

# Transportation Asset Management

## New Guide Advances State of the Practice

LANCE A. NEUMANN,  
MICHAEL J. MARKOW,  
AND LOUIS H. LAMBERT

Neumann is President, and Markow is Principal, Cambridge Systematics, Inc., Cambridge, Massachusetts. Lambert retired last year as Deputy Director, Transportation Planning Bureau, Michigan Department of Transportation, and is now Senior Associate, Cambridge Systematics.

**T**he recent completion of a National Cooperative Highway Research Program (NCHRP) Project, Asset Management Guidance for Transportation Agencies,<sup>1</sup> marks a milestone in transportation asset management. The *Transportation Asset Management Guide* will help agencies gain new insights into asset management and improve their practices.

The NCHRP project also produced a synthesis of U.S., international, and private-sector practice in asset management, the management framework for the guide, and a prioritized list of research to fill gaps in the knowledge and practice of asset management for transportation infrastructure. These products resulted from tasks outlined in the American Association of State Highway and Transportation Officials' (AASHTO) Strategic Plan for Transportation Asset Management, issued in December 2000.

AASHTO has adopted and will distribute the *Transportation Asset Management Guide*. The final draft is available on NCHRP's website.<sup>2</sup> In addition, the Federal Highway Administration, through the National Highway Institute, has developed a one-day course on transportation asset management for agency executives and senior managers.<sup>3</sup>

Following is a preview of the concepts, principles, and techniques described in the guide, with examples

of the improvements that asset management can introduce in the ways an agency allocates resources and employs different types of investments.

### Defining the Principles

Asset management has many interpretations—for example,

- ◆ A next-generation infrastructure management system,
- ◆ A way to bring private-sector thinking into public-sector decisions,
- ◆ An economics-based approach to investment planning and decision-making,
- ◆ A comprehensive program of facility maintenance or maintenance contracting,
- ◆ A management philosophy to secure the future life of transportation infrastructure, and
- ◆ A way of combining pavement, bridge, safety, and other maintenance management systems to yield more effective information.

All of these descriptions reflect elements of sound asset management, but none captures the concept fully. Asset management is a strategic approach to managing transportation infrastructure. It builds on several principles:

- ◆ **Asset management is policy-driven.** Decisions about managing infrastructure reflect the policy goals and objectives that define the condition of assets, the

<sup>1</sup> NCHRP Project 20-24(11).

<sup>2</sup> [http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+20-24\(11\)](http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+20-24(11))

<sup>3</sup> [www.nhi.fhwa.dot.gov/coursedesc.asp?coursenum=1130](http://www.nhi.fhwa.dot.gov/coursedesc.asp?coursenum=1130)

levels of performance, and the quality of services to meet customer needs and achieve economic, community, and environmental goals.

◆ **Asset management is performance-based.** Goals and objectives must have clear measures of performance. Targets established for performance measures will guide decisions in analyzing options, setting priorities, establishing budgets, and implementing programs, and must be technically and financially realistic.

◆ **Asset management examines options and tradeoffs at each level of decision making.** Resources are limited. Investment decisions in other areas and about other assets are interrelated and have an effect on transportation assets. Therefore decision makers should consider all options and evaluate the tradeoffs among alternatives.

◆ **Asset management takes the long-term view.** Analyses of program options should incorporate a long-term view of facility condition, performance, and cost. Analysis procedures rooted in engineering and economics are most effective in assessing the tradeoffs among different actions at different times in an asset's life cycle.

◆ **Asset management bases decisions on merit.** Choices among options during program development, project selection, and program and service delivery should be based on comparisons of costs and of the consequences of meeting performance targets. Objective, high-quality information must be applied at each step, using analytic methods and decision criteria consistent with policy goals and objectives and with the agency's business processes.

◆ **Asset management maintains clear accountability.** Performance measures are monitored and reported. This provides feedback on the effectiveness of transportation investments and services, as well as accountability to management for work accomplished and for the effectiveness of program and service delivery.

## Applying the Principles

Applying these principles defines an agency's way of doing business, its procedures for decision making, and its applications of information technology. Asset management is not a separate function or system but a way of improving an agency's procedures for allocating and using available resources to achieve results cost-effectively.

Most agencies already employ aspects of good asset management practice; the principles in the guide therefore suggest ways for agencies to leverage strengths and improve the integration of data, information, and decision making. To be most effective, the asset management principles must be applied com-

prehensively to all of the agency's infrastructure expenditures, including preservation, operations, and system expansion—in capital construction as well as in maintenance and operations programs.

Asset management should be implemented in as many resource allocation and utilization processes as possible—for example, in policy development; long-range planning; project development; program development and priority setting; delivery of projects, programs, and services; and system monitoring and reporting. Agencies, however, may decide to focus at first on high-priority functions, to gain initial results quickly and affordably.

The *Transportation Asset Management Guide* covers asset management in these investment areas and in resource allocation and utilization. Nonetheless, an agency does not need to mount an all-encompassing effort to make headway in asset management. An agency can apply the concepts and principles quickly with current personnel and information technology—taking advantage of good asset management practices already in place.

Because state departments of transportation (DOTs) and other transportation agencies differ substantially in priorities, business practices, and available resources, the guide presents a broad treatment. By enabling agencies to understand the context of asset management, the guide helps agency managers to focus on the specific areas in which asset management improvements can have the strongest early payoff. A self-assessment exercise in the guide helps agencies determine strengths, identify areas for improvement, and develop an implementation strategy for priority areas.

## Investment Categories

Some practical examples can show what asset management involves and how the principles can improve an agency's practices. Because agencies differ in program structure and in management culture, the examples relate to the types of investments common to all agencies. The descriptions are limited to three investment areas: preservation, operations, and system expansion. These investment areas encompass capital as well as maintenance and operations expenditures.

◆ **Preservation** extends the life of an asset or corrects a distress that impedes mobility, safety, serviceability, or engineering integrity. Preservation counters wear-and-tear, providing a cost-effective way to keep a facility functioning at its intended level. Corrective and preventive maintenance, repair, and rehabilitation are examples of preservation.

◆ **Operations** focus on real-time service and operating efficiency. Operations enable facilities to provide



the maximum level of service before expansion becomes necessary. Examples include real-time traffic surveillance, intelligent transportation systems (ITS), real-time signal controllers, various strategies formerly grouped under transportation system management, safety improvements, ramp metering, incident response, road weather information systems, and traveler information systems.

◆ **Capacity expansion** affects a facility's level of service by adding physical capacity, by creating new capacity through a new facility, or by implementing long-term operating strategies. New construction, for example, may include new mainline facilities, interchanges, or intermodal facilities. Expansion also can be achieved through general-purpose or HOV lanes, climbing and passing lanes, bridge widening or construction of a parallel structure, and improvements on interchanges, intersections, and intermodal facilities. Long-term operating strategies could introduce reversible peak-hour lanes, adjustments to speed limits, and new signals and lane controls.

These investment categories provide a framework for the practical implications of transportation asset management. All agencies invest in these areas, but in different measures. Agencies with mature infrastructure in settled urban areas may emphasize preservation and operations improvements, while agencies in regions experiencing population and economic growth may have a relatively higher percentage of expenditures for capacity expansion.

Projects may comprise more than one investment type, creating interactions among preservation, oper-

ations, and capacity expansion. For example, preservation work in construction or maintenance work zones can cause traffic disruptions that require operations remedies. Capacity expansion may include installation of ITS or traffic monitoring hardware to serve operations needs. Operations equipment requires maintenance.

Breaking down an agency's infrastructure management into preservation, operations, and capacity expansion provides a straightforward way of organizing asset management techniques and of considering strategic tradeoffs among the categories of investment.

## Preservation

Asset management has historical roots in preservation. During the significant capacity expansion under the Interstate program in the second half of the 20th century, the need to manage the maintenance, repair, and rehabilitation of the highway inventory increased, as pavements, bridge elements, and other key features of the earliest Interstate-era highways began to approach the end of their design lives.

As more and more portions of the network aged, competition increased for preservation resources. The need for knowledge and tools to preserve the system as cost-effectively as possible stimulated research programs and the development of computerized decision-support systems for pavement, bridge, and maintenance management.

In this way, preservation had a head start in the field of highway management, propelled by its importance and visibility for transportation agencies and motorists, as well as the early recognition by practi-



Transportation management centers regulate travel on streets and freeways and maximize levels of service.



Crack sealing preserves pavement.

tioners that system preservation required ongoing management. Nonetheless, the *Transportation Asset Management Guide* emphasizes that the other areas of investment—that is, operations and capacity expansion—also must be considered within a comprehensive, balanced approach.

The guide encourages continuing improvements in preservation in areas such as the following:

- ◆ **Application of management systems and other analytic tools.** Pavement and bridge management systems are applied routinely to assess condition, identify projects, and track performance. However, use in higher-level management tasks—such as testing scenarios, developing programs and budgets, analyzing program tradeoffs, and supporting executive decisions—should be expanded.

- ◆ **Preventive maintenance strategies.** Capital and routine preventive maintenance offer economic benefits but are politically difficult to sell. Analytical methods and research documenting the benefits, moreover, are not as advanced as those for design and rehabilitation. Better information is needed on the long-term benefits of preventive maintenance strategies.

- ◆ **Continued development of new materials and practices.** Preservation benefits from better materials and remedial practices. New technology should provide cost-effective options for extending the service lives of assets.

- ◆ **More comprehensive analysis of strategies for road occupancy.** Work zone management is a major issue, involving the safety of workers and motorists, and is key in planning major rehabilitation projects. Economic analyses of the effects of work zone configurations and scheduling will become common practice as preservation activities increase, traffic volumes grow, and urbanized areas spread.

- ◆ **Continued enhancement of analytic and decision support tools.** Development and enhancement of decision-support tools for preservation have been ongoing. The focus will be on information for executives, integration with other applications, incorpora-

tion of customer-oriented performance measures and criteria, and analyses of program-level tradeoffs.

- ◆ **Maintenance quality assurance programs.** Maintenance quality assurance takes a performance-based approach, applying customer-oriented definitions of levels of service to budgeting decisions. Maintenance quality assurance embodies the principles of good asset management.

## Operations

Operations always have been a component of highway management and are a logical extension of the asset management concept. Responsibility for operations, however, has been fragmented within and across agency jurisdictions. As a result, operations have not been integrated effectively into an overall system management strategy.

But just as preservation was recognized as critical to sustaining the service life of infrastructure cost-effectively, operations have been gaining recognition for a strategic role in maximizing the system's ability to move passenger and freight traffic. Operations have become a key element of good system management.

An effective operations strategy relies on a range of equipment and software that must perform reliably throughout the network. The physical assets supporting operations must be integrated into agency preservation programs for inspection, periodic maintenance, and repair.

The general principles of asset management apply to operations as much as to preservation, but with a different focus:

- ◆ The goals and objectives must reflect system service and reliability in real time;



PHOTO: GEOPHYSICAL SURVEY SYSTEMS, INC.; NORTH SALEM, NEW HAMPSHIRE

Ground-penetrating radar instrument locates and inspects utilities, part of maintenance quality assurance.

- ◆ The focus is on immediate response to situations and real-time results, not on a program of projects; and

- ◆ Performance measures and monitoring must track real-time service delivery.

The principles of asset management therefore imply the following for operations:

- ◆ **More integrated decision making.** Decision making in operations must coordinate with decision making in other areas of asset management, to support a unified set of system performance measures. Coordination is necessary, for example, in allocating resources to balance investments in physical assets with those in operating programs; in maintaining and preserving operations assets, as well as other physical infrastructure; in long-range planning, project development, and design; in analyses of program tradeoffs; and in dealing with other agencies and jurisdictions that influence operations policies and practices.

- ◆ **Interjurisdictional considerations.** The so-called trip perspective looks at the entire transportation system without regard to jurisdictional boundaries and operating responsibilities. Many traffic management centers and incident response programs follow this principle.

- ◆ **Comprehensive asset inventories, condition databases, and analytic techniques.** An agency's overall preservation strategy should include the operations hardware. This requires database and analytic capabilities for the operations equipment on a par with those for other infrastructure assets. Moreover, other capabilities can be applied to operations—for example, maintenance management and bridge management systems that include such assets as traffic management devices, ITS systems, sign bridges, and tunnel facilities.

- ◆ **Methods to analyze operations strategies.**

Analytic tools comparable to those used in preservation, for example, are needed to integrate operations fully into an agency's decision making about resource allocation and utilization. Developing such systems will require thinking "outside of the box," to analyze performance over time and in real time. Research is needed to understand performance from the perspective of reliability, response time, and the critical threshold values of motorists, as well as from the traditional viewpoints of physical condition and frequency of repairs.

- ◆ **Greater outreach and education.** Transportation agencies and operators may not recognize the relationship between operations and asset management. Clearly defining this relationship and communicating it through training, outreach, research, and deployment will help in advancing the state of the practice in system management and agency coordination.

- ◆ **Communication of the benefits of operations investments.** New analytic tools can improve an agency's ability to demonstrate the benefits of investing in operations, but demonstrating the actual benefits of systems that are already deployed also is valuable. Field tests and rigorous evaluations are critical in addressing agency skepticism about ITS, and particularly in communicating the advantages of strategies that improve system reliability and that benefit freight transportation.

## Capacity Expansion

In contrast with operations, capacity expansion focuses on project development and program composition through a process that can extend for several years. In contrast with preservation, capacity expansion works through discrete—sometimes large and expensive—capital projects, instead of



Bridge widening (above, on VA-199) is an aspect of capacity expansion.

addressing continuing, systemwide needs.

In addition, the substantial federal matching formula for Interstate construction through the Highway Trust Fund has provided a direct and dependable funding mechanism for capacity expansion projects. The major expansion in U.S. highway capacity through the end of the 20th century, therefore, may be regarded as a massive, successful public works effort—but the expansion usually is not thought of in the context of asset management practice.

That has now changed—capacity expansion is part of resource-allocation decision making. Needs for funding have shifted toward preservation and, increasingly, toward operations.

Asset management for allocating and utilizing resources applies as much to capacity expansion projects as to preservation and operations. Translating asset management for more effective decision making in capacity expansion entails improvements in several functions and capabilities:

- ◆ **Performance-based planning.** A performance-based approach to long-range planning focuses on the outcomes of possible investments and the degree to which the outcomes support stated policies. Capacity expansion projects can affect a diverse customer base.

- ◆ **Updated performance measures.** Performance measures for new capacity projects must reflect more than level of service in evaluating operational or multimodal alternatives for expanding transportation capacity. Measures should enable analyses of the tradeoffs among capacity expansion and other types of investments and should reflect the interests of passenger and freight customers.

- ◆ **Procedures to analyze multimodal and intermodal investments and tradeoffs.** Different analytic methods and data requirements apply when assessing projects in different modes or evaluating the effects on passenger versus freight transportation. Methods for comparing cost and performance impacts across modes are under development but must be deployed and tested in agency settings. Data and analytic issues in freight transportation must be addressed.

- ◆ **Accelerated scheduling.** Capacity expansion projects often require several years from conception to completion, increasing costs and delaying benefits. Ways to accelerate this schedule while maintaining the necessary steps in planning, design, right-of-way, and construction include different ways of conceiving projects—for example, as corridor-based or multimodal—as well as streamlining or fast-tracking preconstruction activities and establishing contract incentives for rapid completion of construction.

- ◆ **Bidding and contracting mechanisms.** Agencies are applying contracting mechanisms such as

design-build on projects with demanding schedules or to supplement agency expertise, as well as alternate bidding to base awards on lowest life-cycle cost. In awarding a paving contract for a new freeway, for example, Michigan DOT examined bids for concrete versus asphalt pavement and saved several million dollars in construction costs.

## Agency Self-Assessment

Asset management takes a comprehensive view of resource allocation and utilization. Most agencies, however, will want to focus on particular priorities. To help identify the most promising areas for focus, the *Transportation Asset Management Guide* includes a self-assessment exercise.

Through the self-assessment, executives and senior managers can characterize agency practices, highlight the gains accomplished or under way, and identify opportunities for improvement. The exercise requires responses to a series of statements, organized under the four functional areas of asset management: policy development, planning and programming, program delivery, and information and analysis. Completing the form takes approximately 30 minutes.

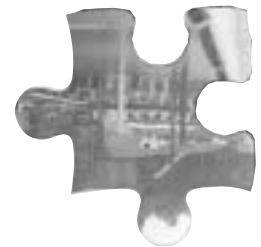
The value of the exercise is in comparing the responses from the agency's executive office with those of managers for such units as planning, engineering, programming, maintenance, finance, operations, and information systems. Bringing together the different perspectives can help identify an agency's strengths and the areas that need improvement in asset management practice. Through this discussion, the agency can develop priorities for immediate and longer-term actions.

The self-assessment is a quick diagnostic tool that yields an overall snapshot of an agency's asset management practices. The information can be used in developing a more comprehensive asset management implementation plan, as described in the *Transportation Asset Management Guide*.

## Implementing Programs

Several agencies have addressed asset management proactively, launching implementation programs and gaining organizational acceptance. The diversity of approaches, however, illustrates not only that asset management draws on a core set of principles, but that application should be customized to an agency's needs, priorities, and situations.

Some state agencies—such as the Colorado, Arizona, Pennsylvania, and Vermont DOTs—have developed plans to identify strengths and priorities for improvements in asset management and information technology. Other agencies have focused on innovations for asset management.





High-occupancy vehicle lanes are tools to manage highway congestion.

### **Michigan's Legislation**

At the direction of the state legislature and administration, Michigan DOT, working with local agencies and other stakeholders, recently played a pivotal role in drafting and securing passage of legislation to institutionalize asset management practice across transportation agencies and jurisdictions. The statute establishes an Asset Management Council charged with developing a statewide asset management process and requires agencies to

- ◆ Collect common data elements for all roads and bridges;
- ◆ Report the true condition of transportation infrastructure, regardless of ownership;
- ◆ Develop multiyear programs from long-range plans; and

- ◆ Report to the Council annually their roadway and bridge inventories, asset conditions, work activities, expenditures, and activities proposed for the next year.

This process will require local and state agencies to develop a strategic plan within 3 to 5 years to reach an agreed-to level for asset conditions and a recommended level of service. These agencies must cooperate to identify the funding levels and sources to achieve these targets.

### **Colorado's Framework**

Colorado DOT has developed investment categories to organize performance and program expenditure information within a framework useful in asset management. The framework includes

- ◆ Both the capital and the maintenance and operations program dollars, so that Colorado DOT and the Colorado Transportation Commission can see how the programs affect system performance;
- ◆ Performance measures, which provide a basis for analyzing results and, eventually, tradeoffs; and
- ◆ An organizational structure for program information.

The framework does not supplant individual capital and maintenance programs—financial mechanisms and program controls remain in place.

### **Other States' Initiatives**

Several states have adopted programming procedures that focus on a policy-driven, performance-based approach to resource allocation and to analysis of tradeoffs. New York State DOT has had a process in place for

Demonstration of system to inspect and evaluate concrete.



GEOGRAPHICAL SURVEY SYSTEMS, INC., NORTH SALEM, NEW HAMPSHIRE

several years. Montana DOT recently instituted a Programming Prioritization Process (or P<sup>3</sup>). Pennsylvania DOT summarizes performance information on a monthly report card, and Washington State DOT issues the quarterly *Gray Notebook* of performance measures and a monthly report card on construction projects.<sup>4</sup>

Asset management principles and techniques also are reflected in maintenance quality assurance programs and the associated levels of service. Several states have undertaken maintenance quality assurance programs, including Arizona, California, Colorado, Florida, Idaho, Iowa, Kansas, Maine, Maryland, North Carolina, Ohio, Texas, Utah, Vermont, and Washington State. A set of the performance measures commonly recognized for maintenance is in development, drawing from workshops, projects, and committee efforts sponsored by AASHTO, FHWA, and NCHRP.

## National-Level Actions

Industry has supported asset management initiatives by individual agencies. At the national level, TRB, AASHTO, and FHWA have been active in supporting conferences, workshops, and TRB Annual Meeting sessions on asset management. The TRB and AASHTO task forces on asset management met jointly in summer 2002 to chart the implementation of asset management from a national perspective.

FHWA has sponsored development of a one-day training course on the *Transportation Asset Management Guide*, and AASHTO and FHWA collaborate in supporting “Transportation Asset Management Today,” a community-of-practice website.<sup>5</sup> Other organizations, such as the American Public Works Association,<sup>6</sup> also have developed materials on asset management. The Midwestern Regional University Transportation Center provides several resources, including a website, research activities, and newsletters.<sup>7</sup>

Research is exploring advances in asset management practice that cut across the investment areas. The NCHRP project produced a prioritized list of research topics in the management, policy, analytic, technological, and academic aspects of asset management. AASHTO selected several of these topics, and studies already are under way through NCHRP.

The projects deal with analytic tools to support asset management, state DOT experience in implementing the Governmental Accounting Standards Board requirements in Statement 34, and identifying and setting targets for performance measures to support asset management. A project nominated for FY 2004 would investigate the effectiveness of asset man-

## Where the Guide Goes

The *Transportation Asset Management Guide* can assist agencies in improving procedures and decisions about allocating and utilizing resources. The book is structured as follows:

- ◆ **Chapter 1: Introduction** defines transportation asset management and outlines past work by AASHTO, FHWA, NCHRP, and international agencies.
- ◆ **Chapter 2: Framework and Principles** explains concepts and tenets of asset management, defines a framework of benchmark practices, and indicates how to customize the management framework to an agency's particular needs.
- ◆ **Chapter 3: Self-Assessment** explains how to use the agency self-assessment test to identify strengths and areas for improvement, provides forms for the exercise, and illustrates how to evaluate results.
- ◆ **Chapter 4: Developing a Strategy** traces how to build a strategy to improve asset management.
- ◆ **Chapters 5 through 8** describe specific applications of asset management to key functions in resource allocation and utilization: policy goals and objectives; planning and programming; program delivery; and information and analysis, including performance monitoring.
- ◆ **Chapter 9: Implementation** presents initial steps to improve asset management and provides a long-term perspective for continuing improvements.

agement implementation. Other research efforts, such as the proposed Future Strategic Highway Research Program, complement the asset management research.

## Questions To Consider

Asset management provides the framework for agencies to assess business practices for infrastructure management, to highlight accomplishments, and to identify opportunities for improvement. When exploring what this framework might do, agency decision makers should consider the following questions:

- ◆ How far has the agency progressed in defining and communicating its strategic direction to all stakeholders?
- ◆ Does the agency comprehensively consider all options in solving problems?
- ◆ Does the agency evaluate tradeoffs in cost and performance?
- ◆ Is the agency concerned about achieving long-term results cost-effectively?
- ◆ Does the agency place value on setting performance goals and on measuring results?
- ◆ What should the agency do to be in the strongest position to justify requests for resources?
- ◆ Even if significant advances in management practices have been implemented, are there better ways to do things?

Asset management addresses these questions by providing an improved way of doing business. The how-tos are presented in the first edition of the *Transportation Asset Management Guide*.

<sup>4</sup> [www.wsdot.wa.gov/accountability/GrayNotebook.pdf](http://www.wsdot.wa.gov/accountability/GrayNotebook.pdf)

<sup>5</sup> <http://assetmanagement.transportation.org>

<sup>6</sup> [www.apwa.net/](http://www.apwa.net/)

<sup>7</sup> [www.mrutc.org/assetmgmt/index.htm](http://www.mrutc.org/assetmgmt/index.htm)