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6th National Conference on Transportation Asset Management

November 1–3, 2005
Kansas City, Missouri

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TRANSPORTATION RESEARCH CIRCULAR E-C093

6th National Conference on Transportation Asset Management

November 1–3, 2005
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Applied Pavement Techology, Inc.

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Introduction

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Applied Pavement Technology, Inc.

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More than 250 attendees benefited from the technical presentations and facilitated discussions conducted at the 6th National Conference on Transportation Asset Management, which was held November 1–3, 2005, in Kansas City, Missouri. The conference was organized by the Transportation Research Board (TRB), supported by FHWA, and cosponsored by AASHTO, the Midwest Transportation Consortium, and the National Association of County Engineers (NACE). Attendees from state, federal, and local governments were represented as were participants from private industry, trade associations, and universities.

The conference was held in conjunction with the 1st National Conference on Roadway Pavement Preservation and provided an opportunity for asset management, maintenance, and other transportation practitioners to share information, acquire new skills, and network with other professionals in this field. The opening sessions were jointly sponsored by both conferences, featuring presentations highlighting the links between pavement preservation and asset management. These sessions cited pavement preservation programs as an excellent example of applied asset management concepts and illustrated how such programs make cost-effective use of available funds with treatments that provide an improved level of service, fewer disruptions to the traveling public, and improved safety characteristics.

The remainder of the 2-day conference featured presentations and facilitated discussions that supported the conference theme: Making Asset Management Work in Your Organization. Sessions were tailored to the varied needs of the participants, with presentations oriented for individuals just getting started in asset management, for individuals who have had some experience with the concepts but want to learn more, and for experienced users who want to enhance their current capabilities. In addition, several sessions were organized to address the special needs of large, complex organizations, small organizations, and transit and rail issues. Other sessions covered asset management applications in varied transportation agencies, establishing and using performance measures, analytical issues in asset management, and best practices in transportation asset management (TAM).

An evening poster session provided an opportunity for participants to interact with several authors in a more informal setting. The conference's closing session offered suggestions for using the lessons learned during the conference and moving forward. Applications from a recent international scanning tour on asset management were highlighted to illustrate the possible applications of asset management concepts in transportation agencies. Following the conference, some participants attended one of three optional workshops sponsored by the FHWA. The workshops featured the Highway Economic Requirements System–State Version (HERS-ST), the use of probabilistic life-cycle cost analysis in pavement analysis, and the FHWA's new web-based benefit–cost analysis tool.

This circular summarizes the content of the conference’s sessions and presentations. The moderator for each session prepared a summary of his or her session as well as summaries of the individual topics included in the session. The intent of this circular is to provide a record and reference of the conference topics so that future deliberations and conferences can build on these efforts.

Developing and Implementing Pavement Preservation Within Asset Management

Network-Level Issues

KATHRYN A. ZIMMERMAN
Applied Pavement Technology, Inc.

The Tuesday morning conference sessions featured plenary sessions for attendees of both the 1st National Conference on Roadway Pavement Preservation and the 6th National Conference on Transportation Asset Management. This session, which was organized by the planning committees for both conferences, featured presentations oriented toward bridging the pavement preservation philosophy to other transportation agencies.

INCORPORATING PAVEMENT PRESERVATION STRATEGIES INTO AN ASSET MANAGEMENT PROGRAM IN A LARGE CITY

Katheryn J. Shields, *Jackson County, Missouri*

Shields serves as the chief executive officer (CEO) of Jackson County, Missouri, which is home to Kansas City and 17 other cities and towns. Her presentation focused on the benefits the county has realized through pavement preservation strategies, including improved pavement conditions, safer roads, and the more cost-effective use of transportation funding. Shields presented the use of a pavement management system (PMS) to support the identification and prioritization of pavement preservation strategies. Through better planning and the use of available technology, Jackson County has improved its road and bridge network from 45% in failed condition to more than 80% in good condition within a 10-year period. The county also reports that that the number of accidents has been reduced by 40% and customer complaints have dropped substantially. Shields emphasized that these improvements have been realized without increases in funding, with reductions in manpower, and increased traffic volumes. She stressed that through the use of budgeting based on needs established through current condition information and objective data to evaluate projects, the county has been able to develop plans for routine and preventive maintenance (PM).

The presentation highlighted several other innovative practices being adopted by the county, such as the county’s website for submitting registrations, job applications, and conducting online searches of property tax records and other pertinent county records.

In closing, Shields emphasized the benefits Jackson County has realized as a result of its pavement preservation program. In addition to improving the pavement conditions in the county, the agency reports that it can be more responsive to customer inquiries because of the improved information available through the PMS. The county intends to continue its efforts to improve the infrastructure conditions, setting a target of raising the average condition of the road network from a 70 to 75 (representing very good condition) and upgrading its chip seal and cold mix roads within the next 5 years.

EXPANDING THE FOCUS FROM PAVEMENTS TO OTHER ASSETS

Deb Miller, *Kansas Department of Transportation*

As the secretary of transportation for the Kansas Department of Transportation (KDOT), Miller is very familiar with the improved pavement conditions that can be realized through the continued use of a pavement preservation program. In fact, Miller was one of several individuals to present Figure 1, which illustrates the dramatic improvements in highway conditions KDOT has realized since beginning its pavement preservation program in 1981. As shown in the figure, more than 95% of KDOT's Interstate and 88% of its non-Interstate highways are in good condition—a dramatic increase from the percentages shown at the beginning of their program.

KDOT's pavement preservation program began with top-level support and has continued virtually unaffected by top-level changes in the organization because it is now institutionalized into the agency's decision making process. The program was initiated in response to the agency's need for more quantitative and reproducible decisions and resulted in the implementation of pavement and bridge management systems for recommending preservation activities. Since this implementation, KDOT has realized improved system performance and has established credibility with the public and the legislature.

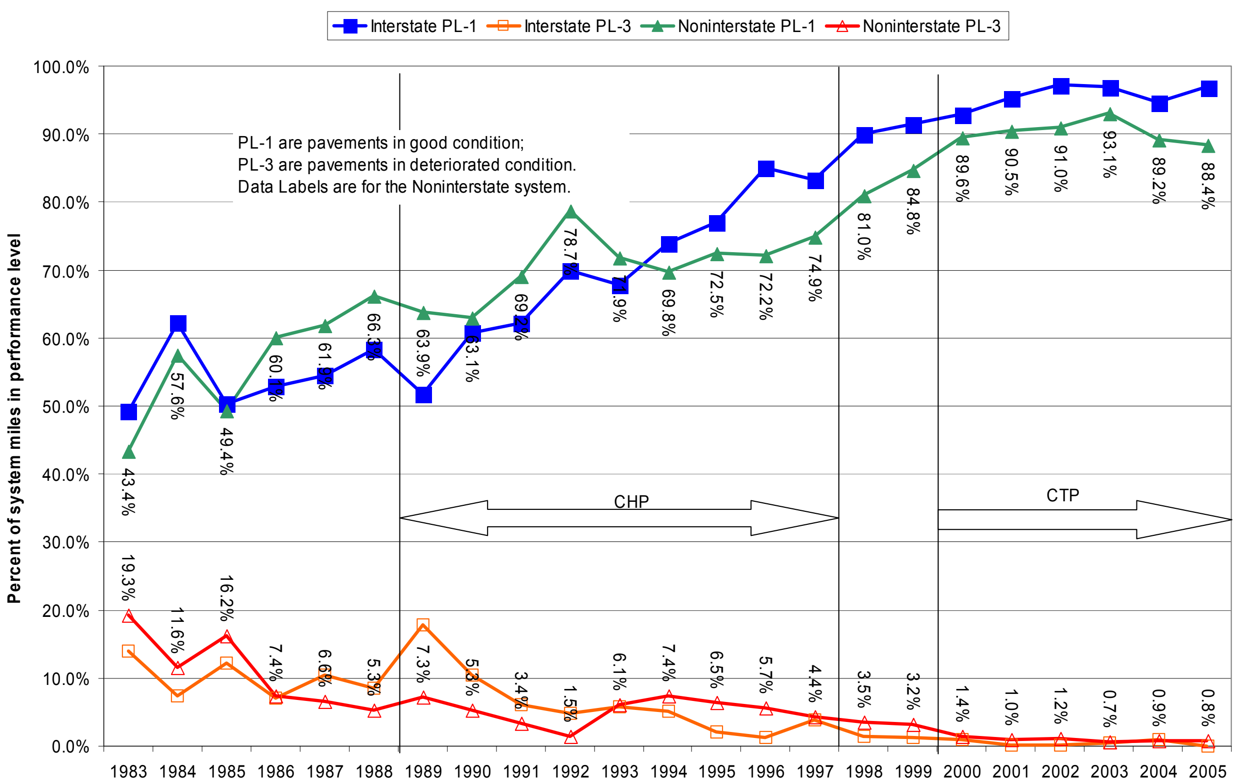

FIGURE 1 Improved pavement conditions under KDOT's pavement preservation program.

Today, KDOT is striving to expand its preservation philosophy into its other transportation assets. Recent initiatives include new systems for aviation, short-line railroad, transit, buildings, and other assets for which KDOT is responsible. The agency is implementing new tools to support these initiatives, such as information technology integration and geospatial enablement tools.

KDOT is expanding its asset management activities over the next several years. Ms. Miller indicated that efforts in the immediate future will focus on more integration among assets, the increased use of performance measures, the development of agency wide trade-offs and analyses, and the increased use of geospatial information.

ASSET MANAGEMENT AND ROADWAY PRESERVATION: INTERACTIONS AND SYNERGIES IN SUCCESSFUL PROGRAMS

King W. Gee, *Federal Highway Administration*

Gee's presentation focused on the partnership between successful TAM programs and roadway preservation programs. He defined asset management as a business decision process that considers many factors, including both economic and engineering needs, to determine how an agency should spend its funds to get the best return on its investment in the transportation system. Key characteristics of an asset management program include the following:

- It is policy driven.
- It is performance based.
- Decisions are based on quality information.
- Options and trade-offs are evaluated.
- Conditions are monitored to provide feedback to improve the process.

Preservation activities are only one aspect of a comprehensive asset management program. Other considerations include operations, expansion, congestion management, and safety. Preservation programs are a cost-effective component of an asset management program because low-cost treatments are used to defer the need for more costly repairs such as rehabilitation or reconstruction.

Gee emphasized the importance of making cost-effective use of available funding because of the increased demands that will be placed on our roadway networks within the next several years. According to the *2002 Status of the Nation's Highways, Bridges, and Transit Conditions and Performance Report to Congress*, the roadway system will have to support substantial increases in traffic, with the greatest increases coming from single unit and combination trucks. By the year 2025, vehicle miles traveled (VMT) is expected to increase by at least 50%. The tonnage carried by these vehicles is also expected to increase dramatically within the next 20 years, with tonnage nearly doubling during that timeframe. Since current funding levels are inadequate to meet today's needs under current loading conditions, roadway conditions across the country are expected to decrease without some type of change in the way agencies conduct business.

Pavement preservation programs provide one strategy for addressing the increasing needs. Gee's presentation included an example from the Nevada Department of Transportation, which was able to reduce its backlog of pavement needs by 50% through its use of its pavement preservation program. The FHWA has a number of programs available to help agencies implement and enhance their preservation efforts, through the Office of Asset Management and the AASHTO Community of Practice website http://assetmanagement.transportation.org/tam/aashto.nsf/home.

LESSONS LEARNED FROM PAVEMENT PRESERVATION PROGRAMS AND THEIR APPLICATION TO ASSET MANAGEMENT

Kirk T. Steudle, *Michigan Department of Transportation*

As the chair of the AASHTO Subcommittee on Asset Management, Steudle was charged with establishing the link between the closing of the Pavement Preservation Conference and the start of the Transportation Asset Management Conference. He began his presentation by emphasizing the support that pavement preservation programs can provide to an agency's asset management goals by extending the life of an asset and slowing its rate of deterioration through the use of low-cost treatments. Steudle then introduced the components of an asset management program that considers various investment options and trade-offs in determining the best program for a group of assets, such as pavements. He emphasized the following characteristics of an asset management program:

- A multidisciplinary approach that includes individuals who have technical backgrounds along with individuals with planning, finance, budgeting, and public relations skills;
- Policies and goals that are established as part of an asset management program necessarily reflecting a comprehensive long-term view of asset performance and costs;
- Continuous measurement of asset conditions, including an analysis of usage patterns and causes of deficiencies;
- Consideration of a broader range of solutions, focusing project development on projects that support policies and goals established by management; and
- Delivery of a program that supports these objectives and monitors the results of the agency's actions.

Many of these same characteristics are integrated into successful pavement preservation programs. For instance, agencies typically set a goal for the pavement preservation program based on performance objectives. Performance measures are used to establish the goal and monitor performance over time. Using this information, preservation strategies are considered, and a program is delivered to move the agency closer to its overall goal.

Steudle illustrated the integration of these two programs by introducing Michigan's proactive role in establishing its asset management policy. Their approach involves external stakeholders, such as the legislature and governor's office, in policy decisions regarding the preservation of the state's assets. Michigan established a Transportation Asset Management Council (TAMC) to analyze policy strategies and report the results to the legislature. Internal stakeholders within the regional and metropolitan planning organizations (MPOs) provide assistance to the TAMC and serve as liaisons to the local agencies within the state.

Steudle summarized his presentation with the following recommendations for agencies' asset management programs:

- Think long term rather than focusing on immediate results.
- View assets as a total system rather than as individual projects. This will force agencies to think more strategically than they have in the past.
- Establish effective performance measures and monitor conditions regularly.
- Collect only quality data.
- Use technology and analytical tools to consider alternate strategies and scenarios.
- Monitor the results of the program over time.

Applying Transportation Asset Management Tools to Decision Making

CHARLES J. NEMMERS
University of Missouri–Columbia

When managing transportation infrastructure, whether someone is a head of a state department of transportation (DOT), a county public works director, a transit operator, or even a consultant hired to help provide support, "it" is all about making decisions—correct decisions. This is not easy as there are many conflicting interests and issues, the results are often hard to quantify, the decisions (and their impacts) are open and political, and most often the public is footing the bill. So how do we improve our decision making? It can be argued that better decisions are made if we are guided in these decisions by evidence. The process that collects information on our infrastructure (inventory, condition), assesses its economic value [level of service (LOS), remaining service life], considers various options (priority–risk assignment), and evaluates the consequences of these decisions can be called evidence-based decision making or asset management.

CONDITION INDEXING AND NATURAL HAZARDS ANALYSIS FOR MDOT RADIO TOWER NETWORK

Charles J. Nemmers, *University of Missouri–Columbia*

Nemmers introduced the panel discussion on using asset management as a tool for decision making by presenting a short program on the radio tower network owned by Missouri DOT (MDOT), showing that there are lots of assets in the state DOT's portfolio besides roads and bridges. He mentioned that in addition to guardrail, culverts, signs and supports, lighting and signal systems, weigh stations, rest areas, office and maintenance buildings, the DOT also owns a network of 50 radio communication towers. Nearly 90% of the MDOT vehicles have radios that use signals from these towers. An earthquake emergency response exercise revealed that the towers' collapse would make communications impossible. Thus, MDOT conducted a study of their tower network.

The University of Missouri–Columbia conducted the study and Nemmers showed how the classical asset management process of inventory, condition assessment, condition indexing, alternative evaluation, priority (or risk) assignment and evaluation was used. The condition indexing approach was explained in more detail. Two towers were evaluated to calibrate the process. The end result is that MDOT is collecting condition assessment evidence on all of the towers which will be input for the condition indexing process enabling MDOT to develop evidence-based (risk analysis) priority ranking of their towers. It is asset management on a small scale, by a very large organization.

SMART INFRASTRUCTURE ASSET MANAGEMENT SYSTEM

Ali Roohanirad, *Jackson County, Missouri*

Roohanirad began by outlining three levels of asset management:

1. Basic asset management system (AMS) with elements such as bridge management, pavement management, and sign management that include maintenance management. There would be condition information, project selection, priority, cost information, and program development. The system may be able to generate work orders. At this level, however, there are no analysis and no forecasting tools; the AMS cannot develop scheduled maintenance plan, update asset condition, conduct needs assessment, trade-off analysis, and so forth (Figure 2).
2. A true AMS. This would include all of the above but would be able to generate work orders based on complaints or scheduled routine maintenance; plus it could perform analysis and would have forecasting tools.
3. Smart AMSs (SAMS). However, what is really necessary is a SAMS, which includes all of the elements of Levels 1 and 2 above plus prediction modeling. With prediction modeling, agencies can
   - Forecast current and future budgets,
   - Develop multiyear maintenance plans,
   - Perform "what if" analysis based on various budget levels,
   - Predict future facility condition,
   - Coordinate maintenance activities,
   - Determine remaining service life, and
   - Maximize a limited budget by using optimization and prioritization models.

Roohanirad walked the audience through the steps taken in Jackson County, Missouri. Twelve years ago, the county began with the basic AMS approach doing only pavement management. However, it involved the entire workforce and placed computers in maintenance vehicles so staff could begin to document the work and begin to develop performance curves. Today the county's Smart Asset/pavement management system (PMS) uses a pavement condition

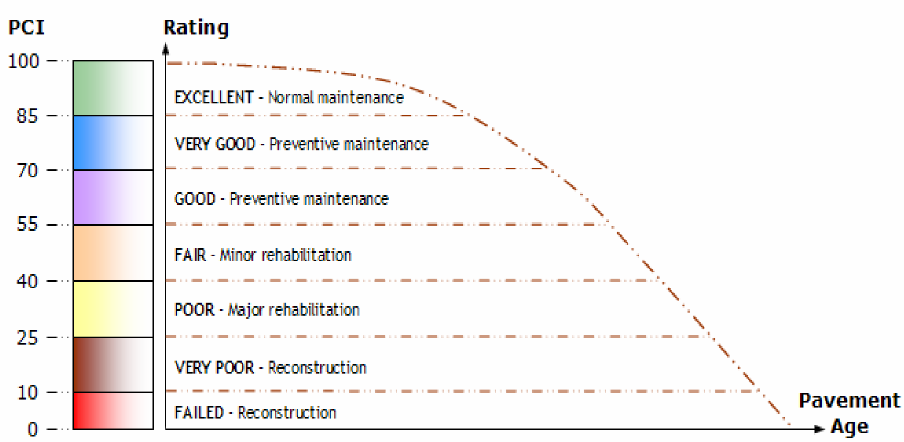

FIGURE 2 Relationship between pavement condition and treatment needs.

index (PCI) generated from the county's own data as a quantitative assessment tool. Jackson County's SAMS is an integrated computer database that provides the tools necessary for performing following analysis:

- Economic/Government Accounting Standards Board (GASB) #34,
- Optimization,
- Structural–engineering,
- Performance–LOS,
- Investment–financial–asset valuation,
- Condition–update asset condition,
- GAP analysis–treatment selection models,
- Scheduled maintenance plan,
- Priority–needs assessment,
- Failure mode–risk assessment, and
- Remaining service life.

The SAMS includes forecasting tools, and this is the key to success.

Roohanirad showed more than 40 computer screen examples to illustrate how the relational database is linked to their SAMS so as to deliver not data, but information, to the decision makers at every level. An excellent example is the chart below (Figure 3).

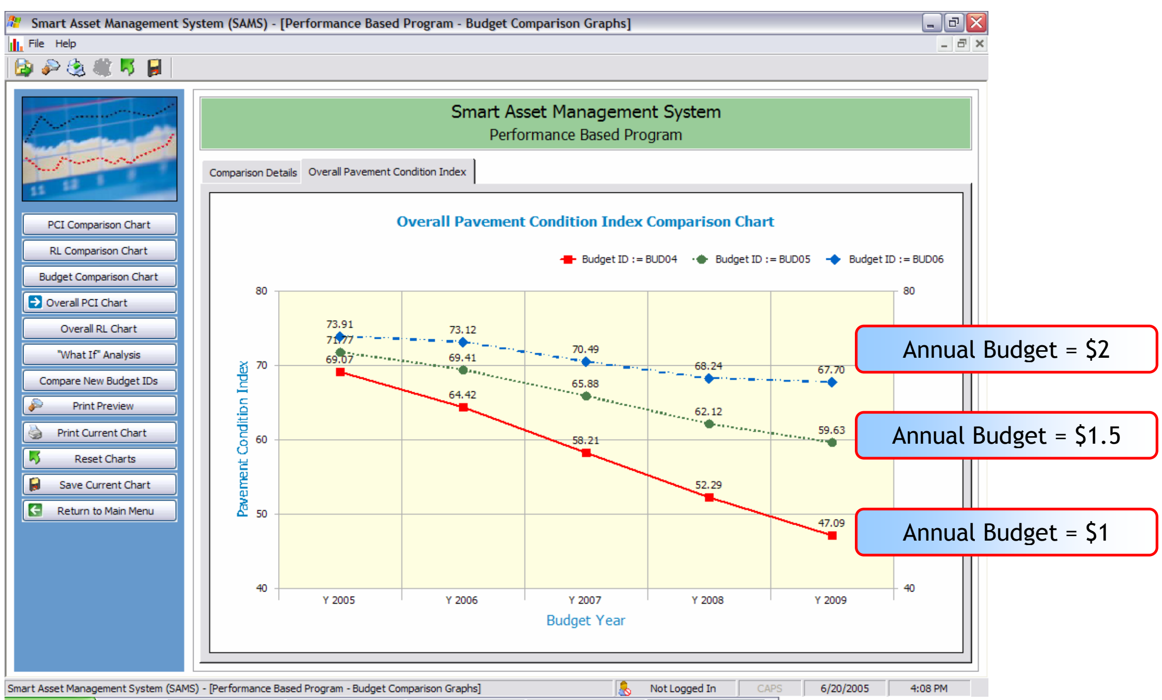

FIGURE 3 Performance modeling comparison for overall PCI.

The presentation showed not theory but real live examples of how an AMS truly is a decision-making tool. The important point he made throughout the presentation was that we need to get through the basic data gathering part of asset management and get to the predicting and forecasting stage where the real dividends are.

OPERATIONAL AND INSTITUTIONAL IMPACTS OF THE INTEGRATION OF A COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM AND ASSET MANAGEMENT SYSTEM

John Cerasari and Jesse Day, *Florida's Turnpike Enterprise*

Using Florida's Turnpike Enterprise as a case study, the presenters addressed the technical, operational, and institutional issues encountered under the integration of a computerized maintenance management system (CMMS) within the Turnpike's Facilities and Telecommunications Maintenance Office (FTM) and an enterprise AMS (EAMS) at Florida's Turnpike Enterprise. The planning, development, and implementation of these systems, the relationship of the systems, the benefit of integrating these systems, and a summary of the integration process were the topic of discussion. The 48-year-old Florida's Turnpike Enterprise consists of a network of toll roads spanning much of south and central Florida. Its $3.6 billion in capital assets includes 449 centerline miles of pavement and nearly 1,200 structures including bridges.

The CMMS is basically an AMS whose software typically supports basic capabilities such as inventory reporting, budget planning and preparation, PM planning and scheduling, work-order processing, and space management. This system was very good at processing work orders and managing contracts, but it was not designed nor implemented to track individual assets. Thus, FTM was unable to meet asset inventory, performance reporting and tracking requirements. An upgraded software program by DataStream called "7i" was implemented and details resulting in its successful implementation were provided to lend insights into each of the phases and steps required.

However, asset management–CMMS is not enough. The next step is an Enterprise AMS, which, as the name implies, serves an entire organization and encompasses multiple asset categories. Turnpike staff recommended the development of a system that could provide an accurate inventory of all Turnpike district assets; quickly assess the condition of those assets; and provide a method to forecast and prioritize periodic and capital expenditures required to renew or replace Turnpike assets. The result was the Turnpike Enterprise Asset Management System (TEAMS). Virtually all commercially off-the shelf AMSs impose predefined business process, data structure, and naming conventions. These applications usually employ "closed" proprietary database designs, and are difficult, if not impossible, to integrate with other systems. As a result of this research, the management team recommended building a new system from the ground up.

In its current state, TEAMS provides a comprehensive inventory of all Turnpike assets. The system also maintains condition data, renewal and replacement prediction information, and supports program-level budget development. A primary responsibility of TEAMS is to protect Turnpike bondholders by improving forecasting for capital and periodic maintenance expenditures. A key feature of TEAMS is the seamless integration of standard reporting capabilities coupled with online mapping capabilities. TEAMS is a graphically driven, fully integrated, AMS using maps and a "web-type" graphical user interface. All Turnpike personnel have access from their desktop computers through the Turnpike Intranet. Both presenters shared their implementation story in great detail.

Two important points need to be emphasized:

1. In most, scenarios, custom applications take longer to implement. However, there are distinct advantages to a custom approach: the organization doesn't have to change existing business processes or data structures; implementation is usually an excellent time to re-engineer obsolete or broken business practices; and a highly involved user-community in the development of the system typically increases user buy-in and, very importantly, hastens acceptance of the application.
2. System users make these systems successful. Dependable, well-designed software and a well-implemented system certainly improve chances for success, but an uncooperative user-community can substantially impede success, if not cause a slow, painful, and costly system failure.

TEAMS and CMMS benefits included

- Moving from PM to predictive maintenance,
- Making repair versus replacement decisions,
- Being able to see what isn't getting done,
- Improving vendor accountability through warranty tracking,
- Determining the value of your pavement management program,
- Making maintenance schedules available to other departments,
- Breaking equipment down by component parts, and
- Budgeting to pinpoint areas in need of attention before costs run out of control.

Exploring Resources

Ernie Wittwer
Wittwer Consulting

This session outlined resources that an agency might use to begin or enhance an asset management program. Speakers discussed training courses that are available as well as the fact that resources can also be found in local technical assistance program centers (LTAPs), within agencies in existing management systems, and within agencies in human resources. The speakers suggested ways that these resources could be used at low cost to make an asset management program work.

AVAILABLE TRAINING

Jason Bittner, *Midwest Regional University Transportation Center*

Jason Bittner outlined the results of a research project that the Midwest Regional University Transportation Center (MRUTC) undertook for the Michigan Asset Management Council and FHWA. The first objective of the research was to catalog training opportunities related to asset management so that the information is more available to the transportation community. A second objective was to review courses on asset management-related topics offered at universities on a for-credit basis.

The definition of asset management-related was fairly broad. It included

- Asset management generally,
- Rigid or flexible pavements,
- Bridge management,
- Inventorying,
- Strategic planning, and
- Monitoring and performance measurement.

The researchers identified some 70 training classes on the topic offered by academic institutions, state departments of transportation, LTAPs, the FHWA, and private providers. Those providers returned 33 surveys covering 40 courses.

Many of the courses found are no longer offered or are offered on an irregular basis. Very few of the classes are offered on a regular basis.

The surveys also asked about the instructional technique. The responses indicated a wide range of techniques used. Illustrated lecture was the most common, but case studies, interactive exercises, and distance learning were also mentioned.

The courses were intended for a range of people, as outlined in the following graph (Figure 4). Given the number of LTAPs who responded to the survey, the focus on local government was to be expected.

The typical length of courses was 1 to 2 days, with lengths as short as ½ day and as long as 3 days reported. The cost also varied. Some are offered without charge, but a fee of between $100 and $200 per participant was common.

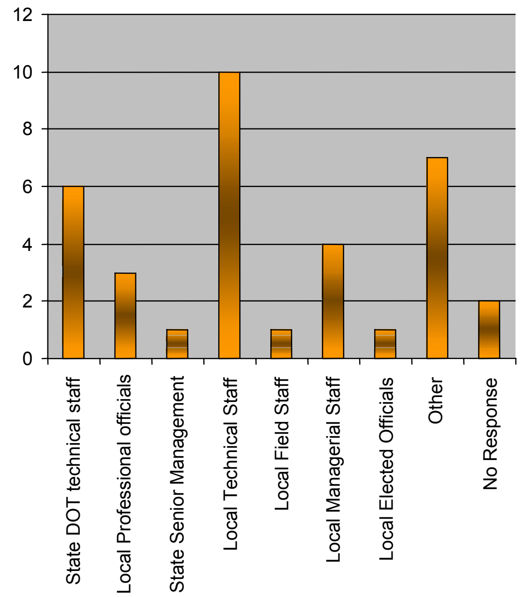

FIGURE 4 Intended audience.

Finally, the instructors also vary. Transportation practitioners and state and federal employees account for the majority of class instructors, but academics and consultants were also listed.

In the realm of the university offerings, 16 classes were identified and reviewed (Figure 5). They cover a range of topics. Most are offered in civil engineering programs, and most carry three credits. The use of texts is unusual; assigned readings are the more common approach in these classes. The entire report of this effort will be available at the center's website: mrutc.org.

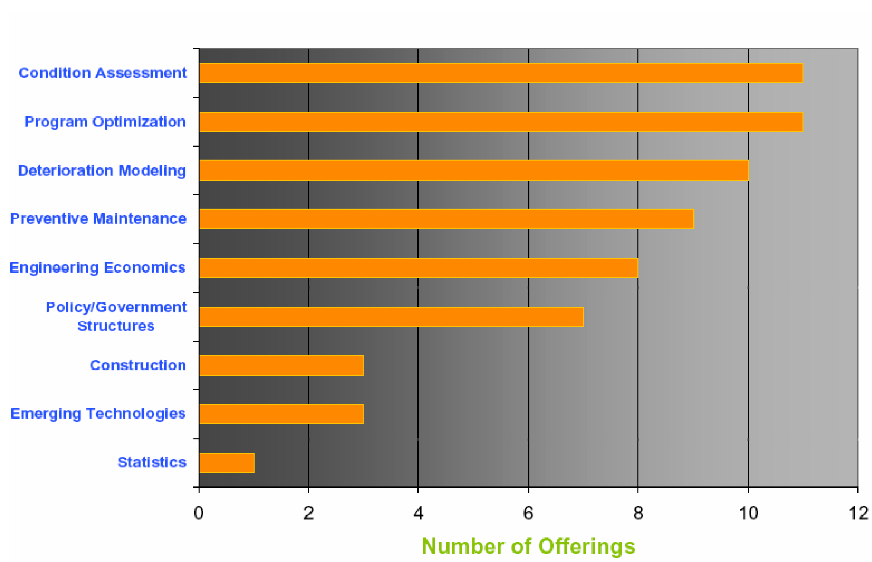

FIGURE 5 Common themes of for-credit asset management class topics.

RESOURCES AVAILABLE THROUGH LOCAL TECHNICAL ASSISTANCE PROGRAM CENTERS

Steve Pudloski, *Wisconsin Local Technical Assistance Program Center*

Steve Pudloski of the Wisconsin LTAP center provided an overview of the LTAP program and of the resources that can be found within LTAP centers. The program is very decentralized with a total of 59 centers located in every state. About two-thirds of the centers are housed at universities; the balance is located within state DOTs.

The mission of the centers is "to foster a safe, efficient, and environmentally sound surface transportation system by improving skills and increasing knowledge of the transportation workforce and decision makers." To carry out this mission, the centers offer training, print and video lending libraries, newsletters and professional resources. Each center also has access to a national network of center employees and resources. Often materials and answers can be found through this network, if they are not readily available from the local center.

In 2004, the centers collectively offered 570 courses on infrastructure management. About 90% of those courses dealt with technical issues, rather than management or decision processes. In 2004, the centers also offered 440 articles on infrastructure management topics. About 95% of these were on technical issues. About 5% of the infrastructure management courses and articles offered in 2004 dealt with asset management, pavement preservation, pavement assessment or GASB-34. Nearly all were technically oriented.

Pudloski summarized the strengths of the LTAP centers as a resource:

- Understanding of local needs,
- Access to local organizations,
- Distribution of information,
- Coordination of local efforts,
- Some technical expertise,
- Access to national pool of resources, and
- Partnerships and interconnection.

He also cited the pavement management training and technical assistance programs that are available in a number of states as an example of the resources available.

PAVEMENT MANAGEMENT AS A FIRST STEP IN ASSET MANAGEMENT

Kathryn A. Zimmerman, *Applied Pavement Technology, Inc.*

Zimmerman began her presentation by asking the audience how many were state or local transportation officials and how many used PMSs. Most of the audience replied positively to both questions. She then outlined the key functions of asset management:

- Monitor transportation asset conditions and
- Optimize the investment in these assets through cost-effective
  - Management decisions,
  - Programming decisions, and
  - Resource allocation decisions.

The challenge faced by many agencies as they begin an asset management program is to choose whether to move ahead with a single asset and add over time or to try a more comprehensive approach. If agencies consider which assets consume most of their resources, which are easiest to collect inventory and condition information, and which have management systems available to assist in the process, they will often decide to focus on pavements first.

Zimmerman outlined how all of the activities of asset management are also present in pavement management, but applied only to that single asset.

Figure 6 is an example of how the outputs from a PMS can be used to set a performance target for pavement quality [international roughness index (IRI)]. In this example, two different analyses were run: The blue line represents the cumulative costs needed for 75% of the network to be maintained in good or very good condition and the lower line represents the cumulative costs to maintain 70% of the network in good or very good condition. The dashed line represents the expected level of funding over the next several years. Using this graphic, the agency can set a realistic performance target of at least 70% of its network in good or very good condition on the basis of the expected conditions over that period of time.

Each of the five activities was illustrated within a PMS in a very similar manner. Focusing on this single asset, a PMS can help to monitor the condition of the pavements relative to defined goals and overtime. It can help make programming decisions and decisions on the appropriate program delivery strategy. And it requires sound, well-organized data, and analytic tools.

Overall, a PMS offers powerful tools to assist in the management of what is usually a transportation agency's largest single asset. It can be used as a starting point for a more comprehensive asset management program.

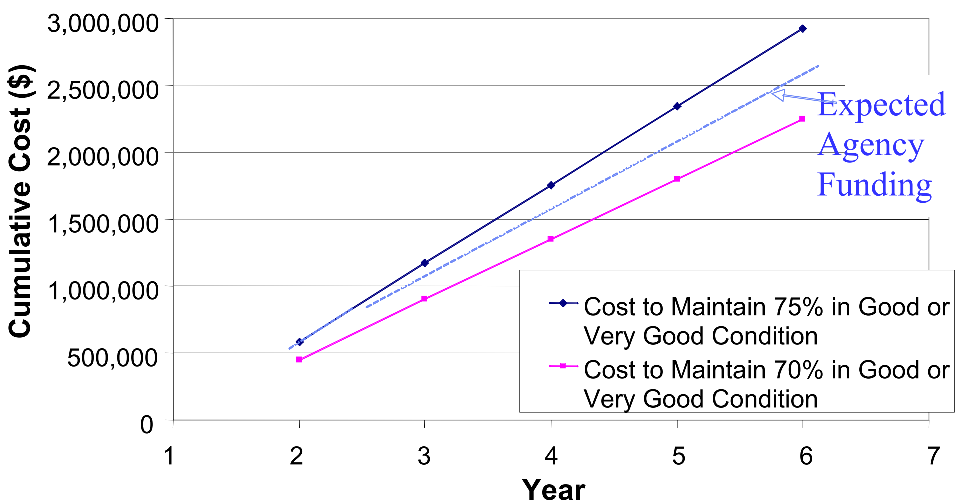

FIGURE 6 Setting performance targets.

ESTABLISHING AN ASSET MANAGEMENT CULTURE

Bart Selle, *Vermont Agency of Transportation*

Vermont made a concerted effort to involve and gain support from a wide range of people inside the agency and among its stakeholders as it developed an asset management program and integrated asset management practices into the basic operations of the agency. Bart Selle of the Vermont Agency of Transportation outlined their efforts and successes.

Their journey began with agency-crafted legislation passed by the legislature. The legislation said that "the agency shall develop an asset management plan which is systematic goal and performance-driven management." This plan was to have performance measures and a project prioritization process.

Even before the legislation was passed, the agency appointed a committee of staff to guide the development of their plan. The committee represented a wide cross section of the agency and was soon seen as a committee that accomplished things. With this reputation, the participation on the committee was enthusiastic producing wide support.

The committee was made up of a core group of program managers and engineers and had subgroups dealing with strategic performance measures, project prioritization, program comparison, highway sufficiency rating, and data integration. A key element of its success was the strong executive support it received.

In addition to the efforts within the agency, an effort was also made to enlist the support of local planning agencies. Each of those agencies was asked to prioritize local projects and to prioritize across asset types. This last effort represented something of a challenge for which no specific guidance was developed. The agency simply felt that local planners who understand the needs and aspirations of their constituents and local conditions were uniquely able to make such evaluations. While generally successful, these evaluations were not without problems. As Figure 7 illustrates, local agencies were reluctant to place a high priority on something such as Interstate bridges, which are clearly a state-level priority.

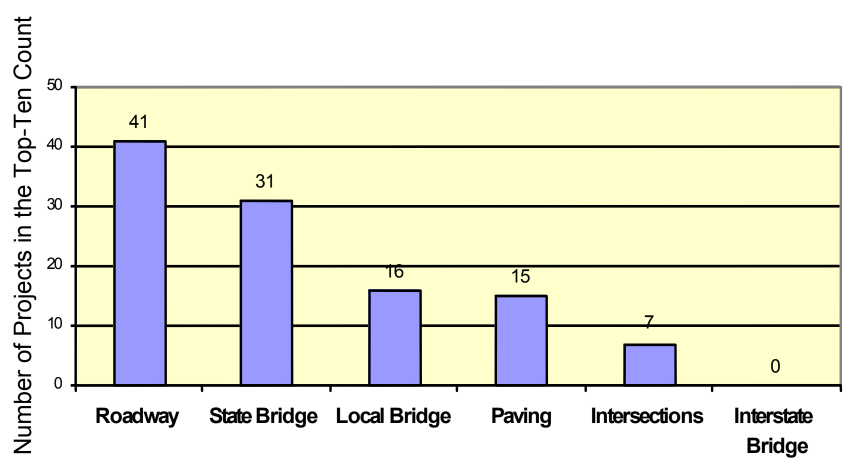

FIGURE 7 Top 10 projects.

To make asset management very relevant to the operations of the agency, it is now being applied to the agency budget request for 2007. The keys to this application are a rational project prioritization process and clear, understood performance measures. For performance measures, the agency has tried to keep things fairly simple. For example, they use a good–fair–poor assessment of pavements. From this they can target desired performance levels and track progress over time, as illustrated in the graph to the left. Measures allow the agency to communicate its plans, needs, and accomplishments to decision makers and to people within the agency. The examples used are pavement related, but Vermont has extended the same processes and principles to the wide range of assets that it is responsible for managing.

Selle closed with a point of caution. He noted that the asset management answer was not always the answer chosen. Transportation projects have momentum, so they tend to progress once they are started. Similarly, politics plays a role in public sector decision-making. But it is important to have the information and baseline created by an AMS to provide information to decision makers, so that decisions are as good as they can be.

Use of Available Tools

Francine Shaw-Whitson
Federal Highway Administration

This session identified several tools available to support asset management and illustrated their use in various applications. A general overview was provided, and in the instance of HDM-4 a paper was written.

NATIONAL PARK SERVICE ROAD INVENTORY ASSET MANAGEMENT AND DATA INTEGRATION

James A. Amenta, *Federal Highway Administration, Eastern Federal Lands Highway*

An overview of the Federal Lands Highway (FLH) Program was presented and the FLH Asset Management Program was discussed, with a focus on three action items:

1. Support implementation of Asset Management at the FLH partner agencies (Fish and Wildlife, National Park Service (NPS), Forest Service, and Forest Highways).
2. Improve awareness and understanding of asset management with FLH partner agencies.
3. Strengthen horizontal linkages to promote integrated decision making.

Amenta discussed the importance of an integrated database and how the PMS is integrated into the overall decision making process, especially for the National Park Service. The PMS has major decision trees that are based on

- Pavement performance indexes [pavement condition rating (PCR), structural condition rating, and roughness condition rating],
- Pavement age,
- Environmental zone, and
- Traffic and speed.

In our national parks, pavement materials are either hot-mix asphalt (HMA) or portland cement concrete, with the majority of the pavements being HMA.

Using decision trees along with geographic information system (GIS) loaded data, the NPS embarked on an ambitious project to collect data on every road in every national park utilizing VisiData.

VisiData is a proprietary, interactive computer software program that allows the end user the capability to display processed data with synchronized digital video images. The user can view, query, and extract the road inventory data that was collected for each national park. Information from the database can be displayed; for example, all roads with a PCRs of 60 or less can be identified. The display will sort and display all the routes in a park with ratings less than 60. The user can also “drive” a specific route to take a cursory review of the roadway features and pavement conditions.

VisiData also provides various levels of review from top management looking at the global picture of the park down to the roads and trails supervisor who is scheduling daily activities in the field.

HDM-4 AS A TOOL FOR ASSET MANAGEMENT

Peter D. Cook, *Sophia Yu Consulting*

HDM-4 is both a set of software tools and a systematic approach used by transportation analysts to assess the merits of alternative highway schemes and projects. While it is not a complete system for asset management, it can potentially make a significant contribution to some components of an asset management framework.

HDM-4 is the fourth version of set of software tools that has been developed over the last 20 years based on a substantial amount of international research. It consists of

- A research program on road deterioration and vehicle operating cost (VOC) effects,
- A set of technical models, and
- A software application that manages the technical models and evaluates strategies and improvements for the road network.

It provides a reasonably complete and well-developed framework for carrying out the valuation (both economic and financial) of highway projects and maintenance programs. In fact, it is probably the most developed framework in existence today representing a documented legacy of method, functionality and experience for highway project and program evaluation and trade-off analysis. It has been used in a wide range of countries, but particularly in developing countries to support economic evaluations of alternative highway projects particularly in support of project and program evaluations carried out by international lending institutions. More recently it has been used to carry out similar evaluations in emerging and developed country contexts.

The presenter provided a practitioner's summary overview of the development of HDM-4, its key features and capabilities, and strengths and weaknesses. Three case studies of its use were briefly reviewed. A preliminary analysis was then made of the potential use of HDM-4 in a U.S. state DOT asset management context. This analysis covered both its potential use in its current form and where improvements would be needed to best adapt it to a North American context. A vision for potential use of HDM-4 in the context of other emerging asset management tools was also given.

USING NETWORK-LEVEL PAVEMENT CONDITION DATA IN NEEDS-BASED BUDGET PREPARATION FOR AN ASSET MANAGEMENT SYSTEM: VIRGINIA DEPARTMENT OF TRANSPORTATION EXPERIENCE

Tanveer Chowdhury, *Virginia Department of Transportation*

Describing the overall condition of the roadway network, setting a performance measure and a target for the network, communicating effectively with top management are just a few examples in which a rating system could play a pivotal role. However, determining the timing and type of maintenance activity just on the basis of index numbers would be too simple at any level (network or project) and might not give an actual assessment of pavement needs.

The Virginia Department of Transportation (VDOT) has been collecting pavement distress condition data, in house, by a "windshield" type survey for the past 4 years. The collected data, as a result, had limitations. This year, VDOT again started using automated and semi-automated methods to collect data but only on a limited basis. In the use of the windshield surveys, there was little or no bias among the data collection teams, although there were issues with consistency and variability. Also, the data were not detailed enough for specific maintenance strategy selection in many cases. However, the challenge for the Asset Management Division was (*a*) to utilize the data collected by the windshield survey method, (*b*) to prepare a needs-based budget for the state's pavement needs, and (*c*) to develop a base for the allocation and distribution of the agency's $200 plus million annual pavement maintenance program.

Selecting proper maintenance activities just on the basis of condition indices would be too rudimentary. The pavement management engineers decided to use the distress ranges that were collected during the windshield survey. Four groups or categories of maintenance activities were selected and under each group several typical maintenance activities are commonly practiced within the state. These groups and their activities were a pavement matrix:

- PM:
  - Preservation of pavement condition and enhancement of pavement life and functionality and
  - No structural improvement
- Corrective maintenance:
  - Correction of minor to moderate distress situations,
  - Some structural improvement, and
  - Functional improvement, if needed.
- Restorative maintenance:
  - Repair of moderate to heavy distress situations and
  - Mostly structural improvement.
- Major rehabilitation:
  - Full-depth reconstruction.

For each group of activity, minimum, maximum, and most likely costs were calculated. Pavement maintenance decision matrices were developed based on every distress, the ranges of its frequency and its severity levels. The decision matrices were also developed on the basis of the combination of different types of distresses and their severity levels that could exist on a pavement section. Finally, the entire interstate and primary pavement network of VDOT was divided into homogeneous sections and a single maintenance activity group was selected for each homogeneous section for cost calculation.

The presentation highlighted

1. Different kinds of distress data that were collected with their extent and severity levels;
2. Different maintenance activity groups selected for cost calculations;
3. Development of the maintenance decision matrices for different distresses and distress combinations; and
4. Preparation of the needs-based budget for the agency.

The presentation ended by concluding that statewide unconstrained needs estimation helps higher-level management make decisions.

ASSET MANAGEMENT: KANSAS DEPARTMENT OF TRANSPORTATION'S NEED-SCORE APPROACH

Rosemary M. Ingram, *Kansas Department of Transportation*

In 1979, the Kansas Department of Transportation (KDOT) was directed to use a project selection system in which the process had documented criteria, was reproducible, had systematic and consistent procedures and was verifiable and quantifiable. KDOT uses a set of priority formulas to prioritize and select improvement projects. These formulas utilize a needs-based, data-driven process to remove possible arbitrariness and bias that may be introduced because of subjective influences of public opinion and the advocacy positions of stakeholders. The advantage of the approach used by KDOT is that the formulas objectively assess the need for improvement by using a multi-attribute needs function to address the trade-offs properly among multiple-competing objectives.

Essentially, the priority formulas calculate a "need score" of how badly any roadway segment or bridge needs major reconstruction or replacement as compared with every other roadway segment or bridge. The need score takes into account both the relative concern for different levels of physical deficiencies of the roadway segment or bridge, adjusted for such factors as traffic volume and the strategic importance of the route and the relative importance of fixing each deficiency to achieve the goals of a quality transportation network. Cost is not considered when the need scores are developed. Thus, the higher the need score, the higher the relative priority for improvement, regardless of cost. This is consistent with KDOT's philosophy that in developing a statewide construction program that includes projects from different regions, one should not lower the priority of a high-need project simply because it is in a region with a relatively high construction cost. This approach can be called "highest need first" as compared with methods used by other states that employ a "worst-first" or benefit-cost approach.

KDOT has successfully used these formulas for nearly 20 years and recently conducted an extensive review of the formulas. This presentation provided details as to how the "highest-need-first" approach works and discussed the formula improvements that KDOT has under way to recognize a maturing improvement program as well as improved technology and data gathering techniques.

MICHIGAN ASSET MANAGEMENT COUNCIL: AN INTERNET-BASED APPROACH TO COLLECTING INVESTMENT DATA TO SUPPORT ASSET MANAGEMENT

Robert D. Surber, *Michigan Department of Information Technology*

The Michigan Center for Geographic Information (CGI) is in the process of developing an Internet-based reporting application to support the statewide TAM process. The easy-to-use application is designed for local and county road agencies to collect information regarding planned or completed capital preventative maintenance (CPM) activities on the road system. Members of the TAMC serve as software requirement and design consultants.

The tool allows any road agency to log in securely to edit CPM information within its respective jurisdiction. It provides drop-down forms and an easy to use map interface to locate improvement investments. If an agency does not have Internet access, authority can be given to another entity (for example, a regional planning commission), to input and maintain CPM information for that jurisdiction.

Historically, CPM activities have not regularly been geographically tracked by road segment. The importance of this tool is that it gives all local and county road agencies with an Internet connection a way to begin collecting this information without much technical or financial commitment. This information is a critical part of the Michigan's TAM process. It will be used in conjunction with the road rating information to enable effective asset management better at the jurisdiction and statewide levels. The CGI will incorporate CPM data from this application and others such as Roadsoft when compiling information for the annual report to the Michigan Transportation Commission. Data inputs into the system include condition data, cost data and cost tables by region and treatment type.

Topics of the presentation included

- Providing the context as to how this tool fits into the overall statewide asset management strategy,
- Discussing system strategies,
- Providing an overview of the functions and capabilities of the application, and
- Discussing lessons learned and future directions.

The next steps in the development of the Internet-based approach investment data collection will consist of completing the Beta testing for a roll-out by January 1. The system should be ready and completely operational by the summer of 2006.

Comparing and Contrasting Asset Management in Transportation Agencies

Omar Smadi
Center for Transportation Research and Education
Iowa State University

This session compared and contrasted the TAM principles in organizations that vary in size, organizational structure, implementation status, and asset type. Different applications of asset management basics were presented to highlight the importance of implementing asset management and the flexibility in the tools implemented.

ASSET MANAGEMENT USED IN DISASTER RECOVERY

David L. Blake, *PBS&J*

This presentation highlighted the use of asset management to help address issues rising from a natural disaster. The case study presented covered Florida's Turnpike Enterprise System and the impacts of the hurricane season on the signs, bridges, and lighting structures along the 595-mi Turnpike system. Asset management was used to conduct a physical damage assessment to determine the financial damage (physical and loss of revenue) due to the hurricane. Table 1 shows the damage caused by each of the four hurricanes that hit Florida in 2004.

The presentation focused on using the AMS to manage the sign damage due to the hurricanes. Florida's Turnpike system utilized TEAMS to get a complete prehurricane inventory, determine cost for replacement, and determine a list of critical temporary signage to help the users of the system. TEAMS shows an accurate inventory and Global Positioning System (GPS) location of infrastructure assets, provides the current condition of assets, and presents a method to forecast and prioritize capital expenditures required for periodic renewal and replacement. TEAMS is not only used for signs, but it is also used to manage such assets as pavements, structures, utilities, and so on. This example shows how a management system can provide a tool to help decision makers estimate the impact of a natural disaster on the Turnpike system and allows them to make decisions regarding providing the right service to the customers.

TABLE 1 Florida's Turnpike System Financial Damage Assessment

Hurricane	**Month**	**Revenue Loss (millions)**	**Physical Damage (millions)**
Charley	August 2004	$3.27	
Frances	September 2004	$14.32	
Ivan	September 2004	$7.57	
Jeanne	September 2004	$7.05	
Total for calendar year 2004		**$32.21**	**$10.30**

CAN TRADITIONAL HIGHWAY ASSESSMENT STRATEGIES BE ADAPTED TO WATERWAY INFRASTRUCTURE ANALYSIS?

Bruce Lambert, *U.S. Army Corps of Engineers*

This presentation discussed how traditional asset management strategies can be used to help manage waterway facilities. Asset management provides a strategic assessment of economic tradeoffs between alternative infrastructure investments recognizing

- Increased demand on system,
- Mature network of roads and bridges,
- Increased competition for funding and support,
- Nontraditional players in decision process, and
- More focus on maintenance and meeting user expectations.

The presentation identified five critical problems that influence the implementation of asset management for waterways:

- Lack of standards and criteria,
- Condition assessment,
- Risk and uncertainty,
- Business line process, and
- Inadequate models and tools.

Even though asset management strategies for highways have been established, there are still some issues to making these strategies adaptable to waterways. Those issues include the following:

- Some highway activities could be applied, such as process and data integration,
- Waterway system is too diverse to rely simply on highway tools, and
- There is a need to look at more collaboration, especially for non-traditional relationships.

DEVELOPMENT AND IMPLEMENTATION OF THE ILLINOIS TOLLWAY MAINTENANCE QUALITY ASSURANCE PROGRAM

John Hausman, *Applied Research Associates–ERES Consultants Division*

The Illinois Tollway Maintenance Quality Assurance (MQA) program is an effort to develop a comprehensive AMS for the 1,650 lane miles of mainline, ramp, and toll plaza pavements in 11 maintenance sections in the state. The effort started as a pavement design and management tool and expanded to cover asset management in general. The MQA program is merely a report card for a maintenance section, a whole route, or an entire network. The idea is to be able to use a consistent methodology to

- Determine LOS defined by agency–customer;
- Measure conditions against agency-defined criteria; and
- Use random sample surveys utilizing a simple pass–fail approach.

To implement a MQA program, all the stake holders need to be involved and provide input and feedback to the process. The MQA program covers a wide range of asset categories and activities from roadside vegetation, drainage structures, traffic operations and safety, and pavements. The following steps are considered critical to the successful implementation of the MQA program:

1. Identify assets and activities and appropriate categories.
2. Develop asset performance/condition criteria.
3. Establish LOS goals.
4. Develop weighting factors (by asset and category).
5. Identify and train field survey personnel.
6. Perform MQA surveys.
7. Report findings and address deficiencies.
8. Update criteria and weighting factors as needed.

With the MQA program, the Illinois Tollway Authority was able to conduct network-level management for the entire system and also allow maintenance sections the ability to conduct detailed MQA inspections, have immediate notification of "critical" failures from survey crew, and develop comparative performance tools that allow for better management of the assets. The MQA program for the tollways will cover toll plazas, oases, and maintenance garages in the near future.

QUARTERLY PROJECT REVIEWS: WASHINGTON STATE DEPARTMENT OF TRANSPORTATION'S EXPERIENCE IN MANAGING ASSETS THROUGH ACCOUNTABILITY AND PERFORMANCE REPORTING

Aaron Butters, *Washington State Department of Transportation*

The Washington State DOT implemented a quarterly project review (QPR) process to be able to manage its assets through better accountability and performance reporting. The process covers all projects in the state capital improvement program. The QPR process covered about 35 advertised projects as of June 30, 2005. The process provides online access to the project information, project update, and the QPR. Figure 8 shows the flow of information covering the different phases of the project.

The QPR process is completed through conducting quarterly review meetings. The meetings cover a wide range of activities related to project delivery. The meetings are held each quarter between headquarters senior management and region/modal offices to establish oversight and accountability regarding the delivery of projects and programs. This covers

- Projects advertised or awarded,
- Status of projects under construction,
- Adjustments to delivery schedule or budget, and
- Project watch list.

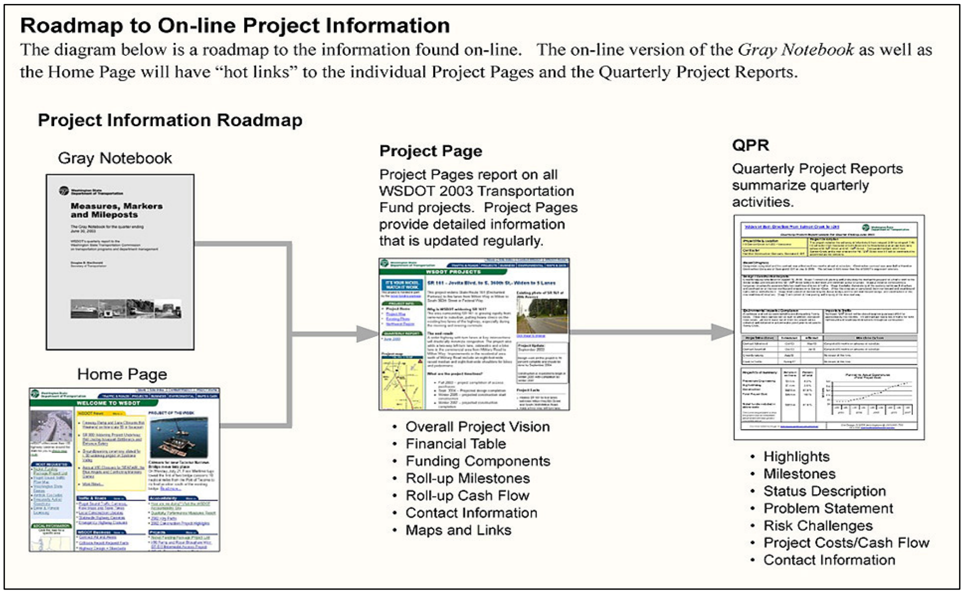

FIGURE 8 Washington State DOT project information roadmap.

The meetings help the DOT in aligning resources to help with the delivery of specific projects or challenges within the program from right-of-way acquisition to environmental permitting, and then to final implementation.

The review meetings are important because they provide a way to better manage the assets (in this case, capital projects) by increasing the accountability and reporting of the measured progress. The idea here is what gets measured gets managed. At the Washington State DOT, this process is termed the Gray Notebook. The delivery of the program is asset management and the successful delivery is the key to the funding of future needs. With this philosophy, the Washington State DOT is able to improve its project delivery to their customers and also secure more funding to continue the program.

Establishing and Using Performance Measures

KATHRYN A. ZIMMERMAN
Applied Pavement Technology, Inc.

Performance measures provide agencies with a means of measuring and communicating asset performance. Initially developed to help improve productivity and efficiency, today's performance measures are outcome based and are aligned with the agency's vision and goals. Performance measures enhance agency accountability and provide information to support policy-level decisions made by the management of transportation agencies, legislative bodies, and other elected and appointed officials. During this session, four agencies presented their success with the use of performance measures to report conditions, support privatized concessions, develop a long-range state transportation plan, and determine budget requirements.

PORTLAND, OREGON, TRANSPORTATION PAVEMENT PERFORMANCE REPORTING

Patricia Bugas-Schramm, *Portland Transportation Maintenance*

As the city of Portland, Oregon, faces population growth, increases in vehicular traffic, an aging infrastructure, and limited funding for transportation asset improvements, the Portland Office of Transportation is working with its stakeholders to maintain current service levels at a reasonable cost, meet future transportation needs, and avoid increased long-term liabilities. In her presentation, Bugas-Schramm documented these challenges and introduced the options faced by the Office of Transportation and its stakeholders for its street network:

- Maintaining the same funding level and increasing the backlog, which results in lower service levels and an increased liability in terms of needed repairs;
- Seeking additional funds to maintain the current service levels; and
- Securing sufficient funds to improve the current service levels.

To help stakeholders make this decision, a pavement asset management plan was developed to help explain the performance measures that were being used by the city, to compare Portland's practices with other agencies, to recommend changes to make the performance measures more meaningful, and to communicate the impacts of various LOS options so that elected officials and stakeholders could determine a plan for maintaining the city's street network. The components of Portland's pavement asset management plan are further described.

Introduce Service Outcomes

The city established its objective to deliver a smooth street network with responsive and affordable street maintenance services. This objective is captured in the city's vision of building and operating the system to last.

Compare Practices with Other Agencies

The city conducted an internet survey of practices in seven comparable transportation agencies and found that all agencies use pavement condition metrics such as a PCI or roughness index and report these conditions in terms of good, fair, and poor categories. In addition, several agencies use backlog as a measure of unfunded needs within the network.

Set Targets on the Basis of User Acceptance and Economic Efficiency

The city set strategic service level targets to help it achieve its objective. Several different service level indicators were used, including pavement condition, backlog, and service response time.

Use Specifics to Show Why Economics Matter

Several graphics were used to illustrate the economic consequences of deferring maintenance activities. Figure 9 illustrates the increased cost to pave one block as pavement conditions deteriorate.

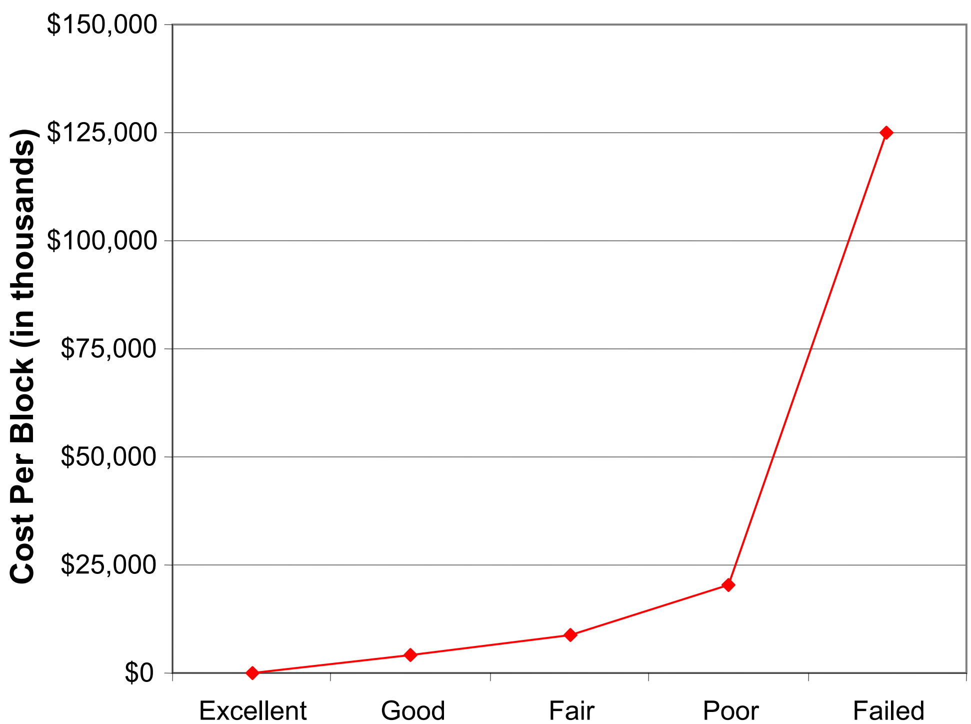

FIGURE 9 Cost of maintaining a street in deteriorating condition.

Question Yourself and Develop New Strategies

During this phase of the plan development, the city of Portland reviewed its backlog and pavement conditions and presented the information in different ways to determine whether the values accurately conveyed the city's needs.

Define Risk

During this phase, the department evaluated its confidence in the street inventory and processes used to assess pavement condition to better define the level of risk associated with its decisions. The department considered a number of factors in defining risk, such as the pavement deterioration rate, the street replacement value, the impact of deferred maintenance on future costs, and the inconvenience to the public. These factors were used to help establish improvement priorities.

Identify Relative Impact of Axle Loads

The relative impact of various vehicles was determined in terms of equivalent single-axle loads.

Develop Strategies That Address Risk

On the basis of factors such as pavement condition, value, risk, demand, and function, several different strategies were developed for consideration by the stakeholders.

Let Stakeholders Choose What They Can Afford

Armed with the information presented in the plan, a decision was made regarding the LOS that can be achieved and the funding levels needed to achieve these service levels.

Bugas-Schramm reported on the lessons learned by the department during the development of its plans. Several of the lessons presented by Bugas-Schramm are included here:

- Describe and use multiple measures of performance, such as condition, function, demand, backlog, and service response time.
- Address data accuracy (confidence) and risk in the strategies.
- Consider rate of deterioration and the impact of failure on the network.
- Involve multidisciplinary teams in developing and reviewing options presented to the stakeholders. Portland brought capital managers, street preservation managers and inspectors, and finance and information technology staff to the pavement asset team.

ASSET MANAGEMENT PERFORMANCE MEASURES FOR PRIVATIZED HIGHWAY CONCESSIONS IN BRITISH COLUMBIA, CANADA

Travis Gilbertson and Shawn Landers, *Geoplan Opus Consultants, Inc.,* and
Bruce McAllister, *British Columbia Ministry of Transportation and Highways, Canada*

The British Columbia, Canada, Ministry of Transportation (BCMoT) has recently embarked on several major highway privatization initiatives, which are delivered within a design–build–finance–operate (DBFO) model over a 25- to 30-year period. The projects introduced during the presentation include the Sea-to-Sky Highway, the Okanagan Lake Crossing, Kicking Horse Canyon, and the Gateway Project. Key to the success of these projects is the development of performance measures that describe the required outcome expected of the concessionaire in terms of operations, maintenance, and rehabilitation (OMR). Additionally, the performance measures served to help ensure that the privatized projects are maintained at service levels equal to or better than comparable highways maintained by the province. Gilbertson represents the company that has been working with the BCMoT as the lead OMR advisor on all provincial DBFO projects.

Under this type of privatized contract, the concessionaire is fully responsible for delivery of the OMR services, which include all maintenance, rehabilitation, emergency response, winter maintenance, and highway operations and corridor management activities. Required service levels are defined in terms of performance measures for minimum condition levels or response times. The performance measures established by the BCMoT are based on best practice and built upon the routine maintenance specifications previously established by the agency. The presentation focused on the development of standardized performance measures used by the BCMoT for its privatized highway concessions.

As part of the development of the standardized performance measures, a three-tiered approach was applied and established the following performance measure categories:

- Key performance measures focus on principal objectives for the key strategic areas of asset and corridor management. The objective of these performance measures is to maintain the structural integrity and value of the assets during the contract period and to maximize the reliability, safety, and availability of the highway corridor at all times. For example, a key performance measure for paved shoulders is to ensure that shoulders are safe and available.
- Asset preservation performance measures focus on ensuring sound asset management and take place by establishing minimum compliance conditions for individual assets. Asset preservation performance measures are defined for highway running surfaces, major structures, and drainage structures on the basis of limiting asset consumption, achieving design life expectations, and existing agency condition rating systems (CRSs). For example, the performance measures for the highway running surface include annual measures for surface distress, roughness, and rutting.
- Operational performance measures define the minimum acceptable requirements for the day-to-day operations and maintenance of the highway. These performance measures are consistent with existing BCMoT specifications with the exception that routine and quantified maintenance are combined and any caps are removed.

All performance measures were subjected to internal and external technical reviews that included benchmark testing, calibration, and pilot testing to ensure that they were practical and achievable. In some circumstances, local area specifications were developed for individual projects to capture unique circumstances that might exist.

In addition to the performance measures for OMR output, end-of-term requirements were established to define the criteria expected at the end of the concession period. Additional compliance criteria were defined for several assets, including highway running surface, structure component condition, drainage and debris control structures, rockfall catchment areas, avalanche control structures, and electrical systems. For example, a remaining service life (RSL) was established as an end-of-term requirement for the highway running surfaces.

USING SYSTEM PERFORMANCE MEASURES IN THE DEVELOPMENT OF A LONG-RANGE STATE TRANSPORTATION PLAN: AN IOWA DEPARTMENT OF TRANSPORTATION CASE STUDY

David J. Plazak, *Iowa State University,* and
Stan Peterson and Craig O'Riley, *Iowa Department of Transportation*

The Iowa DOT is considering the use of system performance measures in developing its long-range transportation plan. This presentation introduced the development and selection of appropriate performance measures and illustrated their use in long-range planning activities. Previous efforts by the Iowa DOT had established performance measures for highway maintenance, pavement management, bridge management, and aviation system planning. The results of a pilot survey on highway customer satisfaction are also available for use in developing the long-range plan, which is expected to be completed in early 2006.

The development of performance measures incorporated three guiding principles (safety, efficiency, and quality of life) over five transportation modes (aviation, highways and bridges, pedestrian and bicycle, public transportation, and railroads). The team establishing the performance measures tried to limit the number of performance measures to 30 so that only high-level performance measures are considered. Representatives from the DOT, university, and mode-specific focus groups contributed to the development of the performance measures. The group elected to use internal Iowa DOT data whenever possible, with adjustments for safety measures where appropriate. Time series data and spatial data were used as much as possible and cases where data was insufficient were postponed for later development. Examples of the resulting performance measures were presented as shown in Table 2.

The performance measures were useful in identifying data gaps and critical trends that needed to be addressed in the long-range plan. In addition, the performance measures were useful in identifying potential action items or needs and to explain these action items to decision makers and various stakeholders. Finally, the information was useful in drawing general conclusions regarding the long-term outlook for each mode of transportation mode and performance goal.

TABLE 2 System Performance Measures

Performance Goals	Modes				
	Aviation	**Highways & Bridges**	**Pedestrian & Bike**	**Public Transit**	**Railroads**
Safety	Percentage of airports with clear landing zones	Overall crash rate	Bicycle and pedestrian fatalities and injuries	Percent of public transit fleet with 2-way communications on board	Total crashes at rail highway crossings
	Number of runway incursions at towered airports	Fatal and injury crash rate		Public transit crash rate per vehicle-mile	Derailments per million ton-miles
	Number of accidents and fatalities	Crash rate for large trucks (combination vehicles)			
Efficiency	Airports with a PCI value of 70% or above on their paved runways	Percent of pavements with good or excellent and poor ride quality	Percentage of off-road trails that are paved	Percent of public transit systems with in-house maintenance capabilities	Average rail operating revenue per ton-mile
	Percent of communities that have a land use plan in place surrounding their airport	Percentage of bridges that are functionally obsolete or structurally deficient	Percentage of on-road trails that meet AASHTO standards	Percentage of public transit fleet operating beyond its normal useful life	Percentage of Iowa rail carriers that are earning a reasonable return on investment
			Average age of off-road trails		
Quality of Life	Population within a 2-h drive of commercial air service	Percent of system operating at traffic LOS "C" or better (separate for urban and rural)	Miles of off-road trails	Population in communities with public transit services sufficient to support independent living and employment	Percent of track-miles able to handle 286,000-lb cars
	Percent of communities within 30 min of a general aviation or commercial service airport	Approximate travel times to major external markets in the Midwest region	Miles of rideable highway routes based on bicycle level of service (BLOS)	Total jobs within ¼ mi of a fixed route transit system	Percentage of track-miles able to operate at 30 mphor more
					Rail fuel use per ton-mile

USE OF OPTIMAL PERFORMANCE MEASURES TO DETERMINE BUDGET REQUIREMENTS

Roy Jurgens and Jack Chan, *Alberta Infrastructure and Transportation, Canada,* and
Lynne Cowe Falls, *University of Calgary*

Alberta Infrastructure and Transportation (AIT), Canada, has been using performance measures in its planning and programming processes since 1998. As part of these processes, performance targets have been established, and results have been published in annual reports and business plans. At the network level, performance measures have been established for utilization, physical condition, and functional adequacy. In 2002, the existing performance measures were evaluated as part of a study conducted in cooperation with the University of Calgary, and recommendations were provided to make the performance measures more budget sensitive in terms of defining functional adequacy and deficiencies. These recommendations were adopted by AIT. This presentation described more recent activities to establish optimal performance levels for each measure and the results that were obtained.

Optimal levels were first defined as being the levels a jurisdiction would strive for in the absence of budget constraints. For example, an agency might define the percent of the network that can be in poor condition and still be defined as acceptable. Once desired, or optimal, performance levels are established, an agency can better plan its funding needs and long-range objectives. A review of practices in other agencies found that some agencies limit the percentage of the network in a deficient condition, others set targets for the percentage of the network in good (or better) condition, and that most agencies have unique definitions for defining road condition categories. Since no prevalent approach was found, AIT moved forward with the development of its own unique optimal performance measures.

To help the agency establish its optimal performance levels, several treatment strategies were evaluated to determine realistic network conditions that could be achieved. These strategies varied dramatically, including strategies that fix all roads in poor condition to strategies that fix roads that have not been resurfaced in at least 15 or 20 years. After evaluating the resulting conditions and funding requirements for each of the strategies evaluated, minimum strategic targets were set at 80% of the network in good condition, 15% fair condition, and 5% in poor condition.

In addition, functional adequacy measures were established that defined criteria for highway width, geometric and surface deficiencies, and weight restrictions. The recommendations approved by the agency included a strategic target that 90% of the highways will be functionally adequate by improving width deficiencies rated in fair or poor condition, geometric deficiencies (based on a subjective analysis), all surface type deficiencies, and weight restrictions on freeway, expressway, multilane, and major 2-lane highways.

Once these strategic targets were established, AIT estimated the budget requirements needed to achieve the recommended performance measures for highway condition and functional adequacy. While these targets are currently being used to monitor the performance of the highway network, the department is considering the use of the optimal performance measures to switch from reporting expected outcomes for specified funding levels to specifying performance targets to establish the overall strategic targets established by the agency. In other words, the department intends to use these measures to change from "monitoring only" to "monitoring and driving" in the future.

Role of Maintenance in Transportation Asset Management
The Buck Stops Here

DOYT Y. BOLLING
Utah Local Technical Assistance Program Center

Within any transportation agency, maintenance plays a major role in TAM. The maintenance unit of a transportation agency is the caretaker of all infrastructure elements for the major life of such elements. The maintenance unit must ensure that the service levels of transportation facilities are maintained, timely preventative maintenance to achieve the design life of facilities is performed, and preservation strategies to extend the service life of transportation facilities are employed. This session addressed the role of maintenance in asset management both on a systemwide basis as well as on an individual infrastructure element basis. The following presentations focus on one or more of these infrastructure asset performance measures.

SIMULATING ROAD SIGN LIFETIME IN NORTH CAROLINA

Elizabeth Allison Harris, *North Carolina State University*

This presentation covered a research project by North Carolina State University (NCSU) to provide a road sign replacement simulation tool that the North Carolina Department of Transportation (NCDOT) can use to optimize the maintenance and replacement of traffic control signs. The project focused on sign retroreflectivity deterioration and damage with respect to age of signs. Field inspections of existing signs of various ages were conducted in five NCDOT Divisions to evaluate the effects that the various environmental factors have on sign condition as well as evaluate the accuracy and efficiencies of sign inspectors.

Nighttime inspection data collection covered the number and location of rejected signs, reasons for rejection, and NCDOT Division's sign inspection and replacement procedures. A total of 1,681 signs were inspected at night. Daytime inspection data collection procedures measured sign retroreflectivity values, sign age, sign color, sign sheeting type, sign message, and sign location (GPS) as well as a photo of each sign. A total of 1,057 signs were inspected in the daytime. Other factors that were evaluated included such things as vehicular damage, vandalism (paintballs, eggs, paint, gun shots), and the effects of nature (tree sap, dirt, water damage). The current average damage rate in North Carolina was found to be 2.3% of signs every year. A spreadsheet analysis was used in the development of the sign simulation tool along with the establishment of sign rejection criteria based on the proposed retroreflectivity standards shown in Figure 10. Sign simulation inputs include sign projected lifetime, sign retroreflectivity performance, retroreflectivity deterioration with time, sign damage rates, sign replacement rates, and number of signs in the field. Sign inspector performance is also taken into account. The simulation tool outputs the number of deficient signs in the field for a given year. The number of deficient signs can be used to calculate the sign maintenance costs per year to keep the NCDOT in compliance with the proposed FHWA standard.

Sign Lifetime in North Carolina NC STATE UNIVERSITY

Signs Rejected Relative to Standard

Retroreflectivity, R	% of signs rejected by sign crew	
	Type I White	Type I Yellow
0? R<10	**71**	**83**
10? R<20	**83**	**73**
20? R<30	26	47
30? R<40	24	25
40? R<50	10	20
50? R<60	2	4
60? R<70	0	3
70? R<80	0	0
80? R<90	0	0
90? R<100	0	0
R≥100	0	0

FIGURE 10 Proposed sign rejection standards.

The sign simulation tool offers the NCDOT the opportunity and means to develop policies and budgets that will ensure that signs are inspected regularly and that sign maintenance budgets are adequate to perform the required maintenance work.

The NCSU Project recommends that additional sign research be conducted to acquire more retroreflectivity versus time data so sign life can be better determined. Project recommendations also suggest that sign farms be established across the state to better test how signs degrade in different geographical areas.

THE BUDGET THAT THE VIRGINIA DEPARTMENT OF TRANSPORTATION BUILT: HOW VIRGINIA'S ASSET MANAGEMENT DIVISION TRANSFORMED BUDGETING FOR HIGHWAY MAINTENANCE

Phebe Greenwood, *Virginia Department of Transportation*

Like many state DOTs, the Virginia DOT (VDOT) was facing pressures to know what infrastructure assets are owned, where they are located, what their condition is, what the performance target should be, when assets need repair, and what their life cycle is. Additional pressures to know how much funding is required, what the optimum funding strategies are, what the cost benefits of repair versus replace are, whether the asset is obsolete, and whether VDOT should outsource for maintenance of these assets. As a result of these pressures and previous disappointment with outsourcing for the development of an AMS, VDOT chose to develop a 6-year system operations plan in-house.

FIGURE 11 VDOT's asset management program.

VDOT's 6-year operations plan embodies the processes of planning, programming, cost estimating, budgeting, data collection, and measuring accomplishments. The plan was developed around the existing infrastructure management systems of bridges, pavements, and random condition assessments. VDOT's new budget process is driven by software models based on data collected biannually or annually through established asset inventories and condition rating procedures. Costs are estimated and modeled on network-level repair strategies. Budgets are tied to performance targets with maintenance activities being tracked and measured. Figure 11 shows a diagram of VDOT's asset management program.

VDOT's maintenance budget process currently models 80% to 90% of a $1.1 billion dollar budget. VDOT's new asset budget process provides objective assessments of maintenance needs; allocates resources based on needs; provides a single system to collect, compile, assess and manage asset information; and sets performance targets; monitors performance; and enhances safety and life expectancies of VDOT's assets.

USING ASSET MANAGEMENT TO DEVELOP MAINTENANCE BUDGETS

Douglas Betts, *Carter & Burgess, Inc.*

This presentation focused on how asset management is used to develop maintenance budgets for the infrastructure elements of pavements, bridges, roadside assets, buildings, and equipment. The budget development process is based on periodic condition ratings and assessments of these elements as compared to the condition goals desired for these elements. Capital budget development begins by comparing current condition ratings with the desired goals for these assets, determining future renewal requirements and future replacement requirements. Future needs are based on deterioration curves for each of these major elements. These deterioration curves are based on annual condition assessments wherein deficiencies are noted and deterioration rates are measured. During the budget development process disruptions of service and stakeholders are taken into consideration as well.

Budget Results

Asset Group	Condition Rating	Replacement Value (millions)	Capital Budget	Annual Operating Budget
Roadways	9.3	$ 1,162.8	$4,965,000	$ 5,168,000
Bridges	8.9	$ 215.9	$1,704,000	$ 187,000
Buildings	8.5	$ 76.7	$483,000	$ 1,346,000
Fleet	7.3	$ 5.1	$1,283,000	$ 290,000
Overall Assets	9.2	$ 1,460.5	$8,435,999	$ 6,991,000

FIGURE 13 Results of maintenance budgeting process.

The development of the operating budget compares current condition indices with the desired conditions along with a root cause analysis of major contributors to asset deterioration. Preventive and predictive maintenance requirements are also reviewed during the development of the operating budget. The results of the maintenance budgeting process are given in Figure 13.

APPLYING ASSET MANAGEMENT STRATEGIES TO TRAFFIC SIGNAL AND STREET LIGHTING SYSTEMS IN PORTLAND, OREGON

Dave Hutson, *City of Portland, Oregon*

This presentation covered the overall asset management program, asset management issues with signals and street lighting, and implementation of the revised signal reconstruction strategy of the city of Portland, Oregon. Lessons learned in dealing with signal and street lighting issues were also addressed. The replacement value of Portland's transportation assets is given in Figure 14.

The major issues cited for signals and street lighting included

- These assets are comprised of numerous individual elements.
- There is inherent difficulty in assessing condition since specifications and standards frequently change.
- Technical obsolescence exists.

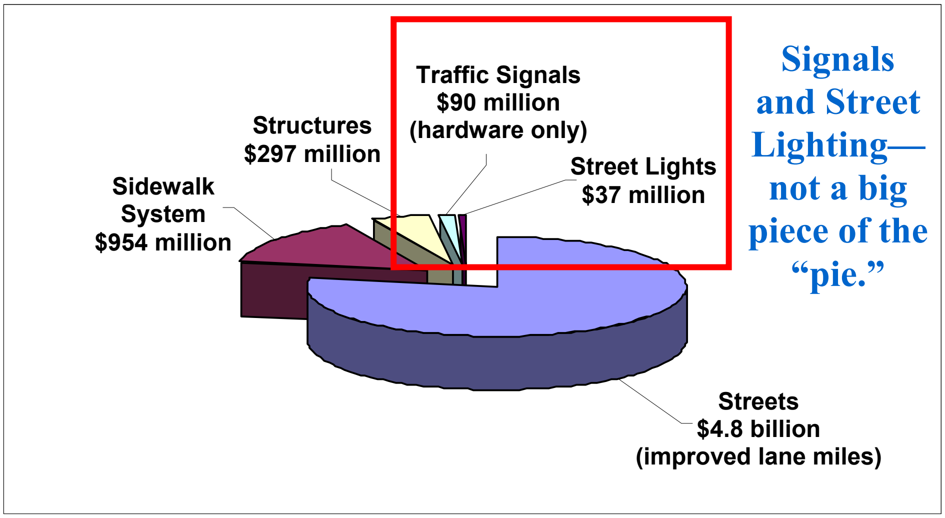

FIGURE 13 Replacement value of transportation assets.

Historically, Portland has used an age-based system to assess condition and the need for maintenance, repair, or replacement. The city is currently developing a condition rating–life expectancy system based on field condition inspections. The city has been tracking the condition of these assets since 1986 using a spreadsheet to predict future conditions.

Until 3 years ago, Portland did a complete replacement of signals when the need arose. It has since changed to a partial replacement strategy that allows the city to make four partial replacements for the cost of a complete signal system replacement. Estimated life expectancy is 25 years for the partial replacement strategy. The lessons learned by the city of Portland in implementing an asset management for signals and street lighting are

- Asset management requires an ongoing commitment as well as time and effort to collect, analyze, and present information.
- To be successful, an agency needs to demonstrate a technical knowledge of the asset and an understanding of the management process.
- It is helpful to demonstrate what actually happens when assets are not replaced as needed. For example, take props like old, rusty signal equipment into budget discussions.
- It is necessary to explain "useful life" to bureau directors and politicians for complicated assets like traffic signals.

Asset Management Applications in Small Organizations

TERRY MCNINCH
Michigan Tech University

DOYT Y. BOLLING
Utah State University

Throughout the United States, there are more than 37,500 small local agencies—rural counties, small cities, towns and villages, and tribal governments. Although small as organizations, they maintain nearly 3,000,000 mi of local roads and more than 299,000 local bridges. That amounts to 75% of the nation's street and highway system. That responsibility creates a critical need for asset management implementation. While most local agencies currently lack the understanding, technical expertise, and staff resources to adopt asset management concepts, some agencies have taken innovative steps and are achieving significant success. This session illustrates the successful application of TAM principles and practices in small organizations.

ASSET MANAGEMENT IN THE CITY OF MARQUETTE, MICHIGAN

Arthur Ontto, *City of Marquette, Michigan*

Arthur Ontto's presentation provided an overview of how the city of Marquette, Michigan, has adopted the concepts of asset management and how this process has benefited managers, elected officials, and residents alike.

Marquette, with a population of 20,000, is the largest city in Michigan's Upper Peninsula. The city maintains a variety of infrastructure:

- 89 mi of water main,
- Two water pump stations,
- Two water storage tanks,
- 85 mi of sanitary sewer main,
- Nine sanitary sewer lift stations,
- 75 mi of storm sewer,
- 86 mi of streets,
- 63 mi of sidewalks, and
- 14 mi of bike paths.

The city invested in the asset management process to

- Understand what the city owns,
- Prevent system failures,
- Deal better with planning and budget constraints,
- Inform the public of infrastructure needs,
- Gauge the LOS provided.

The city's asset management goal was to develop a capital improvement plan.

The engineering department started the process by evaluating every block of each street. PASER (Pavement Surface Evaluation and Rating) condition ratings were collected for all streets with the use of *RoadSoft GIS*, the road management system developed at Michigan Tech University. All utilities were identified, and data were collected as to age and condition. All sidewalks and paths were evaluated and rated. Once the data were collected, the information was all exported into the city's GIS system. Engineering staff researched the expected service life of all assets and developed estimated replacement costs.

Ontto then provided examples of the spreadsheets he used to combine data on street surface, water main, sanitary sewer, and storm sewer, along with the graphic GIS materials he uses for presentation to the city commission and the city manager.

A preliminary plan was developed to define the overall condition of the public works infrastructure and outline the resources that would be needed to maintain the existing LOS. Numerous workshops and presentations were held for city staff and management, city commissioners, and the community as a way to explain the plan and get buy-in at all levels. This effort led to the publication of the 2005 capital improvement plan. The educational sessions were a significant factor in acceptance of the plan by the city commission and city manager.

The city's asset management process has influenced the decision making process in a variety of ways. The city commission and city manager now have sound data to compare infrastructure trade-offs against limited budgets and thereby remove politics from the decision-making process. The city commission, the city manager, and residents understand the infrastructure needs and the funding necessary to maintain it at a level they are accustomed to.

The engineering department can develop long-range plans based on factual data and present the plan in an organized, graphical manner. City work crews are provided with a view of future repair or reconstruction, which ensures that work is performed within the big picture—not scheduling sewer repair the year after a street is resurfaced. And most of all, the plan has elevated the public's level of confidence in the city by providing answers to their questions of "Why is this work being done?" and "When is this work being done?"

The city still faces some challenges. Maintenance of infrastructure data is a never-ending task that requires dedicated manpower. Sufficient funding for infrastructure improvement is a constant struggle. With a new city management and new city commissioners coming on board in the fall of 2005, a new round of informational workshops and presentations will be needed.

DEVELOPING ASSET MANAGEMENT GUIDANCE FOR LOCAL AGENCIES IN MICHIGAN

Kirk T. Steudle, *Michigan Department of Transportation,* and
Joeseph Guerre, *Cambridge Systematics, Inc.*

Steudle provided an overview of the TAM process as legislated in Michigan, including founding of the TAMC by the state transportation commission and procedures for road surface data collection and reporting and training provided to support the mission. As continued support of local agency training, the council contracted with Cambridge Systematics, Inc., to develop a guide and training materials that would provide local agencies with ideas on how they can incorporate asset management principles into the way they do business.

The development process began with interviews at local agencies throughout the state to determine needs and concerns. Most agencies have made significant progress, have examples of good practices to share, and were eager for guidance and willing to improve how they do business. Every agency interviewed had some form of pavement and bridge condition data, but the level of sophistication is not proportional to agency size. All the agencies cited that local streets are underfunded, versus major streets, which are typically in much better condition.

These agencies are faced with significant challenges. They have difficulty estimating the cost and viability of PM strategies and understanding what types of road funding is available. Although most agencies have access to the tools for relating future condition to funding, few have done it because of lack of human resources and other demands. They would like to move toward merit-based project selection, versus the current prioritization based on local judgment and group consensus. The agencies see the need to communicate what peer agencies have done and the success they have achieved.

Cambridge Systematics used the input from the local agency interviews to focus the development of the guide and course materials, encompassing concepts as basic as what is asset management? to those as complex as estimating future pavement condition and developing a multiyear program. The guide will also include nontechnical material such as making the case to elected officials.

THE ART OF SECURING FUNDING FOR YOUR ROADWAY NEEDS

King Lloyd, *City of Glenwood Springs, Colorado*

Lloyd summarized how the city of Glenwood Springs, Colorado, has used a PMS to justify increased funding for the city's streets and roads and the process the engineering department undertook to make that happen.

According to the presenter, even the smallest local agency needs to implement a PMS. That program needn't be complicated. The PMS will put real data at the user's fingertips, instead of a rolled up street map and a note pad in a back pocket. Agencies should select a system that suits their needs and provides answers that decision makers find useful. The city adopted the T2_RMP PMS developed by the Utah LTAP at Utah State University and enlisted LTAP support to get the system implemented. The system allows the engineering department to build credibility through its responsiveness to questions by elected officials and residents. And it provides engineers and planners with the information necessary to determine what repair needs to be done, where it needs to be done, and when it should be done.

Lloyd shared some of the techniques he has used when presenting his plan for increased funding to decision makers and residents. First, understand the types of people you are trying to sell your plan to. Next, the use of RSL is a powerful concept that really drives home the point that keeping good roads good is a cost-effective approach. The plan needs to be as convincing about getting maintenance funding as it is about reconstruction funding. Provide various treatment analyses, showing the impact that different funding levels and treatment strategies can have on RSL. Last, use graphical displays whenever possible—graphs and GIS maps in particular because both elected officials and residents respond well to these types of visual approaches.

THE PAYOFF OF ASSET MANAGEMENT: PROVIDING EXTRAORDINARY SERVICE LEVELS

Tom Struve*, City of Eagan, Minnesota*

Struve explained how the city of Eagan's various departments have adopted different levels of asset management and then went on to explain how the Public Works Department has embraced asset management and has used multiple software programs to streamline efficiencies in service delivery.

The city of Eagan is surrounded by the massive growth of the Minneapolis–St. Paul metropolitan area. Since 1977, its population has increased 400% to 69,000, and its street miles has increased 250% to 233 mi. In the late 1980s, the city began implementing management systems for a number of city departments: city facilities, forestry, water resources, fleet management, utilities, and streets. That implementation and continued support of the asset management process has enabled the city to provide a LOS that far exceeds what it was when the systems were first introduced.

Management of the street system is performed by using the ICON PMS. The surface condition of every road segment is continually monitored and measured and evaluated at least every 3 years. The city's long-term goal is to implement the most cost-effective maintenance strategies to ensure the overall weighted average PCI of any neighborhood will be no less than 45 and that the global overall weighted average PCI of all paved streets in the city's system will be no less than 75.

Struve explained that decision makers use this information to develop maintenance strategies that meet the following objectives:

- Consolidation of work activities,
- Extended life cycle of repairs,
- Stabilized work load, and
- Financial stability.

The city performs an annual review of its infrastructure refurbishing and maintenance plan as well as an alignment of needs with funding and revenue. All this activity is coordinated with the capital improvement plans for the county and state DOT.

A big payoff of the city's asset management implementation has been education of the residents. Elected officials stand behind the data from the management systems, thereby demonstrating to the residents the validity of the process. Elected officials and city management are viewed as being well informed and making decisions in the best interest of the residents. Neighborhood meetings are conducted to explain maintenance and reconstruction plans. Cost estimates are provided in detail. Notification letters are sent to all residents in affected areas, allowing residents to stay informed regardless of whether they were able to attend the neighborhood meeting. The end result is great public improvements and full support of the residents.

Transportation Asset Management Applications in Large, Complex Organizations

MARY G. MURRAY
Federal Highway Administration

This session provided the participants with information, asset management principles, and tools that different states have successfully used to improve their pavement and bridge programs, address decisions about the feasibility of rehabilitating a bridge or highway, and increase the life of their infrastructure. The presenters demonstrated that integrating data collection early in the planning phase allows for better decision making about project funding and spending outlays so that pavement performance will improve over time.

UTILIZING A ROADWAY ASSET MANAGEMENT PLAN AS A PREVENTIVE MAINTENANCE TOOL

Douglas Betts, *Carter & Burgess, Inc.*

It is important to have sound historical or background data on pavement and bridge maintenance when analyzing asset conditions and developing an ongoing maintenance plan to implement cost effective maintenance strategies. Using asset management tools such as PCI, CRS, and Ride Index measurements to analyze pavement conditions allows agencies to determine where each pavement segment is in its life cycle so that the appropriate maintenance strategy can be applied. PCI and CRS deterioration curves can indicate how long a pavement system should last with appropriate maintenance. Some differences between CRS and PCI, however, are that PCI does not take into account the ride and is not calibrated for estimating the deterioration rate associated with truck traffic.

After analysis, the pavement condition can be mapped on the deterioration curve, and maintenance strategies can be developed on the basis of maintenance philosophy. The presenter discussed four broad maintenance strategy categories (localized maintenance, preventative maintenance, rehabilitation, and reconstruction), and their use can be determined on the basis of the level of pavement deterioration. The curves help anticipate when the activities should occur, to allow time for design, public education and input, permitting, utility relocations, coordination with other departments, etc.

An agency can obtain data that point toward appropriate maintenance decisions, whether it is localized maintenance to fix an immediate need, PM to preserve the original design, rehabilitation (when localized or PM is no longer a cost-effective option because of severe deterioration of the pavement), or reconstruction (when PM or rehabilitation activities are no longer an option to extend the useful life of the pavement). The results from the analysis of these four strategies can be easily incorporated into a maintenance plan that should be updated annually. The updates take into account current scheduled activities and the latest inspection information. Results from this approach include the communication of good stewardship of the assets, a budget planning horizon for fund allocation, documentation of the maintenance philosophy and approach, and a greater understanding and consistency of decision making.

INTEGRATION OF MAINTENANCE AND PAVEMENT MANAGEMENT SYSTEMS IN NORTH CAROLINA

Charles Pilson, *Agile Assets, Inc.*

The study provided background on North Carolina's PMS and maintenance management system (MMS). Data used in the PMS was collected from North Carolina's annual and biannual interstate pavement condition surveys, historical data from maintenance and construction records, profile and roughness data, and skid resistance data. The collected data were analyzed using decision trees, performance models, long-term strategic recommendations and plans, which are to be integrated with field planning activities.

Some challenges faced by NCDOT were to

- Integrate PMS into MMS Plan, develop a schedule, execute, and manage the cycles of the plan.
- Factor maintenance cost for certain activities into the decision making framework in the pavement management unit.
- Make pavement management recommendations that include making a long-term PM plan more available to field personnel.
- More closely integrate pavement preservation into pavement management.
- Store and maintain the linear reference system (LRS).
- Closely monitor the pavement preservation programs.

Solutions to the challenges included the development of separate PMS and MMS databases coupled by database links. NCDOT decided to store events using route, milepoint, and leave location referencing systems under GIS with GIS keeping a log of change transactions that they will query on a regular basis to update linear references in PMS.

Potential short-term benefits included an integrated plan with a schedule and managed cycles between MMS and PMS (including seal and resurfacing programs), better tools to manage these programs closely and monitor the long-term effects, and location-based data available to both systems under the LRS managed by GIS section. Other short-term benefits include making pavement management recommendations and PM plans more available to field personnel and allowing for integrated reporting.

Potential long-term benefits include more efficient data collection and the use of data for management and modeling analysis. Other long-term benefits include being able to better integrate pavement preservation activities into pavement optimization analysis. The survey results were used in more efficient allocations of maintenance dollars.

ASSET MANAGEMENT DATA COLLECTION FOR SUPPORTING DECISION PROCESSES

James William Bryant, *Virginia Department of Transportation*

Data collection is not only a key part of the asset management process, it's also important in the decision-making process. This presentation's objectives were to investigate how data collection is linked with decision processes, specifically at the project selection level and to propose a framework for effective and efficient data collection to support project selection decisions.

The objectives were accomplished in two phases. The first involved a literature review, which found that most transportation agencies are considering the integration of individual management systems in the development of comprehensive AMSs. Decision processes and data needs were identified for the three levels of decision making, which were strategic, network, and project levels. Each of these decision levels has a different focus and impact on the project.

A two-part TAM survey was utilized in the study to get general information on an agency's asset management and its roadway asset management. Findings from the survey showed that U.S. transportation agencies still collect data predominantly based on past practices and staff experience. The most important criteria for project selection are available budgets and earmarked funds, engineering parameters, and public demands and user opinions. The most important data for supporting project selection are structural and functional condition of the asset and the usage of the asset.

The study concluded that the U.S. transportation agencies have explicitly defined decision levels and are moving toward rationalization of data collection activities. Further research will involve identifying best practices, enhancing data collection framework, and developing standards.

Questions were addressed on the following topics:

- Cost information on data acquisition research, which will require additional follow-up as part of the further research.
- What it means to have an AMS in place.
- How data is being updated by states—states have formed GIS sections to maintain infrastructure data.
- Data collection links to the decision process.

HOW STATE DEPARTMENTS OF TRANSPORTATION USE AND COMMUNICATE INFRASTRUCTURE MANAGEMENT SYSTEMS RESULTS

Omar Smadi, *Iowa State University*

The use of infrastructure asset decision support tools like PMSs, bridge management systems, pavement monitoring management system, and HERS-ST (an economic tool to incorporate pavement condition data) has improved Iowa's project selection process and allowed better management of its highway budget dollars resulting in better service to the customer. The study discussed the importance of asset management focusing on the aging U.S. infrastructure, the change from construction to preservation, the role change in government, performance-based management, increased accountability, and the fact that asset management is almost a $1.75 trillion investment. Resource allocation across assets, network-level performance, funding impacts–trade-offs, and input to the individual management systems are results from implementation of the decision support tools.

Iowa has learned to plan more efficiently, set goals, develop strategies that will allow it to continually improve its asset management process, and maximize its costs by continuing to look for opportunities to obtain and communicate information to the decision makers. In the future, Iowa plans to develop a sign management system, work with the Iowa DOT linear referencing system for integration, and include "operations" as part of the asset management process.

The presenter addressed questions on Iowa's efforts to collect information of which Iowa has a GIS section to also handle mapping for bridges. Another question on retroreflectivity frequency was addressed by referring to the segment of the study on application matrix.

Transportation Asset Management Applications in Transit and Rail Organizations
Part I

TROY COWAN
ARES Corporation

This session focused on overall approaches to asset management within two different transit agencies of widely varying ages—one very mature (almost 80 years old), the other at its mid-life point (almost 30 years old). The session's speakers emphasized agencywide topics, highlighting goals and objectives, performance metrics, asset investment strategies, long-range asset plans, and other similar topics of interest to other agency's senior managers (e.g., CEOs, chief operating officers, and chief financial officers).

The discussions then dealt with various high-level policy questions and issues and culminated in a facilitated session with the audience to bring out overarching visions, assumptions, and decision criteria for possible use in guiding transit authority asset management planning.

The speakers were asked to give a brief overview of the size and complexity of their systems, their agency's vision for asset management, their current issues and challenges, and their current plans and approaches to solving those issues, as well as to give some insights into the decision criteria used to choose those approaches and the solutions to the challenges and issues.

A MATURE SYSTEM: PORT AUTHORITY OF NEW YORK AND NEW JERSEY'S MAINTENANCE MANAGEMENT IMPROVEMENT PROGRAM

Ernesto Butcher, *Port Authority of New York and New Jersey*

The Port Authority of New York and New Jersey (PANYNJ) operates across a two-state region with more than $14 billion in assets and four operational line divisions. It has a board appointed by two governors and a funding process that includes operating revenues and bonds only with no tax receipts.

PANYNJ's Asset Management Vision

The five strategic campaigns from PANYNJ's 10-year strategic plan were listed, one of which was very specific to asset management: "sound, secure, state-of-the-art infrastructure." This led to a reaffirmation to repair, maintain, upgrade, and replace existing assets, with the use of appropriate new technology and managerial practices to select which work to perform on which assets. The desired results included reduced life-cycle costs, high LOS, and increased reliability, safety, and security.

Current PANYNJ Asset Management Issues and Challenges

PANYNJ's assets are heavily traveled and its facilities heavily used, moving approximately 400 million people per year with an aging infrastructure (many systems more than 50 years old). While PANYNJ has several significant maintenance management policies and processes in place (e.g., maintenance standards, operating procedures manuals, MMIS systems), these have fallen into a state of disuse due to budget cutbacks and resource reassignments. Several disconnects now exist, including no linkage between asset management needs and maintenance being preformed, incomplete asset base for use in planning maintenance efforts, and lack of process for tracking true maintenance costs.

Current PANYNJ's Asset Management Strategies and Solutions

PANYNJ is addressing their issues and challenges by establishing clear linkages between asset management and overall business objectives; by taking a broader, more systematic approach to asset life management; and by implementing an explicit and visible way of consistently doing things in a business-like way. In his slides, Butcher detailed specific actions being taken regarding asset condition assessments, performance measures, and work process improvement. Benefits to be expected include understanding the true cost of maintenance, accurate accounting of assets, better budgeting of maintenance related work, and improved investment decisions related to asset management.

A MIDDLE-AGED SYSTEM: METROPOLITAN ATLANTA, GEORGIA, RAPID TRANSIT AUTHORITY'S TRANSIT ASSET MANAGEMENT

Carter Rohan, *Metropolitan Atlanta Rapid Transit Authority, Georgia*

The Metropolitan Atlanta Rapid Transit Authority (MARTA) operates across the metropolitan Atlanta area, spanning multiple counties in addition to the city of Atlanta. Operations run 22 h per day and support almost 300,000 boardings per day across MARTA's rail and bus systems. MARTA's rail system began operation in the late 1980s, and is now under going the first of its major renewal cycles.

MARTA's Asset Management Vision

MARTA's strategic approach to asset management relies on corporate policy, internal performance targets, resource utilization overviews from a long-term perspective focused on accountability using objective and analytical tools.

Current MARTA Asset Management Issues/Challenges

MARTA's assets have already used up 49% of their available useful life (based on $4.3 billion in asset value). MARTA has projected its capital requirements out 40 years and is faced with the challenge of obtaining the funds to execute the reinvestment plan, especially in light of additional needs for system enhancement, expansion, and regulatory compliance.

Current MARTA's Asset Management Strategies and Solutions

MARTA has developed a 10-year plan to distribute funds between the identified needs. The 10-year plan allocates 87.2% of the $1.9 billion planned budget to system reinvestments. The funds are then divided between the various assets based on a detailed condition assessment process covering the entire inventory in a time-phased plan over the 10-year period. Current initiatives focus on rolling stock (buses, bus drive trains, rail car conversions, etc.); fare gates (both as a replacement and a system enhancement); radio communications enhancements; track and rail station renovations; security upgrades; and, last, a significant investment in business process transformation using enhanced software and hardware.

DISCUSSION POINTS

Need for a National Transit Policy

The emphasis in both presentations was strategic investment in sustaining transit assets' life through planned maintenance programs, either operating funded or capital funded. This led to discussions about how this is not unique to these two entities, but is in fact a need impacting the nation's entire transit infrastructure.

Discussion then turned to the lack of a national transit policy, comparable to the national highway policy. It was noted there are federal funds available for rolling stock (railcars and buses); however, no federal funding programs exist to address infrastructure reinvestments.

Considerations for Developing a National Transit Policy

At the conclusion of the session, the attendees were polled for their ideas for key characteristics to be included in the description of an ideal transit agency. Three aspects were

- The key characteristics of the perfect transit system (the "vision"),
- Key assumptions that underlie the vision's components, and
- Essential decision criteria that would be used to select between options formulated to achieve the vision.

The traits and ideas for each of these are listed, below, as recorded during the session. These vision characteristics, assumptions, and decision criteria are presented here as thought starters, with the intent of promoting additional thought development and planning leading to the next session dealing with transit asset management planning.

Decision Criteria Used in Transit Systems

- Money
- Politics
- Technology
- Revenue generate

- Leadership and
- Culture changes

The Vision: Traits of a "Perfect Transit System"

- Availability
- Safety and security
- Reliability
- Involve ridership
- Efficiency
- Attractive choice
- Wireless internet
- Convenience
- Seamless
- Easily accessible
- Interconnected
- Adaptable
- Barrier-free
- Economical
- Customer-driven
- Pleasant
- Free
- Meets needs
- Data transparency
- Dedicated funding
- Affordable to other modes
- Adequate funding
- Convenient route planning
- Environmentally friendly
- Clean
- User feedback
- Safe
- Forward thinking
- Responsive

Assumptions Behind the "Perfect Transit System"

- Ridership demand will continue and grow.
- Maximizing mobility
- Customers matter
- Infrastructure condition will decline.
- Exciting and fun
- Land use policy will impact ridership.
- Auto congestion will increase.
- Provide mobility options
- Service expectation will increase
- Dependability will be assured.
- Auto will be strong competition.
- Customers' choices
- Customers' expectations
- Changing of rider-base and out-of-town riders (public) funding will decrease.
- Homeland security (operations)
- Inadequate leadership
- Need for a national vision
- Transit systems are not financially self-supporting.
- Importance of economic growth
- TRB involvement

Issues in Large, Complex Organizations
Facilitated Discussion

TOM MAZE
Center for Transportation Research and Education
Iowa State University

The speakers in this session, all from state transportation agencies, were asked to identify:

1. The origins of asset management in their organization,
2. The objectives of their organization's adoption of asset management,
3. The means of asset management at their agency, and
4. How asset management changed their agency and how change has been accommodated.

ASSET MANAGEMENT AND PERFORMANCE MEASUREMENT
Steve Takigawa, *California Department Of Transportation*

The California Department of Transportation (CalTrans) has a maintenance budget of $867 million per year and nearly 5,500 maintenance employees. Takigawa, the chief of the Division of Maintenance, has instituted performance measures and a budget model for maintenance activities that has helped to steer the department's asset management activities.

In the 1990s, CalTrans started with bridge management systems intended to comply with state and federal bridge inspection requirements, a PMS that was mainly developed to identify locations with distress, an equipment management system that was mainly used to report equipment use, and an outdated roadway maintenance management system. From these legacy systems, the division of maintenance evolved these systems in an asset management context, and asset management was tied to performance management.

Program-level action plans were written to tie asset management and performance management together. These plans had identified performance measures, which could be reported to individuals and organizations outside the agency, and must reflect the strategic goals of the agency. To be able to manage performance, relationships had to be drawn among condition, funding, and performance targets. The various asset category systems are used to forecast the performance and condition of critical infrastructure assets. The Division of Maintenance currently uses linkages between an integrated MMSs, a bridge management system, PMS, and a LOS system (defining the LOS targets for highways of varying importance) to manage and forecast performance. The adoption and development of these systems

- Was based on goals and objectives that were determined based on consensus building;
- Ensures clarity of mission and outcomes;
- Uses the data and performance measures to align resources—budget, project, and program decisions—and drives improvement of the department's overall performance; and
- Enables the department to operate like a business and be accountable internally and externally.

This has led to modernization of CalTrans's maintenance, improved resource investment, AMSs becoming central to the management of the maintenance enterprise and performance measurement, and increased accountability and transparency.

ASSET MANAGEMENT EXPERIENCE AT THE KANSAS DEPARTMENT OF TRANSPORTATION

Dennis Slimmer, *Kansas Department of Transportation*

The early adopters of AMS at the KDOT were the managers over bridges, pavement, and maintenance (developed in the 1970s). KDOT developed a flat file system called CANSYS, which contained an inventory of assets and their condition. This early system was useful in identifying preservation needs and needed capital improvements. However, most of the needs were based on engineering judgment, and were not consistent, or reproducible. The results of this system were scrutinized and questioned by the public and the legislature.

The defining act that put the KDOT on the road to data-driven asset management was a legislative directive requiring the KDOT to develop a consistent and reproducible method for allocating financial resources. This resulted in the KDOT creating the Office of Project Selection, an executive group called the Project Review Committee, and a Preservation Project Development Committee. Both the project selection process and the preservation project development process were linked to the agency's budget by cash flow analysis.

By adopting an asset management approach, the KDOT achieved the objectives of the legislative directive and has a consistent and verifiable approach to project selection. The use of consistent and data-driven methods for project selection resulted in building trust with the public and legislature. The KDOT also feels that through asset management, it was able to achieve better results with limited resources.

From their early beginnings of CANSYS to the present, KDOT has built a number of individual AMSs including those for maintenance, equipment, shop, and communications. The CANSYS has evolved and is used to help KDOT develop priority highways and segments and helps drive the programming for the statewide transportation improvement plan.

ASSET MANAGEMENT EXPERIENCE AT THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

Aaron Butters, *Washington State Department of Transportation*

Like all DOTs, Washington State DOT (WSDOT) has a wide variety of assets to manage, and Butters reviewed the status of each asset individually. The WSDOT owns and manages more than 3,400 bridges. Two bridges that are valued at more than $100 million are in need of replacement, 55 other bridges are structurally deficient and represent a total replacement cost of $600 million, and more than 200 geometrically deficient bridges represent a total of $1.4 billion in needs. Challenges in trying to integrate bridge management within the department-wide asset management include

- Protectiveness of technical experts of their data,
- Incorporation of system perseveration work into capacity projects, and
- Development of a prioritization process that includes the benefits and costs.

The WSDOT has divided its highway pavement network into three classifications of highways: chip and seal pavement, HMA pavements, and concrete pavements. WSDOT's objective is to resurface and replace these pavements on a frequency that results in minimum life-cycle cost. Challenges that they face in accomplishing their minimum life-cycle cost objective include

- Design of standards and environmental mitigation driving up the cost of preservation,
- Resistance to change,
- Ensuring that the most cost-effective pavement type is selected, and
- Lack of a predictive model for timing of concrete pavement failure.

The WSDOT is working to develop management systems in the areas of electrical systems (signals and message signs), drainage structures, and roadway slopes.

BENCHMARKING ASSET MANAGEMENT RESOURCE ALLOCATION AT LARGE, COMPLEX ORGANIZATIONS

Tom Maze, *Center for Transportation Research and Education, Iowa State University*

The Center for Transportation Research and Education (CTRE) is currently conducting a research project to benchmark how state transportation agencies bridge resources across functional areas to make resource allocations decisions that achieve agency-wide objectives. CTRE has interviewed managers of 16 states and has conducted detailed case studies within four states. They have found that although state transportation agencies have the same basic core businesses, each has unique methods and requirements for resource allocation. Some of the characteristics that successful states tend to have in common are

- The first priority in allocating resources is preservation;
- There is a broad understanding of the fund allocation–project select processes in all offices within the agency;
- The linkages between offices in decision making are structured and well understood;
- Top management is engaged and knowledgeable of the resource allocation process; and
- These agencies have objective performance measures, good information systems, and rigorous programs for condition data collection and condition projections.

Some general findings from their research follow:

- Federal requirements on the use of federal funds are an impediment, but not a barrier.
- Less funding is allocated by state transportation agencies on the basis of political and geographical formulas than was initially believed.
- For many agencies, sustainability is an issue:
  - As a result of allowing debt service to get out of hand and
  - As a result of declining revenues in dollars, and increasing costs.

Transportation Asset Management Applications in Transit and Rail Organizations
Part II

TROY COWAN
ARES Corporation

This session was designed for division leaders and operational unit directors charged with making asset management processes work and work well within the agency and their units. The topics covered agency-wide applications or focused on specific conveyances or departments; both very hands-on and solution oriented. The objective was to give the attendees lessons learned and ideas for improvements they can implement and the results they can expect.

CAPITAL NEEDS ESTIMATION PROCESS FOR SMALL AND MEDIUM-SIZE TRANSIT OPERATORS IN DOWNSTATE ILLINOIS

Richard S. Laver, *Booz Allen Hamilton*

This presentation dealt with a recently completed a detailed capital needs assessment covering all transit operators located in downstate Illinois, outside of metropolitan Chicago, including more than 50 different urban and rural transit operators with a combined fleet of 1,500 vehicles.

The study found downstate operators face significant capital needs and the average vehicle age for the downstate fleet greatly exceeds the national average. Most operators face growth in travel demand and most rural and senior service operators face an aging population and overcrowding issues (i.e., fleet sizes that are too small relative to ridership). The study's mission was to equip Illinois Public Transportation Association with a clear understanding of downstate capital needs for system preservation and expansion, technology enhancements, and safety and security improvements.

As with other states, Illinois is facing tremendous financial difficulties, and the competition for scarce state funds remains intense. To obtain funding in this environment, it is crucial that transit advocates adequately demonstrate to legislators not just the magnitude of their needs, but the positive benefits of meeting those needs and the serious consequences of not doing so.

The study included four key tasks: collecting supporting data (through questionnaires and on-site inspections), developing replacement rules, constructing a needs model, and assessing investment needs. The model developed was based on cost curves to determine minimum total cost to the agencies by vehicle type.

The end result was a capital needs estimate of $81 million required to catch up on the deferred replacement investments and approximately $30 million required annually to sustain the fleets thereafter. The study also demonstrated how current funding was insufficient to meet current needs out to 2013 and beyond. In contrast, it was shown how enhanced replacement models would lead to a significant decrease in operating costs.

AN EVOLUTIONARY APPROACH TO ASSET MANAGEMENT INFORMATION SYSTEMS: THE NORTHEASTERN ILLINOIS REGIONAL TRANSPORTATION AUTHORITY EXPERIENCE

Sidney E. Weseman, *Regional Transportation Authority*

This presentation described the regional transportation asset management system (RTAMS), an interactive web-based system, developed incrementally over more than 5 years for use by transportation professionals, as well as public officials and private citizens. The presentation dealt with environment at the time of its original development (2000), the design approach and resulting development experience, future plans, and lessons learned.

The RTAMS data cover the entire Northeast Illinois regional transportation authority (RTA) transit system (3,700 square miles, 260 municipalities, providing 554 million rides in 2004). RTAMS goals included improved access to transportation asset information, savings of staff time in filling information requests. The approach was to develop the system with RTA staff, managing developmental risks using an incremental and evolutionary approach to growing the system, using technical assistance from the University of Illinois. The RTAMS data warehouse has four major data sets: transit assets and services; highway assets; political jurisdictions; and tollway assets. The presentation displayed multiple shots of RTAM's data screens and example outputs, ranging from ridership data to listing of capital projects to sales tax revenues resulting from RTAMS operations. The lessons learned from this presentation included that incremental approaches work well; an agency needs to on the constant lookout for institutional paralysis; "location' is a powerful data organizer; and there needs to be continuous attention to partners and customers.

FOCUSED WORK: PRIORITIZED LINEAR ASSET MANAGEMENT FOR RAIL

D. Noah Eckhouse, *Optram/Bentley, Inc.*

Focusing on the unique needs associated with linear assets (e.g., rail tracks, bed as associated assets), this presentation demonstrated one solution to inventorying, assessing, and monitoring linear assets' condition parameters, as well as prioritizing and managing the maintenance work.

In the presentation, linear assets were defined and examples presented, differentiating them from regular distinct assets (e.g., rail cars). Intrinsic to the definition was the concept of the corridor encompassing the linear asset (rail tracks, etc.) and its supporting infrastructure (e.g., linear assets such as fencing and beds, and distinct assets such as transformers and signals).

Maintaining the linear asset requires maintaining the asset and the related infrastructure within the corridor, and scheduling the work in a way to minimize downtime and maintenance costs for the asset as a whole, maximizing throughput and return on investment (ROI), as well.

The system discussed tracked all aspects of the assets inside the corridor (linear and distinct), displayed where work was required, assisted in prioritizing the work and monitored its progress. The system can handle both corrective maintenance work orders, as well as routinely schedule preventative maintenance activities. The presentation closed with discussion of a New Jersey Transit example, using system screens shots to demonstrate the system's capabilities.

THE SAGA OF AN ASSET: RETROCOMMISSIONING— THE SECOND CHANCE TO GET IT RIGHT

Jean Backes, *Port Authority of New York and New Jersey*

This presentation highlighted the unique problems associated with being a more than 80-year-old agency, spanning two states, encompassing all major transportation modes (air, rail, vehicle and sea). It included an overview of PANYNJ, its uniqueness as the first nationally chartered multi-state transportation authority, its age, its scope, and its funding mechanisms (all from operating revenues, none from taxation).

PANYNJ has a need for retrocommissioning across its asset base for multiple reasons: an asset may never have been commissioned; an asset may need to be assessed for improvements required or to enhance system functionality; and the operations and maintenance (O&M) functions supported may require a tune-up. The presentation stressed that in all of these the maintenance functions were never viewed as a significant player, as operating funded maintenance was not emphasized in a capital-rich budget situation.

When doing retrocommissioning, project selection is important for success, as well as gathering basic inventory information from O&M manuals, equipment lists, maintenance histories, etc. The objective is to improve long-term maintenance strategies and programs to maximize the asset's economic life. The result is a master plan of deficiencies and improvements to be addressed, leading to a rehabilitation–renovation program.

Benefits include giving the facility owner a complete set of technical information necessary to maintain and sustain the facility, a comprehensive maintenance program (including diagnostics and lists of required repairs to sustain the facility) to reduce overall and long-term maintenance costs while increasing functional availability.

Data Integration Applications in Transportation Asset Management

JAMES WILLIAM BRYANT
Virginia Department of Transportation

JACK R. STICKEL
Alaska Department of Transportation and Public Facilities

Integrating a large transportation agency's financial work program database with a fully functional, web-enabled AMS can provide substantial agency benefits. Integrated data can help maintain facilities at a higher level of service and lower the cost to maintain over time. Historical, current, and planned project information can be successfully implemented with the pavement, roadway, structures, and facilities asset information to provide program-level funding and candidate project building tools. A common linear referencing system for maintenance work activities and project development can provide an enterprise solution for managing transportation assets.

REAPING THE REWARDS OF A SUCCESSFUL WORK PROGRAM DATA INTEGRATION

Rhonda K. Taylor, *PBS&J*

This presentation looked at the evolution of the Florida DOT Turnpike System from an authority-based system to enterprise operation. The Turnpike Systems Plan helps forecast required funding levels and prioritize periodic capital expenditures for the Florida Turnpike System. TEAMS is a web-enabled desktop application that shows an accurate inventory of infrastructure assets (and certain capital assets), provides the condition of assets, and forecasts and prioritizes capital expenditures required for periodic renewal and replacement.

The TEAMS mission is to assist Turnpike personnel in efficiently and proactively managing the assets of the Turnpike by providing inventory, condition, and forecasting, ensuring the safety of customers and protection of investments.

Data Integration

It is generally most cost effective to leverage existing legacy databases owned by an agency to extract, integrate, and disseminate the data. Because the financial information changes daily, current project costs, limits, and scopes must be reported at the same rate. This, in turn, enables managers to generate reliable and accurate inventory, performance, and cost reports.

TEAMS integrates a wide variety of related databases that includes crash data, tolls, facilities, work order system, structures, roadway, utilities, and pavement. Using a common linear referencing system such as the milepost linear referencing method enables the data to be positioned spatially with a GIS through the dynamic segmentation process.

Benefits of Data Integration

Integrated data can help maintain facilities at a higher LOS, lower the cost to maintain them over time, and follow the "fix it before it's broke" principal. An automated AMS can identify which projects are planned, where they are, when they will be constructed, and which projects to include in any analysis. There are three primary benefits from data integration:

- Better condition forecasting,
- Better project selection and scoping, and
- Greater fiscal responsibility.

Lessons Learned

Integrating work program information into an AMS can provide project trade-off analysis, such as the annual cost of delaying "big ticket" projects, such as a pavement resurfacing project. However, there are required prerequisites to make such a system successful:

- Get agency buy-in at the start.
- Understand the user needs.
- Data entry and project programming guidelines should be established and enforced.
- Asset management team leaders must be involved in the user requirements development.
- Customized systems cost more but potentially meet 100% of the users' requirements.
- Be prepared for data maintenance and plan for it before system rollout.

LOCATION REFERENCING FOR AN ASSET MANAGEMENT SYSTEM: A STATE DEPARTMENT OF TRANSPORTATION APPROACH

Jack R. Stickel, *Alaska Department of Transportation and Public Facilities*

A fundamental requirement for a successful AMS is the ability to report work activities easily and locate assets regardless on the work center's location referencing method. This presentation examines the approach the Alaska Department of Transportation and Public Facilities (ADOT&PF) has taken to enable maintenance personnel to use feature referencing and offset distances to report work activities and asset locations and have the location stored in the geodatabase using the enterprise location referencing method.

Data Collection Priorities

Before establishing a data collection program of any type, an agency should consider the purpose, accuracy, and agency capabilities for the program. As a minimum, the agency should consider (J. W. Bryant, Jr., and C. D. Larson. *Asset Management Data Collection Guid*e. AASHTO Edited Version: Final Draft Document)

- What is the intended purpose of the data collection process?
- What data collection method provides the level of detail to meet this purpose?

- Which assets to include?
- What is the best method available to collect the data?
- What resources are available to collect the data?

Location Referencing Solution

ADOT&PF developed a customized approach to allow the O&M staff to enter work and asset locations by milepost. First, a reference feature data file, which provides a look-up table of features and their milepoints, is imported into the ADOT&PF MMS. Second, the MMS user interface will be modified so users can select reference features and an offset (+ or – offset distance). The MMS will assign the appropriate milepoint in the location referencing system. An enterprise geodatabase typically stores feature locations in multiple location referencing methods. The approach allows O&M personnel to enter the locations by feature offset and have the feature locations to be stored in both spatial coordinates and the route/milepoint linear referencing methods.

Enterprise Location Referencing Benefits

This approach of integrating transportation and maintenance feature data into a common linear referencing method offers maintenance personnel the capability to use feature referencing to report work activities and locate assets. Additional benefits include

- Easy reporting of maintenance work activities,
- Timely access to work-related information and maintenance station profiles,
- Full GIS capabilities, and
- Capability to integrate MMS with other ADOT&PF databases.

SUPPORT FOR ASSET MANAGEMENT

Bill Roth, *Kansas Department of Transportation*

KDOT Transportation Asset Management Enterprise Architecture is a strategy aimed at aggregating and integrating KDOT management data so that it can be available across the agency. This presentation looks at the background for KDOT's GIS Portal (KGATE) warehousing strategy, the factors influencing the decisions to develop KGATE, and its role in support for asset management. A short tutorial of KGATE is available at https://kdotxtra.ksdot.org/kgate/index.html.

Drivers of Change

KDOT is facing many of the same issues other agencies face in developing geospatial technologies for asset management: implementing an enterprise solution, collaborating with business partners, introducing easier public access and involvement, implementing security procedures, and improving access and integration. The loss of experienced personnel and the need to upgrade technologies adds the need for cumulative systems and information availability.

Paradigm Shift

The KGATE paradigm shift is from infrastructure, solutions, and applications to infrastructure, solution, application, delivery, and information services. The developer can assemble any combination for specific case. There are more opportunities for shared enterprise solutions but these require a better understanding of our external partners.

Changing Information Technology Landscape

Service delivery and automation will become increasingly important. Information technology (IT) governance is still important, but IT infrastructure and solutions will become of secondary importance. Payback from IT infrastructure may come from unanticipated usage.

Understanding the Business Processes

Being able to understand and model the agencies' business processes will help improve service delivery. There needs to be an understanding of business functions and activities. Agency services must provide business and performance views across the integrated systems. The goals for service delivery are to

- Provide a single place to get everything about a topic,
- Allow business users to get the information themselves,
- Enable business users to see and modify processes with minimal support, and
- Develop a common process terminology and models for all DOTs.

The ultimate objective is to display data meaningfully, in the user's context and format, so the right information gets to the right people in the right time frame. Otherwise, match the deliverables to the information needs of the audience. The systems should be extensible to other parties that include consultants; local, state, and federal government; and other agencies.

Transportation Review

All assets should be within the scope for a transportation review. This may involve cutting across transportation modes and structure ownership. This may involve other asset types and transportation modes that are new to the agency, such as bike, rail, subways, and public transit. The asset improvement result is a single GIS delivery solution.

SPATIAL INFORMATION TECHNOLOGIES FOR ASSET MANAGEMENT: A PEER REVIEW SUMMARY

James P. Hall, *University of Illinois*

Transportation agencies face a number of issues in implementing GIS for asset management. Agencies must deal with multiple software platforms, a wide variety of legacy systems, multiple linear referencing methods, and historical data that typically are not spatially enabled. These issues lead to data stewardship concerns that involve data quality, timeliness, accuracy, and precision impact spatial information technology support for asset management. Data stewardship concerns span across field data collection, data processing, data update cycles, standards, database integration, and training. All these considerations play a role in the technical and organizational issues involved in an enterprise implementation.

The Bureau of Transportation Statistics sponsored a spatial information technologies for asset management peer exchange on October 31 and November 1 immediately preceding the 6th National Conference on Transportation Asset Management. The peer exchange asked five invited transportation agencies about their spatial data support for asset management. Each agency prepared a report, based on the following questions:

- How are the organizations using spatial information technologies to support and enhance asset management decision making and resource allocation?
- What are the benefits of using spatial information technology to support asset management?
- What spatial information technologies are being used to access and integrate data for asset management decision making activities?
- What spatial IT-enabled tools and products have been developed for user and management-level decision support for asset management?
- What roles or action can national organizations undertake to help state and local transportation agencies improve the use of spatial IT for asset management?

Spatial Information Technology-Enabled Tools and Products

Each agency has developed web-based queries to meet their agencies' business needs. The queries include both static decision maps and dynamic decision making products. More complex queries include those that will answer "what if" questions. Projected future products with greatest benefit include

- Automated data collection and processing,
- Data integration–conflation tools,
- More sophisticated web-enabled analysis tools,
- Road centerline—verification and accuracy,
- Economic analysis trade-off models,
- More integration with nontransportation assets,
- Improved query products for nontechnical managers,
- Enterprise implementation, and
- Mobile access.

Benefits to Using Spatial Information Technologies

Agencies must deal with managing change, data integration, and communication between systems and business areas on a routine basis. The most promising areas to deal with these issues include

- Data visualization—for staff, managers, legislature;

- Enterprise integration—across business areas and transportation modes;
- Complex analysis—data matrix for decisions;
- External databases—incorporate databases from outside, e.g., MPOs;
- Data delivery—intranet/extranet/Internet delivery; and
- E-government capabilities—public participation.

Roles of National Organizations

There was a wide agency view on what national organizations could provide, depending on where the agency is in the spatial IT development for asset management. The most frequent references to initiatives include

- Share best practices—case studies, documentation, exchanges, websites;
- Remote open data architecture;
- Finalize NDSI efforts, Transportation Data Content Standard;
- Upgrade national data sources—better standards;
- Develop transportation models; and
- Education asset managers of capabilities.

Analytical Issues in Transportation Asset Management

Gerardo W. Flintsch
Virginia Tech Transportation Institute

This section illustrated the use of analytical asset management tools for evaluating trade-off, allocating resources, selecting projects, and establishing and achieving transportation agency goals.

MONITORING AND MAINTAINING KANSAS DEPARTMENT OF TRANSPORTATION ROADWAY ASSETS THROUGH A PMS AND FUNDING PROGRAMS

Richard W. Miller and Rosemary M. Ingram, *Kansas Department of Transportation*

This presentation discussed a tiered approach used by the KDOT for pavement management. KDOT has annually surveyed and reported pavement condition since the early 1980s. This information is used for project programming in a process that consists of three tiers: (*a*) a need-based analysis for major rehabilitation and reconstructions (worst first); (*b*) a system performance optimization approach for minor rehabilitation, and (*c*) a routine maintenance strategy to "clean up" the rest of the network.

The first tier selects reconstruction or heavy rehabilitation projects by using a prioritization process: sections are ranked on the basis of geometric, capacity, and pavement need. Historically, about 60% of the need criteria are extracted from PMS condition data. The next tier is an optimization system that selects minor rehabilitation and PM projects. This system is part of the agency's PMS. This tool allows the agency to specify goals for pavement performance and computes the corresponding budget needs by using a network optimization system (NOS). The NOS recommends the mileage to be attended for each district and 3 years of candidate project locations with tentative scopes. The process is flexible and allows the addition of projects not recommended by the NOS. The implementation of the program requires that 40% of project mileage be selected from the first year of PMS recommendation, 60% from first 2 years, and 75% from all 3 years. This process was used to solicit budget authority from the state legislature and resulted in two successful transportation programs spanning nearly 20 years. The final tier is routine maintenance. For routine maintenance, the PMS produces "location and amount of routine maintenance" reports. These reports can be used by maintenance planners to estimate work loads and material demands.

Although it is hard to quantify to what degree each of these tiers contribute to achieving improved pavement performance over time, the historical condition data clearly indicate system improvement. The agency believes that a PMS with strong ties to program funding and project selection has clearly led to greatly improved pavement condition and helped ease the agency into transition into the world of asset management. Future improvements include system enhancements, incorporation of forward-looking performance measures to support management decisions, keeping upper management involved and aware, and appropriate integration with other management systems to support asset management.

IMPLEMENTING THE ONTARIO MINISTRY OF TRANSPORTATION'S PRIORITY ECONOMIC ANALYSIS TOOL

Alison Bradbury, *Ministry of Transportation in Ontario, Canada,* and
Joseph A. Guerre, *Cambridge Systematics, Inc.*

This presentation introduced an Excel-based tool for project-level economic analysis of transportation investment projects. The presentation also illustrated how the priority economic analysis tool (PEAT) fits into the Ministry of Transportation in Ontario's (MTO's), Canada, broader asset management efforts, and described the MTO's approach to implementing the new tool.

MTO has been implementing an asset management business framework (AMBF) for the past 3 years. The AMBF provides MTO with an ambitious blueprint for incorporating asset management concepts into its existing business processes. The backbone of the AMBF is the corridor investment plans (CIP), which identify and define deficiencies within corridors, report on performance measures, and analyze different long-term management alternatives including changes in condition or functionality.

The MTO developed PEAT in support of the AMBF. PEAT is a project-level economic analysis tool that enables users to analyze rehabilitation and improvement projects for highways, intersections, and bridges using an economic approach that considers both agency and user costs. PEAT provides a framework for consistent cost estimates across the agency. As a project moves through the project development process, its cost estimate improves and the most recent version of the estimate is incorporated into the economic analysis.

PEAT helps answer two fundamental questions: (*a*) Is a project a good investment from an economic basis? and (*b*) If so, when should it be implemented? PEAT answers these questions by applying the best practices of established economic analysis for future agency costs, travel-time costs, VOC, safety costs, and delay costs due to work zones. The model utilizes currently available MTO data and is calibrated to Ontario conditions. Noneconomic factors are also considered when the value of a project is determined. The priority of a project not only depends on the economic and noneconomic factors but also on the need to meet performance measure targets for the province.

The MTO is working to provide users with detailed guidance on when and how PEAT should be incorporated into the agency's annual investment planning process. The implementation effort also includes training, pilot testing on the CIPs, and sensitivity analysis. It is expected that PEAT will become an integral part of the new Integrated Highway Inventory System and will be able to easily gather information from existing management, information, and mapping systems.

RANKING INTERCHANGE NEEDS WITH THE SOUTH CAROLINA INTERACTIVE INTERCHANGE MANAGEMENT SYSTEM

William Edward Robert, *Cambridge Systematics, Inc.*, and
Ron Patton and Kevin Sheppard, *South Carolina Department of Transportation*

This presentation described a web-based interactive interchange management system (IIMS) being implemented by the South Carolina DOT (SCDOT). Interchanges are vital and complex components of the highway infrastructure, combining a number of distinct assets. These assets include road segments, ramps, bridges, culverts, tunnels, guard rails, signs, signals, lighting, and landscaping. Interchange construction and operation represents a significant component of the capital and operating expenses of the SCDOT. Interchange improvements are a strategic means for SCDOT to improve safety and reduce fatalities and personal injuries among the traveling public.

SCDOT is using the IIMS to facilitate data collection effort for its Interstate interchanges, including more than 200 interchanges and to support analysis and ranking of Interstate interchange needs in South Carolina. The IIMS provides SCDOT with a high-level planning tool to identify interchanges most in need of improvement and to evaluate the potential impact and cost-effectiveness of interchange improvement projects. The system contains an inventory of SCDOT interstate interchanges. Also, it incorporates a comprehensive set of models to predict agency and user costs for the existing configuration of an interchange, as well as for different candidate improvement alternatives. The IIMS models predict the VOC and travel time costs incurred by road users under different operating assumptions and calculate accident costs based on accident data collected for the interchange over time. The system predicts costs incurred by commercial vehicles forced to detour around the interchange because of load or height restrictions. It can be used to test alternatives such as changing ramp configuration, making intersection improvements, lengthening ramps, and adding lanes. The models used by the system are derived from models and approaches developed for the Highway Capacity Manual, the FHWA HERS and the AASHTO Pontis Bridge Management System.

Provided information on the existing interchange configuration and predicted future traffic, the IIMS can be used to predict the performance of each interchange, test different improvement options, and generate ranked lists of interchanges requiring improvement. The system is being developed in two phases. In the first phase, scheduled for completion in summer 2005, the system is being developed and put into production, and a data collection program is being conducted for a pilot set of 40 South Carolina interchanges. In the second phase of the work, data will be collected for the remaining 200 interchanges, comprehensive needs assessment will be performed, and minor enhancements to the system will be made as needed.

SENSITIVITY ANALYSIS FOR FUZZY LOGIC–BASED LIFE-CYCLE COST ANALYSIS APPROACH

Chen Chen and Gerardo W. Flintsch, *Virginia Tech*

This presentation introduced a fuzzy logic–based model for life-cycle cost analysis (LCCA) of pavement rehabilitation strategies and an investigation of the sensitivity of the model recommendation to variation in the various input parameters. LCCA is a key component in the TAM process, and it has been extensively used to support project selection-level decisions. Since LCCA is often based on uncertain, ambiguous, subjective, and sometimes incomplete information, fuzzy logic techniques are particularly appropriate to be used to enhance LCCA if it could be properly embedded into the procedure. The proposed LCCA algorithm is a rule-based fuzzy logic system in which the user can define rules to reflect the agency policies and strategies. The model's input variables include both structural and functional conditions of transportation assets. Outputs of the model are maintenance and rehabilitation strategies recommended by fuzzy logic inference rules. These strategies comprise selected treatment and recommended timing for those treatments. Agency costs over life span of the asset facility are estimated and discounted to current values. Although the model currently considers only agency costs, it has been designed to incorporate user cost in future enhancements.

One obstacle in using fuzzy logic systems is related to the definition of fuzzy set membership functions and inference rules. The sensitivity analysis evaluated the sensitivity of a prototype fuzzy logic–based LCCA model to inputs, fuzzy variable membership functions, and fuzzy logic inference rules. The motivation of the sensitivity analysis was to help design a practical setup process for fuzzy-logic-based LCCA models to support TAM decisions. The analysis specifically focused on the following questions: (*a*) What is the effect of changes in the membership functions of fuzzy variables (inputs and outputs) on the model output? and (*b*) How sensitive are the results to changes in the inference rules used in the fuzzy logic system?

Examination of the recommendations of a prototype fuzzy logic–based LCCA model and the results of the sensitivity analyses indicates that it is feasible and practical to use fuzzy logic techniques in LCCA. The linguistic inference rules permitted the incorporation of engineering knowledge (rules) into the estimation process of life-cycle costs. Although the output of the fuzzy logic–based LCCA model is sensitive to several of the membership functions' features, the recommendations of the model are relatively stable. As expected, the combination of rules used has a noticeable effect on the predicted life-cycle costs. However, the effect on the recommendations is not large; since the PM policy is selected in most of the cases. In addition, the location of the effective fuzzy area of the control variables (asset functional and structural condition) has the most effect on output life-cycle costs. In contrast, the overlapping of the membership functions does not have a significant effect on the output. However, a larger overlapping of the adjacent membership functions could help avoid the abnormal occurrence of maintenance, rehabilitation, and replacement activities. The effects of changes in the membership functions of output variable are less than input variables.

Best Practices in Transportation Asset Management

SUE MCNEIL
University of Delaware

This session showcased best practices in specific areas of TAM in the United States and internationally. Panel members focused on particular elements of an organization's asset management strategy or a specific strategy to enhance or development one area, for example the impact of maintenance on performance.

SUCCESSFUL DELIVERY OF AN ASSET MANAGEMENT SYSTEM USING ITERATIVE DEVELOPMENT METHODOLOGY

Charles Larson, *Virginia Department of Transportation*

VDOT maintains 91,332 km of highway, 12,603 bridges, four underwater crossings, two mountain tunnels, four ferries, 107 commuter parking lots, and 41 rest areas. Assets included as part of the highway infrastructure are structures, drainage, traffic devices, and roadside and special facilities. Emphasis on asset management has grown with increased pressures to know more about the assets (what assets are owned by VDOT, where are they located, what is their condition, when will they need repair, and how much funding is required), a shift toward privatization of highway maintenance and operations (1996), and a mandate to practice asset management in the Code of Virginia (2002). As such, asset management involves a multidisciplinary team including business, IT, and project management expertise with time, cost, and scope constraints.

Initial asset management project management methodology relied on the "traditional" or waterfall approach for construction. Experiences between 1995 and 2001 substantiated concerns around several pitfalls.

- Defining all requirements at initiation is impossible.
- Requirements change on the basis of technology, team learning, and new developments.
- Large projects have a high risk of failure (100% of projects over a certain amount failed).

As a result, projects were delivered but suffered delays. Clearly, an improved methodology was needed to develop future AMS products. The National Aeronautics and Space Administration incremental project development methodology was explored. The basic concept is that complete and useful products are delivered every 3 to 6 months. Subsequent iterations apply feedback and address high-risk items recognizing strategic directions provided by active involvement of agency management.

AMS products developed by incremental development include the following:

- Inventory and condition data for pavements, bridges, signs, guardrail, pavement markings, etc., used to establish $2.934 billion in unmet needs;

- Output of AMS used by the governor to support a request for an additional $97.4 million through our General Assembly; and
- Continued, small successes helping to demonstrate value of AMS to agency and promote change.

The project team received the Commissioner's Award for Outstanding Achievement (2005).

VDOT found the iterative methodology to be viable for AMS development. The methodology helps to identify the most important needs for an AMS (so they can be targeted first), address high-risk items early in the project, and seek continuous feedback from stakeholders. The methodology also adapts to changing requirements and technology and applies continuous learning gained in earlier iterations.

JUMP-STARTING YOUR INITIATIVE

Glen Ames, *Utah Department of Transportation*

With the analogy of jump-starting a car with a flat battery, the various steps from initial organizational framework to implementation were explored in the context of Utah DOT's asset management effort. These steps, organizational framework, self-assessment, goals, objectives, and strategies, and implementation are shown in Figure 14.

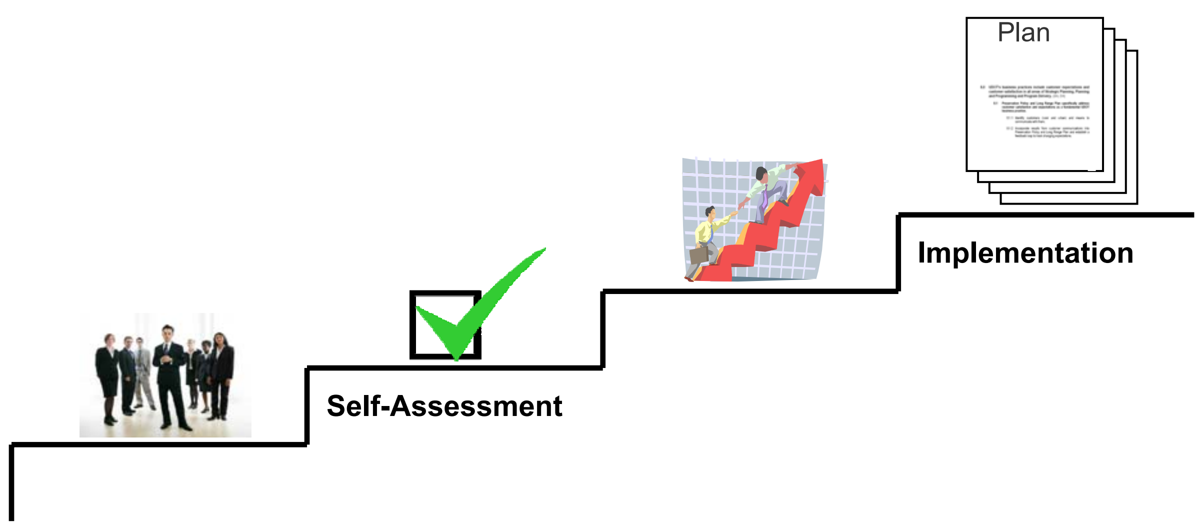

FIGURE 14 Steps in jump starting your initiative.

For the Utah DOT, the organizational framework involved assembling an asset management team, an asset management committee, and an asset management executive committee. The primary responsibility of each team was to nurture asset management in the context of the next relationships among the various committees with the asset management team having primary responsibility for implementation and development.

The self-assessment survey from the AASHTO *Asset Management Guide* was used by the asset management team to determine where the agency stood. The team added questions related to transfer of assets and desired practice versus current practice. Classes of respondents were used to track differences in perspectives in the analysis of the responses and the differences between current and desired practice became the basis for a gap analysis.

On the basis of the survey responses, goals, objectives and strategies were developed to reflect higher-level outcomes, performance targets, and mechanisms for implementing the goals and objectives.

The implementation plan then turns strategic goals, objectives, and strategies into an action plan that links each goal to the survey responses and action items that include assignment of responsibility (including specific names), due dates, and a schedule. The asset management committee reviews the plan each year to be sure that it is responsive to staff changes.

Utah DOT found that by following the process outlined, their agency was able to organize itself quickly; take the self-assessment survey; develop goals, objectives, and strategies; and produce a full asset management implementation plan within 6 months.

TRACKING MAINTENANCE ACTIVITIES FOR NETWORK-LEVEL PERFORMANCE MEASUREMENT

Roy Jurgens (coauthor: Jack Chan), *Alberta Infrastructure and Transportation, Canada*

At Alberta Infrastructure and Transportation (AIT), performance encompasses three elements:

- Utilization,
- Functional adequacy, and
- Physical condition (IRI).

Three-year targets are set in business plans in terms of anticipated outcomes. In terms of physical condition, targets are set with a 5% deterioration rate for different categories of road. However, in reality, AIT does not know where maintenance has taken place. In fact, it found that in some cases improvement rather than deterioration had actually occurred. For example, a thin overlay patch will improve condition.

Therefore, it was concluded necessary to develop a maintenance inventory. A pilot study was completed in 2004 for activities such as crack sealing, pot hole patching, spray patching, laid patches, deep patches, fog coat, reseals, skin patches, diamond grinding, thermo patches, and reprofiling. The study involved about 7.1% of the network and recorded information such as

- Operator name,
- Highway,
- Control section,
- Roadway,

- Lane,
- Start and end coordinate,
- Maintenance type,
- Completion date,
- Work order number,
- Quantity and unit of measure, and
- Cost.

Data were collected by using a pocket size GPS receiver and handheld or laptop. Software was loaded on to the handheld or laptop. To illustrate the magnitude of the change, a crack project reduced IRI by 4.3%.

It was concluded that changes in IRI occur because of deterioration and other factors. For example, outsourcing contractors are not required to report where they complete maintenance activities. There are also data errors (missing maintenance records) or variability in the measurement due to time of year, lateral variations, or different vendors. Therefore, maintenance data is important.

Additional data collection must be undertaken before deciding whether the maintenance inventory should be extended province wide. Also, further work is required to assess the other reasons for negative deterioration.

USING PERFORMANCE MEASURES TO ENHANCE ASSET MANAGEMENT IN NEW ZEALAND

Travis Gilbertson, *Geoplan Consultants, Inc.*

This presentation addresses performance models in the context of different procurement strategies used by Transit New Zealand.

Transit New Zealand is the national highway agency in New Zealand. It is a state-owned road authority, responsible for approximately 11,000 km of state highway. All professional services and physical works are outsourced. Transit New Zealand's approach to asset management is illustrated in Figure 15.

However, there are three models of procurement: (*a*) traditional, (*b*) hybrid, and (*c*) performance-specified maintenance contracts. In the traditional model, there is a contractual relationship between the client and the consultant and between the client and the contractor, but no direct functional relationship between the client and the contractor. The performance-specific maintenance contracts function like a public–private partnership. However, the hybrid model includes a direct functional relationship between the client and the contractor. In the hybrid model, the client provides governance, the contractor is focuses on short-term asset maintenance issues, and the consultant addresses longer-term asset management issues.

In the hybrid model, the client provides governance and funding. The consultant provides the asset management functions (asset preservation, corridor regulation, road hazard mitigation, information management, and performance monitoring). The contractor provides asset maintenance.

Performance measures are used to identify drivers and problems, identify solutions, work on continuous improvement, demonstrate compliance, establish benchmarks, identify external

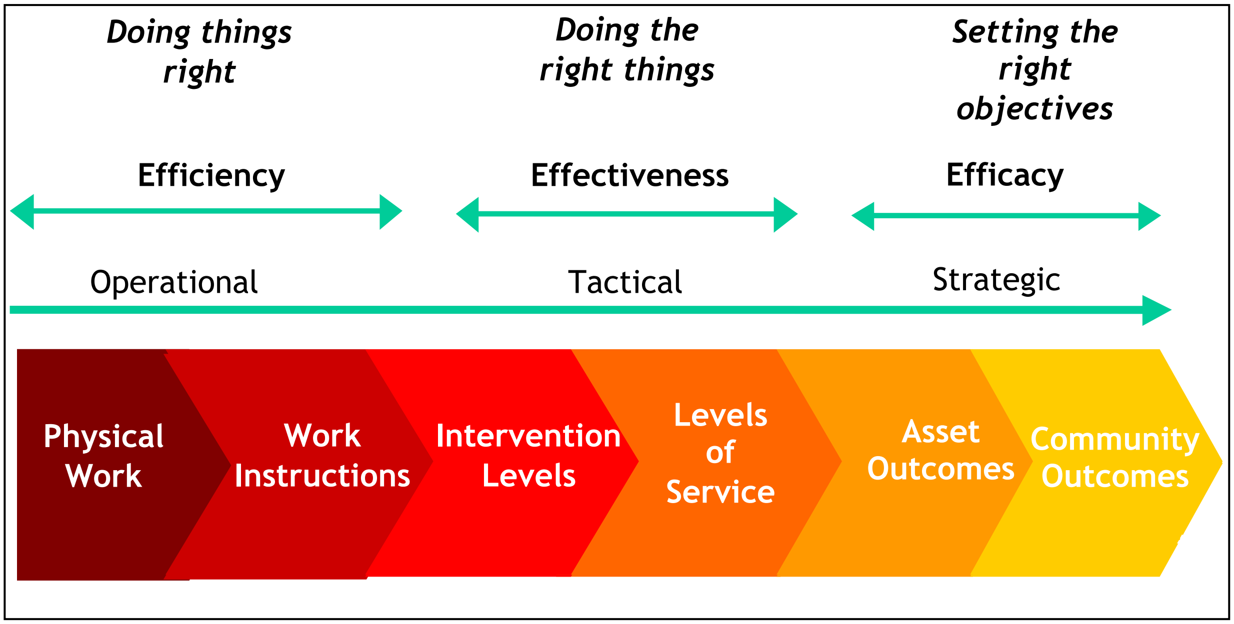

FIGURE 15 Transit New Zealand's asset management process.

influences, and recognize deficiencies. Effective performance measures relate measures to objectives, are easy-to-use and cost effective, and focus on improvement so that trends are more important than achievements, feedback is timely, and the review process is supported.

Key outcomes related to performance measures include

- Road safety,
- State highway protection,
- Environment,
- Asset management,
- Contract delivery,
- Culture,
- Services, and
- PM.

As a result, the contractor used 12 management performance measures, 48 operational performance measures (OPMs), and five network performance measures. The consultant uses 20 OPMs.

For example, the objectives for the maintenance contractor's work schedules are to

- Promote whole-of-life cost-effective maintenance works so all performance criteria are achieved,
- Optimize the LOS and investment,
- Improve the reliability of the network consultant's forecasts, and
- Provide sufficient information for the network consultant to respond to stakeholder and customer issues.

Performance measures relate to the accuracy and frequency of reporting. For example, the routing work schedule details the location and extent of all routine (including noncyclic) maintenance work the contractor proposes to complete during each month. For the maintenance contractor, three major noncompliances is a breach of contract. Figure 16 illustrates the key success factors as they relate to the contractor performance system.

The benefits of the hybrid compliance experience are that it encourages a "no surprises" environment, increases understanding of contractor–consultant activities, encourages improved networking, promotes innovation, and supports improved compliance.

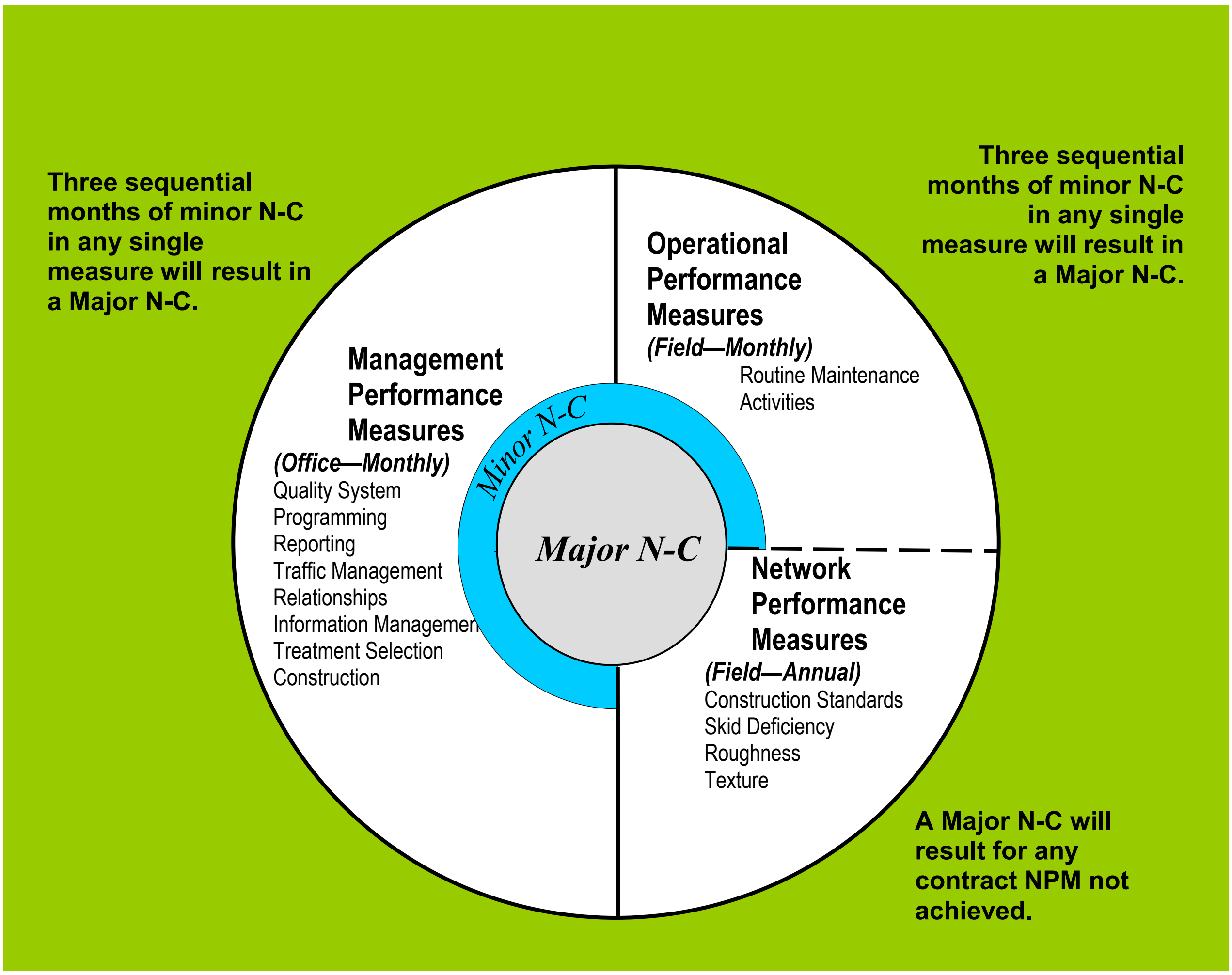

FIGURE 16 Contractor performance system.

Data Issues in Transportation Asset Management

VICKI MILLER
Federal Highway Administration

JACK R. STICKEL
Alaska Department of Transportation and Public Facilities

An asset management data collection program can help meet transportation agencies' business requirements and help establish sustainable funding levels to maintain the desired LOS. Some agencies may consider including intelligent transportation system (ITS) and multimodal transportation assets. A video log program can be an effective supplement to capture asset type, attributes, location, and condition. However, the program must first address the agency's user needs. A detailed work plan should include the asset types and attributes to be collected, the desired location accuracy, data collection equipment and procedures, agency business processes, data processing procedures, quality assurance, the ability of the inventory to be integrated into existing databases, and resource availability. Video imagery can help visualize the transportation assets to the agency, stakeholders, local government, and the public.

COST-EFFECTIVE COLLECTION OF A NETWORK-LEVEL ASSET INVENTORY

Michael Nieminen, *Roadware Group, Inc.*

This presentation examined how the city of Hamilton, Ontario, Canada, implemented an AMS.

The trend is toward increased utilization of GIS-based AMSs. Choosing a cost-effective strategy for roadside asset inventory data collection requires a clear understanding of the technologies and methods employed in mobile GPS data collection, the accuracies that are typically possible, and the challenges faced in the inventory program. Those agencies considering a video log system should address the following questions:

- What asset attributes should be collected for each asset type?
- What types of assets can be efficiently collected by using a mobile vehicle?
- What GPS coordinate accuracies can be achieved for asset positions?
- What are the limitations of using a mobile vehicle for the asset inventory?

Roadware collected digital video imagery for the city of Hamilton's 4,000 lane mile network with GPS positional accuracy better than ±1.5 m. Data collection focused on specific asset attributes for 55,000 signs and catch basins. Five control sites were established; an independent survey crew performed a traditional land survey to establish the accurate position of 78 individual features across the five sites. Image displays from the Roadware Surveyor software help demonstrate the asset features and the attributes process.

The presentation covers the five steps in the image data capture implementation:

- Data collection with ARAN vehicle—reference stations options;
- Postprocessing with GPS data—optional;

- Data importing—links digital images, data, and post-processed GPS files;
- Asset extraction—dependent on number and type of assets in inventory; and
- Export asset data—imported into AMS or GIS.

Asset Attributes

Any asset that can be visually determined from images captured along the roadway can be collected. Asset types can be assigned from code tables, e.g., Manual on Uniform Traffic Control Devices (MUTCD) codes for signs. Standard collected attributes are

- GPS positions,
- Asset type,
- Basic condition rating (good, fair, poor), and
- Digital image for each asset.

Types of Assets

A data collection vehicle will have high resolution digital cameras, a GPS receiver, an inertial sensor system, and distance measuring equipment. Panoramic imagery, collected at regular intervals along the roadway, e.g., 21.12 ft, can be used to inventory any asset that appears in the video image.

During data collection, the vehicle's onboard GPS system stores a record of the vehicle position. All images are georeferenced to the location at which they are captured. During the feature extraction process, software calculates the location of the feature in relation to the vehicle position. The system user then marks the asset position, the dimensions if desired, and records asset attributes.

Limitations of Vehicle-Based Collection

Technical hurdles in vehicle-based asset data collection include equipment, processing business rules, and data extraction software and procedures. Other limitations include

- Some assets perhaps not visible in the camera views,
- No possible determination of detailed data (such as asset serial numbers), and
- No possible assessment of condition in detail.

ASSET MANAGEMENT AND DATA COLLECTION USING DIGITAL VIDEO AND GPS DATA EXTRACTION TECHNIQUES

Andy Dalziel, *Stantec Consulting*

Populating an agency-wide GIS requires a substantial investment from both the agency and the stakeholders. To maximize the ROI in GIS, the asset data collection program must produce complete, accurate, and current data sets and be done in a cost-effective manner. New mobile technology using digital video coupled with an inertial positioning system and stereoscopic photogrammetric analyses provides an efficient and cost effective means of populating a geodatabase. This presentation examined a case study for the regional municipality of Halton, Ontario, Canada, that maintains the infrastructure data for the Regional Road Network Right of Way.

Data Collection Program

A transportation agency must determine which assets are to be collected and what is the best method for field data collection before implementing an asset data collection program. Key steps include

- Cataloging existing data sources (paper, Mylar, computer-aided drawing, and GIS);
- Reviewing the detailed data requirements data;
- Performing a data gap analysis;
- Establishing rules, relationships, and linear referencing schema; and
- Documenting the approach to execution of data collection.

The presentation covers the different data collection methods, the data sources, advantages, and disadvantages of each method. A scoring matrix was established for each transportation infrastructure asset with respect to the data collection methods.

Data Collection Selection Methodology

Data requirements will help shape the data collection methodology selected. Specific requirements included data collection accuracy, e.g. submeter, road geometry, asset types, and specific attribute data. The capability to integrate the asset management data collection with existing or proposed transportation systems or GIS is also important. Surveying existing data collection methods that meet these requirements and analyzing the advantages and disadvantages of the systems will help identify the return on investment.

Project timelines, resources available (agency, contracting, funding), and other benefits (both within and outside the agency) fit into the final selection method. A mobile digital video survey satisfies the data collection requirements for the Halton project.

Mobile Digital Video Survey Work Plan

Documenting the approach to asset data collection requires establishing a work plan. The work plan should define the life cycle of the data collection. The data flow and data processing steps should include

- Equipment preparation steps,
- Business data models,
- Field data collection procedures,
- GPS post processing procedures,
- Feature extraction, and
- Quality assurance–quality control.

The equipment preparation should include the number of cameras, camera orientation, and the vehicle dynamics to help increase accuracy and positioning. The data models should schematically depict the databases, servers, data flow, and data repositories. The GPS postprocessing should describe the steps that include real-time data acquisition and any software that provides further postprocessing such as including the vehicle dynamics and any base stations used.

Anticipated Benefits

Regional Network Right of Way

The video survey meets the Halton Transportation Services Department's immediate needs for their Regional Road Network Right of Way for

- Accurate georeferenced high-resolution digital image archive of the road network, including asset and attribute data relationships;
- Visuals for public presentations;
- Customer complaint review feedback tool;
- Reduced field visits;
- Dataset for emergencies;
- Dataset to catalogue and remove illegal signs;
- Dataset for nontransportation assets with the right of way (hydro line crossings and fire hydrants); and
- Automated vehicle identification integration with ESRI software.

Meeting Multiple Business Needs

The video survey has the potential to meet multiple agency business needs. These stakeholder business needs stem from the data requirements phase and the work plan. The primary data use will be for asset management planning and sustainable asset management. There may be ancillary data uses for Americans with Disabilities Act obstruction and compliance and E911 systems. Anticipated benefits for the Regional Municipality of Halton include

- GIS transportation infrastructure database,
- Public works asset management,
- Immediate safety maintenance needs,
- Full video log network for liability issues,
- Pavement management program, and
- Engineering for preliminary design.

The asset data collection program is integral to establishing the unit cost and replacement value on the agencies' transportation assets. A detailed financial analysis should include an estimate for a sustainable funding level and revenue requirements to maintain the desired LOS. Multiyear funding plans to meet the desired LOS can be established.

Visual presentations are effective in communicating the asset replacement value to the agency, local government, and the public. The impacts of rate and levy programs on transportation assets can be effectively demonstrated for all public services. Comparing the daily cost for various public services can put the infrastructure costs in terms the household can understand.

VIDEO-BASED ASSET DATA COLLECTION AT NEW JERSEY DEPARTMENT OF TRANSPORTATION

Kirk Weaver, *Michael Baker Jr., Inc*

Kirk Weaver presented information on New Jersey DOT's (NJDOT's) experience in using video-based data collection. This mobile mapping technology utilizes multiple cameras placed at varying angles on top of a vehicle that is driven down a route, providing high-resolution geo-referenced digital images showing the transportation infrastructure of the roadway. Previous collection of field features for inclusion in the NJDOT's Highway Maintenance Management System was performed using a GPS-based GIS mapping software running on a laptop computer.

Weaver highlighted the benefits and key issues in using this technology. Specifically, he explained how this new approach to data collection has allowed NJDOT to collect maintenance asset data quicker, safer, cheaper, and more accurately than by previous methods. By collecting precisely positioned stereoscopic video images and utilizing state-of-the-art feature extraction methods, NJDOT is able to collect 50% more asset data with 75% less field time. For example, staff collect more information on features such as signs, mounts, striping, and rumble strips. This technology promotes a safer data collection effort because only one crew is running at highway speeds and no crash trucks are needed. This allows for existing staff to be reallocated to other projects.

A key benefit is the customized feature extraction software used to calculate the geographic coordinates for any pixel in the photo. To map the centerline, for example, a user simply clicks on the centerline of the roadway in each successive photo. The software then calculates the geographic coordinates for the point. All points are then connected to form a centerline. Attribute values can also be determined. If features are missed during collection, it is easy to go back to the photographs file and extract the features. There is no need to go out into the field again.

One disadvantage he mentioned, however, in using this approach is the requirement for specialized software and vehicles. Not many companies are equipped to do this at the present time. Other key issues to consider are: equipment reliability, file management, training, and maintaining the data. This topic initiated much discussion and interest among the audience.

ADDING INTELLIGENT TRANSPORTATION SYSTEMS EQUIPMENT TO THE ASSET MANAGEMENT MIX

Marcella L. Yates, *Washington State Department of Transportation*

The WSDOT has an initiative to develop a comprehensive ITS inventory system. Yates shared information on the process and the work WSDOT has accomplished thus far. The impetus for change to focus on ITS was due to the GASB 34 inventory requirements. Other reasons included the exponential growth in the traffic and weather areas of ITS, better accountability, increased credibility, and improved infrastructure information.

The project started with identifying the ITS equipment being inventoried now. When WSDOT staff started looking at this, they discovered multiple inventory systems with uneven and inconsistent items. Some items were not included in any inventory system, while other items were inventoried in one system or another or both. She described how an initial forum was set up by the traffic management center managers throughout WSDOT to discuss this issue. They came to a consensus of migrating to a single inventory system. In addition, a multidisciplinary work group was formed and charged with identifying criteria for the ITS equipment to be included in the inventory and recommending a single inventory system for collecting that information. As a first step, the WSDOT is now in the process of moving items by regions into the signal inventory maintenance management system. Next for WSDOT is to finalize what to inventory and to evaluate their long-term systems strategy and direction.

Interesting Applications of Asset Management Concepts
Poster Session

KATHRYN A. ZIMMERMAN
Applied Pavement Technology, Inc.

A poster session was included in the conference program to provide an opportunity for presentations outside of the session topics. A reception was held in conjunction with the poster session, providing a forum for the presenters to interact directly with the participants in a relaxed setting. The posters included focused on a range of topics including applications of GASB 34, bridge management, priority selection, safety indexes, and the use of asset management to support maintenance operations.

LESSONS LEARNED FROM VALUATION APPLICATIONS IN TRANSPORTATION ASSET MANAGEMENT: EXAMPLES OF BEST PRACTICES AND THEORETICAL APPLICATIONS AFTER 5 YEARS OF THE GOVERNMENT ACCOUNTING STANDARDS BOARD

Adjo Akpene Amekudz, *Georgia Institute of Technology,* and
Pannapa Herabat, *Asian Institute of Technology*

This poster summarized some of the lessons learned from both practical and theoretical applications of TAM valuation during the 5 years since the GASB issued Statement 34. The requirements under GASB 34 resulted in a resurgence of interest in valuation methods both in practice and in academia, with a distinction between depreciation-based methods and condition-based methods. The poster included a summary of some of the literature available on this topic, including documentation available from FHWA, APWA, and GASB. A NCHRP research project on approaches used by state highway agencies to comply with GASB 34 requirements (NCHRP 19-04 and *NCHRP Report 522*) reported the following findings:

- In practice, for the first year of GASB 34 implementation, 56% of state highway agencies adopted the depreciation approach for reporting on their infrastructure (giving such reasons as the approach was perceived as simpler to implement, preferred or more familiar to state financial officials, in some cases the approach designated by the state government, and perceived by some as presenting the state in a more favorable light).
- Several states that selected the modified approach believed that the analysis to support this approach could help build a case for maintaining or increasing funding.
- Topics recommended for additional research (new project: NCHRP 19-07: Methods for Condition Assessment and Preservation):
  - Condition assessment methods (to allow better integration of asset management data in financial reports),
  - Linking condition targets to required expenditures,
  - Cost categories (capitalized versus expensed), and

   - Additions and retirements of infrastructure facilities.
- There are several applications of asset valuation in the literature; various examples were given: case studies on pavement valuation for various political entities – cities, countries etc. (see Kaldec and McNeil, 2001); developing multipurpose frameworks for valuation (Amekudzi et al., 2002); analyzing the effect of maintenance on the valuation of pavements (Herabat et al., 2002; Sirirangsi et al., 2003); applications of different asset valuation methods (Cowe Falls et al., 2004); and applications of traditional versus option valuation methods (Gavin and Cheah, 2004).

Some of the lessons learned include a greater awareness of asset valuation issues, more emphasis on asset preservation, and the accounting for asset value by public agencies. More specifically, the presenter listed the following lessons learned:

- Valuation has brought the following benefits to asset management practice:
   - A general awareness of data limitations for assessing and reporting on infrastructure value (e.g., condition assessment, linking targets with required expenditures),
   - Resulting investments in research to address these gaps, and
   - Increased interest in research applications on valuation methodology in infrastructure asset management.
- Other potential benefits include:
   - More objective basis for periodic infrastructure reporting leading to increased credibility and
   - Better understanding of the impacts of investment on infrastructure value leading to improved decision-making process.

LEST WE FORGET: ASSET MANAGEMENT HAS ITS UNIQUE ATTRIBUTES

Ibrahim M. Mouaket, *City of Toronto, Ontario, Canada*

In this poster, the author emphasized the unique characteristics of asset management that cause it to be different than the infrastructure management systems that preceded it. Fundamental to these differences is the emergence of infrastructure management systems (such as bridge and PMSs or maintenance management systems) from engineering concerns while asset management is rooted in broader concerns such as public expectations, investment options, and greater transparency and accountability of government agencies. As a result, asset management requires a different approach than the more traditional systems developed to address technical needs. In the author's opinion, most approaches to asset management have missed these differences.

The presenter authored and shared the following attributes of asset management to illustrate these differences:

1. Asset management framework is three-dimensional, requiring a focus on philosophy, process and tools. Old component management systems were concerned only with engineering judgment and tools; they were not concerned with the process of managing the assets, did not include funding, enforcement or management of use, for example.

2. AMS is driven by publicly acceptable performance measures. Component management systems (CMS) are driven with engineering performance measures. AMS allows for variation of strategy by community, CMS allows for variation either by location or by class.

3. AMS has to use publicly acceptable accounting principles (i.e., accrual accounting) whereas CMS uses curvilinear discounting rates reflective of the performance curve. Although the curvilinear approach is more useful for managing the asset portfolio, the reconciliation between the two needs to be addressed but often is overlooked.

4. The value of the asset is the main target of AMS; CMS does not have that on its radar. Most commercial AMS software have packaged CMS and added a program to calculate the current value of the asset. That value is not used as a parameter for decision making in the routines nor is it calculated at the end of the cycle.

5. AMS has to be transparent and can be audited by a neutral third party. It clarifies authority–accountability profiles. CMS never had that consideration. In fact many of them operate as "black boxes."

6. Asset management is focused on integrating engineering, management, financial, and marketing data. CMS is focused on engineering and financial data only.

7. AMS is focused on answering "what if" questions raised by decision makers by making use of newer data warehousing concepts. CMS is not focused on that area at all.

By ignoring these characteristics, or attempting to modify CMS to address asset management activities, the author states that a number of different problems will arise, including an overall sense of disappointment when the needed capabilities are not delivered. Additionally, the skills required to conduct asset management are not fully developed and integrated, which limit an agency's ability to manage effectively. The author supports the recognition of the differences between AMS and CMS and the incorporation of these differences into the development of asset management tools.

IMPROVING BRIDGE PROGRAMMING IN MASSACHUSETTS USING THE PONTIS BRIDGE MANAGEMENT SYSTEM

William Edward Robert, *Cambridge Systematics, Inc.*

In 2003, Massachusetts Governor Mitt Romney initiated a "Fix It First" policy, which established a statewide commitment to repair and maintain the state's existing infrastructure. A major component of this policy was the reduction of the number of structurally deficient bridges in Massachusetts. To implement this objective, the Massachusetts Executive Office of Transportation and the Massachusetts Highway Department (MassHighway) were charged with developing an aggressive statewide bridge program necessary to deliver the greatest improvement in Massachusetts bridge conditions, given reasonable budget scenarios.

This poster described the steps Massachusetts took to develop a performance-based bridge program. This included the implementation of the Pontis bridge management system and the establishment of bridge management policies. Using the analysis results from Pontis, MassHighway rolled out a 20-year plan that meets the governor's objectives. It includes a 20% reduction in structurally deficient and weight-restricted bridges and commits the commonwealth to spending $200 million annually on bridge preservation, reconstruction, and replacement by 2009. The use of the bridge management tool greatly facilitated the development of the plan and the agency's ability to evaluate the impacts of different investment strategies. MassHighway will continue to use the Pontis system as it implements the plan over the next several years.

USING A CONDITION ASSESSMENT INDEX AS A PROJECT PRIORITY SELECTION TOOL

Douglas Betts, *Carter & Burgess, Inc.*

This poster presents the use of a condition assessment index (CAI) as a tool that can be used to establish priorities as part of an agency's asset management program. The use of the CAI was illustrated through an example for the North Texas Tollway Authority (NTTA), which considers safety, maintenance requirements, and traffic volume in establishing its priorities in selecting projects that will enable the agency to meet its condition goals. First, asset condition is assessed on an annual basis. The results of the survey are used to identify candidate projects, the repairs needed, and the estimated costs. These projects are then evaluated using the priority criteria presented earlier together with the contribution each project makes toward improving the overall asset condition. Those projects that significantly improve the overall condition of the asset or raise the overall condition to the desired goal are identified as candidates for funding. The NTTA successfully used this approach to determine maintenance funding needs and projects to be funded.

MICHIGAN DEPARTMENT OF TRANSPORTATION AND MICHIGAN DEPARTMENT OF NATURAL RESOURCES ASSET MANAGEMENT STRATEGIES

Robert A. Ranck and Bruce Watkins, *Michigan Department of Transportation*

In a collaborative effort between the Michigan DOT (MDOT) and the Michigan Department of Natural Resources (MDNR), MDNR officials are being trained on asset management strategies for preserving the state park campgrounds, roadways, harbors, and boat launches. Although in the past these facilities were managed in reaction to comments by public users, a new strategy is being implemented to manage these facilities better. This strategy includes an asset inventory, condition assessment, and analysis tools to help evaluate preservation strategies. The inventory includes the use of GPS for georeferencing locations.

A key emphasis in this poster was the tremendous progress that has been made since the start of this initiative and the plans for the future. Illustrations of the types of data currently available and the use of this information in developing preservation strategies were included.

ASSET MANAGEMENT: THE RIGHT SOLUTION

Wendy L. Peckham, *PBS&J*

This poster presentation summarized the results of an investigation into best practice in the area of TAM. The benefits realized by agencies using good asset management practices include the ability to

- Assess remaining service life;
- Identify and prioritize maintenance and rehabilitation needs;

- Link project selection to preserve the investment in assets, meet customer expectations, and improve safety characteristics;
- Forecast future conditions;
- Evaluate the consequences of different investment strategies; and
- Estimate funding levels needed to meet agency goals.

The poster included considerations for implementing both off-the-shelf (OTS) or proprietary systems. In general, proprietary systems can be tailored to the unique needs of each agency. However OTS programs generally cost less and entail less risk to the agency. Regardless of the approach used, the authors recommend that the data to support the system not be collected until the system data requirements are known. The most appropriate system should be selected on the basis of the needs of the agency, the business organizational structure, and the agency's requirements for software functionality, integration, and accessibility.

MIDWEST REGIONAL UNIVERSITY TRANSPORTATION CENTER, U.S. DEPARTMENT OF TRANSPORTATION REGION 5

Jason John Bittner, *University of Wisconsin–Madison*

The Midwest Regional University Transportation Center (MRUTC) is a consortium of Midwestern universities conducting research, outreach, and education in asset optimization and management techniques for transportation agencies. This poster highlighted some of the recent projects conducted through the agency's research program.

SYNTHESIZING EXPERIENCES OF IMPLEMENTING ASSET MANAGEMENT IN THE WORLD

Sue McNeil, *University of Delaware,* and
Daisuke Mizusawa, *University of Illinois–Chicago*

Although asset management practices have been emerging for many years, the authors of this poster emphasized that five barriers to asset management implementation emerged at the 2004 TRB Asset Management Peer Exchange: existing legacy data systems, organizational issues (such as cultural resistance, lack of defined goals and objectives, and lack of communication), technological issues (such as lack of analysis tools and processes and inability to quantify benefits), lack of educational tools, and costs.

To address these issues, the authors presented successful implementation efforts that have been used around the world to showcase applications that have overcome these barriers. The examples illustrated agencies from Australia and Canada that have incorporated asset management principles into their planning process for the maintenance and rehabilitation of transportation assets. These practices were then compared with practices in the United States, and recommendations for a successful implementation were presented.

USING PLANNING AND DESIGN-BASED ASSET MANAGEMENT PERFORMANCE MEASURES TO SUPPORT ASSET MANAGEMENT PROGRAM DECISIONS BASED ON RETURN ON INVESTMENT

William S. Otero and Mark A. Sawyer, *HDR Engineering, Inc.*

The focus of this poster was on the early use of asset management principles to maximize the possible ROI for transportation assets. The authors promoted the use of a LCCA that considers planning, design, construction, and maintenance activities over the more traditional approach in which a limited number of design options are considered. In fact, the authors reported that asset management programs that essentially focus on the accounting requirements needed to support GASB 34 will not be able to maximize fully the return on transportation assets.

The authors recommended the following considerations in developing an effective asset management framework:

1. The consideration of planning, design, and construction objectives;
2. Comprehensive planning and design criteria by which asset condition and performance can be accurately measured; and
3. The use of performance measures that provide meaningful feedback throughout asset planning, design, construction, and maintenance.

This typically requires a complete review of the agency's practices to ensure that effective performance measures are in place and the ROI can be evaluated. An example framework from El Paso County, Colorado, was presented in the poster. As a result of the framework that was developed, the authors report that county personnel have been able to develop a fiscally sound transportation plan that integrates maintenance considerations in the design of assets and increases the ROI on its transportation assets.

PONTIS-BASED HEALTH INDICES FOR BRIDGE PRIORITY EVALUATION

Dan Scherschligt, *Kansas Department of Transportation*

This presentation illustrated the use of a Pontis-based health index to evaluate the conditions of the bridge deck and structural conditions by the KDOT. This approach replaces the priority formulas that had been used for the past 20 years to select bridge rehabilitation projects. The priority formulas were based on assessing the functional and structural deficiencies in a bridge so that an adjusted, weighted needs score could be computed. The adjustments to the weighting factor provided a means for the agency to take factors such as traffic into consideration in developing project priorities. Historically, the priority formula has used National Bridge Inspection (NBI) ratings.

The new approach recommended by the authors incorporates the use of the element-level bridge inspections described by AASHTO in the *Guide for Commonly Recognized (CoRe) Structural Elements* which are stored in KDOT's Pontis database. The inspection data are more detailed and provide a better understanding of bridge structural deficiencies than the NBI ratings because they are based on critical bridge elements rather than an overall evaluation. If the new approach proves to be feasible to the department, then the agency may consider collecting only the detailed data and eliminating the NBI ratings completely.

Early development of the health index was based on work in other states, including Colorado and California. The health index concept used by Caltrans was found to be reliable and was selected for further testing. As part of this study, the health index was customized to conditions in Kansas and tested so that the recommendations under both approaches could be compared.

SAFETY INDEX

Glen Ames, *Utah Department of Transportation*

In recent years, addressing safety issues has emerged as an issue of national prominence. However, there are many different methods for rating safety, each of which leads to different strategies to address deficiencies. For example, some agencies consider the crash rate, which measures the number of crashes per million VMT, while others consider crash severity, such as the number of high-severity crashes per year. UDOT set a target to reduce the number of total crashes with a special emphasis on reducing crashes with major injuries or fatalities.

As part of this initiative, UDOT sought to develop single strategic performance measures of each strategic component: safety, mobility, pavements, and bridges. This led to the development of a safety index that is calculated for each 1-mi road segment and results in a rating of 1 to 10, with a 10 representing a segment with poor safety characteristics. It is representative of the level of risk to the driver in terms of both crash rate and severity.

UDOT provides the safety index in several different formats to several internal divisions, including program development, asset management, traffic and safety, planning, and the state transportation improvement plan planners. These groups use the safety index to assist with the following:

- The identification of safety projects for the long-range plan,
- Prioritizing pavement and bridge projects,
- The identification of spot improvements, and
- The development of corridor studies and transportation master plans.

In addition, the use of the safety index provides a common basis for describing safety characteristics throughout the department. UDOT has found the safety index to be very useful without being a burden to collect. The author recommended the development of a similar index in other transportation agencies.

USING ASSET MANAGEMENT TO SUPPORT SIGNS AND PAVEMENT MARKINGS MAINTENANCE OPERATIONS

David Hutson, *City of Portland, Oregon*

The city of Portland, Oregon, has been actively incorporating asset management principles into their daily operations for several years. This poster highlighted the city’s use of asset management tools to support the maintenance operations for the city’s signs and pavement markings.

The project documented in the poster involved several distinct activities. For example, conditions were assessed on more than 13,000 stop signs within the city to identify signs in need of replacement. As part of the inspection, the city's sign inventory was also updated and improved. This information was used to track the city's progress in replacing nonstandard signs, which also allowed the city to report on underfunded maintenance in this area. An assessment of pavement markings was also conducted so the city could estimate costs associated with a transition to more durable, longer lasting pavement markings (such as long-line striping). A LCCA was conducted of the various options to determine the optimal use of these materials.

As part of this project, integrated work management and inventory systems were also developed. These tools provided a means of estimating work needs for improved project planning and monitoring city initiatives. For example, the city initiated a school sign conversion program to comply with new MUTCD and local mandates and was able to track its progress toward completing that initiative.

The success of the project is due, in part, to the collaboration of a cross-functional team in developing the tools. With the involvement of individuals responsible for both maintenance and capital projects in the process, there is a better integration of the final projects selected for each program. In addition, both groups have had access to information, which improves credibility in the process. Additionally, suggestions for improvement have a broader focus representing various perspectives to the process. The city has also benefited by minimizing the life-cycle cost associated with these activities while improving the timeliness of its compliance with government mandates.

Future Directions and Research Needs

SUE MCNEIL
University of Delaware

This discussion focused on the research needs and strategies for addressing these needs. The four panelists represented different perspectives: an academician, aUTC, a consultant, and a representative from a state department of transportation.

AN ACADEMIC PERSPECTIVE

Adjo Amekudzi, *Georgia Institute of Technology*

These remarks draw on the 1st Infrastructure Management Research and Education (IMRE) Workshop held in 2003 before the Annual Meeting of the Transportation Research Board. The objective of the workshop was to develop a plan to strengthen infrastructure management research and education. The workshop was sponsored by the National Science Foundation (NSF) and attended by 12 academics, two practitioners, and an NSF program officer. Issues discussed included graduate recruitment, generating interest and awareness of infrastructure management among graduate and undergraduate students, the role of different parties involved in infrastructure management, and the main research priorities in infrastructure management. Table 3 summarizes the research needs identified as part of the workshop.

TABLE 3 Research Needs Identified

Area	Topics
Data collection and Integration	Maintaining databases of condition data (currency) Metadata standards Improving data quality Automated data collection
Condition assessment	Condition assessment processes for hidden infrastructure Using remote sensing capabilities Better warning systems Linking condition assessment with decision making processes
Performance modeling	Capturing the effect of routine maintenance in life–value Modeling preventative maintenance Enhanced modeling techniques Defining performance measures
Analysis	Tradeoffs in the decision making process Asset valuation methodologies Risk analysis–cost of failure Treatment selection methods
Big picture issues	Documenting the benefits of asset management Infrastructure security Applications of emerging technologies Sustainable development
Teaching infrastructure management	Clearinghouse for infrastructure management course materials Translating research into course materials

A UNIVERSITY TRANSPORTATION CENTER PERSPECTIVE

Jason Bittner, *University of Wisconsin–Madison*

These key research issues were drawn from a workshop held as part of the 4th National Asset Management Conference in Madison, Wisconsin. The workshop was organized around five key areas derived from the Asset Management Guide. Important gaps that have been identified include:

- The link between asset management and security;
- The role of asset management as a communications tool, particularly going beyond the "pretty pictures";
- Analysis of trade-offs;
- Benefits of asset management; and
- Risk management and risk assessment.

There are two UTCs with themes focused around asset management. Additional information about the MRUTC at University of Wisconsin–Madison may be found at www.mrutc.org. Additional information about the Midwest Transportation Consortium at Iowa State University may be found at http://www.ctre.iastate.edu/mtc/.

A CONSULTANT'S PERSPECTIVE

Peter Cook, *Sophia Yu Consulting, Inc.*

One of the challenges facing researchers and system developers is the wide range of asset types, size and structure of organizations, and different approaches to asset management. Recognition of this diversity provides some insight into future directions and research needs. The software to support a full range of options is not readily available and is currently custom built for each agency. This is the same internationally. In some areas, there are some common themes. For example, there has been a lot of development related to work management and maintenance management, but this does not fit all the planning needs.

One way to look at this is to consider three tiers of asset management support with software for different agencies:

- Basic CBA with use of AASHTOware and perhaps some GIS visualization tools,
- More systematic AM framework within each type of infrastructure, and
- Full-fledged AM with trade-off capabilities.

Clearly, research and training is needed, and this research and training should be geared to these three levels.

A STATE DEPARTMENT OF TRANSPORTATION PERSPECTIVE

Jeffrey Smith, *Maryland Department of Transportation*

The state DOT experience is influenced by the background of the individual including involvement in the asset management community and his or her experience with research. In asset management, research issues can be organized around the asset management building blocks: inventory; condition assessment; performance and modeling; and program development.

From a research perspective, inventory issues are primarily centered on

- Data collection techniques,
- Frequency of updates,
- Updating the inventory between larger asset inventory data collection cycles, and
- Making inventory data available.

Condition assessment issues focus on

- Setting appropriate performance target levels,
- Defining objective performance rating scales,
- Selecting methods for condition assessment data collection,
- Frequency of condition assessments, and
- Extent of condition assessments, i.e., sampling versus entire population of the asset.

Research-related issues related to performance assumptions include

- Limited performance–service deterioration models for many assets,
- Limited knowledge of how various remedies extend the performance of an asset throughout its service life,
- Striking an appropriate balance between model complexity and usability, and
- Confidence in future projections.

Program formulation issues include

- Capital versus maintenance investments,
- Needs versus political realities,
- Optimization of resource allocations in a stovepipe world, and
- Balance between centralized versus decentralized project selection.

Other research-related issues include assessing the benefits of asset management itself, integrating quality control mechanisms throughout processes, and the trade-offs involved in developing a super system versus numerous “subsystems” working together.

DISCUSSION

One participant observed that asset management has become more than just a name. It is a whole new way of doing business. Focus is not just on projects but is on recognizing that the different sources of money come with constraints, and asset management addresses the trade-offs among capital and operating expenditures, major and minor maintenance, and expansion. Part of changing the culture is moving from the silos or separate offices for various functions to integrating the various functions throughout the organization. This is illustrated by changes in FHWA, where the Office of Asset Management started out as a stand-alone office and now asset management functions are beginning to be integrated into planning, maintenance, and operations. Other methods to facilitate the integration of asset management into the culture of organization are the "sharing" of ideas, workshops, and training. Other related observations recognized that

- Many organizations embrace asset management when they are forced to through downsizing (this was the case in Alberta);
- Organizations need to build on existing expertise;
- Data should be centralized to the extent possible; and
- There is a need to simplify processes such as design options given the least life cycle cost.

Participants were also able to identify research needs:

- Toolsets for asset inventories, MMSs that are linked to the inventories, and integrated data sets.
- Benchmarking of progress that standardizes measures for condition and expenditure. The work of the ICMA provides a good example of how benchmarking can be used in a proactive way.
- Asset valuation and infrastructure reporting. The ASCE report card has the potential to be a useful tool for raising awareness of infrastructure issues. The ASCE committee on infrastructure systems is about to embark on a project addressing these issues. There is also a need to distinguish between managerial valuation and accounting–historical valuation. In the United Kingdom, asset value is an important tool for understanding the cost of maintenance and what the users want from the network. In Ontario, Canada, infrastructure value serves as indicator for preserving existing investments. Neither case uses historical or accounting value. Also allows for trade-offs between very different types of infrastructure such as highways and parks.
- Standards.
- Self-assessment—building on the Asset Management Guide to focus on feedback, updating systems and missing data. This would be a good topic for a peer exchange.
- Optimization: What do you optimize on? Maximize remaining service life, minimize expenditures and so on.
- Performance measures—trends.
- New types of assets—ITS–vehicle–infrastructure.
- Using simulation models to understand trade-offs.
- Risk analysis.

Some time was also spent discussing opportunities for funding research projects. The most well-know mechanism is NCHRP. NCHRP projects are solicited from the community and selected by AASHTO's Standing Committee on Research. Potential projects are more like to be funded if there is strong state support for the project. AASHTO's Standing Committee on Planning also has limited resources to fund "rapid-response," low-budget projects. Pooled funds also served as a good mechanism for funding research projects. A group of states can define a research project and provide funds to support the research. The FHWA Office of Planning also has some limited funds through the capacity building program. Finally, the UTCs support projects.

Dissemination and exchange of ideas and information is also very important. The Transportation Asset Management Today Community of Practice website (http://assetmanagement.transportation.org) serves as a resource for information including the exchange of research ideas. Lists of recent projects are posted under the research topic area. Peer exchanges are also important. Two peer exchanges have been conducted on asset management.

Finally, the Asset Management Guide is an important resource. A chapter identified gaps and research needs, and the TRB Committee, the AASHTO Subcommittee and the FHWA will be considering strategies for updating this resource.

RESOURCES

1. IMRE. Infrastructure Management Research and Education Workshop, 2004. http://128.173.204.63/IMRE_Workshop/homepage.htm (April 2004)
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3. Cambridge Systematics, Inc. *Transportation Asset Management Guide*. American Association of State Highway and Transportation Officials, Washington, D.C., and FHWA, U.S. Department of Transportation, 2002. http://downloads.transportation.org/amguide.pdf. Accessed October 2, 2005.

Asset Management
Getting Started

Omar Smadi
Center for Transportation Research and Education
Iowa State University

This session provided guidance to agencies that are beginning their asset management implementation process or have recently begun. The presentation topics included implementing roadway investment planning, adapting infrastructure management software to meet the agency's needs, and managing the data integration effort to support a successful implementation of an AMS.

NEW CAPABILITIES AND NEW APPROACH IN ROADWAY INVESTMENT PLANNING

Larry Redd, *Wyoming Department of Transportation*

This presentation highlighted the steps necessary to develop the Wyoming DOT (WYDOT) Enterprise Resource Planning (ERP) system. The steps included the justification for why a new system is needed, how it was done, and the objectives achieved. WYDOT needed to

- Select and implement new software for core financials and for asset management (maintenance, pavement);
- Integrate these packages together, as well as integrate with other systems (GIS, safety, traffic, bridge, payroll, etc.); and
- Absorb some other systems (signs, construction history, etc.) into the overall ERP.

The WYDOT followed a comprehensive process covering the following tasks:

- Mapping WYDOT's business processes,
- Defining the "vision" for asset management,
- Determining system requirements,
- Writing an request for proposal and managing the procurement of software and implementation services, and
- Focusing on implementing a quality product.

This took place in a phased and evolutionary approach where people, processes, and technology were attended to. These three components highlighted the importance of the user to the success of the system developed.

The presentation covered the WYDOT asset management vision including: inputs and tools, decisions, results, and goals. The system connects data to the department's key objectives (Figure 17).

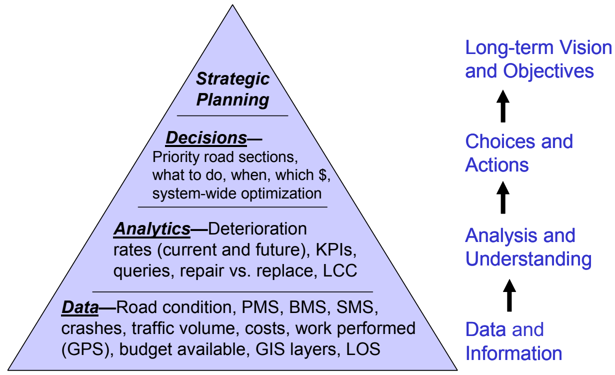

FIGURE 17 Relationship of data to objectives.

The system development effort covered the asset management process flow, technology, new system capabilities, and software needs. The resulting system is capable of conducting dynamic information query utilizing different location references schemes, integrating data from different management systems, and dealing with people issues from roles and responsibilities to interrelationships to a system roll-out strategy, and the ability to create a "learning" organization.

ADAPTING YOUR WORK MANAGEMENT SYSTEM TO MEET YOUR NEEDS

Joel Knight, *gbaMS*

This presentation discussed the process followed by the city of Overland Park, Kansas, and the software vendor, gbaMS, to adapt the management system to fit its needs. Overland Park has 1,650 lane miles of roads, 26,047 traffic signs, 12,914 storm structures, 394 mi of storm conduit, 14,810 street lights, 230 signalized intersections, 768 mi of sidewalks, 129 bridges, and 130 retaining walls. The process started in 1997. The city recognized the inefficiencies in their current processes and decided to optimize, report on, and track work performance and the need to improve communication between the different departments. Figure 18 shows some of the common problems agencies face when starting their management system implementation process.

The city was driven to provide better customer service and to warehouse its data so that a different system can be integrated. To be able to accomplish these goals, the city decided to follow a phased approach to take advantage of a lower initial investment and streamlined deployment. In the initial phase, the city dealt with the storm water management, work order management, and the service requests systems. The city was able to evaluate different vendors and select the one that met its needs. Once the implementation process started, the following challenges needed to be addressed:

- Simplified work flow process,
- Several work locations in 1 day,

FIGURE 18 Problems with management system implementation.

- Multiple types of work (install, remove, replace),
- Spending more time on data entry than working, and
- Required duplicate entry for inspections and work orders.

The city was able to overcome these challenges and implement a system that met its needs in a phased approach that allowed the city to get buy-in from the users and also allowed the city to move forward with other systems and assets in the city. The goals for the system implemented are

- Lower operational costs,
- Increased system reliability,
- Meeting customer needs and expectations,
- Ease of adaptation,
- Common and standardized processes,
- "Slice and dice" data for analysis and reporting, and
- Interfaced with other applications.

PLANNING AND MANAGEMENT DATA INTEGRATION EFFORTS FOR ASSET MANAGEMENT

Teresa Adams, *Midwest Regional University Transportation Center, University of Wisconsin–Madison*

This presentation covered data integration and IT projects as they relate to asset management development and implementation. The presentation included three case studies as part of a project for the MRUTC. The states included as case studies were Michigan, Ohio, and Wisconsin DOTs. The results from the research project were summarized for this presentation.

The presentation covered the data integration and information technology aspects from three different perspectives:

- Top management,

- Business managers, and
- IT department.

When considering top management, asset management is considered a strategic initiative driven by business needs. Data integration is not considered asset management but rather leads to data access, consistency, and currency to support the asset management decision making. The following covers the role and involvement of top management:

- Top management announces the initiative and gives the development team the directive.
- Staff understands that management is fully committed.
- Top management appoints a cross-agency steering committee to guide the development process.
- Top management has ongoing involvement through period briefings and meetings.
- Development team uses peer network and research resources in project planning and development.
- Bring new leadership up-to-date so that they don't make decisions to invalidate ongoing strategic investments.

The IT department views the agency as a business to be supported, and the chief information officer and the staff function as a business analysts. The IT team's view changes from focusing on the solution to focusing on the business process. This evolution of the IT department may take 4 to 5 years.

The data integration and information technology efforts face challenges that need to be addressed for the successful implementation of the AMS. The following is a list of some challenges.

- Manage project expectations and scope creep.
- Develop communication tools.
- Use external expertise.
- Create data teams.
- Designate data owner-user.
- Get participation in system development.
- Location referencing systems.
- Managing technology and technology choices.
- Manage integration.

At the end, to ensure success, measures of success should be implemented. The measures need to evaluate project development performance by measuring change and the user's ability to adapt to business process changes. The accomplishment of key requirements will measure the success of the project.

Taking the Next Step

KENNETH J. LEONARD
Cambridge Systematics, Inc.

The session provided a forum for dialogue on developing AMSs, what has worked, and what has not worked. It included four examples from agencies that have initiated AMSs, how they were developed, what was important, and the key implementation steps. Additionally, the session provided advice on the next steps for those agencies that have decided to implement asset management, have done a self-assessment, and are ready for the next step.

ASSET MANAGEMENT IMPLEMENTATION STRATEGY

Ibrahim M. Mouaket, *City of Toronto, Ontario, Canada*

This presentation outlined the process that was used in implementing asset management in Toronto, Ontario, Canada. The city used an incremental approach—"evolution is better than revolution." An incremental approach is also less expensive. Toronto had to eliminate the silos in the organization so communication could occur across the six city departments. The presentation identified the steps necessary to develop an AMS, including defining the purpose, building consensus, establishing goals, dividing the business into chunks, picking a good example, building on what you have, developing a logical framework, involving stakeholders, using interactive models, ensuring available data, developing a prototype, and empowering staff. Another importance piece of advice provided was to focus on outcomes, not outputs.

INCORPORATING MANAGEMENT SYSTEMS INTO A COMPREHENSIVE ASSET MANAGEMENT PROGRAM

Kathryn A. Zimmerman, *Applied Pavement Technology, Inc.*

The key theme here was the importance of incorporating management systems into the comprehensive TAM system. Traditionally, management systems are used individually, but it makes more sense that they work together in a comprehensive system. It is important to have detailed data at the highway section level that can be aggregated up to the network level and then the strategic level. Performance measures should be used to evaluate the condition of the sections and the network so management can be informed at the strategic level. At that level, the information can be used by management to evaluate the consequences of different investment levels.

IMPLEMENTING A STRATEGIC HIGHWAY TRANSPORTATION ASSET MANAGEMENT SYSTEM IN UTAH

Jeffrey L. Zavitski, *Deighton Associates, Limited*

Utah used an incremental methodology to develop a TAM system for pavement, bridges, safety, mobility, and maintenance. It was emphasized that agencies need to get senior level managers involved and supportive from the beginning. The presenter advised not to strive for perfection right away, but to go one step at a time. He reported that Utah used the NCHRP Asset Management Guide developed for AASHTO, including the self-assessment tool. Utah believes the AMS should be used to communicate the impacts or results of their investments to management. The system must include both horizontal integration among program areas (pavement, bridges, safety, etc.) and vertical integration in the organization from staff to management.

MATURING ANALYSIS OF THE VIRGINIA DEPARTMENT OF TRANSPORTATION ASSET MANAGEMENT SYSTEM

Zongwei Tao, *Booz Allen Hamilton*

VDOT is developing its AMS by using the AASHTO Asset Management Guide. It is using an incremental process and is at the mature stage of the AMS development. VDOT has a pavement and bridge management system and now is integrating signs, traffic signals, etc. Some advice given was to improve data, focus on integration, expand the stakeholders, create resource forecasting capability, create scheduling, improve buy-in, and incorporate maintenance. The presenter suggested integrating data from the individual management systems into the AMS and using proven asset management tools.

Plenary Session and Conference Wrap-Up
Using Lessons Learned and Moving Forward

SUE MCNEIL
University of Delaware

This closing session provided an overview of the international TAM scan, and panelists provided examples of how the lessons learned can be applied to state and local agencies in the United States.

At the close of the conference, the organizing committee and the leadership of the AASHTO Asset Management Subcommittee, the TRB Committee on Transportation Asset Management, and the FHWA Office of Asset Management wanted to make sure each participant returns home with not just some new ideas but some strategies for implementing those new ideas. This includes a network of contacts and resources that the asset management community can draw on not to just talk about the ideas or think about them but actually move toward implementation.

ASSET MANAGEMENT STRATEGIES IN SUPPORT OF ORGANIZATIONAL DECISION MAKING: EXAMPLES FROM AUSTRALIA, CANADA, NEW ZEALAND, AND THE UNITED KINGDOM

Kirk Steudle, *Michigan Department of Transportation*

The purpose of the scan was to investigate best case examples of asset management techniques and processes in the world and identify lessons and applications for the United States. FHWA, AASHTO, and NCHRP sponsored the scan.

The team found several common drivers for adopting asset management approaches. These included limited resources, increasing demands, need for greater credibility with elected officials, public linking funding to system performance, and strategic oversight where private provision of services was used. The team also found several common attributes among the agencies visited. Particularly relevant to U.S. experiences are the long-term commitment to developing an asset management program, the integration of policy with asset management, heavy reliance on performance measures, consistent use of management systems including prioritisation and scenario analysis, life-cycle costing and risk assessments, and public involvement.

A wide variety of examples were presented. They included the use of performance measures in each of the agencies visited; the promotional materials developed in New Zealand; the use of risk measures in New Zealand; Queensland, Australia; and England; and the culture of asset management developed in each of the agencies visited.

Most important, the team was able to identify a series of lessons learned that are applicable to the United States.

1. Asset management programs have been used successfully to justify transportation funding (even in tight economic times) and to convey to decision makers that the investment is being delivered in the most cost effective manner possible.

2. Adopting an asset management approach in an organization does not mean that everything has to change.
3. Asset management efforts are data-driven. However, developing an asset management culture in an organization does not have to wait the many years it might take to develop database information systems.
4. Data should have a clear purpose and be directly related to asset management decision making. Data collection costs should be tracked and data itself treated as an asset, with the same DBOM, and LCCA as is used for other assets.
5. Condition and remaining asset value are important indicators of the degree of need and LOS that are associated with different asset types. AMSs are much more appropriate to use for asset valuation than straight-line depreciation accounting rules.
6. The integration of asset management concepts into public–private partnership agreements was an important challenge facing transportation officials. A comprehensive asset management effort needs to be part of any agreement to ensure the asset is being returned to the owner in good condition.
7. Before core services are contracted out, performance-based management systems should be in place to allow the infrastructure owner to know what LOSs are required. This was described in the scan as being a "knowledgeable owner."
8. Creating asset manager positions or at least assigning responsibilities for the asset management function is an important foundation for an effective management program
9. Asset management efforts are best achieved when they are linked to strategic goals and desired outcomes.
10. All asset management programs used the concept of risk for establishing investment priorities.
11. Risk concepts need to be incorporated more systematically into U.S. asset management efforts.
12. Trade-off analysis techniques are more complex than simply assessing priorities within one asset category. The scan team did not find any case where technically based cross-asset trade-off tools were used. This is an important area for further development in the United States.
13. Cross-functional teams, consisting of engineers, planners, finance analysts, operations staff, and communications experts, can best understand the many different aspects of asset management, such as data collection, developing strategies, and quality assurance.
14. Asset management training for all levels of transportation officials is an important initiative for changing the culture of an organization and in establishing asset management expectations among key stakeholders.

In summary, it was clear that asset management as an organizational culture, a "business decision-making process," and as a policy direction is a critical foundation for transportation programs that are facing significant capital renewal and preservation needs. The United States is clearly facing such a challenge.

AN IMPLEMENTATION PLAN

Dennis Merida, *Federal Highway Administration*

The scan team developed an implementation plan. The plan included "quick" action items and longer-term implementation tasks.

Quick action items included

- Continuing development of AssetManager NT & PT by AASHTOWARE,
- Repackaging existing materials from the scan for the TAM–asset management community practice website,
- Updating the NHI course, and
- Holding a senior executive forum on asset management.

Longer-term action items center on refocusing the national viewpoint of the transportation system from merely expenditures to investments in mobility, people, goods and services by using an asset management-based methodology. Several tasks were identified to support this action item:

- Task 1. Initiate a study to develop a national TAM model for the Interstate system to determine the benefits of using asset management plans for all segments of the Interstate Highway System.
- Task 2. Develop a prototype based on asset management practice in England, including national policy, performance indicators, and reporting requirements for national and local agencies.
- Task 3. Target a state or region to take a holistic view of the entire public asset inventory providing increased funding flexibility.
- Task 4. Develop linkages between transportation planning and programming and asset management at the MPO level.

Other action items focus on creating an asset management culture in the United States. Theses include joining with other efforts, agencies, and resources to imbed the topic into existing efforts on an ongoing basis, creating a National Asset Management Steering Committee (NAMS), developing and promoting education, training, and outreach initiatives based on NAMS model, and extending U.S. asset management practice through research and staff studies.

EXAMPLES OF LESSONS LEARNED

Patricia Bugas-Schramm, *City of Portland, Oregon*

The international scan provided benefits at the international, national, regional, and local levels. At an international level, the scan provided contacts for networking and exchanging ideas related to best practices. This has included identifying asset management software, a comparison of strategies for estimating useful life for various classes of assets, trade-off analysis, and stakeholder involvement.

At the national level, lessons learned from the scan have been presented at the APWA International Conference and in the *APWA Reporter* and have initiated discussion of new research directions. The scan also provides an opportunity to serve as resource for other organizations and communities.

At the regional level, presentation and briefings have served as a mechanism for dissemination. There is again an opportunity to serve as a resource to other agencies on asset management implementation. At the local level, the scan has helped city management to recognize that Portland, Oregon, DOT is a leader in asset management. The scan reinforced the importance of many ongoing activities and provided lessons learned and experiences that can be used for informal benchmarking. Tangible activities that have drawn from experiences gained on the scan include the addition of risk assessment–confidence assessment to asset management process, the integration of asset management preservation needs in the capital planning process, and generally elevate the visibility of asset management.

RESOURCES TO SUPPORT ASSET MANAGEMENT

David Geiger, *Federal Highway Administration*

Although resources to support implementation are limited, there are several opportunities available through the FHa Office of Asset Management. These include tools such as HERS-ST and LCCA, publications, training (such as the workshops held at the end of the conference) and research projects. The office also provides technical support through field visits to individual agencies, and the TAMT website. The Office of Asset Management also works with other parts of FHWA, such as the link with planning to support capacity building.

DISCUSSION

Several questions centered on the challenges related to getting resources for the implementation efforts. As several of the action items are research projects, it is important to leverage state planning and research funds through NCHRP and pooled fund studies. A related issue is criteria for measuring success. Several audience participants whom the team had visited on the scan pointed out that asset management is integrated into the organization. In England, the term “asset management” is never explicitly mentioned in the business plan. In Alberta, Canada, asset management is integrated into all activities.

Another question related to the role of accounting valuations of assets in the asset management process. The team pointed out that in Queensland and England the agency had worked with the accounting professionals to develop a useful measure of asset valuation. Not only did this help to convey the importance of the assets to the public and politicians but linked the two functions more closely.

The session closed with a reminder that the international scan report is available on TAMT website, and a frequently asked questions sheet related to the scan is also available.

RESOURCES

Bugas-Schramm, P. The Tipping Point? Trip Summary on the International Scan on Transportation Asset Management. *APWA Reporter*, American Public Works Association, September 2005. http://www.apwa.net/Publications/Reporter/ReporterOnline/index.asp?DISPLAY=ISSUE&ISSUE_DATE=092005&ARTICLE_NUMBER=1113. Accessed October 13, 2005.

APPENDIX

List of Acronyms

AASHTO	American Association of State Highway Transportation Officials
AIT	Alberta Infrastructure and Transportation
AMS	asset management system
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
BCMoT	British Columbia Ministry of Transportation
CAD	computer-aided drafting
CAI	condition assessment index
Caltrans	California Department of Transportation
CIP	corridor investment plans
CMMS	computerized maintenance management system
CPM	capital preventive maintenance
CRS	condition rating system
DBFO	design–build–finance–operate
DOT	department of transportation
ESAL	equivalent single axle loads
FHWA	Federal Highway Administration
FLH	Federal Lands Highway
GASB	Government Accounting Standards Board
GIS	geographic information systems
GPS	Global Positioning System
HERS-ST	Highway Economic Requirements System: State Version
HMA	hot-mix asphalt
IIMS	Interactive Interchange Management System
IT	information technology
ITS	intelligent transportation system
LCCA	life cycle cost analysis
LOS	levels of service
LRS	linear reference system
LTAP	local technical assistance program centers
MARTA	Metropolitan Atlanta Rapid Transit Authority
MassHighway	Massachusetts Highway Department
MDNR	Michigan Department of Natural Resources
MMS	maintenance management system
MQA	maintenance quality assurance
MRUTC	Midwest Regional University Transportation Center
MTO	Ministry of Transportation in Ontario
MUTCD	Manual on Uniform Traffic Control Devices
NACE	National Association of County Engineers
NBI	National Bridge Inspection
NCHRP	National Cooperative Highway Research Programs

NCSU	North Carolina State University
NOS	network optimization system
NTTA	North Texas Tollway Authority
OMR	operations, maintenance, and rehabilitation
OPM	operational performance measure
OTS	off-the-shelf
PANYNJ	Port Authority of New York and New Jersey
PCI	pavement condition index
PEAT	priority economic analysis tool
PM	preventive maintenance
PMS	pavement management system
QPR	quarterly project review
ROI	return on investment
RSL	remaining service life
SAMS	smart asset management system
TAM	transportation asset management
TAMC	Transportation Asset Management Council
TEAMS	Turnpike Enterprise Asset Management System
TRB	Transportation Research Board
UTC	university transportation center
VOC	vehicle operating cost

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