for which people volunteered to serve.

Michigan used an inter-agency committee, as required by its asset management legislation, to guide the implementation of asset management throughout the state. Its committee is made up of state and local officials, staffed by the state DOT, and reports to the State Transportation Commission. Among it charges is defining a common set of data and analytic systems to support the overall asset management program.

Agencies also tended to focus on their areas of strength to gain momentum in their asset management efforts. The Florida Turnpike Authority is an example of this. They began their effort in those areas where the best systems already existed. They began this process using a focus group of asset managers—for bridges, pavements, and so on. The focus group was intended to provide information on what data existed to manage assets and how the data were being used. The primary finding of the focus group was that many holes existed in the data, much of what did exist was weak, and many managers were reluctant to take an active part in the implementation process because they feared exposing the weakness of the information they used to make decisions.

The Turnpike Authority initially focused on four asset groups: pavements, bridges, roadways, and facilities. Efforts were made to develop or enhance the systems needed to

manage these assets. After success was demonstrated in the four focus asset groups, the Turnpike found, like Vermont, that people wanted to take part.

The DOTs in Georgia and Pennsylvania are also examples in which the focus began in an area of strength. Both have well developed pavement and bridge management systems. They used those systems to allocate, or, in the case of PennDOT, significantly reallocate, resources. Both also recognized that they could not manage their very large systems without better systems. For example, the relatively simple decision of how many dollars to allocate to the maintenance and renewal of 110,000 miles of roadway or to 25,000 bridges in Pennsylvania was greatly facilitated by the management systems. The management systems were used to determine that by reallocating funds from roadways to bridges, the overall quality of bridges has improved without significantly reducing the quality of pavements. Finally, both state highway agencies also agree that they have many challenges before them on the journey to fully utilize asset management tools. Better integrating data, improving analytic and financial forecasting tools, and better understanding customer expectations are just some of the issues raised.

Washington State and Wisconsin DOTs took steps to create maintenance performance measurement systems, known as MAP and COMPASS, respectively, to better define and measure the services delivered through the states' maintenance programs. Both used wide agency and public involvement in determining these performance measures, which could be used to assist in making asset management decisions about funding allocations.

The agency's available resources and needs helped some agencies determine their first steps towards implementing an asset management program and focus their efforts. The Alcona County Michigan Road Commission noted that the basic needs of this small, rural county were very similar to those of large urban counties, but they lacked the financial and staff resources to build or maintain complex data systems. Instead they turned to the Michigan LTAP Center for help. With the LTAP Center's help, the county implemented a roadway management system based on Roadsoft software, which provides GIS and road management features. With laptop data collection and the Pavement Surface Evaluation and Rating (PASER) condition evaluation, the Roadsoft approach has provided the county with a simple, easily maintained structure within which pavement strategies can be developed and implemented.

Cole County, Missouri had a similar experience. They turned to the University of Missouri at Columbia for help. Graduate students built a spreadsheet-based database system and collected the data to populate it. GPS devices bought from a local electronics store provided geographic referencing. Under Cole County's program, pavements are evaluated on a simple five-point scale. About one-third of the system is inventoried and evaluated each year. This fairly simple system allows the county to evaluate and plan for its maintenance needs. It has also improved the public's understanding of the road conditions and has increased the agency's accountability.

Near the other end of the complexity spectrum is Oakland County, Michigan (near Grand Rapids). Its experience was somewhat similar to Cole County's in that it had a need for

an accurate inventory and condition assessment of its roadways. As a larger agency, it faced an additional problem: the reluctance of staff to support an asset management system. To overcome this obstacle, a quick win was needed. That win was achieved by making plans, aerial photos, and other documents available electronically. This relatively inexpensive effort delivered something useful to the staff and, as a result, got their support.

A number of agencies also reported using the NCHRP self-assessment tool as a way of identifying areas of strength and weakness.

Conclusions

1. Technology can serve as an effective driver for advancing asset management in an agency. Technology has evolved to the point of enabling management information and technical analysis that would have been impossible only a few years ago.

2. Organizational culture may be one of the most significant obstacles to advancing asset management in an agency. A number of speakers identified the organizational culture as the most difficult thing to change in trying to implement an asset management culture and decision support procedures within an agency. Only those very small agencies where the manager is essentially a one-man operation, will not have to contend with organizational culture as a potential obstacle.

3. There is no one particular agency model that will serve as the panacea in moving forward with asset management. Two very different examples given in this session drive home this point. The Florida Turnpike's organizational approach in moving forward with asset management was to form a focus group of pre-existing infrastructure managers, e.g., the pavement manager, the bridge manager, and so on, and to give the managers the tools and knowledge to begin to incorporate the asset management ethic in decision making. South Carolina DOT (SCDOT) created the position of Assets Manager and assigned this position responsibility for the asset management functions within the agency. The SCDOT speaker stressed the need for the Assets Manager to have no stake in any of the assets being managed, to be able to gain the trust of other managers with high stakes in certain assets, and to become a credible partner for all the stakeholders within the agency.

4. Agencies that are taking substantive steps to follow good asset management practices may or may not elect to use the modified approach for GASB 34 reporting. The Florida Turnpike's Chief Financial Officer contributed to the development of the GASB 34 requirements. However, this agency uses the accounting approach (the basic approach) to report on assets. Gwinnett DOT, which is also taking active steps to move forward with asset management, has

elected to view GASB 34 as a reporting requirement and uses the basic approach rather than the modified approach to report on their infrastructure.

5. Those agencies that evaluated the NCHRP Self Assessment Tool found it helpful in identifying gaps in their present approaches to asset management or endorsed it as a useful starting place for agencies interested in beginning asset management.

Chapter Two
Local Government Experience

"There's more than one way to skin a cat."

Since local governments typically have fewer independent stovepipes for managing assets than state highway agencies, they may be said to have a much broader view of infrastructure assets and the goals that can be achieved through effective management of those assets. As a result, these smaller agencies may also have a greater variety of criteria and standards for judging the performance of their assets. In addition, local government agencies depend on a variety of funding sources to support the development and management of transportation assets, and typically have few resources to invest in asset management systems. Because of the large number of local government agencies in the country and the variation in the responsibilities and resources of each agency, the approach they take to infrastructure asset management varies greatly.

Many local agencies have found meeting the requirements of the Government Accounting Standards Board's *Statement 34* particularly challenging. The American Public Works Association (APWA) has provided guidance and training materials to assist local agencies with understanding and implementing infrastructure asset management systems since Statement 34 was issued.

Local Agency Asset Management: Key Points

- **It can be done!** Participants demonstrated that agencies of all sizes and scopes can implement useful transportation asset management systems, and that these systems have yielded solid management benefits.
- **Commitment comes from top down.** Participants agreed that top management levels of the agency must make a commitment to adopting asset management principles and implementing asset management systems for the effort to succeed.
- **There are problems that will need to be solved during the implementation.** Establishing the system is not easy and will present unique challenges for each agency.
- **There's more than one way to skin a cat.** The challenges of implementation can be met through creative problem solving.

Case Studies
Seven different local government reports were made. They are summarized below.

Alcona County (MI) Road Commission and Michigan LTAP Center
Alcona County (MI) Road Commission's experience with asset management is closely tied to the Michigan Local Technical Assistance Program (LTAP) Center.

Alcona County, located in northeastern Michigan's lower peninsula, is largely rural and contends with snowy winters. The county has an area of 720 sq mi and a population of about 11,000. The commission's 32 employees manage 760 miles of road and 24 bridges with an annual budget of about $4 million.

The commission's limited staff and financial resources preclude significant expenditures on management tools and the effort required to maintain such tools. The agency nevertheless shares with larger commissions the need to operate its road system efficiently and seeks to maximize the return on the county's road investments. With the assistance of Michigan's LTAP Center, the commission has implemented a roadway asset-management system based on the RoadSoft platform and a field data collection system using laptop computers. RoadSoft software, which provides geographic information system (GIS) and road management system (RMS) capabilities, was initially developed by Michigan's LTAP Center to help agencies meet previously issued (and since repealed) federal requirements for pavement management systems.

Pavement condition is assessed using the Pavement Surface Evaluation and Rating System (PASER) visual inspection system. The system was designed for local use since it is easily understood, simple to explain, and can be easily implemented by agency personnel. Condition rating factors are based on visual observations, knowledge of the road, and some understanding of the road's history (for example, the year of last reconstruction). The road commission has found the system to be a reliable basis for maintenance planning, although ratings assigned in the middle ranges of condition are more difficult to make and may vary somewhat from observation to observation.

The condition rating is independent of pavement type and does not depend on the importance of the road within the county network. Despite the difficulties associated with making ratings in the middle condition ranges, there is little variation in the ratings by inspectors with similar training and knowledge. Most inspectors' ratings are reported to be within one condition level (on a 1 to 9 rating scale).

The commission has established a standardized set of strategies for treating pavement sections when current and forecasted conditions indicate that action is warranted. Sealcoats and spray injection patching are used, for example, when significant distress occurs in pavements reconstructed within the past six to eight years. Standard deterioration curves have proved adequate for maintenance scheduling.

The management system as a whole has been a valuable and affordable tool for the commission and provides the information needed by the commission's board of directors, which focuses on the county's entire system. The commission's employees work to maximize the number of miles of roadway in good condition or better using the pavement management system. The system has helped legislators and members of the public serving on township boards and road committees understand maintenance alternatives and the consequences of failures to take appropriate maintenance actions.

The commission works with townships in the county to complete road condition assessments in their areas and to develop deterioration curves from historical data on pavements in service. The management system is then used to support development of alternatives for addressing existing and projected road deterioration. Commission staff develop cost estimates for maintenance activities and used the information to develop a feasible program for addressing road needs. The information can also be used to project the revenue needed to maintain the roads at various condition levels.

The Alcona County Road Commission has found that the management system, in addition to being easy to explain and usable with limited staff and financial resources, has been useful in promoting public understanding of the task of managing the county's roadway assets and thereby enhancing taxpayer support for the commission's work. The commission has been able to argue effectively that timely preventive maintenance can extend roadway lifetime and improve overall performance.

The commission nevertheless has encountered some problems in developing and using the management system. Budgets available for preventive maintenance activities inevitably are limited. Even if this were not the case, and despite the system's theoretical arguments to the contrary, the commission has found that preventive maintenance cannot produce a "perpetual road" that never requires reconstruction. Finally, the system does not take into account the cost to road users of traffic disruption caused by preventive maintenance activities, which diminish the public's willingness to pay for preventive maintenance.

The Kent County (MI) Road Commission

Kent County (MI) Road Commission's asset management efforts focus on the primary road system under the Commission's jurisdiction. Kent County is the home of Grand Rapids, a growing metropolitan area in southwestern Michigan. The commission works with the metropolitan planning organization (MPO), as well as municipal government agencies and the county, to manage the county's road system. The commission has implemented a pavement management system and uses a six-step planning process.

The core of the county's pavement management system is the MicroPAVER program, developed by the Corps of Engineers. The commission annually surveys the condition of one-third of the system for which the agency is responsible, and provides updates of road conditions by jurisdiction within the county. The cost of updating the pavement condition information is approximately $200 per mile, with 80 percent of the funding coming from Federal Surface Transportation Program (STP) funds.

Economic development in the county drives demand for expansion of the road system. The commission uses its management system to help assure that as major expansion, construction, and reconstruction projects are considered, adequate investments are being made to preserve the overall system in acceptable condition levels. To this end, the commission annually assesses existing and projected roadway conditions and forecasts the system level impact of alternative investment scenarios. The commission's six-step planning process entails surveying existing conditions, documenting assessed needs for maintenance activities, selecting projects and packaging them for procurement, projecting future conditions, updating the roadway improvement program, and monitoring the system's performance.

Using the results of the annual condition survey (one-third of the system is inspected each year) and projections of pavement condition, the commission prepares a list of desirable reconstruction and preventive maintenance improvements. These are listed along with desirable major investment projects to improve access and expand roadway capacity. Projects to be undertaken in the coming year are selected in coordination with other state and local authorities and packaged to assure logical improvements. For example, an emphasis may be placed on projects in major corridors and higher growth areas. Projected future conditions are reported for the primary road system, the economic support network, the all-season network, and for the entire local road system and by township. The five-year improvement program is updated annually.

Pavement performance is monitored by assessing the pavement condition index (PCI), used in the MicroPAVER program, to track condition deterioration rates for various types of pavements and road improvements. The commission has thereby been able to make progressive improvements in the management system's reliability.

Road Commission for Oakland County (MI)

Oakland County (MI) established a comprehensive transportation asset management system. Oakland County, a part of the Detroit metropolitan area, is the home of more than 1 million people and businesses with an annual payroll of $31.9 billion, served by approximately 2,500 centerline miles of roadway. The road commission is responsible for much of the roadway system, including 110,000 signs and 1,400 signals. Within the county's 900 square mile area, there are 1,450 lakes, making the road system somewhat irregular and disjointed despite its underlying grid. For a variety of reasons, the commission decided to establish its asset management system without regard for the agency's approach to compliance with GASB Statement 34.

Much of the commission's information about the road system is contained in old maps, paper files, and indexes. Staff knowledge and experience levels vary significantly among operating units within the commission. One of the commission's objectives in devising an asset management system was to provide a common framework for collecting and using information to make good decisions about road system management. Commitment to establishing the asset management system also varied significantly among operating

units. While it was easy to define the steps to be taken to establish a system, the path turned out to be complex and sometimes convoluted.

An early task included the development of a reliable inventory of asset conditions. There was significant staff interest in having highly accurate location information— for example, for signs and signals— but only limited interest in regular condition assessments. Further, there was reluctance to accept that condition data must be kept up to date if it is to have lasting value. The commission's asset management implementation team explored several options for conducting the initial asset inventory and considered the requirements to keep the inventory updated over time in the decision to select an approach. The team considered collecting asset data by asset type (for example, pavements, signals, signs, or culverts), by geographic area, by functional responsibility (for example, design or maintenance), or by some combination of two or more features. The team decided to undertake a comprehensive inventory in a pilot area selected to be representative of the county as a whole.

The team judged that early accomplishments would help convince skeptics of the project's feasibility. One such accomplishment was the conversion of available plans, drawings, aerial photography, and other documents to Adobe Acrobat computer files. This relatively inexpensive step dramatically improved staff access to data formerly stored in a basement file room.

Field data collected for the pilot area are being made available as well. The experience gained in collecting these field data provide the basis for estimating unit costs for data collection for the rest of the county. The asset management system will utilize, at least initially, the agency's existing spreadsheets, pavement management packages, and other software for managing signs, signals, roadways, and other classes of assets.

An assessment of the commission's pilot effort will provide the basis for deciding the level of resources needed for the county-wide implementation of the asset management system.

Hillsborough County (FL)

Hillsborough Country Florida has developed the Hillsborough Asset Management System. (HAMS) Hillsborough County, in west central Florida, is home to the city of Tampa.

HAMS currently includes transportation and stormwater components, and incorporates asset valuations to comply with GASB Statement 34. Assets are broadly categorized as linear or point features. Data collection relies on mobile mapping technology using camera equipped vans, manual field observations with GPS technology, and other specialized technology. The entire system is GIS based and uses proprietary and public-domain components for inventory and inspection data management.

Asset condition is rated on a simple three-level scale (good, fair, poor or unknown) unless a more sophisticated system has been put in place. Pavements, for example, are rated

using surface condition, roughness, and structural sufficiency in accordance with procedures outlined in its pavement management system. The asset inventory includes a wide range of components for which the county is responsible, ranging from pavements and culverts to manholes and sidewalk handrails.

The asset management system includes deterioration models, management activity definitions, decision and prioritization models, budget analysis, and reporting to support integrated decision-making about how to most effectively manage the county's assets. Maintenance management, including production of work orders and schedules, accounts for an important segment of the asset management application. For pavements, the system considers activities ranging from crack sealing to microsurfacing and ultrathin bonded asphalt overlays to resurfacing and full reconstruction. A neighborhood servicing program enhances the system's responsiveness to citizens' concerns.

Benefit cost analysis is used to establish priorities among proposed asset improvement activities. Benefits assessed for roadway improvements include savings from the reduction in vehicle accidents and delays. Improvements are grouped into logical packages for prioritization and programming of funds; for example, sidewalk improvements are associated with public schools within the county's jurisdiction, and schools are ranked against one another in the final programming.

The management system maintains a comprehensive estimate of asset values using discounted replacement cost data. The current adjusted value of the county's roadway, bridge, and railroad crossing assets exceeds $5.8 billion. Hillsborough County's use of the modified approach to meeting the requirements of GASB Statement 34 has been accepted by rating agencies and arguably has strengthened the agency's commitment to providing adequate revenue for accelerated investments in stormwater and transportation capital improvement programs.

Cole County Public Works, Jefferson City, MO

Cole County Public Works Department, in Jefferson City, MO moved from managing its assets based on the knowledge and memories of agency staff to a systematic approach. As staff retirements occurred, the knowledge of the county's assets was being depleted and the management system was threatened. There was no "back-up" to retain information from past decisions and to pass along such information to new managers.

The introduction of GASB Statement 34 provided added impetus for change in the county's asset management practices. County staff explored existing "canned" software packages that might facilitate the initial inventorying and condition assessment of the county's transportation assets. The packages considered had broad scopes—for accommodating varieties of assets— and were flexible, with "bells and whistles" to support various functions. Purchasing such a package would offer technical support to the county staff during management system implementation. However, the packages were costly, complicated, and would require periodic staff training to keep up with new capabilities as the software packages are upgraded. The county decided instead to devise

its own package, with the help of the local university. Missouri University graduate students were employed to gather the initial data.

The system, designed to be simple to develop and use, was based on a spreadsheet model, with inventory data collected using inexpensive GPS devices purchased at a local electronics store. The most complex task was designing the unique identifier "tag" to be used to designate specific assets. A five-digit identifier was adopted.

Roadway types and other characteristics were defined using existing county procedures. A visual inspection was made of pavement condition, with ratings assigned on a five-point scale from "excellent" (5) to "failed" (1). Specific pavement distress and drainage conditions were also recorded. Drainage structures, traffic signage, and guardrail were also inventoried and rated for condition. Bridges were inventoried but not rated, because the state department of transportation rates all "off system" bridges every two years.

The inventory is updated by re-assessing about one-third of the county's roads each year. Agency construction inspection staff conducts the ratings using a condition rating manual.

The system is used to evaluate upcoming maintenance needs by reviewing conditions and using standard performance prediction curves. Analyses are made of the estimated costs to maintain or improve system components with current maintenance techniques and to extend or prolong service life with different maintenance techniques. These estimates are used in developing "long term" (3-5 years) maintenance projections and capital improvement programming.

The county's financial staff initially had agreed with public works staff that the "modified approach" to GASB 34 compliance would be adopted. That plan changed, however, when the county commission and auditor decided that the conventional historic-cost-and-depreciation approach would be required. Values of the asset inventory were estimated using construction cost data for 2001 to develop unit replacement costs for major pavement types. Estimated current values were then computed by applying reduction factors reflecting observed condition; e.g., the value of a segment in "fair" condition was calculated as 67.5 percent of the new-construction replacement cost. The current value of the county's road assets totaled nearly $134.7 million.

The system provides information that increases the agency's accountability for the performance of the county's assets. Because of the system, the agency has found that taxpayers grow accustomed to a particular level of service and expect it to be maintained. The system helps the county address this issue by providing a basis for discussing tax rates to assure funding of maintenance will be adequate for the expected levels of service desired by the public.

Association of Oregon Counties

The Association of Oregon Counties provides the Oregon Integrated Road Management System. The Association has been providing asset management software to Oregon

Counties for over ten years. This software has evolved over time and provides some experiences - to suggest lessons about what characteristics of software influences whether it will be used over an extended period.

The Integrated Road Information System (IRIS) program was established in 1990, and currently employs seven computer programmers to develop management tools for the middle range (by size) of Oregon's 36 counties. The small counties typically do not need management systems of the sort produced by the IRIS program, while the large counties develop their own custom systems. IRIS is a multi-component software suite for pavement management, vegetation management, equipment management, GIS, budgeting and financial accounting, and department administration.

The system is still evolving. For example, after initial development, a survey of 18 counties showed a desire for added inventory capabilities for signs, culverts, bridges, average daily traffic, and road classification. The Association had not initially given priority to these capabilities, but added them to the road inventory module. Other capabilities that were thought to be a high priority when the system was developed are now rarely used, such as pavement markings, accidents, underground utility crossings, intersections, and rights-of-way.

The experience of 25 counties that use the system shows that much less data are used than initially anticipated. For example, more than half of the counties report not using the sign inventory capability at all, while those that use the module do not use all available data fields.

Module	Counties Not Using	Available Fields	Fields Used
Signs	13	30	18
Culverts	5	31	10
Bridge Inventory	5	35	7
ADT	16	9	6.5
Road Classification	7	6	5

Data collection and data entry issues have been significant factors influencing how the IRIS is used. For example, the quality of data entry is related to who does the work. A truck driver cannot be expected to provide a level of accuracy that might be delivered by an engineering technician. However, the more control the user has over the data entry flow, the better the application will be received, regardless of the qualifications of that user. Ideally the user can customize data-entry screens. Users that are primarily data entry people usually prefer to use a spreadsheet style screen for data entry. Generally speaking, the less data entry and data management required, the more the system will be used.

Computer-assisted and automated data entry systems have not been particularly successful in Oregon counties. These have included electronic data collection in the field, e.g., using notebooks computers or PDAs, and data entry using bar codes and scanners. Their failure can be attributed largely to the lack of computer sophistication among the maintenance workers at the county level.

Lessons have been learned about information reporting as well. Pre-set formats ("canned" reports) seem to work well for high-level summary reporting, but not for detail

reporting. Users need the ability to develop custom reports that provide only the information required in a format that is useful to the intended audience. Users particularly like to export information to spreadsheets, allowing them to sort and otherwise manipulate the data for quantity calculations and other uses.

Finally, some general lessons can be found in Oregon's county experience. The level of detail available in data is critical to whether the management information is going to be used by the front line supervisor or upper management. The ability to easily access the exact information the user is looking for is very important. However, regardless of the level of data available, unless the user of the information is involved with the collection of the data, the information is less likely to be used for other than high-level management decisions. There must generally be some sense of prior user commitment to the system if information is to be used at all.

In designing transportation asset management software, a balance must be struck between features and ease of use. If there are too many features, the user will be confused. If there are too few features, the users will not like the application.

City of Redmond, WA

The City of Redmond, Washington has developed a transportation asset management strategy with particular regard for compliance with GASB Statement 34 reporting requirements. Redmond is unusual among the local government participants in that its roadway system is relatively young and its council is inclined to allocate funds for improvements in excess of amounts that can readily be spent (e.g., because of limited ability to acquire rights of way).

Besides the streets themselves, the street system includes signs, curbs and gutter and the right-of-way. These assets were being tracked in the city's GIS system prior to the onset of GASB Statement 34 considerations. Streetlights and traffic signals are reported separately using their own asset listing. Hiking and biking trails are also included among the transportation assets the Public Works Department manages and are also managed in a separate module.

Redmond's transportation asset management system currently has four principal elements: a geographic information system (GIS), a pavement management system, a park trail tracking system, and a project cost system. Considerable effort was devoted to strategic planning when the system was established, and subsequently to education and training of the GIS, engineering, and financial technicians who maintain the system. Similarly, considerable effort is put into keeping the information system current and compatible with the county's financial reporting system, particularly with respect to capital projects, contributed assets (e.g., facilities or rights of way), and abandoned assets.

Every two years the city contracts with the Northwest Pavement Management Association to rate the entire street system. The contractor "walks the streets" of Redmond and assesses condition according to state standards reflecting the number of

potholes, alligator cracking and other cracks. Based on a rating of 100 to represent perfect conditions, the city's roads typically have an average rating of approximately 83.

Using these ratings, an analysis is made to estimate the remaining years of life of particular streets and the system in its entirety. The information was used to determine the monetary value of the street system for initial GASB 34 compliance.

Once the value of the current assets was established, the city undertook to put in place a process to keep this information current. The public works department has assigned a staff member to monitor all capital projects, which includes substantial resurfacings. This staff person is charged with reporting the value of new or improved infrastructures to the GIS group based on the total project cost as the projects are completed. The value of infrastructure contributed to the city or abandoned is estimated by the construction division and reported to this staff person, who then relays the asset information to the GIS team.

By building on existing management systems and involving all staff who would be responsible for providing and maintaining data, the city was able to beat GASB 34 financial reporting requirement deadlines, without imposing much stress on the organization.

Common Issues

A summary of the major issues raised by local governments based on their experience in moving infrastructure asset management theory into practice captures the key elements of the presentations:

- Getting management and staff commitment is an important requirement for a successful adoption of asset management philosophy and principles.
- Building and maintaining the asset inventory is a necessary first step, but may be accomplished by progressively drawing on available information while conducting in-field surveys.
- Asset condition assessment and valuation may be accomplished at several levels of sophistication without compromising the value of the asset management system as a decision making tool.
- Asset-management "systems" may be based on simple spreadsheets as well as sophisticated database management packages, to match the needs and resources of the agency.
- Condition monitoring and maintenance of asset inventory data are essential to maintaining the validity of the asset management system, and require particular management commitment.
- Inter "modal" comparisons—i.e., to establish priorities among different functional asset subsets for resource allocation— can be supported by the asset management system.
- Payoffs from adopting transportation asset management practices include enhanced support by citizens and elected officials for preventive maintenance

activities, a net reduction in agency costs for managing the network, and improved asset conditions.

- Standards regarding satisfactory or acceptable levels of service for infrastructure assets may vary substantially from one community to another.
- Sharing of information among departments and establishing common data bases is an effective way to reduce the costs associated with the implementation of asset management system and improve the quality of management information. Existing data, such a property assessment records, can be used as a basis for setting up the asset management system.
- Definitions of management actions such as "maintenance," "preservation," and "capital projects" vary from one jurisdiction to another, making comparisons of experience more difficult.
- Asset management tools are needed that do a better job of helping managers deal with the consequences of constrained budgets.
- Asset management tools need to be simple and "fun" if they are to be used over an extended period of time; the definition of what is "fun" varies among users, but typically has something to do with being easily understandable, able to adapt to the user's specific interests, and easy to operate without entailing lengthy, tedious activities for data entry, formatting, and other routine operations.

The participants agreed that the commitment to adopting asset management principles must come initially from senior management and elected officials. However, change agents or champions are needed at several management levels to extend that commitment throughout the organization and assure that the unique character of the agency and its asset portfolio are reflected in the design and implementation strategy for the asset management system. Effective communication of the leadership vision throughout the organization is essential. Over the longer term, agency officials must contend with the challenge of maintaining knowledge of and commitment to asset management principles among elected and appointed officials who may serve part time and for limited terms in office.

Asset management agencies in smaller jurisdictions particularly may lack adequate resources to undertake development of even a relatively simple asset management system. Officials in such agencies need information to help them understand what may realistically be expected of an asset management system and what type of system may be appropriate to their jurisdiction. Organizations such as the LTAP centers could provide such information to local governments.

Those who seek to use asset management systems must contend with the persistent problem of people's inclination to focus on specific projects rather than system considerations, to be most concerned about the localized issues regarding "my road." Asset managers and their constituents must overcome the "worst first" approach and move towards an approach that involves establishing priorities for management action. The responsible asset management official needs to be able to convey the broader context of system performance and to help people understand the need for actions to preserve as well as expand asset capability.

The majority of local government users need "off-the-shelf" products for asset management. They generally lack the staff time and skills needed to tailor tools to fit their specific situation or the funds to hire consultants to do the job. Tools adequate to meet the needs of smaller jurisdictions may be relatively unsophisticated. For example, methods for rapidly screening proposed roadway repairs and improvements to identify those warranting higher priority can be very useful for creating short lists for discussion among elected officials; efforts to develop an "optimum" priority list are not particularly useful in the political setting of a smaller jurisdiction.

Asset management principles and tools could be particularly useful if they can be adapted to discussions among the multiple agencies influencing asset performance in the typical local governments setting. For example, water and energy utilities and police and fire services may compete for leadership roles in decision-making about reconstruction activities as well as for funding to enable such activities to progress. In addition, asset management tools would be helpful if they could assist in the balancing of sources and uses of funds in jurisdictions where there are tight restrictions on how funds from various sources may be applied.

Workshop participants largely agreed that consistent definitions of management actions and service levels for system management would be useful in helping elected officials and the public to understand the issues of asset management. To the extent that GASB 34 encourages such standardization across jurisdictions, the statement will in the long run enhance asset management capability. Participants agreed also that the LTAP centers are a valuable resource for local governments seeking assistance with transportation asset management.

Finally, workshop participants suggested there are substantial payoffs to be gained in sharing of data and information about such matters as performance of signs and road striping to support development of reliable deterioration and risk functions. Materials and equipment producers often consider such information proprietary. Local governments in similar service settings would likely welcome support from Federal agencies or other sources for pooling and analysis of such information.

Chapter Three
Asset Management as a Communications Tool

We've got to make the black box a glass box.

The new currency of government is trust. This was the primary message of a speaker who urged participants to consider asset management as a set of tools to help manage their facilities and to communicate with elected officials and the public. Trust is largely a product of understanding and performance. An asset management program can improve understanding by taking some of the mystery out of how and why decisions are made, by making a glass box out of the black box. It does this by clearly articulating goals in terms that are meaningful to stakeholders, by documenting current conditions, and by estimating future conditions based on alternative policy strategies and investment levels. It can improve confidence in agency performance by clearly reporting achievements—and failures—and progress toward established goals.

The participants and speakers introduced a number of issues that must be addressed to successfully use asset management as a communications tool in a transportation agency. Some of the issues that emerged at the workshop are included below.

Issues

- A consistent message is important from all asset management stakeholders within the agency and to all audiences.
- Common goals must be defined and presented to all opinion leaders and decision makers.
- Establishing and maintaining credibility with the public and the legislature is critical.
- Defining and maintaining accountability to the public, legislature, and other decision makers is critical to using asset management as an effective decision tool.
- Demonstrating efficiencies is a good way to establish an agency's desire to protect and stretch public resources.
- Flexibility in presenting information is required to match the medium to the needs of specific groups.
- Tailoring the message to the audience is important; not everyone has the same base knowledge, the same interests, or the same need to know.
- A consistent level of interaction through different means—media, public meetings, web, etc.—is needed to bring the message to the targeted audience.

A number of states and local agencies shared their experiences in using asset management concepts to communicate with the public and their decision makers.

Ohio DOT

The state transportation revenue structure for the Ohio Department of Transportation (ODOT) has not changed for many years. This resulted in growing, unfunded needs in the transportation arena and deteriorating conditions. ODOT used asset management as part of a larger effort to make the case for an increased investment in transportation.

A first step was helping elected policy makers understand the extent of the responsibilities vested in the DOT. This effort included highlighting some basic points about the state transportation network that might not have been clear to a casual observer and were not well known by the state legislators.

When compared to other states, Ohio can make the following claims:

- 35th largest in geographic size.
- 10th largest highway system.
- 4th largest interstate network.
- 2nd largest inventory of bridges.
- 5th in terms of total traffic volume.
- 5th in terms of truck volume.
- Located within one days' drive of 50% of North America's population and 70% of its

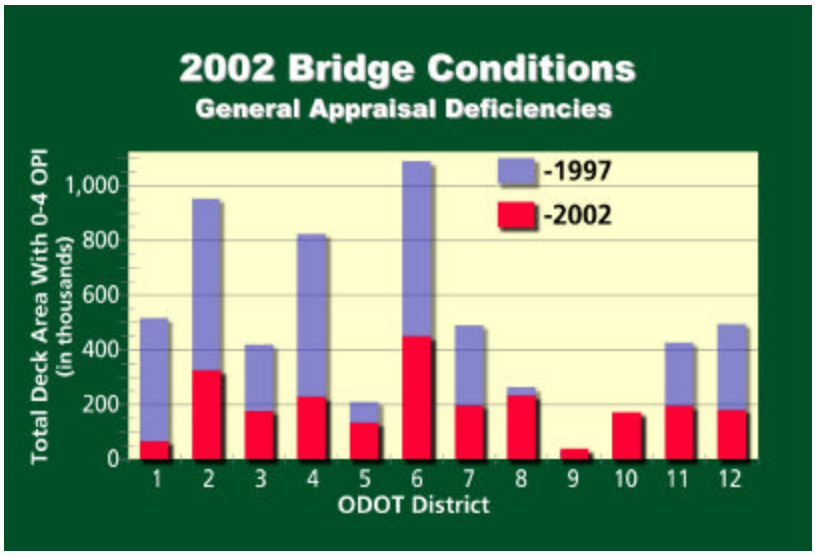
This relatively geographically small state juxtaposed to the huge service demands that have been placed on the transportation system helped illustrate the transportation needs that existed and the overall demand for investment in transportation assets.

The next step involved communicating concise goals and related accomplishments. The goals articulated by ODOT fell into six categories, as shown below.

Ohio Goals

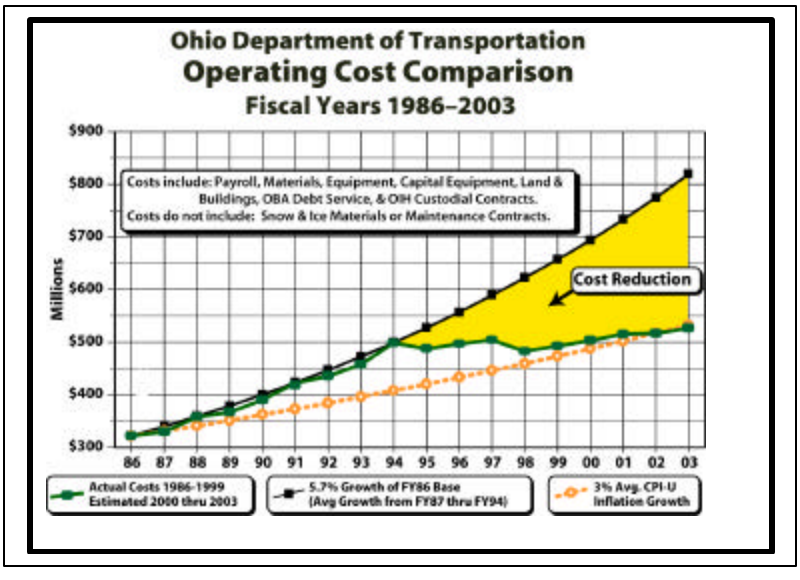
- Improving pavement conditions.
- Improving bridge conditions.
- Implementing safety improvements.
- Investing in the future.
- Delivering the program.
- Operating efficiently and effectively.

Having defined the agency's goals, ODOT's next task was to illustrate what had been done to meet the goals and what still needed to be done. Since bridge deficiencies had been significantly reduced in the five years prior to this effort, ODOT used the simple graphic shown below to illustrate its progress in this area. The graphic effectively illustrates the improvement in bridge condition in a manner that is easily understood:



As shown in the graphic, seven of the State's twelve districts had made marked improvements in bridge condition when measured in terms of deck area with deficiencies.

Another goal area in which significant improvement had been made was operational efficiency. Again, a graphic, which may be more complex than would be desired, was used to present the good news that operating costs had been reduced by more than $200 million from what would have been expected based on earlier trend lines.



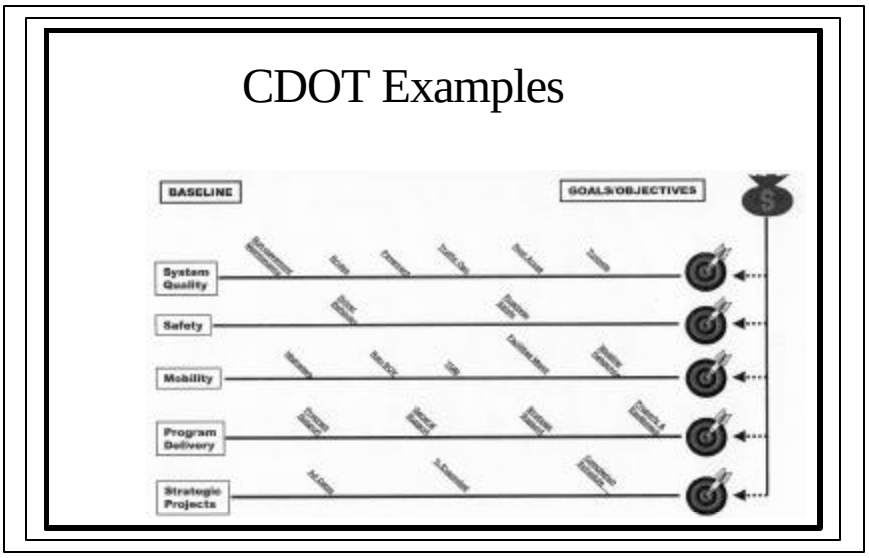
Much of the perceived savings was accomplished by changing agency work rules and practices to provide more flexibility in staff assignments. Under those changed rules workers may have various assignments, for example shifting from winter maintenance to project inspection, that tend to balance seasonal activities.

ODOT found that the use of these types of communication tools, used regularly, flexibly, and with a common message by a range of transportation professionals, helped tip the political scales in favor of greater transportation investments. Specifically, ODOT:

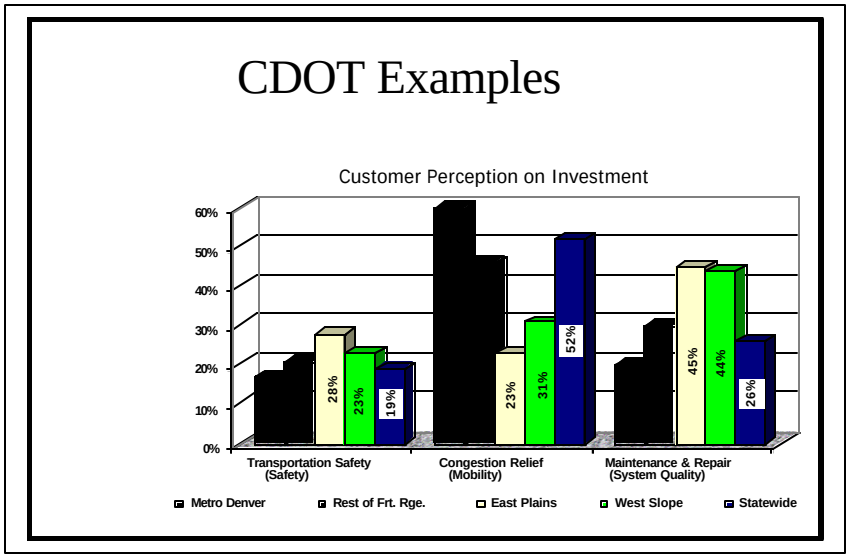
- Received a motor fuel tax increase.
- Prevented revenue diversions from the transportation fund.
- Gained the Governor's support for a ten-year major investment program.

Colorado

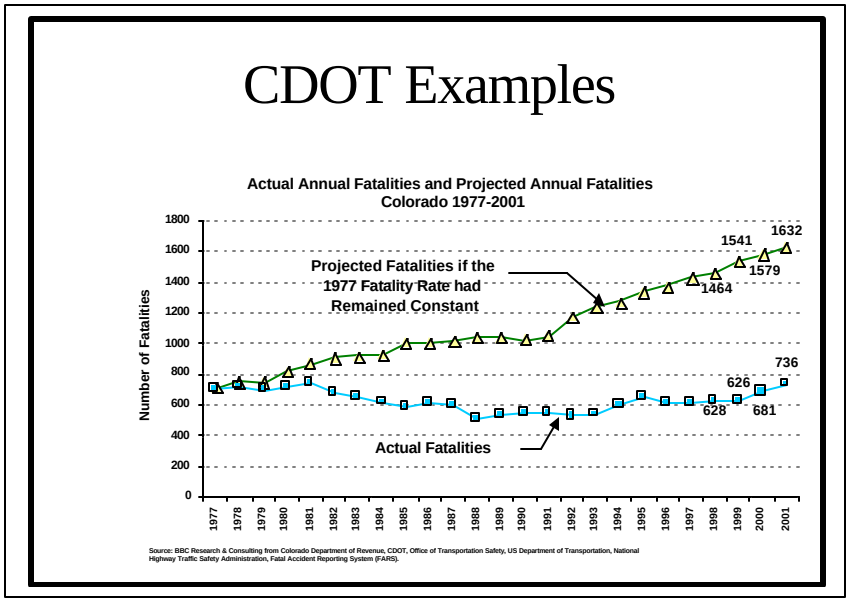
Colorado Department of Transportation (CDOT) focused much of its efforts on clearly defining and communicating performance measures and strategies. They used these measures and strategies to allocate funding to a number of different program categories, as illustrated by the following:



CDOT also made an effort to clearly link their performance measures to the agency's vision and mission and to understand and express themselves in terms that had meaning to their customers. As the following graphic illustrates, understanding a customer's perspective proved difficult because different customers valued different things:



Finally, they reported on the progress made in each of the performance areas. The following graphic illustrates CDOT's report on safety improvements that had been realized:



CDOT efforts to clearly define goals that were linked to the agency's mission and vision, expressed in terms that related to customers' desires, and reported in terms that its customers understood allowed the agency to better communicate its situation to decision makers.

Michigan

Unlike many other states and local government, the Michigan Department of Transportation (MDOT) is attempting to develop and use an asset management system for all highway transportation agencies in the state. The state undertook this effort, in

part, because of the legislature's desire to better understand the needs of the entire state highway system. It has the added benefit of putting the same analytic tools to work on effectively managing the highway system.

Their basic approach is summarized in the following:

Michigan

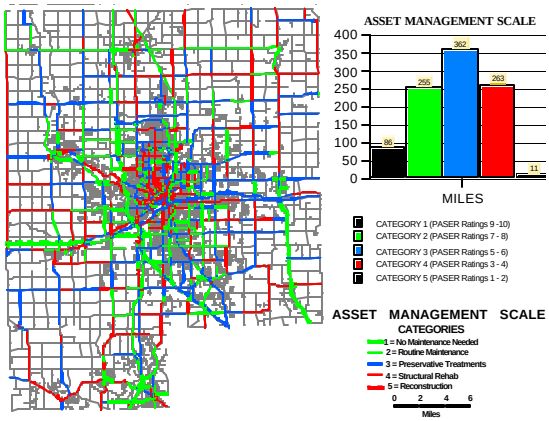
Communicate SYSTEM NEEDS by working:

- ✓With Elected Officials
- ✓With Key Stakeholders
- ✓With the Public
- ✓Internally with the Council and Department

Michigan is also unique in that it has legislation directing an advisory group to oversee the development of the state's asset management system. Under the law, the advisory committee consists of state and local officials, including representatives from MDOT, and reports to the Michigan Transportation Commission, which is a part-time policy advisory group for MDOT.

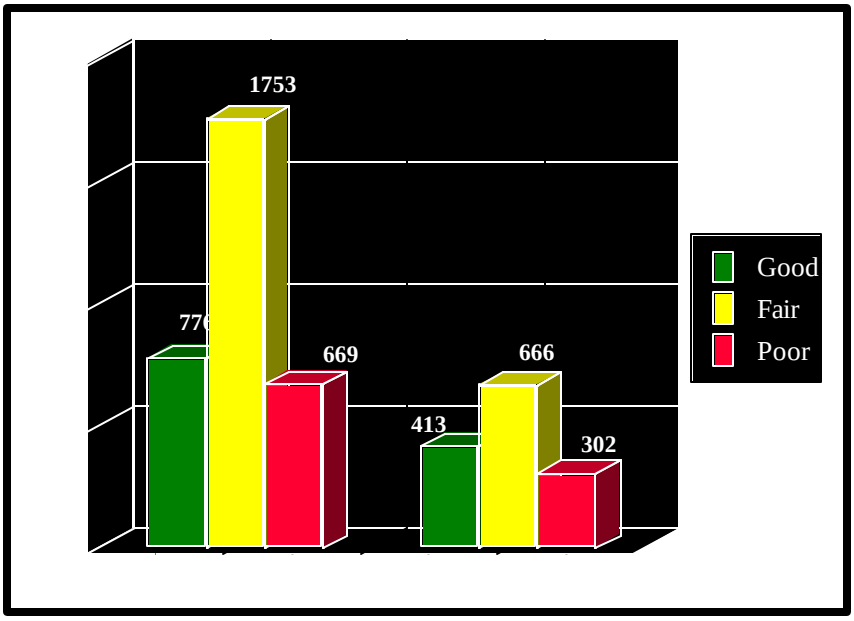
As a result of these actions, the state and local governments are able to illustrate the condition and needs of their pavements in easily understood visual presentations in a consistent manner using simple, pavement evaluation tools. An example of way in which highway conditions are presented is provided.

MI DOT Examples



In a similar way, MDOT demonstrated the condition of the state's bridges.

Bridge Condition



When it is fully operational, the Michigan asset management system will provide government officials at all levels with a powerful tool to understand the condition and needs of the state transportation system and practices used to manage it.

Wisconsin Towns Association

The Wisconsin Towns Association represents more than 1200 local units of government in Wisconsin. They recently partnered with the Wisconsin DOT (WisDOT) and other associations representing local governments to secure passage of a state law that requires all local governments to report roadway condition to WisDOT, using an approved pavement management system.

Their goal in seeking this change of statute was to provide decision makers with better information on the condition of the state's local road system. When coupled with bridge information already maintained by WisDOT, this new data provides a solid overview of the condition of the roadway assets maintained by local governments. Since the state provides a significant amount of funding for the maintenance and improvement of locally controlled roads in Wisconsin, this information will improve the budget discussions in the state legislature. Another benefit of the new information will be the availability of an improved tool for local officials to manage their highways and bridges.

The tool used by most local governments in Wisconsin is PASER, a simple inventory and rating system developed by the state Local Technical Assistance Program (LTAP) center. (Michigan is also using the PASER system). The PASER system is PC-based and uses a simple visual evaluation criteria that points to probable treatments for deficient conditions.

To make the data available to specific local governments and collectively for all governments, WisDOT partnered with local associations to develop a web-based information system that is available using a web browser. It combines a geographic information system with the database for local road inventory and condition. With it, a local agency can produce a graphic presentation of the condition of its routes and compare its situation with that of other similar agencies. Statewide policy analysts can also obtain overall information on system condition.

After a full cycle of information is available later this year, the tool will enhance future discussions of local road needs and funding in the state.

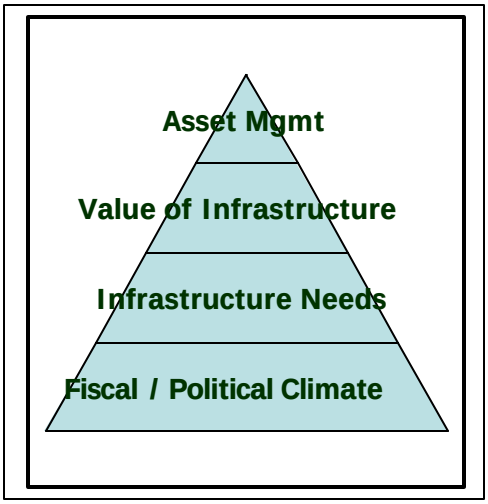
Minnesota

The Minnesota Department of Transportation (MnDOT) provides another somewhat unique example. In this case, the local governments worked with the Transportation Policy Institute, a quasi-public organization, to develop an advocacy program for revenue changes in transportation. The program used many asset management concepts.

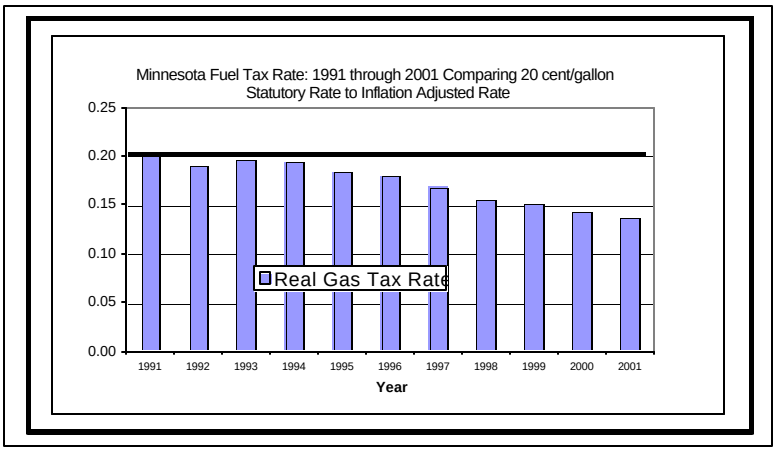
One of the first elements of the program was deciding who to talk with and the primary reasons for the discussions. The following graphic illustrates the recommendations that were made:

- Citizens/Taxpayers/News Media/Advocates
    - To hold elected officials accountable.
    - To help people understand the value of the transportation assets.
    - To get people to recognize the link between investment levels and system quality/performance.
- Elected Officials (including federal, state, and local officials and candidates)
    - So that policy makers can make informed decisions on budget priorities.
    - So that investment decisions will be made with the full knowledge of total costs.

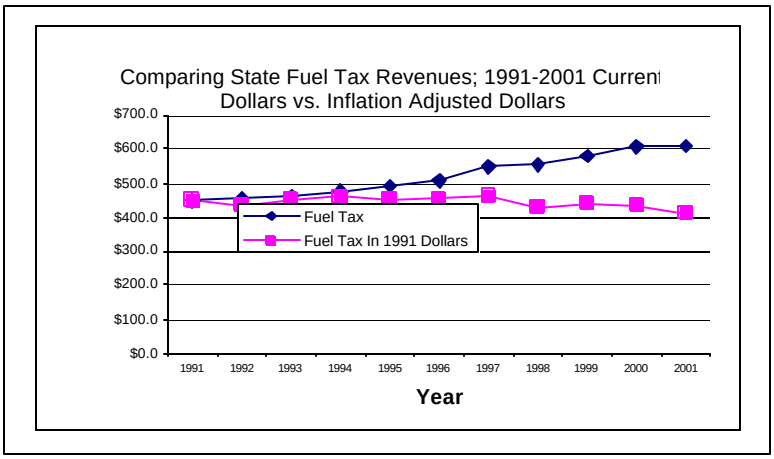
The state's approach took into account a number of factors that influenced the probable outcome of its efforts, as shown in the following figure:



Another effort was made to illustrate the stagnating buying power of the state's motor fuel tax. The following graphic illustrates this point:



This reduction is the real rate was then compared to the loss in real buying power:



This figure was used to emphasize that despite the growth in fuel consumption; inflation effectively reduced the buying power of a constant rate fuel tax.

Despite these persuasive arguments, MnDOT was not successful in passing the revenue changes they sought.

Other Comments

The foregoing examples were provided by the agencies that were specifically asked to comment on their use of asset management as a communication tool. A number of other agencies, as a part of their presentations on other subjects, also commented on the power of asset management information to improve communication efforts. Several additional examples are provided.

- The Pennsylvania Department of Transportation (PennDOT) used its asset management tools to brief a new governor and Secretary on the condition and needs of the state transportation system.

- The Vermont Agency of Transportation (VTrans) found that asset management tools allowed for better decision-making. The presenter noted that VTrans' goal was to have good decisions made using quality data. Asset management may not dictate the outcome of a decision process, but at least all of the participants have good information on which to base their decisions.

- WisDOT talked about the use of asset management, in this case in the operations area, to involve stakeholders in the policy development process.

- Many county officials noted that the availability of asset management information improved the understanding of their boards in making decisions, often protecting needed funding for maintenance and operations.

Chapter Four
Private Sector Experience

"Can public agencies learn from the private sector?"

Much work has been done to try to move the experiences of the private sector to the public sector. In fact the 1st National Asset Management Workshop was titled "Advancing the State of the Art into the 21st Century Through Public-Private Dialogue." More recently a project supported by the Midwest Regional University Transportation Center (MRUTC) documented case studies of asset management in six private sector transportation-like organizations.

The important question has been "Can we learn from the private sector?" At the Fifth National Conference on Asset Management, August Olivier, Director of General Motors' Worldwide Facilities Group presented asset management experiences at General Motors; and P.S. Sriraj, Research Assistant Professor at University of Illinois, presented case studies from the MRUTC project, "Evaluation of Near-Transportation Private Sector Asset Management Practices", focusing on asset management experiences at Union Pacific and Xcel energy.

The experience of these private sector agencies contains several elements that may be of interest to the public sector:

- All three organizations found that institutional and cultural change was a barrier.
- General Motors found that it took some time to build the base of supporting information and models for life cycle costing and prioritization.
- General Motors also emphasized the importance of asset management as a communications tool, using simple classifications and charts to relate complex information.
- All three organizations believe that their approach to asset management works for their organization. They emphasized that their approach was fairly simple and logical. It is important to know what you have, where it is and what condition it is in.
- For all organizations safety was the number one priority, followed by efficiency. Questions such as "How will this impact safety?" and "How can we approach this more efficiently?" were frequently asked.
- All three emphasized that asset management is not rocket science but it does require a cultural change. Senior management and the leadership of the organization must be committed to asset management, providing the resources to implement asset management

General Motors

Prior to 1997, facilities management at General Motors was decentralized with decisions being made by individual plant and facility managers. Requests for resources for facility maintenance and improvement competed with new product development, operations and marketing within each plant or facility's budget. In 1997 General Motors' (GM) Worldwide Facilities Group took over the management of General Motor's facilities. These facilities include 150 million square feet of buildings, an annual construction budget of between $750 million and $1.5 billion, a $640 million annual maintenance budget and a $525 million annual housekeeping budget.

GM's Worldwide Facilities group's goal is to support the manufacturing processes. GM's objective in centralizing the management function was to provide a consistent approach to the stewardship of corporate assets and attempt to optimize investments. This strategy not only takes advantage of economies of scale in purchasing, it also takes a portfolio-wide perspective, using cost / benefit and risk analysis to make investment decisions. For manufacturing buildings the emphasis is on life cycle costs and asset sustainment, while recognizing life safety, environmental principles, energy conservation and the need to support the core business with flexible and reliable facilities.

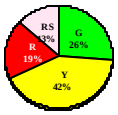
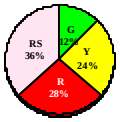
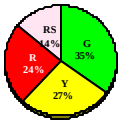
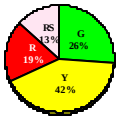
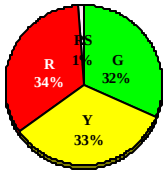
GM uses life-cycle cost analytic techniques to explore "build new" versus "renovate" decisions and to focus on high cost features of GM's building. The process used net present value to capture investments in buildings and real estate and how they relate to taxes, labor costs and impacts on the community. An analysis of expenditures indicated that 21 items related to architectural, mechanical and electrical activities accounted for over 60 percent of total costs. This analysis was used to identify standard configurations. For example, air-handling units represent around 7 percent of costs. A life cycle cost focused on the costs of three different types of units. Further analysis, which recognized benefits such as maintainability, revealed the benefits of using industrial grade units. Other non-monetary benefits considered include safety, aesthetics, expandability, schedule impact, and flexibility.

In terms of sustaining existing assets, GM uses project prioritization procedures. Projects are given priority in terms of impact on 1) safety, 2) regulatory, 3) risk of repair or failure, 4) strategic value, 5) cost savings, and 6) long term repair and replacement costs. Remaining life is used to document the impact of expenditures on asset renewal versus maintenance on asset sustainment budgets. Assets are categorized and color coded according to the percentage of useful life remaining as follows:

Green: 50-100% of useful life remaining
Yellow: 15-50% of useful life remaining
Red: 0-15% of useful life remaining
Red Stripe: 0 useful life remaining & collateral damage occurring

A key element of this process is communication using graphs and charts. The relative proportion of assets in each color-coded category representing the need for investment is documented and shared with decision makers. Trends over time under four different budget scenarios are also documented as shown in Figure 1.

Figure 1. Asset Sustainment Reporting Example

Spend Option	Minimum (Safety, Reg. & HR R&R)	Carry over 2003 Spending	Maintain Current State	Engineering Recommendation
Total Spent (Project Expense)	$2.2 M (2.2M)	$34.5M (10.5M)	$55.0M (17.5M)	$82.0M (25.0M)
Remaining Useful Life *2004 Year End Condition*	5.3 years	5.7 years	6.3 years 	6.7 years
Remaining Useful Life *2008 Year End Condition With Level Spending for 5 years*	1.3 Years 	4.7 Years 	6.3 Years 	10.0 years 
Maintenance Cost Impact	↑↑↑↑↑	↑↑↑	→	↓↓

Union Pacific

Union Pacific is a Class I railroad with 33,000 miles of track in 23 states. Assets include locomotives, rail cars, and highway tractors, track, and right of way. These assets were valued at $31, 551 million in 2001.

At Union Pacific asset management was introduced in 1996 in response to problems that occurred as a result of the merger of the Union Pacific and Southern Pacific railroads. Asset management was integrated into the company through a series of performance measures that link track condition to the customer at every level in the organization. Geographical units throughout the organization report these measures on a weekly basis. The performance measures are correlated to a service delivery index and an index of customer satisfaction. These measures in turn are linked to revenue. To make this strategy operational, Union Pacific employees have six key questions that link individual

actions and decisions to the asset management goals. Accountability was the underlying focus for this approach.

Xcel Energy

Xcel Energy is an electricity and natural gas delivery company. Xcel Energy serves 3.2 million electric customers and 1.6 million natural gas customers in 12 states. Assets include gas and electricity generation, distribution, and transmission facilities valued at $6.4 billion. A key element of asset management at Xcel Energy is distinguishing among the roles of asset owner, service provider and asset manager.

At Xcel a management change in 2001 focused on separating the functions of service delivery from asset provision. Its introduction of asset management principles followed the successful implementation of asset management at its parent company, Yorkshire Electric. This involved development of asset inventory and introduction of supporting tools, such as a work tracking software and fault analysis tools, some of which were customized for Xcel while others were off-the-shelf software. Their objective is "to repair or replace assets the day before they fail" implying that they want to maximize the useful life of the asset while minimizing the disruption due to unexpected failure.

Commonalities and Differences of public sector organizations.

Table 1 compares some of the private sector experiences with those of public sector organizations.

Table 1. Comparison of Public and Private Sector Approaches

Area	Public Sector	Private Sector
Motivation	–Need for mandates to "sell" asset management (Michigan, Vermont)	–Need for paradigm shift to introduce seminal changes in asset management policy (UP, Xcel)
Strategy	–Asset management is better financial planning (Michigan)	–Asset management is the fiber of our existence (TTX)
Role of information	–States are hiring CIOs to provide direction (Michigan) –Facilitated compliance with GASB34 (Hillsboro county (Florida), Cole County)	–Importance of Information Technology (United, UP) –Importance of Inventory and data (All case studies)
Approach	-Retaining functional silos, while being aware of the need for feeding information from these systems into an Executive Information System (EIS) (Pennsylvania, Washington)	–Two schools of thought about asset management: (1) No need to change the business model, it is more a question of integration of models to achieve system optimum (TTX, GLGT) (2) Complete reorganization to introduce asset management (UP,

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Chapter Five
Asset Management Tools

Better tools lead to better decisions.

Introduction: The Asset Management Tools workshop session included a brief overview of Transportation Asset Management (TAM), how it works, and the general categories of tools that are useful in doing TAM. The session emphasized that the goal of a transportation asset management system is to improve the quality of decisions made to maintain, sustain or improve a transportation system. This requires data on the extent and condition of the system and tools to help understand the performance of the system under different policy options and investment levels. The moderators identified three of the major classes of TAM tools: management systems, data integration techniques, and economic analysis tools. These classifications reflect areas of emphasis and are not exclusive to each other. In fact, most tools incorporate some degree of data integration, economic analysis, and management system capabilities in hybrid formats. For instance, life-cycle cost analysis (LCCA), an economic analysis tool, is an important component of many pavement and bridge management systems.

Key Points

- Benefit cost analysis is most useful in comparing alternative investment options, or projects.
- Lifecycle cost analysis can be used to make decisions within a single project to make the most effective design decisions for the life of the project
- Some agencies use benefit cost and life cycle tools sequentially to narrow the investment options and make design decisions, or to make the most effective design decisions before looking at trade-offs between projects.
- Tools such as FHWAs Highway Economic Requirements System are intended to assist in evaluating program level trade-offs.
- Many agencies have used many tools to break down the functional silos of their organizations and to improve the overall decision processes.
- Some tools can be very complex or quite simple, depending upon the complexity of the agency and of the issue.

Management Systems: Management systems enable agencies to organize and analyze the massive amounts of data collected about the agency's pavement, bridge, and other asset networks. These systems allow agencies to document the condition of various types of assets and perform systematic estimations of existing and future needs and revenues needed to maintain, or improve, the asset system. Many states and local governments use pavement and bridge management systems to provide the information needed to make more informed decisions regarding the maintenance or rehabilitation of those assets. Some states are trying to use congestion and safety management systems to make better

decisions on how those parts of their investment programs are managed. Management systems were discussed extensively in other workshops during the conferences and therefore were not emphasized in the Analytical Tools Workshop.

Data Integration Tools: Some states are attempting to use data integration techniques to pull the output from these management system silos together to improve the overall allocation of resources. This approach will be greatly facilitated by NCHRP Project 20-57, *Analytic Tools to Support Transportation Asset Management*, which was the subject of a presentation at the workshop.

NCHRP 20-57 is intended to "produce user-friendly tools for State DOTs that will improve their ability to identify, evaluate, and recommend investment decisions for managing the agency's assets." This objective addresses the concern that current tools available to States, such as management systems, used in planning, program development, and program delivery may not be geared to the investigation of the full range of investment options or to the analyses needed to compare and conduct tradeoffs among alternatives. The research plan for NCHRP 20-57 includes a needs assessment (completed), the evaluation of existing tools (completed), recommendation of new tools (completed), design and test of the tools (completed), production of prototype tools (completed), field-testing of the tools at State DOTs (future), and delivery of the tools (future).

The assessment of current tools revealed a broad spectrum of available tools, ranging from pavement and bridge management systems, to LCCA tools for design selection at the project level, to project level benefit-cost tools, to benefit-cost tools that can enable trade-off analysis at the pavement or bridge program level. Most States use pavement and bridge management systems. Most of the available tools, however, are not used to their full potential.

The NCHRP 20-57 study team found a high-level of interest among agencies in new tools that would enable trade-off analysis within and among investment categories, as well as tools offering enhanced project evaluation and comparison, LCCA, and the ability to do standards analysis and monitoring and feedback. The team learned that, to be successful, these tools must be tailored to conform to agency staff resources and business needs, should support an evolutionary process to achieve user buy in, and should have technical champions.

The NCRHP 20-57 effort will deliver an operational network tool that will integrate the performance results of separate management systems, allowing the analyst to see the performance results of shifting funds from one asset category to another; or the consequences on one category if a desired performance level in another category is attained. This tool will support resource allocation over the long term. The effort will also produce a "proof of concept" for a program level tool, in which the effects of adjusting project mixes on short-term program performance can be evaluated. The tools will be available in October 2004.

Questions from the audience in Seattle focused on the adaptation of the network tool to State management systems. One commenter noted that many States do not do multi-year prioritization with their pavement and bridge management systems, and asked how this would affect use of the network tool. The presenter responded that States would need to conduct multi-year prioritization runs of their management systems to get useful information from the network tool. However, the tool is general enough to use bridge management system results even if they are not at the element level.

Economic Analysis Tools: The session also included a brief description of economic analysis tools. These tools are an important component of asset management because it is difficult to evaluate highway projects based solely on performance measures since different performance measures are difficult to compare. For instance, a project that reduces the risk of crashes is difficult to compare to one that results in a savings of travel time without economic considerations. By assigning monetary values to such performance measures, and then calculating the projects' monetized benefits and costs, economic analysis can help reveal if either project is worth pursuing (its benefits exceed its costs) and which one would generate the greatest net benefits (in the event there are insufficient funds to invest in both).

Economists can assign dollar values to most of the costs and benefits of transportation projects. For instance, the value of travel time in business is usually estimated at the average traveler's wage plus overhead. Personal travel time is usually valued at a percentage of average personal wage, based on what travelers would be willing to pay to reduce travel time. Economists often use the dollar amount that travelers are willing to pay to reduce the risk of injury or death to estimate values for injuries and fatalities associated with crashes.

To be effective, economic analysis needs to consider the life cycle of a project or program—not simply initial costs. To the extent possible, benefits and costs need to be expressed in dollar terms in the years in which they occur in the life cycle. Dollar values occurring in the future must be "discounted" to present value amounts, based on the opportunity cost of resources, so that they can be compared objectively.

Widely used economic analysis tools include benefit-cost analysis (BCA) and life-cycle cost analysis (LCCA). BCA compares the discounted value of a project's or program's benefits to the discounted value of its costs. Most BCA applications are directed at individual projects, but some applications, such as the FHWA's Highway Economic Requirements System-State Version (HERS-ST), are intended for program-level analysis. In some cases, the transportation agency will have decided to undertake a project with a given benefit level (e.g., immediately replace a damaged two-lane bridge), and will be looking for the least-cost method of accomplishing it. In this case, LCCA, which focuses on minimizing costs only, is appropriate.

The usefulness of economic analysis of highway projects or programs can be significantly augmented through the use of travel demand models and other methods to accurately forecast traffic levels on a facility, and risk analysis to deal with uncertainties

concerning future costs and benefits. Economic impact analysis can be applied to the results of BCA to study the effects of transportation improvements on regional employment, business activity, and tourism. These impacts are often very important to decision makers in the context of TAM.

The audience raised a number of questions pertaining to the role of economic analysis. Following one session in Atlanta, there was a discussion on the appropriate use of LCCA versus BCA. Some practitioners combine the use of LCCA and BCA in a two-step process. For instance, some apply BCA to gauge the economic merits of a project and then use LCCA techniques to reduce the cost of the preferred option. Others employ LCCA first to minimize the life-cycle costs of alternatives, and then apply BCA to test the economic merit of the alternatives. Also, whereas FHWA recommends that user delay costs associated with work zones be part of LCCA, some practitioners believe that the inclusion of user costs should be limited to BCA.

Following a session in Seattle, some audience members noted that it is difficult to assign monetary values to community and environmental effects of transportation projects. The workshop panelists noted that the cost of complying with community and environmental requirements is often incorporated into the project design. Remaining impacts that cannot be monetized can be treated qualitatively relative to those benefit and costs impacts than can be monetized. Risk analysis can also be used to deal with uncertain costs and benefits. In some cases, agencies can make use of multi-criteria analysis, a non-economic technique for evaluating projects with large community and environmental effects.

State Experiences: Representatives from several States described the experiences of their States with economic analysis tools during the workshop.

<u>Oregon DOT</u>
The Oregon Department of Transportation (ODOT) presented its experience with the Highway Economic Requirements System (HERS), a program-level economic trade-off model developed by the FHWA in the 1990s. In the latter half of the 1990's, ODOT adapted the HERS model (referred to as HERS-OR) to support its development the Oregon Highway Plan (1999).

ODOT used the HERS-OR model to supplement existing tools, including pavement and bridge management systems, with the purpose of capturing all benefits and costs from potential investments, not just agency costs and benefits. The combined modeling results were reviewed for engineering and economic reasonableness. The HERS-OR tool enabled planners at ODOT to view the effects of three alternative highway-funding levels (preservation only; preservation with feasible modernization; and preservation with unlimited modernization) on average estimated speeds and pavement condition, and to plot identified cost-beneficial actions on a statewide map.

ODOT reports that it currently uses elements of HERS-OR for various analysis purposes, including valuation of travel time associated with unanticipated delays caused by

incidents and detours, which is used in informing ODOT personnel and the public. ODOT uses the capacity module of HERS-OR in its Congestion Management System. HERS-OR also plays a minor role in supporting ODOT's Bridge Limitation Strategy.

ODOT is considering future uses of HERS in the form of FHWA's new HERS-ST model, which is structurally similar to HERS-OR but has additional features such as a user-friendly interface, improved GIS-based graphical reporting tools, revised capacity calculations, and FHWA technical support. Possible uses for HERS-ST at ODOT include support for average effective speed analysis on highway segments, including truck speeds; project-level analysis using performance measures and benefit-cost analysis; integration of HERS-ST with travel demand models (to enable traffic reassignment calculations based on policy-driven scenarios); and sensitivity testing of key input data and values.

Pennsylvania DOT

In the late 1970's, the Pennsylvania DOT (PennDOT) faced growing pavement investment requirements; aging infrastructure; mounting user delays associated with construction work zones; and increased scrutiny about such delays from industry, the public, and the legislature. To address this development, PennDOT resolved to implement a life-cycle cost analysis (LCCA) pavement selection method that would identify the total costs of ownership, incorporate road user costs associated with work zones, and support communication with its stakeholders. PennDOT's LCCA program was targeted to interstate projects over $1 million and all roadway pavement projects over $10 million. PennDOT required that at least one Portland cement concrete and one bituminous concrete alternative be considered in each analysis. User costs due to work zone delay and vehicle operating costs must be included in the analysis in addition to agency costs. PennDOT only uses LCCA to compare pavement alternatives that yield the same level of service and benefits to users.

PennDOT noted that the LCCA policy has generated several benefits for the agency and the traveling public. It has led to improved pavement designs and professional development at PennDOT due to better data on pavement costs and performance. Because of the need to show life-cycle costs, it has led to improved competition and lower bid prices by pavement contractors. Highway users benefit because their delay costs are directly considered in pavement selections. PennDOT has also benefited from improved credibility for its pavement selection process due to the greater transparency of the process, leading to fewer industry and public challenges.

Problems encountered by PennDOT in implementing its LCCA method included the initial assembly of necessary pavement data (expedited by the collection of the data at the same time the LCCA method was being developed); development of user cost data (resolved through consultation with a national source for data on user costs); and treatment of uncertainty (engineering judgment can be used to select among pavement alternatives whose costs are within 10 percent of each other). PennDOT noted that a strong agency commitment is required to implement a major change in policy such as the one for using LCCA.

New York State DOT

New York State DOT (NYSDOT) has several stovepipe management systems in place, but needed the ability to do tradeoff analysis to compare projects identified by one management system to those identified by others (i.e., horizontal tradeoff decision making). To do this, NYSDOT developed its TAM Tradeoff Model, which uses benefit-cost calculations to do horizontal trade-off decision-making. With this tradeoff model, NYSDOT will be able to select the best mix of projects identified by stovepipe management systems. Although unable to maximize net present value with this model, NYSDOT can obtain significantly greater net benefits than would be possible using more traditional approaches such as multi-year prioritization, cost effectiveness analysis, conformance to policy and goals, and (especially) "fix the worst first."

The tradeoff model used by the NYSDOT measures economic benefits in the form of avoided excess user costs, such as traveler and freight delay, accident costs, and vehicle operating costs. NYSDOT views excess user costs as equivalent to hidden taxes on road users. These benefits (avoided excess user costs) can be calculated for investments in individual assets, linked assets, and entire corridors. The benefits of each investment candidate are matched against its annualized costs, in the form of a benefit-cost ratio, and then the candidates are ranked in order by their benefit-cost ratios. This benefit-cost information feeds into the project selection process at the regional level, contributing to the eventual development of an integrated transportation plan.

NYSDOT will likely undertake a number of technical refinements to the tradeoff model and the supporting systems, including incorporation of agency cost savings into the process, and standardization of economic parameters used in the various management systems. Once these steps are completed, the tradeoff model will be deployed for evaluation at selected regional offices.

Chapter Six
Data Integration

Data rich. Information poor.

Most complex transportation agencies are data rich and information poor. Nearly all state departments of transportation and large county and municipal agencies are dependent upon old data systems that were designed to do specific tasks: pay bills, monitor contracts, manage revenues, collect inventories, and so on. Unfortunately, for those agencies, effective management of assets requires a wide variety of information; information that may exist in any of the old transactional systems. The challenge is to glean data from these existing systems or to create new systems that provide the needed information.

Some presenters offered tips to deal with some of the management concerns:

- Remember that the key to asset management is moving from a project-level focus to a systems-level focus.
- Treat IT as a strategic rather than a tactical resource. Like the first point, this suggests elevating the focus and thinking more broadly.
- Include the agency's chief information officer in the senior management group that directs the agency's total efforts. This will enable that person to understand the true goals and help to make IT become an integral part in its strategic direction.
- Keep responsibility for data within the agency's functional silos because the functional experts are there, but help those experts see the broader uses and importance of their data.

The Size of the Challenge

Presenters at the Fifth National Asset Management Conferences illustrated the nature of the data integration challenges and the range of solutions available. The challenges and the tools available to meet the challenges are greatest for large complex agencies because of the number of people involved in the decisions and the intricacy of the decisions themselves. Not only must pavements and bridges be maintained, so must extensive roadway facilities, trails and pedestrian facilities. While decisions are made and plans drawn for maintenance or preservation, safety improvements, capacity enhancements, aesthetic enhancement, and operational investments must also be considered. In some agencies all of these potential investments must compete with investments in transit, air or rail. Choosing well from this lengthy list of potential options requires information in a consistent format and with consistently applied definitions over the range of available options and over time.

Not every agency is this complex. Some deal only with pavements and bridges, with little need for safety or capacity concerns, no need to address anything beyond routine operational issues, and no thought or responsibility for non-highway modes. Even these simpler agencies undoubtedly have some concerns with turning data into information.

Cole County, Missouri is one of those simpler agencies. It needed solid information on the extent and condition of its highway assets. It met the challenge with a spreadsheet model developed by graduate students from the University of Missouri.

The more than 1,200 town governments in Wisconsin also illustrate the data requirements in smaller, less complex agencies. With few exceptions, they, too, only need information on the extent and condition of highway assets—pavements and bridges. They met their need through a cooperative effort with the state department of transportation and the state Local Technical Assistance Program (LTAP) center. This partnership produced a web-based, Geographic Information System (GIS)-enabled database that relied on a simple inventory and pavement management system. The agencies used the Pavement Surface Evaluation and Rating System (PASER), to assess and analyze current pavement conditions.

Finally, Alcona County, Michigan is another relatively simple transportation agency. The County personnel also relied on their state LTAP center, using PASER, Roadsoft and laptop computers to create a system that met their information needs. Roadsoft is a pavement management system developed through Michigan's LTAP center.

These smaller agencies illustrate a key point: not every transportation department faces the same needs for information or the same challenges in creating it. Each agency has to evaluate the types of decisions they must make, the complexity of those decisions, and the resources available to meet those challenges as they decide how to proceed with an asset management program. Often the simplest solution that will meet the needs of the agency is the very best.

Data Integration in a Complex Setting

Much of the discussion of data integration necessarily focuses on information technology. It is, however, good to keep in mind the words of one state presenter: "The technical stuff is easy. It's the management part that's hard." With this in mind, lessons learned from agencies that have successfully addressed data integration issues can beneficial. These lessons include the following:

1. Find organizational agreement on the need to integrate data systems. This usually means leadership from one or more respected senior leaders in the agency and a demonstrated need for change.

2. Define the department's information needs and compare them to existing data sources.

3. Define data standards, including how each data element should be measured, stored, and stored.

4. Select a strategy and a tool (or tools) that meet the defined needs.

5. Implement that strategy and put the tools in place.

6. Manage the new system to ensure that it is really providing the information needed over the long-term.

Note that IT is involved as a major component in only two of the suggested six steps. The balance of the responsibilities lies with management.

The data integration initiatives undertaken by the agencies represented at the workshop were motivated by a variety of factors, as indicated in the following summaries.

Kansas DOT

The Kansas Department of Transportation (DOT) felt the need to keep pace with technological change, to develop an application roadmap, and to integrate its information silos to better support management's decision-making activities. As new technology emerged, a growing need had developed to identify and integrate technology into an enterprise-wide IT solution. Data in KDOT is currently stored in 4 different databases on 3 different platforms and accessed from 5 different web services. An application roadmap is necessary to overcome the growing number of systems, and the cost of maintaining systems with incompatible or cumbersome connectivity issues. Likewise, the integration of data is necessary to support a more comprehensive and objective approach to decision-making.

Georgia DOT

The Georgia Department of Transportation (GDOT) recognized its need for data standards to ensure a common understanding of spatial data, to promote or enable interoperability among different data structures and systems within the agency, to support the establishment of data structures at local, regional and global levels, and to promote data and information sharing. The agency has databases that contain valuable information that cannot be readily linked or joined, have massive data redundancy, require duplicitous effort to maintain, are void of data ownership and responsibility, and cannot be shared.

South Carolina DOT

The South Carolina Department of Transportation (SCDOT) was dealing with significant data, such as those found in financial systems. These are not traditionally GIS-enabled. Likewise, much of the data are referenced in multiple referencing systems, exist in multiple formats, utilize different business rules and logic, are stored in different places, and are developed with different technologies.

Washington State DOT

For the Washington State Department of Transportation (WSDOT), the decision to develop a linear referencing system and build a data warehouse was motivated by the need to improve the quality of information used to make decisions, increase business communication, maximize data value through quality, share data with common definitions, and minimize data collection and storage costs.

Montana DOT

The Montana Department of Transportation (MDOT) needed to link its bridge inspection data with bridge rating data in a client-server environment to develop a common library of material and bridge element data. Other objectives included providing database level and application level data security, eliminating re-coding of data from bridge design to bridge rating, and allowing data users to connect from any location in the DOT network to the database.

Oregon DOT

The Oregon Department of Transportation (ODOT) developed an intranet-based GIS-enabled transportation information portal that was designed to allow various units in the agency to access data and information from their desktop computers. The agency needed to make the data available from the seven management systems (Pavement, Bridge, Congestion, Safety, Integration Transportation Information System, Freight/Intermodal, and Traffic Monitoring) to those who needed the information for analysis and decision-making.

In general, data integration was viewed in these agencies as necessary to support both long-term and tactical management decision-making, provide greater accessibility to data, integrate or link different applications (including stand-alone programs) and new technologies that are being introduced (and make sure that they are compatible), minimize data collection and storage requirements, improve the quality and accuracy of data (e.g. source of truth) and maintain consistent data definition throughout the agency.

To initiate the data integration efforts, each agency organized a committee or team to look into the specific data integration issues and/or provide leadership to the integration effort. For example, the Washington DOT established a Data Council that placed accountability for data resources in the hands of the department employees who have a stake or interest in its quality and protection. The Data Council also provides a forum for the data stewards, data creators, data users and data resource management to work cooperatively in the best interest of the Department. The goals of the Data Council are to provide leadership and guidance in order to maximize the consistency of data definitions and values throughout the Department, minimize the cost of collecting and maintaining accurate data, encourage sharing of accurate and timely data, and promote data as a departmental asset. Similarly, the Kansas DOT established a steering committee consisting of 15 people to lead the development and implementation of the enterprise architecture.

In each agency, a needs analysis, or requirements analysis, was conducted to identify the problems that existed with respect to data integration as well as possible approaches to address the issues. In terms of the approaches taken, the agencies adopted a framework or architecture for data integration; explored, developed or customized data integration software; developed and implemented data (e.g., spatial) and application (e.g., GIS) standards; or created a warehouse or clearinghouse for transportation data.

SCDOT's Roadway Information Management System (RIMS) was developed to provide more efficient and easier on-line access to road information that has been collected for the last 50 years. The types of data available from the system are photologs, aerial photos, topography, and road characteristics. Developing and adopting departmental standards for all these data in RIMS allowed the system to be linked to other systems that provide or use the information, including the agency's Pavement Management System (PMS). An Integrated Transportation Management System (ITMS) is currently being developed to allow various information systems and data sources (including RIMS, PMS and the Highway Maintenance Management System) to share data. A middleware approach to the ITMS has been conceptualized and prototyped using the Microsoft BizTalk software. As shown in Figure 1, the middleware was designed to retrieve data from disparate databases and provide this information to the users through a GIS-based web software and server. The middleware uses XML data schemas to process the disparate data. SCDOT is still evaluating this approach, which is an alternative to data warehousing.

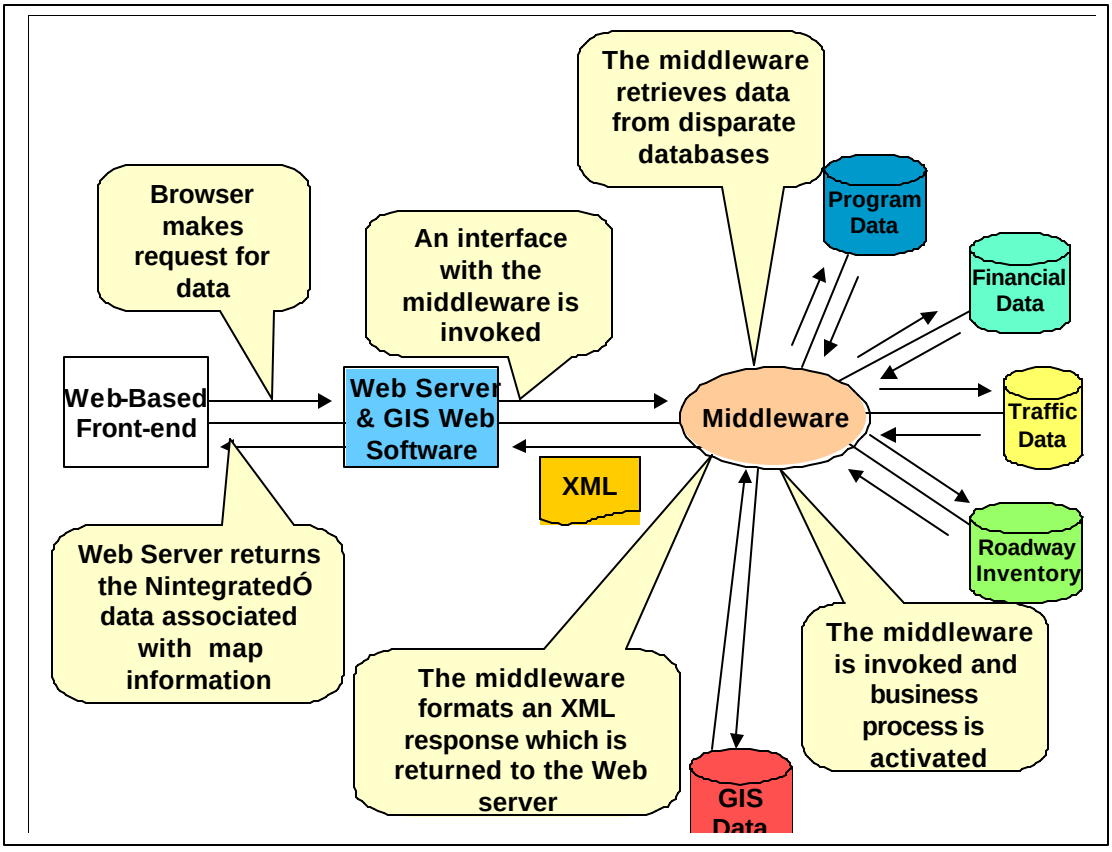

Figure 1 – South Carolina Prototype Middleware Approach to Data Integration

The Kansas Department of Transportation (KDOT) Enterprise Architecture (EA) initiative took several years to evolve and required multiple phases of implementation, including high level, component level, and quantitative level activities. KDOT conducted 14 topic meetings that were business area focused and involved more than 200 attendees, and built over 100 models (data, context, work flows, and radar charts) to come up with enterprise level models that can be used as the basis for the Strategic IT long-range plan for the agency. The vision for the Enterprise Architecture is engineering-based, improves the quality of data, reduces the effort to capture data, improves the availability of information to all, promotes standards and identification of all IT resources, and establishes a clearinghouse for information about agency IT efforts. The models developed for the Enterprise Architecture will be used for implementing business reengineering, portfolio management, business intelligence and other IT applications. The next steps for the Kansas DOT are to create an enterprise-wide data model, to develop an approach for information awareness across the agency, and to work with other Kansas state agencies to integrate KDOT EA with the statewide EA.

For GDOT and WSDOT, the creation of standards for spatial data and GIS applications, including the development of linear referencing systems for those data, enabled the agencies to link their disparate databases and allowed integration of data from multiple data sources.

The ODOT's TransViewer computer program provides the capability to integrate the Oregon Transportation Management System (OTMS) data and make them available to all users of the data on the agency's website. The vision for OTMS is the full integration of information, with additional provisions for data analyses and tools to help decision-makers prioritize Oregon's transportation needs. TransViewer provides access to OTMS data, which includes pavement, bridge, safety, congestion, freight and traffic monitoring data. Using the TransViewer program, ODOT employees can view and download data on their desktop computer. The TransViewer application will provide additional data and information to the users in the future.

As expected, all of these agency initiatives were met with a number of obstacles. Technical impediments to data integration included the difficulty in selecting a specific software program, tool, or strategy from a wide array of available options and the risk that whatever was selected might not meet the agency's long-term needs. From the organizational standpoint, significant challenges were encountered in trying to gain agreement or consensus on the use of standards and in getting everyone in the agency to cooperate in the effort. The existing business culture in most agencies is stove-piped and does not easily lend itself to integrated data management and decision-making.

In general, the data integration efforts of the agencies were received positively both internally and externally of the organization. Many stakeholders see the effort as essential in improving the data management and decision-making capabilities of the agency. However, there is some level of skepticism in some of the initiatives, again because of the uncertainty in the outcome and the costs associated with the effort. The need to

communicate the success of the initiatives and the benefits achieved becomes even more important in those scenarios.

Within the agencies that have taken steps toward data integration, these initiatives have changed the way the agency does its business. Each organization now has a different way of looking at its data, treating data as a corporate resource and making sure that data are managed efficiently and used to the agency's greatest advantage. By physically consolidating or linking their data, or adopting certain tools and methodologies to facilitate data integration, the agencies derived significant benefits. The reported benefits include standardizing the way business is conducted, providing opportunities for more interaction among organizational units, reducing redundancy in data collection and storage, improving procedures for using and representing data, making more informed and comprehensive decisions, providing greater availability of data for users and external customers, and being able to perform more complex queries and analyses of data very efficiently.

The data integration experiences presented can provide valuable direction to other agencies with similar needs for data integration. However, each agency is different in its business processes, needs and organizational culture, therefore there is no guarantee that the same tools, strategies, and technologies will produce the same results no matter how identical the organizations may be.

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