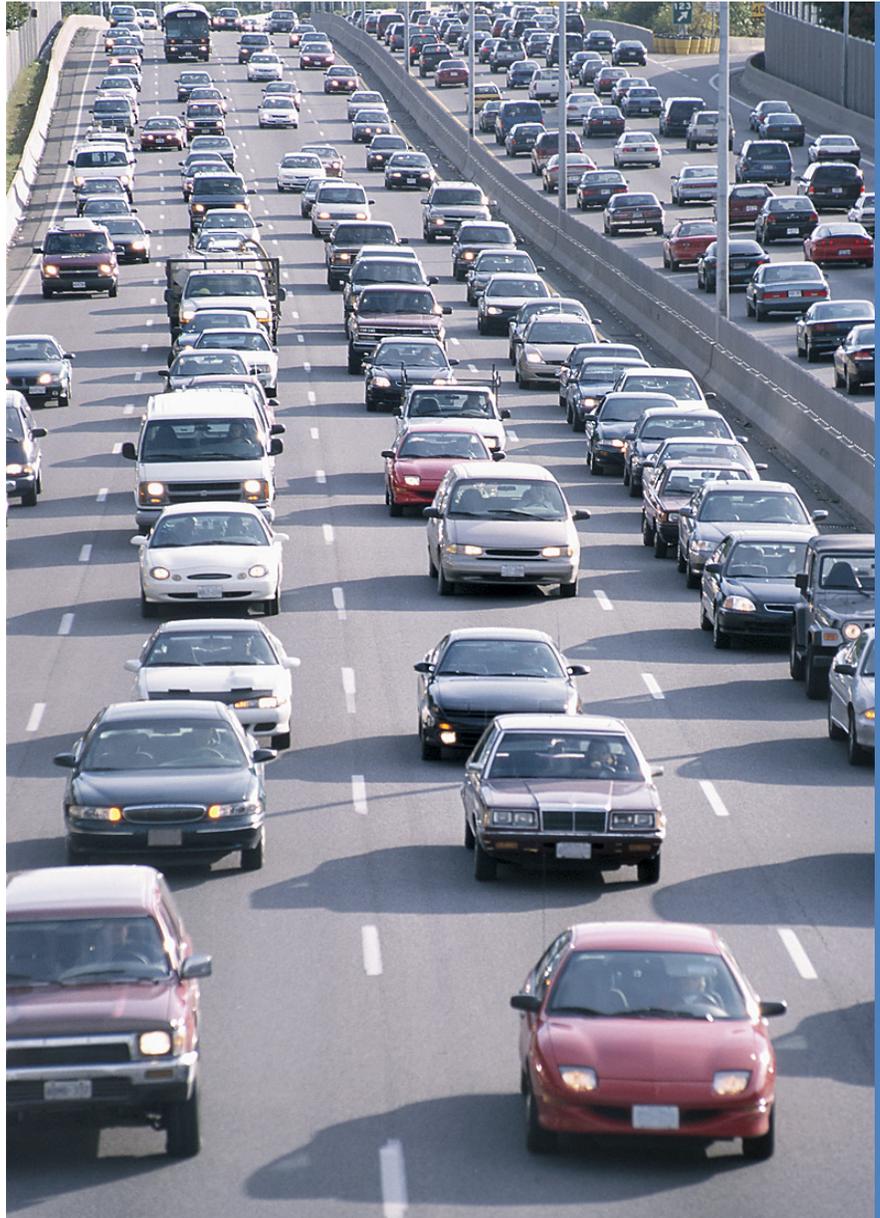


Beyond The Short Term

Transportation Asset Management For Long-Term
Sustainability, Accountability and Performance



U.S. Department of Transportation
Federal Highway Administration



Beyond The Short Term

Transportation Asset Management For Long-Term Sustainability, Accountability and Improved Performance

Message from the Director,

Transportation Asset Management (TAM) has long been recognized as a sound, long-term approach to managing infrastructure. It provides decision makers with a rational, long-term systematic process for making difficult and complex decisions about how to achieve the highest system condition levels for the lowest cost, over the longest term.

TAM also is evolving to help transportation officials address two new challenges. TAM provides a sound basis for demonstrating the long-term sustainability of current infrastructure practices. By using TAM as an over-arching framework, transportation executives can demonstrate that they are making decisions to sustain the transportation system to the best of their ability over the long term.

Also, TAM can demonstrate accountability. TAM relies upon strategic long-term goals, the pursuit of measureable targets and the continuous evaluation of results. In this way, TAM not only produces short-term performance metrics but it closely resembles "quality systems" such as Six Sigma which are widely recognized as leading to improved performance. TAM can be the foundation for performance measurement systems which assure not only short-term performance but also long-term sustainability.

This report re-examines TAM as an approach for sustainability and as a system for greater accountability and improved performance. It also includes advice on Change Management practices to elevate and expand TAM practices within a department of transportation.



Butch Wlaschin
Director
Office of Asset
Management



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Asset management provides the linkage between a need to demonstrate short-term performance while also ensuring long-term sustainability of highway assets.

Executive Summary

Asset Management: Linking Accountability and Sustainability

Transportation agencies face increasing pressures from Congress and state legislatures to demonstrate results, accountability and transparency in their management of highway assets. The National Surface Transportation Policy and Revenue Study Commission issued a clarion call for performance accountability in the federal transportation programs. Senior members of Congress are examining how to tie federal transportation spending to state accountability. The Government Accountability Office called for greater linkage between federal transportation expenditures and transportation agency results.

As transportation agencies consider how to respond to these calls for accountability and transparency, the appeal of Transportation Asset Management (TAM) becomes increasingly apparent. Asset Management provides agencies with a proven framework to demonstrate long-term accountability and accomplishment in the management of highway networks. As Asset Management matured in the past decade, it became increasingly clear to its practitioners that it provides a systematic, data-driven and

continually improving framework for managing assets. In this maturation, Asset Management has come to closely resemble many other "quality systems" that major corporations use to meet customer goals, achieve performance targets and to continually improve their products. "Quality Systems" such as ISO, Six Sigma, the Balanced Scorecard, Baldrige, Total Quality Management and Performance Management all have elements which resemble Asset Management. All of these systems rely on variants of the famous "Plan, Do, Check, Act" processes first recommended by "quality" guru W. Edwards Deming in the 1950s and 1960s, and shown in Figure 1 on page 3. His writings lie at the heart of most major "quality" programs in use globally today. General Electric uses Six Sigma to ensure the quality of its jet engines. Award-winning hospitals rely on the Baldrige Process to ensure high levels of patient care. More than 17,000 ISO standards were developed to ensure quality in technical processes. A highway agency's embrace of Asset Management allows it to demonstrate that strategies similar to those which ensure the success of Fortune 500 companies ensure

the long-term, sustainable quality of its highway network.

As these "quality" systems do for major corporations, Asset Management does for transportation agencies. It helps them manage scarce resources, articulate rational investment policies, measure the effects of past decisions and provide alternative scenarios to improve future performance. Asset Management allows highway agencies to document that their investment of scarce resources is made within a logical, comprehensive and systematic framework. Agencies that use Asset Management are so data driven, results focused and policy based, that, for them, producing performance metrics to demonstrate results is practically incidental. The agency officials reviewed in the following case studies expressed little trepidation about producing performance metrics because their Asset Management frameworks produce metrics as a matter of course.

This report addresses three major areas of Asset Management.

First, it examines asset management as a framework for demonstrating accountability - both in the short-term management of current transportation programs but also for the long-term sustainability of a state highway network. In describing Asset Management as a framework for demonstrating accountability, this report also spends considerable time addressing similarities and differences between Asset Management and Performance Management. To the uninitiated, the differences between the two management frameworks or philosophies may not be clear. The growing movement for accountability has led to a significant emphasis upon Performance Management and this report examines how it and Asset Management complement and enhance each other. The report also briefly compares and contrasts Asset Management to the other highly respected quality systems such as the Balanced Scorecard, ISO and Six Sigma.

Second, this report examines successful organizational structures and leadership strategies for instilling Asset Management into transportation agencies. Implementing Asset Management requires much more than buying a new software package or adopting new terminology. It involves creating new cross-cutting collaboration between traditionally separate

disciplines within a highway agency. When a highway agency is optimally structured or managed to fully capitalize on Asset Management, the formerly separate functions of planning, design, construction, maintenance and information technology all must work together more closely. Instead of operating strictly within their own silos, they need to collaborate to carefully manage assets throughout each phase of the asset's life. Successfully creating such cultural and organizational change requires skills in areas such as Change Management, Organizational Communication and Organizational Theory. These fields are seldom discussed in transportation literature but their practice can be essential to change the approach, the attitude and the culture of large organizations which are trying to embrace Asset Management. Shifting the direction of a large organization requires consistent, sustained leadership, communication, education and the creation of a common consensus among the different subcultures within a large organization.

Third, this report examines case studies of successful Asset Management programs across the United States and internationally. Although these transportation agencies differ significantly in their size, political structure, and resources, certain principles of how to instill Asset Management within them appear to be universal. Examples as diverse as North Carolina, Sweden, New Zealand, Utah, Maryland, Australia and Oregon are examined. Despite the significant geographic, cultural and governmental differences between these examples, their underlying strategies for successfully ingraining Asset Management into their organizations are strikingly similar.

Management trends come and go, creating a degree of skepticism among some that the lasting benefits of them may not be worth the effort to adopt them. However, the results of Asset Management are difficult to dispute, particularly during an era of accountability.

- In Utah, the agency has successfully convinced its Legislature and its Transportation Commission of its sound stewardship by demonstrating the systematic and comprehensive way it manages the state's highway assets. As a result, *Governing* magazine rates it an A for infrastructure

- management and its Legislature has bestowed unprecedented levels of funding upon the agency;
- In New Zealand, the national transportation agency has ingrained Asset Management into legislation. Now, it is a basic principle of national transportation policy that assets should be preserved at a high level, and be sustained into the future. More than 98 percent of the New Zealand pavements meet smoothness targets;
- In North Carolina, the Department of Transportation has successfully made organizational changes to improve and sustain the performance and condition of its assets to meet the needs of the 21st century. It has aligned and assigned ownership, roles, responsibility and accountability for performance of the system across business units, eliminating silos and forcing collaboration. Accountability for system performance is clear and transparent, starting at the highest level and cascading down to all employees. These approaches have been integrated into the agency's day-to-day operations and are expected to continue irrespective of changes to the leadership of the agency.
- In New South Wales, Australia, the state transportation agency has ingrained Asset Management into all levels of its operations. It produces a Total Asset Management Plan which functions like a parallel budget document to ensure that agency expenditures and agency efforts achieve its long-term Asset Management targets. It has sustained 87 percent of its pavements in good ride condition for at least a decade, and is forecast to maintain those levels into the future. It reports having only one load-limited bridge in its populous and urbanized state.
- In Sweden, the nation's Road Authority has used Asset Management and a Balanced Scorecard framework to keep more than 95% of major routes above acceptable pavement targets for more than a decade despite its harsh climate and diminishing purchasing power.
- The Oregon DOT has developed a comprehensive asset management process which guides decision making while also providing legislators with

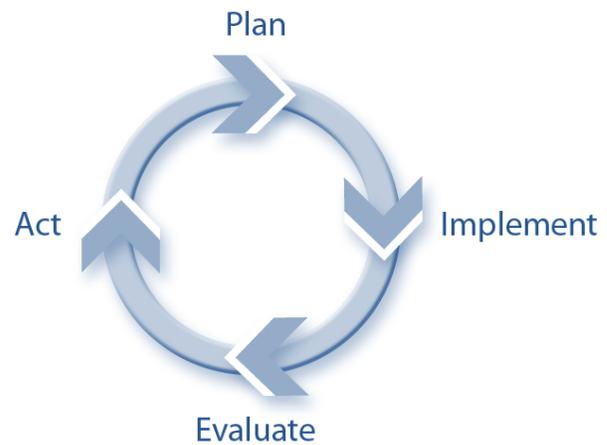


Figure 1 The "Plan, Implement, Evaluate, Act" cycle is inherent in "quality systems" and is essential in asset management as well.

performance information to assure them of the agency's direction.

These diverse agencies relied on several common management tactics for deploying Asset Management into their agencies.

Leadership Driven

In all of the examples, the use of Asset Management has evolved from an isolated technical or planning effort to a department-wide focus which was embraced by senior leadership. The leadership impetus came in different forms. In some cases, it came from a strong individual executive who was personally committed to Asset Management. In other cases, strong legislative emphasis led to the embrace of Asset Management. While there are variations across agencies, it is clear that a strong leadership focus underlies sustained efforts to adopt Asset Management.

Performance Focused

Another key finding is that departments that have successfully embraced Asset Management tend to have a strong systems approach to managing. That is, the department has embraced the Goal-Setting-and-Performance-Measurement processes inherent in the "quality systems" such as Six Sigma or ISO. In most of these cases, the focus upon systematically measuring and improving assets conditions was not unique. Similar strategies were applied to other

department functions such as reducing crashes, delivering projects, or responding to customers. It appears that once Asset Management is ingrained in an agency, expanding a performance focus to other agency programs becomes simpler.

Transparent

A strong sense of transparency seems to accompany agencies that have embraced Asset Management. These agencies were able to document to the public and to policy makers that they have embraced a rational, systematic, long-term approach to managing assets, often for the lowest life-cycle costs.

Data-Driven

The journey to long-term Asset Management has led to a steady improvement in inventory data and forecasting tools. As the agencies become more focused upon asset performance, they become more data hungry and tend to improve their asset inventories and data systems.

Formally Structured

Formality marked many Asset Management systems. Asset Management was rooted in official policies, ingrained into agency standards, manifested in agency manuals and articulated in agency publications.

System Based

Although the management *structures* of these agencies

vary widely, they appear to have evolved similar management *strategies* including the primary strategy of adopting a systems approach to managing their agencies. In these states and countries, the Asset Management framework does what virtually all management systems are supposed to do – it provides a process, a logic, and a feedback cycle to methodically and comprehensively get things done with ever-improving results. By adopting Asset Management, these agencies find themselves well positioned to respond to the growing demands for performance and accountability.

This report does not replicate the excellent work in the Asset Management Guide, either the earlier 2002 guide or the current update. Nor does it seek to supplant any technical or procedural guidance on Pavement Management, Bridge Management or Maintenance Management. It relies very little on engineering but instead addresses organizational change management, institutional communication, organizational theory and systems approaches to managing. It examines the management strategies, the organizational structures and information needs of transportation executives who seek to lead their agencies to the next generation of Asset Management. The Asset Management Guide and its related reports explain the “what” of implementing Asset Management. This report examines “how” executives have instilled Asset Management and its related practices within their departments. It also explains how in an era of accountability, they can rely on Asset Management to demonstrate their agency's efficiency, effectiveness and transparency.

Management Frameworks Defined

Asset Management is a strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives.

Pavement Management provides decision makers at all management levels with optimum strategies derived through clearly established rational procedures. A Pavement Management System evaluates alternative strategies over a specified analysis period on a basis of predicated values of quantifiable attributes, subject to predetermined criteria and constraints.

Bridge Management includes the establishment of optimal investment funding levels and performance goals for an inventory of bridges, as well as identification of the appropriate combinations of treatment scope and timing for each individual bridge over the lifecycle.

Performance Management is an on-going process which translates strategic goals into relevant and detailed measures which are then tracked to ensure uniform achievement of institutional goals. Performance Management Systems include an "institutional learning" function in which the agency analyzes the root cause of failure or success to achieve its performance targets, and disseminates the lessons of that analysis to perpetuate continuous improvement.

Table 1 The table provides definitions for the management systems commonly referenced in this report.





Asset management can provide a framework for transportation agencies to manage their resources, both their physical resources and also their human and informational resources.

Chapter 1 Overview of Asset Management

To devise the best organizational structure and the best leadership strategies for Transportation Asset Management, it is important to first understand all the functions which comprise this discipline. This section summarizes the basic functions of Transportation Asset Management as described in the Asset Management Guide and other documents. Much of the description relates to Pavement Management as an illustrative example of Asset Management. However, the general principals could apply to any asset, not just pavements.

As the Asset Management Guide notes, transportation asset management is a strategic approach to managing physical transportation infrastructure. It became a focus in the 1990s after the earlier development of Pavement Management, Bridge Management, Maintenance Management, Fleet Management and even Facilities Management systems. Each of these processes applies a systems approach to managing not only individual assets but also the entire class of assets for the lowest, long-term, life-cycle cost.

The term Asset Management can be ambiguous to both the uninitiated as well as those who are familiar with these earlier management systems. To the uninitiated,

Asset Management can be vague because it is named after two generic words, “Assets” and “Management.” It is described in general ways which could refer to many systematic processes. To the non-transportation specialist, the descriptions of “good” Asset Management sound like the description of just “Good Management.” Both rely on effectively executing a logical strategy to achieve the highest returns for an organization. To the experienced transportation practitioner, it can be difficult to differentiate Asset Management from the earlier systems such as Pavement Management, Maintenance Management and Bridge Management. A comparison of the definitions in Table 1, page 5, illustrates the similarities.

Further complicating the dialogue is the increasing focus upon “Performance Management.” In this report, Performance Management is defined “as an on-going process which translates strategic goals into relevant and detailed measures and targets which are then tracked to ensure uniform achievement of institutional goals.”

Performance management relies heavily on the use of performance measures to assess whether the

organization is achieving its goals. It also has an “institutional learning process” built in because it requires continuous analysis of results and root-cause evaluation of why results were not achieved. From that analysis, adjustments can be made to improve performance.

Performance Management for federal agencies is required in the 1993 Government Performance and Results Act, although the Act’s requirements did not extend to states. Performance management was strongly recommended for the federal transportation program in the 2007 National Surface Transportation Policy and Revenue Study Commission Report and it has been an increasing focus of AASHTO. So in addition to the original pavement and bridge management systems and Asset Management, the transportation community is now also coming to grips with “Performance Management.”

In many ways description rather than definition helps to clarify Asset Management. Transportation Asset Management applies a “rational and comprehensive” approach to managing pavements, bridges and other assets.

As the Asset Management Guide says,

“At its core, asset management deals with an agency’s decisions in resource allocation and utilization in managing its system of transportation infrastructure. Asset management is a way of looking at an agency’s “way of doing business” to see if there are better ways to reach decisions in infrastructure management – for instance, by basing decision methods and criteria on current policy guidance, considering a range of alternatives, focusing on outcomes of decisions, and applying more objective information to decisions.”

Asset Management has been defined as,

“... a strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives.”

The antithesis of Asset Management is neglect of

assets until they deteriorate and require reactive maintenance treatments to restore at least minimal functionality without regard to long-term need or performance. Instead, Asset Management is about applying policies, forecasts, tradeoffs and economic optimization to comprehensively manage an inventory of assets. Asset Management is distinguished by being:

Policy-driven—Resource allocation decisions are based on a well-defined set of policy goals and objectives.

Performance-based—Policy objectives are translated into system performance measures that are used for both day-to-day and strategic management.

Analysis of Options and Tradeoffs—Decisions on how to allocate funds within and across different types of investments (e.g., preventive maintenance versus rehabilitation, pavements versus bridges) are based on an analysis of how different allocations will affect achievement of relevant policy objectives.

Decisions Based on Quality Information—The merits of different options with respect to an agency’s policy goals are evaluated using credible and current data.

Monitoring Provides Clear Accountability and Feedback—Performance results are monitored and evaluated for both efficiency and effectiveness.

The general principles of asset management are similar, whether the assets involved are pavements, bridges, roadside features, or even facilities. By using pavement management as an example, the following steps illustrate the type of methodical, systematic and cyclical steps inherent within Asset Management.

First, a target level of service or performance goal for pavements is set. This target or goal usually is based on customer requirements, such as the degree of smoothness customers desire balanced against the available budget.

Second, the inventory of pavements is developed, if one does not already exist, and current conditions are assessed against the desired targets.

Third, an economic-tradeoff analysis is conducted at the program level to determine what is the estimated

optimum amount to invest in pavements to achieve the highest economic return. Investing too little will lead to degradation of pavement conditions which will be more expensive in the long term to repair. Investing too much draws essential resources from bridges, safety, maintenance, capacity and other important needs. This tradeoff can be conducted through a state-of-the-art optimization software program or it can be a much simpler straight-line forecast based off of the pavement inventory and past expenditure levels. Either way, it begins with a logical economic evaluation of the amount that should be budgeted for pavements.

Fourth, once the optimum amount of pavement spending is estimated, a rational analysis is conducted to allocate funds among preventive maintenance, reactive maintenance, rehabilitation and pavement replacement categories. Preferably, each category's spending levels would be predicated upon a highest Return on Investment analysis. If such a formal analysis is not possible, engineering judgment and past experience can be relied upon.

Fifth, once pavement sections are selected for treatment, the actual treatment would be based upon a rational analysis of the individual pavement to provide it the lowest-cost treatment at the right time. The pavement's place on the Pavement Deterioration Curve would be located and the appropriate preventive, reactive, rehabilitative or replacement treatment would be selected.

Sixth, once the pavement was brought to good condition, a planned and rational multi-year preventive maintenance schedule would be identified, and then executed.

Seventh, the pavement's performance would be assessed annually and adjustments made in its treatment schedule to provide the highest Remaining Service Life.

Eighth, if the pavement fails to perform as expected, a root cause analysis would be conducted so the agency can learn from the poor performance and can take corrective action so it is not repeated.

Ninth, the attributes of that pavement's performance and treatment costs would be fed into a Pavement Management System to continually assess if pavement

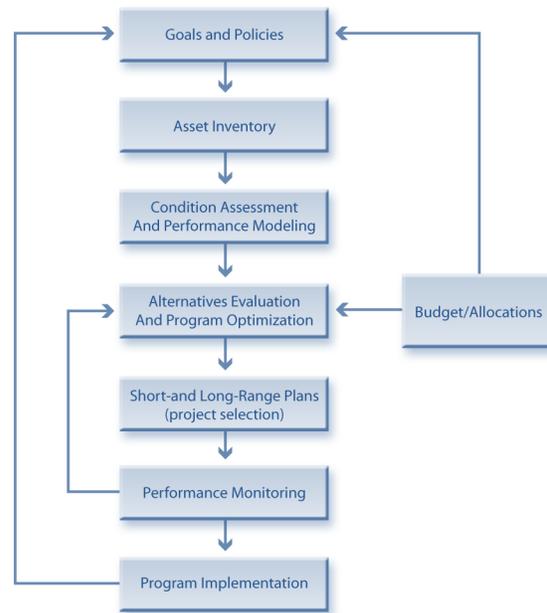


Figure 2 The asset management process includes a continuous and systematic setting of goals and evaluating of results.

goals were met and if adjustments need to be made to achieve overall pavement goals, expenditures or strategies.

In a fully developed Transportation Asset Management environment, similar rational and comprehensive approaches would be taken for the bridges, maintenance items, the department's fleet, its equipment, and even its human resources. Figure 2 above illustrates the basic steps within Transportation Asset Management. Similar steps would be taken for any individual class of assets, as well.

In short, Asset Management is a comprehensive, rational, systems approach to managing pavements, bridges and other transportation assets.

Haas and Hudson speak in similar terms when describing pavement management.¹

“Good pavement management is not business as usual. It requires an organized and systematic approach to the way we think and in the way we do day-to-day business. Pavement management, in its broadest sense, includes all activities involved in the planning

¹ Haas and Hudson, 1994, pg. 4.

and programming, design, construction, maintenance, and rehabilitation of a pavement portion of a public works program. A pavement management system (PMS) is a set of tools or methods that assist decision makers in finding optimum strategies for providing and maintaining pavements in a serviceable condition over a given period of time. The function of PMS is to improve the efficiency of decision making, expand the scope, provide feedback on the consequences of decisions, facilitate the coordination of activities within the agency, and ensure the consistency of decisions made at different management levels within the organization.”

Nearly 50 years ago, a renowned Yale economist named Charles E. Lindblom wrote a famous public sector management article in which he argued that most public agency decisions are not based on rational and comprehensive analysis, such as that described by Haas or the Asset Management Guide. Lindblom argued that instead, decisions generally are based on narrow, incremental changes to past practice, or “muddling through.”² He wrote in 1959 that the complexities of conducting a rational, comprehensive analysis of many alternatives was generally so difficult and expensive that public agencies could not afford it. Instead, they tended to make minor, incremental changes to past practice as a means of “muddling through” their policy-making process.

The advent of powerful scenario-producing information systems such as travel-demand models, pavement management systems, HERS-ST, Pontis, and many maintenance management systems now allow transportation policy makers to run numerous forecasting scenarios. They can routinely evaluate different investment levels and different investment mixes between programs to seek the optimum program budgets and strategies. The “rational and comprehensive” decision-making process that evaded Lindblom’s peers now is available to transportation executives for many of their most-important infrastructure decisions.

In the absence of sound Asset Management, the

² Lindblom, Charles E., *The Science Of Muddling Through*, in *Public Administration Review*, Vol. 19, pp. 79-88, 1959

following conditions are likely to be found, much in the manner described by Lindblom:

- Investment levels for various programs are based upon outdated formulas, geographic splits, political compromises or simple past practice;
- Bridges, pavements and maintenance assets are not treated systemically with an optimum mix of timely preventive and reactive treatments;
- The department lacks a clearly defined set of goals for where it wants its system conditions to be and it lacks strategies for how it will get there;
- Planning, design, construction, maintenance and information technology lack adequate coordination and take a “silo” approach to their role in managing assets;
- In other words, an agency “muddles through” its infrastructure-management process.

Asset Management therefore relates to improving existing agency functions such as long-range planning, short-range programming, scheduling of maintenance and the delivering of projects. These functions clearly are not new. What is new in an Asset Management approach is that they are conducted in a tightly coordinated fashion to ensure they result in the highest-system conditions for the lowest cost over the life of the department’s infrastructure planning horizon.

Asset Management should not be viewed as yet another new program, requiring another new bureaucracy. Rather, Asset Management is a “way of doing business.” It brings a particular perspective to how an agency conducts its existing procedures, reaches decisions, and applies its information technology capabilities. It suggests principles and techniques to apply in policymaking, planning, project selection, program tradeoffs, program delivery, data gathering, and management system application.

There is no one correct table of organization and no one correct set of performance measures that will guarantee a successful Asset Management program. However, there are a variety of common functions which need to occur in an Asset Management structure. Leaders seeking to instill Asset Management in their organizations will have to decide how best to coordinate these functions.

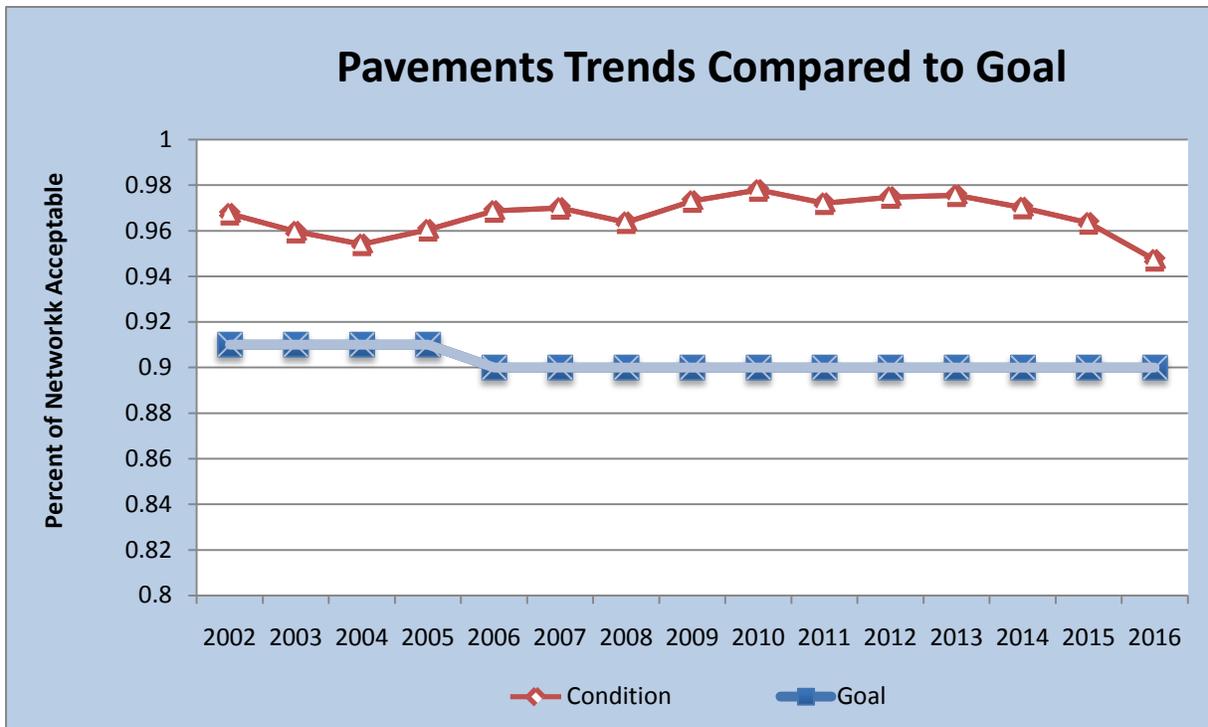


Figure 3 The ability to illustrate future trends and the results of current practices allows asset management practitioners to demonstrate the consequences of current decisions.

Asset Management Is a Strategic Approach

Asset Management requires a strategic approach to managing a department’s infrastructure. A strategic perspective takes a long view of infrastructure performance and cost, and considers options in a comprehensive, proactive, and informed way. It is driven by policy goals and objectives and relies on systematic assessments of asset performance and cost in making decisions on future actions.

An agency which practices sound Asset Management has well-defined policies that can be related to clear objectives and measures of performance. Management emphasizes customer service and accountability for system performance and cost effectiveness. Decisions on allocating resources are policy driven and performance-based, consider a range of alternatives, have clear criteria for decision making, and investigate the most cost-effective solutions through analyses of tradeoffs.

TAM Breaks Down ‘Silos’

Asset management encompasses a number of business processes related to infrastructure management in DOTs, including those related to planning, program development, design, construction, maintenance, information technology and knowledge management. The functions of planning, design, construction, maintenance and information technology work through common, coordinated processes to ensure that each contributes to asset management, without encumbering the other. The “sub-optimization” that can occur within silos is prevented through effective communication and coordination strategies. The business processes are managed to elicit effective contributions from all levels of the organization, and to foster communications on Asset Management needs and accomplishments both within and outside the agency. The organizational roles of each unit are clear, but also clear is the shared requirement that each unit coordinates with and complements the other. For instance, if maintenance has responsibility for crack sealing of pavements, it understands that role and executes it in a timely and appropriate manner in the pavement’s lifecycle. Design provides plans on time to provide treatments when needed. Information technology understands the information needs of the other functions and provides

the data they require. In short, the units function in a coordinated fashion to execute the thousands of individual steps required. Management authors sometimes refer to this as “Horizontal Alignment,” which often does not occur in large organizations without specific effort from the senior leadership.

Asset Management Relies on Good Information and Analytic Capabilities

Quality information – accurate, complete, timely – is important at all stages of Asset Management. Information technology is a practical necessity in supporting Asset Management. A sound Asset Management program relies on information regarding past asset performance, remaining service life, the expected performance of treatments and a forecast of future trends. The needed trend forecasts must address not only expected infrastructure performance but also future resource availability. Information is needed in standard reports for system-wide performance. Also innumerable ad hoc reports are required for front-line managers seeking to optimize their short-term performance of individual assets.

Asset Management Practices Are Flexible

Successful Asset Management practices vary considerably across the nation because of the significant differences between how states are organized and governed. Asset Management performance measures, data systems and analytical tools also vary widely because of the disparate development of information systems over the decades. No two states have the same legal structure, span of responsibility or legacy information systems. Each state and locality which undertakes Asset Management does so in a fashion unique unto itself.

Asset Management Works at Multiple Levels

Asset Management provides benefits at three levels, a

policy level, an administrative level and a technical level.

First, at the public-policy level it provides the organization with a clear framework it can use to explain its investment decisions and to illustrate the investment tradeoffs that it faces, as in Figure 3 above. If legislators ask for scenario planning to illustrate the impacts of increased or decreased investment, the agency can respond in a systematic fashion. The agency can explain its infrastructure-management philosophy and document that it is rational, comprehensive and economical, based on the lowest-overall life-cycle cost.

Secondly at the administrative level, Asset Management provides the agency a means by which to organize its disparate and widely distributed resources in a coordinated fashion to achieve one of its key missions – the optimization of roads, bridges and other transportation assets. The typical department of transportation will have essential staff distributed across dozens of counties and regions and hundreds of construction projects. Asset Management policies and practices provide a unifying structure and philosophy to coordinate these widely distributed people and the resources they control.

Third, at the technical level, Asset Management systems provide the information that engineers, planners, information technology specialists and managers need to conduct their jobs. Asset inventories provide information on the extent and condition of assets. Degradation rates can be used to predict assets’ future remaining service life. Information about the performance of past materials and construction techniques can be used to assess the adequacy of construction standards and materials. The planned preventive and reactive maintenance needs provide structure to the efforts of maintenance forces. In summary, Asset Management provides a “knowledge management” framework which contributes to continued organizational learning.

People, Processes, Plans and Products

Two of the agencies examined in this report, the Oregon and the Utah DOTs, use very similar language

in describing the major focus areas necessary to instill asset management successfully. They describe “people, processes, plans and products” as being essential. The fact that four fundamental aspects of an organization need to be engaged reflects the complexity and comprehensiveness of Asset Management. Changing people, changing processes, changing plans and changing products can involve a transformative evolution which extends to most major business areas of a large transportation organization.

Such transformation has been experienced by leading

Asset Management practitioners, and by those organizations which have embraced other advanced frameworks such as ISO, Baldrige or Six Sigma. This report will later describe those other systems and illustrate how they compare to Asset Management. But first, the report will describe what leadership strategies and organizational structures have been used successfully to ingrain these frameworks into the people, processes, plans and products of transportation agencies.

The Case Studies

Beginning with the next chapter, case studies follow each section. These case studies elaborate upon and illustrate the themes from each topical section. Particularly they focus upon the common issues that agencies confront and how they address them when they attempt major organizational change to improve asset conditions.

All of the case study agencies stressed that they do not consider themselves to have achieved a perfect process. All stressed that while they are pleased with their progress, they are on a long journey and their asset management practices continue to evolve. Each agency has taken a different approach based upon its statutes, geography, history and organizational structure. No case study is presented as representing the definitive approach. Rather, they illustrate the rich and innovative approaches which have been adopted. In their diversity, they illustrate that Asset Management principles can be applied successfully in many different settings, with different organizational structures and with differing legal frameworks. From New Zealand to North Carolina, agencies have achieved success with asset management practices in their own ways.



models or be conducted by ad hoc analysis of past trends and future projections. They should extend at least a decade into the future to fully capture the long-term effects of current practices in planning, programming, construction and maintenance. To understand whether today's actions are sufficient, the departmental leader needs to understand how today's actions will affect system conditions in the future. By its very nature, Asset Management assumes a long-term view. Therefore, a long-term strategic approach to thinking about the department and about organizing its activities is essential to implementing Asset Management.

The department's planning function must be able to produce sound investment scenarios. The asset planning functions reside in various units in different agencies. Sometimes, the asset planning functions are in the Planning Division, other times they are within districts, or materials units, or for bridges they may be in the structures divisions or even maintenance. Wherever the asset planning function resides, it must do more than fulfill the short-term mechanics of the federal or state planning process. The planning function must conduct strategic long-term forecasts of system conditions and provide senior management with alternative investment options based upon various long-term scenarios. The scenario which best meets the department's policy needs, system-condition goals and financial resource forecasts can be selected.

An important component of the department's strategic, long-term approach is to meaningfully translate the long-term objectives into short-term performance measures which are drivers for annual activities. If the department seeks to increase preventive maintenance investments for greater long-term pavement performance, the number of preventive maintenance projects in the short-term Transportation Improvement Program probably needs to increase. The planning function can measure and track the short-term annual and bi-annual pavement project accomplishments for their conformance to the long-term objectives.

Formerly separate functions often become linked in an Asset Management process, therefore cross-cutting coordination is important. The maintenance

of asset inventories is an important planning function within an Asset Management environment. Another important planning function is the development of the State Transportation Improvement Program (STIP), or the collection of capital projects and activities to be undertaken. In an Asset-Management framework, these two formerly separate functions become linked in important ways. Each year as the inventory conditions are updated, the conditions should be assessed and compared against the short-term condition goals which the department had set for the year. Also, the development of the projects in the STIP should be carefully done so that the particular projects actually include the precise number of preventive, reactive, rehabilitative and replacement projects which were prescribed in order to achieve the desired long-term system conditions. As mentioned earlier, all the traditional departmental functions occur in an Asset Management operation but they often occur with more cognizance and linkage as to their effects upon other aspects of the department. In this case, the development of the STIP is done with a clear objective of achieving the short-term system-condition goals, which are one annual component of a multi-year strategy. Also, as the annual inventory assessments of the condition of bridges, pavements and maintenance items occur, the resulting overall condition levels are compared to "field verify" whether the forecasted conditions were actually achieved. The two formerly separate functions of STIP development and inventory condition updates become strategically linked in an Asset Management planning framework.

Traditional planning and forecasting scenarios must be clearly understood by policy makers. The planning functions must fulfill an important forecasting role, both internally and externally to policy makers. Departments are always influenced by outside policy forces, whether they be gubernatorial, legislative, media-driven or embodied within a commission. These forces will seek to influence project selection and programming to whatever ends they deem most important. The policy and planning process of an organization can provide these influencers with clear information on the tradeoffs to be faced and the consequences to be expected from their decisions. To effectively influence the investment decisions, the forecasts need to be clear, credible and

understandable. This requires the planning function to not only be expert in conducting forecasts but also to be able to clearly explain them to the public and policy makers. Important within this forecasting function is:

- the clear estimation of available resources;
- the trends in system condition;
- the investment tradeoff scenarios which are possible, and;
- a recommendation for how to balance these complex, and competing needs.

These competing needs can be between asset classes such as bridges and pavements, between important objectives such as safety and environmental enhancement, or between modes.

Project Delivery Reliability is Key to Timely Asset Treatments

The coordination between the asset planning functions and the project delivery functions is very important in an optimized Asset Management operation. The planning and programming functions play an explicit role in selecting specific projects to achieve specific system-condition goals. Outcome-related metrics drive programming decisions, as opposed to more general output measures such as merely the number of miles paved or whether a department hit a goal for the size of its construction program. The programming and project-selection decisions are explicitly tied to predicted asset-deterioration cycles. The timing of preventive and reactive maintenance projects are carefully planned to maximize asset-condition longevity. For any one project, predicting this time window and delivering a treatment project accordingly is relatively simple. When departments are managing thousands of disparate pavement sections and thousands of separate structures, the coordination of hundreds of specifically scoped and specifically timed projects becomes quite complex. Therefore, the coordination between planning and design functions must be sound.

For instance, by tracking structural deficiencies in pavement sections, the pavement planning officials

can identify pavement sections appropriate for preventive maintenance treatments. Projects for those treatments can be scoped and timed appropriately with the design division. The pavement planning function also can assist design by forecasting the cumulative effects of all programmed projects upon meeting the department's pavement or bridge-condition goals. If the overall program is not projected to achieve the desired goals for a specific horizon year, either additional projects can be considered or the scope of the existing projects can be altered to achieve the asset condition goals.

Projects are reliably delivered on time and within scope in an agency that successfully optimizes asset management. The role of design or plan development units is to reliably deliver the appropriately scoped project on time so that the lowest-lifecycle-cost treatment actually is delivered to the asset when it is needed. If preventive or reactive maintenance is delivered too late in an asset's deterioration curve, the treatment effectiveness will be diminished. The importance of treatment timing is particularly acute considering the lack of adequate funding that most agencies experience.

Agencies are seeking to stretch their assets' useful lives without letting them deteriorate to a stage where they require expensive reconstruction or replacement. This creates a treatment window in which the appropriate low-cost treatment will improve the asset but the same treatment delayed may be inappropriate for that asset. For instance, a minor overlay timed appropriately can extend a pavement's life but a minor overlay on a severely structurally deficient pavement will accomplish little in the long-term. The overall lifecycle cost assumptions of when to treat an asset and how to treat it must be predicated on the reliable assumption that the treatments will occur on schedule.

Design units also must have sound cost data to successfully support Asset Management. Asset Management is about seeking the highest-return-on-investment strategies for the assets over their useful life. Assumptions about how to treat those assets must be predicated upon sound cost information. This cost information generally comes from a

comparison between estimated costs and actual costs. The actual costs are derived not only from the awarded bids, but also from all the change orders which occur to a project during its construction. The final, as-built costs must be tracked and translated into useful unit costs which are fed back into the planning forecasts. The accuracy of the unit costs which can be escalated with realistic growth factors is essential to investment forecasts and scenarios. To coordinate the accuracy of planned, estimated and as-built costs, requires coordination of the planning, estimating and construction sectors. The accurate data they generate must be available to the Asset Management planners who are forecasting system needs. In the Utah DOT case study, the Asset Management staff noted that capturing reliable asset-treatment unit prices was a key step in their Asset Management development. Separating the costs of pavement treatments from ancillary costs in projects was important to forecasting budget levels needed to sustain pavement conditions.

Departments have a formal, documented process for approving significant change orders and cost increases in an Asset Management framework. Because funding and programming decisions have been carefully balanced in an Asset Management environment, a significant cost increase in one project results in the delay or cancellation of another. The cost change which results in a project delay or cancellation may ripple through the carefully balanced network analysis. The production or plan delivery unit needs to formally report the cost increases and coordinate that information with the planning and programming staffs who had balanced the program originally. Not only are project-delivery dates carefully tracked, but adherence to project cost and scope must also be coordinated.

The Importance of Maintenance Should Not be Overlooked in Asset Management

Maintenance forces can become a key partner in an Asset Management framework. Maintenance activities traditionally have been reactive but they become incrementally more strategic and pro-active when they are fully integrated into an Asset

Construction's Critical Quality-Control Role

It is self-evident that sound construction, inspection and materials-testing practices are important in Asset Management. The detailed adherence to materials and construction specifications are always a priority. In an Asset Management framework, the reliance on sound construction techniques is even heightened because the organization is relying on the full performance of any particular treatment as part of its carefully choreographed and balanced program of projects.

Management framework. The daily work maintenance forces do can be strategically focused upon the maintenance activities which most directly support the continued performance of assets. These activities are unglamorous but important. They can include:

- Systematic crack sealing;
- The application of low-cost treatments such as chip seals;
- The cleaning of under drains;
- General drainage maintenance;
- The strengthening of shoulders which can prevent pavement edge failures;
- The clearing of scuppers and expansion joints on bridges;
- Bridge deck patching;
- Full-depth pavement repairs which contribute to pavement structural integrity instead of mere surface patching.

It has been common in recent decades for maintenance forces to operate under , however, for those forces to be explicitly trained as to how the above activities can extend the life of pavements and bridges. In a fully organized, asset management framework the front-line maintenance forces are viewed as an important ally in the process.

Information and Analysis Rises in Importance in Asset Management

Information and analysis is probably the area of a traditional department of transportation which most grows in importance during the transition to a full Asset Management environment. As departments embark on an Asset Management effort, they quickly consume ever-increasing amounts of information and analysis. Legacy asset inventories such as bridge, pavement and maintenance inventories are increasingly relied upon as the basis for scenario and tradeoff analysis. Management systems are often found to be lacking in the detail and flexibility which decision-makers soon require as they seek ever-more complex scenario planning.

Nearly all departments have basic inventories for their pavement, bridge and maintenance assets. In some cases where Asset Management was not emphasized, these inventories degraded in terms of the accuracy and timeliness of their data. If the data were not heavily relied upon for decision making, there was little institutional imperative to sustain them in a high condition. Once decision makers come to rely upon sound condition data as the basis of scenario forecasting and project selection, the need to update and enhance the legacy inventories rises in importance.

Management systems are called upon for increasingly sophisticated scenario analysis. As the department refines its Asset Management approach it will seek to increasingly improve the accuracy, specificity and scope of its scenario forecasting. As it discusses

options with policy makers, they will seek answers to ever-more complex questions about the effect of different investment options. These scenarios will put increased pressure upon traditional management systems, which the information technology unit will be asked to enhance.

The measurement of performance in all Asset Management functions will require continuous reporting. Departments which rely heavily upon Asset Management tend to develop “dashboards” and other performance reporting processes. These reports are desired so that policy makers can measure progress of the multiple and inter-related functions which must occur continuously to effectively implement Asset Management.

Leadership and Communication Link Strategy and Action in Asset Management

The execution of Asset Management requires vision, communication and continuous self-evaluation. In short, it requires leadership. If left to their own best efforts, the various units within a department will attempt within their span of control to improve the assets under their jurisdiction. However, to effectively achieve the extensive coordination and resource-allocation tradeoffs described above, a leadership structure needs to be in place. This structure must be able to effect timely and reliable execution of activities and it must be able to enhance institutional learning by compelling the continuous analysis of results. In short, the successful change from “business as usual” to a “rational and comprehensive” system requires compelling leadership.

North Carolina DOT Case Study

Following is a case study of the North Carolina DOT. The evolution of asset management in North Carolina clearly reflects many of the evolutionary trends described in Chapter 2. In North Carolina, the roles and responsibilities of many disparate units were clarified to focus their efforts to collaboratively embrace asset management as the organization's framework for managing its highway system. The North Carolina case study also foreshadows trends relating to organizational structures and informational needs that are discussed in Chapters 3 and 4.

North Carolina DOT - A Case Study In Leadership, Performance Management, Accountability And Asset Management

To best serve North Carolinians in the 21st century, NCDOT conducted an internal review to identify areas of improvement that could be undertaken to help them better manage all the transportation assets, projects, programs, initiatives and services. This report discusses the changes implemented by NCDOT as a result of that review. Actions taken by NCDOT included changes to its processes, management strategies, organizational structure, roles and responsibilities. It resulted in a stratified approach to investment in the multimodal transportation network. It aligned accountability and performance measures around a clear understanding of agency mission and goals. The approach also focuses on systematically managing all assets within the charge of NCDOT.

Performance measures and accountability were simple and transparent. They cascaded from the top leadership down to each employee. Employees could link their job responsibilities and actions to performance of the agency mission and goals. NCDOT's actions have resulted in systems, policies processes and structures that have enabled the agency to forecast the condition of its infrastructure and develop strategic and tactical plans to systematically manage its assets. The process helps the agency to better address system needs while working within budget constraints.

DOT FACTS

The North Carolina DOT was established in 1915 as the State Highway Commission. Over the years, the agency has gone through major changes when the General Assembly consolidated services provided by other state departments into the DOT. The agency, earlier referred to as the North Carolina Department of Transportation and Highway Safety, was later shortened to the North Carolina Department of Transportation and incorporated the Division of Motor Vehicles.

The North Carolina DOT is amongst DOTs that manage not only state and local roads and ferries, but also provides funding and oversight to rail, public airports, and other modes of transportation. The agency has the

second largest state-maintained highway system in the nation and an annual budget of approximately \$4 billion.

Nearly 12,000 employees in the agency headquarters and across 14 highway division offices, 41 district offices and 100 county maintenance facilities are involved in managing all of these assets.

In the late '90s, NCDOT established a Maintenance Quality Assurance program and implemented a Maintenance Management System. The goal was to estimate and plan its routine maintenance and

The DOT manages:

- 79,009 road miles
- 158,592 paved lane miles
- 6,644 miles of unpaved miles
- 17,756 State Structures
 - 14,000 Bridges
 - 3,756 Culverts
- 511 Traveler Information System and Intelligent Transportation System that includes
 - 140 dynamic message signs
 - 200 traffic cameras
 - 500 centerline miles of Interstate Motorist Assistance

resurfacing needs. The agency's initiative was in response to the State Legislature passing a General Statute requiring the agency to survey the condition of the State Highway system every even-numbered year and reporting the findings to them.

Significant increase in the use of the state's infrastructure has been observed and this is expected to continue to increase. With inflation and funding

constraints, maintaining the condition of an agency's asset has become a tremendously challenging task.

According to projections, the VMT of North Carolina is expected to **double by 2020 and the population is expected to grow by 50% between 2000 and 2030**. This will make North Carolina the seventh most populous State by 2030. The constraints in funding and the increases in population and VMT will magnify the challenge of the agency to keep the transportation assets in good condition.

Setting Direction

In 2008, the agency revised its mission and goals to meet the transportation needs of the 21st century. The goals of all the business units were revised to be closely tied to the mission and goals of the agency.

The revised goals addressed all aspects of asset management necessary to run a world class transportation agency. It addressed processes to effectively manage the network proactively and make it last longer while ensuring safe and efficient movement of people and goods. The goals also focused on Human Resources, considering the employees as assets and creating an environment that would attract, retain and bring out the best in the employees.

The State Highway Administrator, Terry Gibson said *“Long term success of an organization has to come from within. This can be accomplished by setting clear directions and enabling the employees to feel like shareholders, involved in the long term success, taking ownership and contributing to its continuous improvement.”*

The Agency Mission

Connecting people and places in North Carolina - safely and efficiently, with accountability and environmental sensitivity.

The Agency Goals

- Make our transportation network **safer**.
- Make our transportation network move people and goods more **efficiently**
- Make our infrastructure **last longer**.

- Make our organization a place that **works well**.
- Make our organization a **great place** to work.

Review and Continuous Improvement

The heart of all effective management strategies lies in planning, implementing, reviewing and correcting. This cycle has to occur continuously in order for the improvement to be effective and appropriate to the changing times. The NCDOT initiated an effort to better understand the challenges of the 21st century. The objective was to identify the areas within the DOT where improvements could be made and to lay the foundation for how to best deliver transportation services to North Carolinians in the 21st century within the constraints of the budget.

In 2007, to assist in this effort the leadership hired McKinsey and Company to survey, review, identify and diagnose the operation, processes, workings and the organizational structure of the DOT. The company worked closely with the NCDOT team in completing this assessment. Many agencies conduct similar internal reviews including the use of external assistance such as that used by NCDOT to accomplish the objective of reviewing and refining/ making changes to existing processes, programs, structures and policies. Based on the goals set by the NCDOT, McKinsey and Company made recommendations to build capabilities and support the transformation that would enable the agency to deliver transportation services to North Carolinians in the 21st century. After the review, the agency systematically implemented a series of changes. The agency also implemented a revamped Continuous Improvement Program that helps it to continue the review and refinement of various aspects of its organization as they relate to the mission and goals of the agency.

This has resulted in many new ideas for improving the life of assets and the delivery of services within the DOT. In 2009, the agency received over 20 suggestions for improvements. One of these suggested improvements was about, ***“How to improve asphalt surface treatment.”*** The process started by the leadership taking the initiative to make continuous

improvements and this approach is now integrated into the agency culture. It is thus more likely to continue in the future.

Leadership and Communication

As organizations continue to grow, business units try to make internal improvements. Often these internal improvements are not done in collaboration with other business units and are narrowly focused more on improving unit specific products and services. Without continuous review and alignment of the goals of the organization with the goals of each of the business units, over the years these can get off synch. This can lead to the *silo effect*. Reviews at the organizational level can be expensive and can be perceived as wasteful, making it difficult for public organizations to conduct frequent review and realignments.

Change is always difficult. But when such reviews and changes are led by the agency leadership that is open to and leading the change, it sets an example for its employees also to embrace such change.

When NCDOT conducted its review in 2007, its leadership identified the formation of silos as one of the challenges that needed to be addressed. They found that even though business units had streamlined their internal operations, because of the presence of silos, often the goals were not collaborative and in many cases competed with those of other units. The sum of these improvements did not result in the better performance of the agency as a whole.

Clear, Simple Common Mission and Goals

Having clear and simple mission and goals makes it easier for employees to understand, adopt and contribute to the success of an organization.

NCDOT leadership addressed the issues of silos and competing goals by revising and setting simple but very clear goals and a clear mission for the agency. The goals of each business unit were completely aligned with the mission and vision of the organization. The agency then set up an implementation plan to communicate these goals and its mission across the agency. These were repeatedly communicated to all employees. The

communication and changes included:

- One Common Focused Direction.
- Revised the mission and goal statement to make it consistent within the agency.

Communication and Common Understanding

The NCDOT mission and goals were cascaded throughout the organization. The agency adopted a practice in use at many well-run organizations to start every meeting by tying the objectives of the meeting back to the mission and goals of the department. This practice achieves two objectives:

- Firstly, it reminds everyone about the mission and goals of the agency, and
- Secondly, it forces employees to relate the objective of the meeting to the mission and goals of the agency. This helps further align agency activities with common goals and reduces the formation of silos.

Like most large organizations, in the DOTs, many business units, divisions and offices contribute to the successful delivery of projects, programs initiatives and services. In organizations where business units are silos it is difficult to assign accountability or responsibility for successful delivery of products at the agency level. Accountability and responsibility can be defined clearly when the sub-deliverables, sub-tasks and sub-products to be delivered by each business unit are well defined.

Silos within NCDOT made it difficult to clearly assign accountability and responsibility. This led to missed opportunities due to lack of collaboration in areas including in planning, project selection and implementation. Duplication and contradictory decisions led to some waste of resources and efforts. It also led to imbalance in staffing with respect to the overall agency goals.

“Employees tend to focus on the goals of their business unit often at the cost of agency goals. Silos coupled with lack of processes for agency wide prioritization, accountability and coordination leads to delays in projects and waste of resources” said the Chief Operating Officer, Jim Trogden.

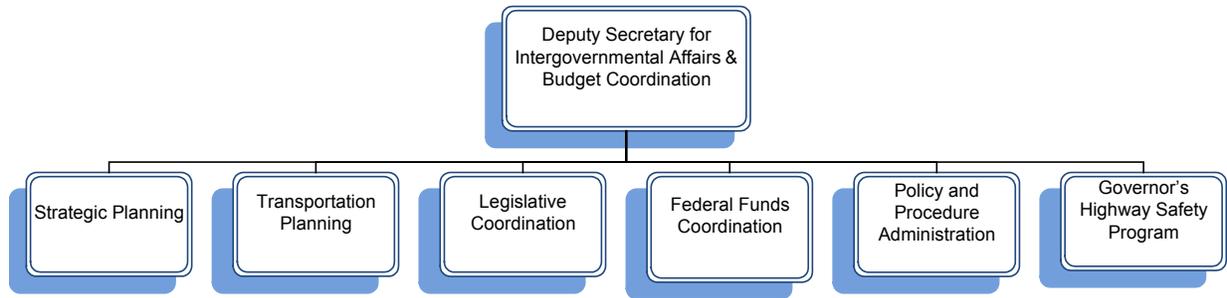


Figure 4 The Strategic Planning Office reports to the Deputy Secretary.

To create an efficient streamlined organization, where there was less duplication of efforts and there was collaboration to meet the transportation needs of 21st century, NCDOT reviewed the operations of all of its divisions and identified areas for improvements.

Restructure and Realign

Restructuring of an organization has to be done thoughtfully. It is important to restructure in order to realign areas of the organization for efficient functioning and improved collaboration across the agency. NCDOT restructured itself by focusing on developing a more productive organization. They restructured only selected areas that would lead to accomplishing the overall success of the organization and the proactive management of assets and services based on long and short term goals of the Department.

Realignment should facilitate maximum coordination and align business units to collaborate, be accountable and responsible in delivering the agency's goals and mission for the 21st century effectively. Some of the actions taken to address the issues with collaboration included:

- Selective organizational restructuring and realignment to support collaborative and well coordinated decisions in project planning and project delivery;
- Alignment of business units along functional lines and improvement of coordination amongst business units;
- Improving coordination across geographies in planning, designing, delivering and maintaining projects;
- Restructuring in a way to improve accountability

for delivery of projects, programs, services and initiatives;

- Improved coordination of Core Processes;
- Working with employees to change mindsets to a more collaborative approach focused on organizational success and accomplishment versus individual or business-unit-specific accomplishments;
- Focus on Outcome Based Performance Metrics.

Collaboration from Cradle-to-Grave

An approach to improving efficiency and increasing effectiveness in decision making identified by NCDOT was to increase sharing and collaboration in processes from planning through project development. To facilitate this, the agency recommended the **implementation of a Project Collaboration Software** that supports core processes in planning, programming and project development. This prevented isolation and disconnect in decision making amongst the various business units and processes necessary to plan and develop projects in a shorter period of time.

Focus Resources in Strategic Planning and Asset Management

To strategically help with improving overall management of assets and to link it to strategic planning, NCDOT created the Strategic Planning Office (SPOT). SPOT was responsible for analyzing system-needs, conducting trade-off analysis and prioritizing

projects, for the Statewide Transportation Improvement Program (STIP) state-wide. SPOT as shown in Figure 4, is high in the organizational chart and is responsible for coordinating the submission of candidate projects for the STIP and prioritization based on the DOT’s mission and goals.

SPOT assisted the agency and helped make strategic planning transparent and proactive. The process followed by SPOT involves comprehensive 1-year, 2-year and 8-year strategic planning efforts. The steps involved:

- Every 8 years, establishing a strategic direction and creating a 30 year outlook;
- Every 2 years, developing strategic prioritization based on a 5 to 10 year outlook;
- Every year, creating action plans based on a one to two year outlook.

The formal and systematic annual process of prioritization guides the development of the Transportation Improvement Plan. Though collaborative in nature, it takes input from multiple sources and applies a numerical value based on the contribution of the project to reaching the department’s goals and objectives. The agency has also a process for stakeholders to provide input early in the process.

Keeping the process transparent and communicating the details of the prioritization models publicly has helped the agency to improve and shorten the selection and prioritization process.

Office of Asset Management

Transportation Asset Management (TAM) has been a part of the agency’s operation for a long time. It was formalized in 2003. According to Terry Gibson, the NCDOT State Highway Administrator, the approach of the staff has been “*give us the resources and hold us accountable for the performance of our transportation assets. The agency already had many elements of Asset Management in place. With the revised performance management process and the resulting performance measures being closely linked to the goals and performance being measured based on the results, Asset*

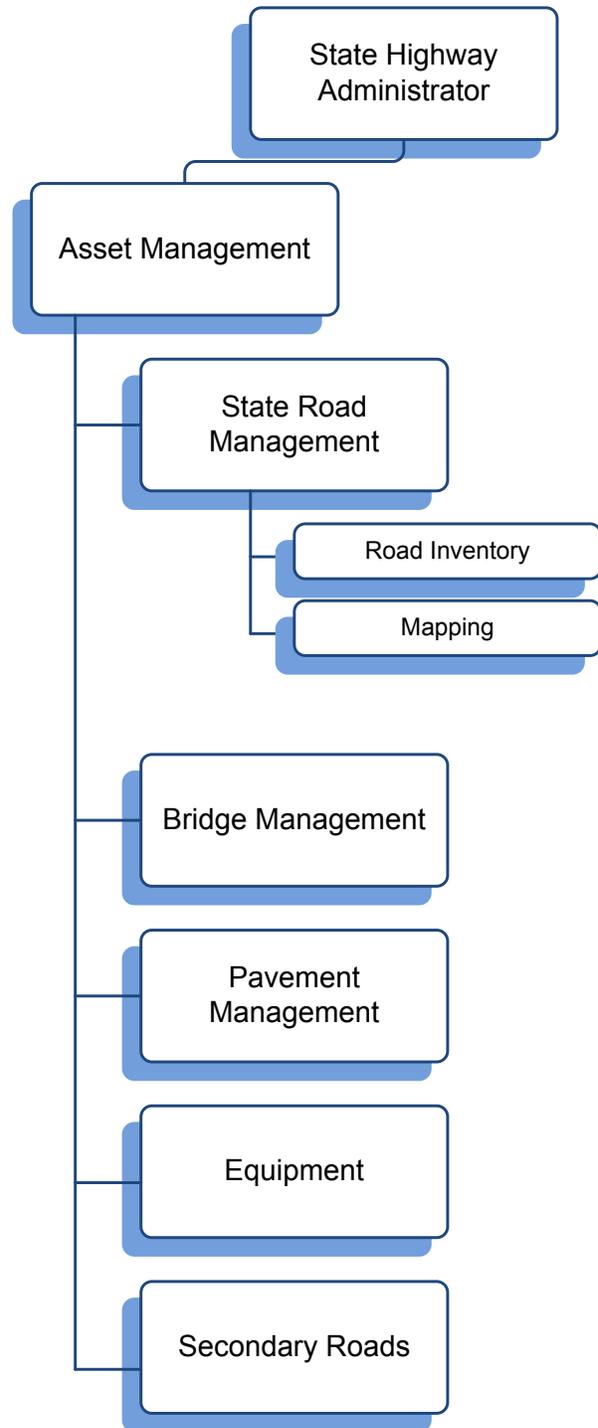


Figure 5 Organizational chart for asset management. Management has become more appreciated.”

According to Mr. Gibson, Performance Management and Asset Management are closely tied. Any agency starting the journey into developing effective performance management processes and measures can

use some of the following simplified steps:

- Jump-start the process by creating a TAM office;
- Assign someone the responsibility and authority which by itself will force change in the organization;
- Develop performance measures and metrics and tie them to performance of the assets;
- Lay out the benefits of TAM in the context of the mission and goals of the business;
- Communicate the goals, objectives and role of TAM to all the business units and explain how each business unit could use TAM to make better decisions and improve performance of projects, programs, services and initiatives within their charge.

Since TAM makes sense from a business perspective, agencies will be able to get buy-in across the organization, sooner or later, depending on the organization and the type of strategies they use to educate and communicate.

Jon Nance, Chief Engineer stated, *“we use Asset Management linked to the performance of our assets to communicate with the legislature and stakeholders. This has resulted in an increase in our budget and has helped to improve their understanding of our strategies, efforts and challenges.”*

NCDOT uses tools to translate conditions of the assets into strategies. For example, the number of miles of pavements in good, fair and poor conditions is used to develop short term and long term strategies. These strategies are translated into action plans for the field managers.

Asset Management plays an important role in the NC DOT. As shown in Figure 5, The Director of the Asset Management Office reports to the State Highway Administrator. The Office of Asset Management is responsible for coordination of condition assessments on all three tiers (state, regional and sub-regional) of the roads, pavements and bridges and the management systems that support these assets.

“Transportation Asset Management has allowed us to communicate financial resources to the legislature. It is a mechanism to show how you are good stewards of

funds and how you are making the best use of resources to benefit the public”, said Terry Gibson. Lacy Love, Director Asset Management said, *“Asset Management has been important for decision making in NCDOT. It helps the agency have an accurate picture of the current conditions of the assets and the resources required to change and improve the conditions of the system.”*

The Asset Management group has an important role in providing data and sharing the information required to accomplish the outcomes and results established through the performance management process.

Terry Gibson, said, *“The agency’s asset management is focused on highways for which we have very good information. We are looking to ultimately develop a cross functional analysis to help us meet targets of performance across all modes.”*

The North Carolina Multimodal Investment Network (NCMIN)

NCMIN is an investment template developed by NCDOT to help prioritize investment strategies based on how the components of the transportation network contribute to serving different transportation movements. The agency also developed the Strategic Highway Corridor initiative to *“protect and maximize the mobility and connectivity on a core set of highway corridors.”* In North Carolina, all transportation facilities are classified into three groups based on their function in serving transportation. The three tiers as shown in Figure 6 are defined as follows:

- **Statewide Tier** serves long-distance trips, connects regional centers and has the highest usage. This includes the Strategic Highway Corridors (SHC) which consists of 7% of the roads that carry over 45% of the traffic.
- **Regional Tier** serves to connect major population centers. All Primary routes (US and NC) not on the Statewide tier fall into this tier,
- **Sub-Regional Tier** serves localized movements and is of most interest to cities and
- counties. This includes all secondary routes (SR) not on the SHC.

Tiered approach to asset management is an effective way to prioritize and make decisions when large numbers of assets compete for limited resources. In

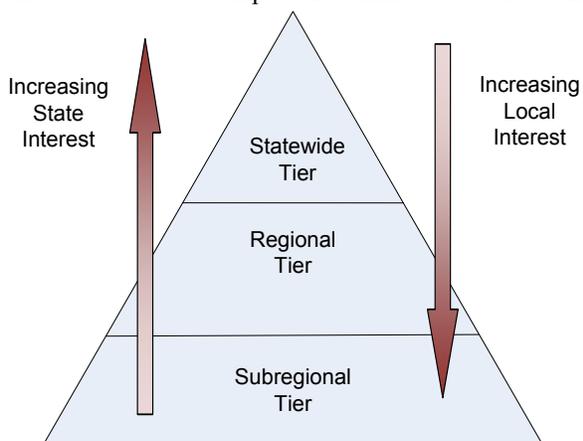


Figure 6 Conceptual representation of the Multimodal Investment Network.

NCDOT this tiered approach is an effective strategy for making decisions on investments based on the use and function being served by the transportation component.

Being Strategic in Selecting Projects and Services

The NC DOT portfolio of projects and services is explicitly linked to the revised goals of the agency. The portfolio of projects is based on the long-term as well as short-term goals. The portfolio also is based on innovative funding approaches beyond relying on existing sources of funding. The plan of activities includes day-to-day actions that need to occur for effective performance of the assets as well as the long term actions required by the agency. The short term plans become part of the annual action plan for the managers.

Role of Data in Quality Processes

Good decisions depend on the quality and consistency of data being used. In quality processes such as Baldrige, Six Sigma, Balance Scorecard and ISO, the quality of data and information systems and their contribution to data driven decision making, are major components of the evaluation process. The quality of decisions depends on the sustainable availability and the

quality, reliability and consistency of the data and directly contributes to the quality of the agency's plans.

One of the big data challenges faced by organizations is the lack of consistently reliable data to make decisions. Standardization of data has always been a challenge. Often, data pertaining to the same asset used by different business units for decision making even for the same period of time is different. This may be because:

- different business units collect their own data;
- the frequency and hence "how current the data is" varies across business units;
- the interpretation of the data by different users is different, or;
- business units save the data in their own databases that are not linked to and do not communicate with other databases in the agency.

This results in islands of data that do not connect with each other. All of these issues of data inconsistency make it difficult for an agency to make sound strategic decisions. These issues can lead to external stakeholders, the public and the legislature questioning the credibility of the agency's decisions.

NCDOT, in the review of its internal systems, found a lack of integration of data in its core businesses such as Bridge Management, Pavement Management, Maintenance Management, Traveler Information Management System, Accident History, Construction Management, Project Management, Financial Management (SAP system) and GIS.

Based on the findings, NCDOT identified the need for Data Integration, Enterprise Document Management and Project Collaboration Software as high priority projects necessary to support the delivery of transportation projects, programs, services and initiatives effectively. To accomplish these, the agency identified the following goals for Data Integration:

- Integrate data across DOT to enable management reporting;
- Ensure consistent and accurate reporting;
- Provide reporting from a single source.

To address the lack of integration between many of the systems pertaining to core processes, the agency implemented changes to its data warehouse and

integrated important data about the performance of core assets and functions into a one-stop performance management and accountability system. The agency thus created a single source of business intelligence data for all DOT management reporting. This single view of the data across the enterprise - an essential element of asset management - has resulted in an integrated approach to making decisions on the short-term and long-term management of the agency's infrastructure assets. This has also helped the agency in its analysis of the conditions and in developing corrective actions required for developing the short-term and long-term plans.

Data Collection and Dissemination

DOTs have many assets and therefore, data collection in a DOT can be a very expensive process. NCDOT has over 75,000 miles of pavement and over 17,700 structures. Monitoring and evaluating the condition and performance of these assets require collection of large numbers of specific data throughout the life of the asset. NCDOT addressed the data collection and data consistency issue by consolidating and centralizing strategic data collection for the Division of Highways under the Office of Asset Management.

To make sure that all users get on-time access to the same data, the collected data is streamed to all users. The data is also mapped and stored in the central repository. This approach ensures that the same type of data is not collected by multiple areas within the agency. It also enables consolidation of data to a single repository so decisions made across the agency are based on the same data.

Aging Assets, Long Term Decisions and Asset Management

NCDOT is facing the same challenges that many other states are facing. Many bridges across the nation are nearing the end of their life. Delayed action will mean more expensive treatments. However, the current funding situation makes it extremely difficult for states to address the challenges in maintenance and preservation that need more immediate action.

- In North Carolina about 8,000 bridges will need to be addressed within the next 20 years.
- About 12,700 bridges are owned and maintained by NCDOT;
- 3,400 bridges have an estimated remaining life of less than 10 years;
- The agency will need to address about 400 bridges each year to make gains on the number of deficient bridges;
- The agency is able to address only 100 per year leading to approximately 200 bridges becoming structurally deficient each year.

One of the issues the agency found was that delays in project delivery led to the agency not being able to use all of its federal allocation of "B" funds. Bridge project delivery issues included overdesign at the sub-regional tier, lack of budget controls where scoping was not based on a budget, too long a time between planning and letting of projects. The agency found that improving coordination and development, and including maintenance, preservation and rehabilitation strategies in project prioritization would help the agency to increase the number of bridges that it addressed each year.

The agency also found that accountability and responsibility of the bridge program was too dispersed. To address these issues, the agency identified the need to create a structure with a Central Bridge Manager, Division Bridge Manager and Right-of-Way Utility Coordinator responsible for coordination and successful management of bridge projects. The intent of this organization change was to make the Central Bridge Management Office accountable for the entire bridge program with the Division Managers being accountable for bridges in the divisions. The agency is in the process of implementing these changes and hiring managers to fill these new roles. The agency also understood that all bridge projects are not the same. To address the varied needs of the divisions, the agency implemented two different project management approaches for bridges. One consisted of a TRI-managed process and another is a Division Managed Process. The selection of the type of process depends on the complexity of the project and the site conditions. The agency also implemented budget-based design and construction. It is also developing formal processes and capturing these in manuals for bridge preservation and management and

communicated these through training the employees. The agency has also established two new positions to help with their preservation efforts; a pavement preservation engineer and a bridge preservation engineer.

Streamlining and Instituting On-site Project Scoping for Bridge Projects

NCDOT streamlined preconstruction and project development to reduce the time taken from planning to project letting. The agency focused on making sure that over-design was eliminated and “right-sized” its bridges to meet transportation needs. They are institutionalizing on-site scoping of bridge projects to minimize the number of alternatives. The agency believes this will lead to saving time and money in the completion of projects. The agency is grouping projects geographically and plans on letting them as “groups of projects as one” for economy of scale.

Performance Tied to Mission and Goals

The agency developed a detailed performance management process with participation and involvement of a large number of its employees. The leadership sought input from all employees before the process was finalized. In this revised performance management process, the performance measures are tied to the mission and goals of the agency. The mission and goals of the agency are focused on how to most effectively manage the agency’s assets in the short and long term. The process led to the reduction of the silo-effect and increased collaboration and synergy between the various business units and maximized the returns on the efforts of all employees. The group developed performance metrics through collaborative processes that involved many workshops and meetings of Employee Subject Matter Experts. The Performance Metrics Relationship Chart linked outcomes to agency mission, goals and values. It tied as shown in Figure 7:

- Outcomes and expected results to agency goals;
- The way an employee is expected to act to

uphold NCDOT values;

- The skills needed to be effective for required competencies.
- Contributions to achievement of higher-level metrics as they relate to NCDOT’s mission or goals;
- Meeting customer requirements;
- Improving processes;
- Carrying out key job responsibilities.

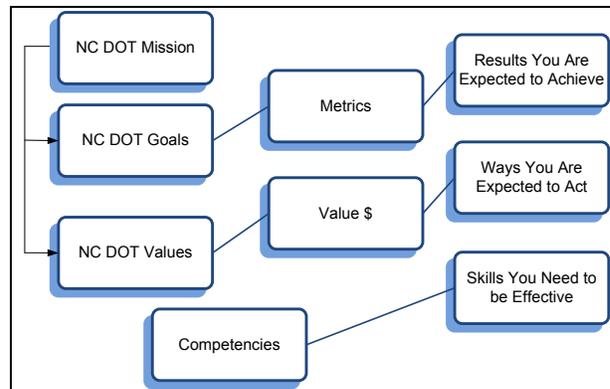


Figure 7 Performance metrics relationship chart.

The agency then went through a rigorous and systematic process of relating each job in the agency with goals. This ensured that every job function was tied to goals and performance measures. More importantly employees knew what was expected of them in their jobs and how they contributed to accomplishing the agency’s goals.

The performance metrics had measures, targets and weights. The targets are based on the expected conditions and performance of the agency’s assets and are directly tied to the strategies and approaches used by the agency to manage its assets.

- The “Measure” was defined as “results of action to be gauged related to Mission and Goals.”
- The “Target” was defined as “the desired level of achievement.”
- The “Weight” was defined as “the level of importance.” Lagging Metrics to Adjust Target for Leading Activities

The agency identified lagging metrics to adjust targets

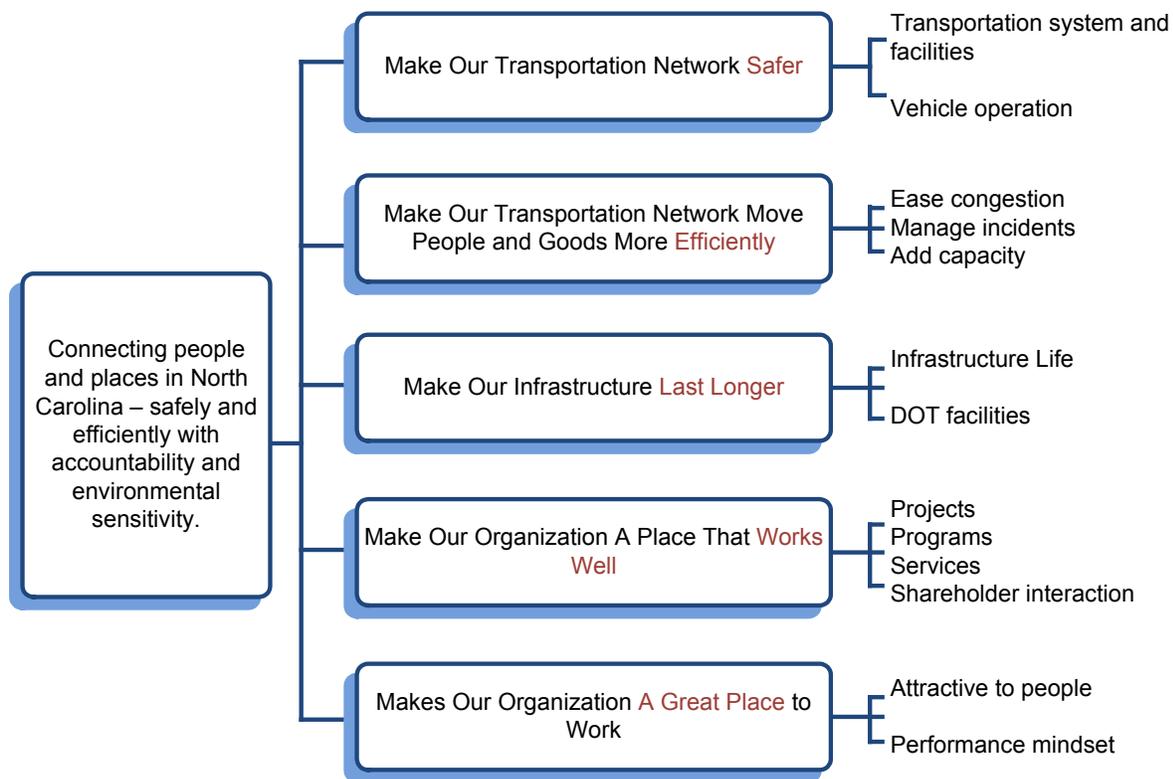


Figure 8 The relationship between mission, goals and assets.

for metrics of leading activities. Leading indicators measure and track performance before a problem arises. They are proactive and task specific. They indicate what may happen in the future based on the value of the measure and are good to predict the ability to meet future goals.

Examples of some **leading activities** for the **lagging metrics** for “Crash Rates” that provide information about safety are:

- Improving shoulder drop-offs;
- Adding reflective markers;
- Adding turn lanes;
- Reduction of VMT by use of alternative modes;
- Timely project delivery.

NCDOT has had performance measures for a number of years; some formal, some informal. The agency has been tracking and measuring its performance in the past. The change now is that the agency is more focused on the on-time and on- budget delivery of its deliverables than on the completion of the activities. Following are some examples of revised measures:

- A specific quantitative measure of 1.5 to 1.75 Crash Rate versus a generic goal of providing leadership to ensure safety;
- 90% to 95% system reliability on the strategic highway corridor;
- 85% to 90% delivery on schedule and on budget for projects.

The NCDOT performance system is result based. The measures are tied to the mission and goals of the agency. For effective management of its assets, NCDOT has linked all of its projects, programs and services to goals.

The focus on effective management of the agency’s assets is reflected in Figure 8. It shows how performance of the goals directly ties to performance of the assets. For example, the life of infrastructure is tied to the Goal “Make our infrastructure last longer.” Effectiveness in easing congestion and effectiveness in managing incidents, are tied to the goal “Make our transportation network move people and goods efficiently.”

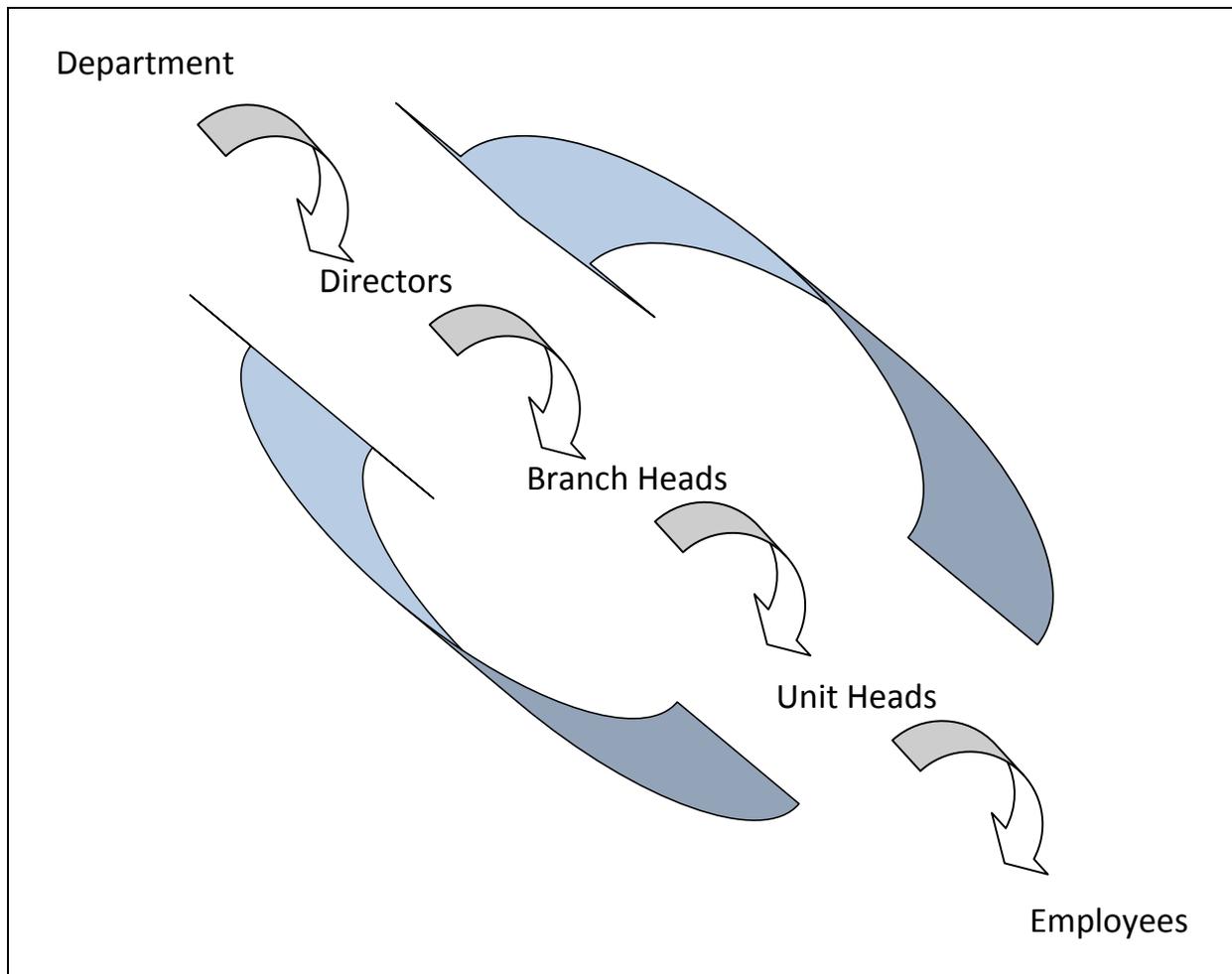


Figure 9 Performance measures cascade from the top of the organization.

Performance Management, Accountability and Asset Management

The Performance measures developed by the NCDOT are used to:

- Measure process results;
- Measure expectations;
- Establish goals for the agency;
- Establish goals for the individual;
- Gauge performance throughout the organization;
- Provide information to make better decisions.

In view of the current nationwide focus and the direction of the US Congress in considering

performance management to gauge the performance of the overall transportation network, DOTs are reviewing their own agency's performance framework. The approach to performance management and the measures developed and adopted by NCDOT serves as a illustrative model for other DOTs to study as they review, revise or develop their own approach.

Effectiveness of Cascading Performance Measures

Measuring the performance in the NCDOT starts with the Secretary of Transportation and cascades down to each level of the organization and reaches every employee as shown in Figure 9. Strategic direction, clear metrics and leading by example goes a long way in obtaining agency-wide buy-in on evaluation of

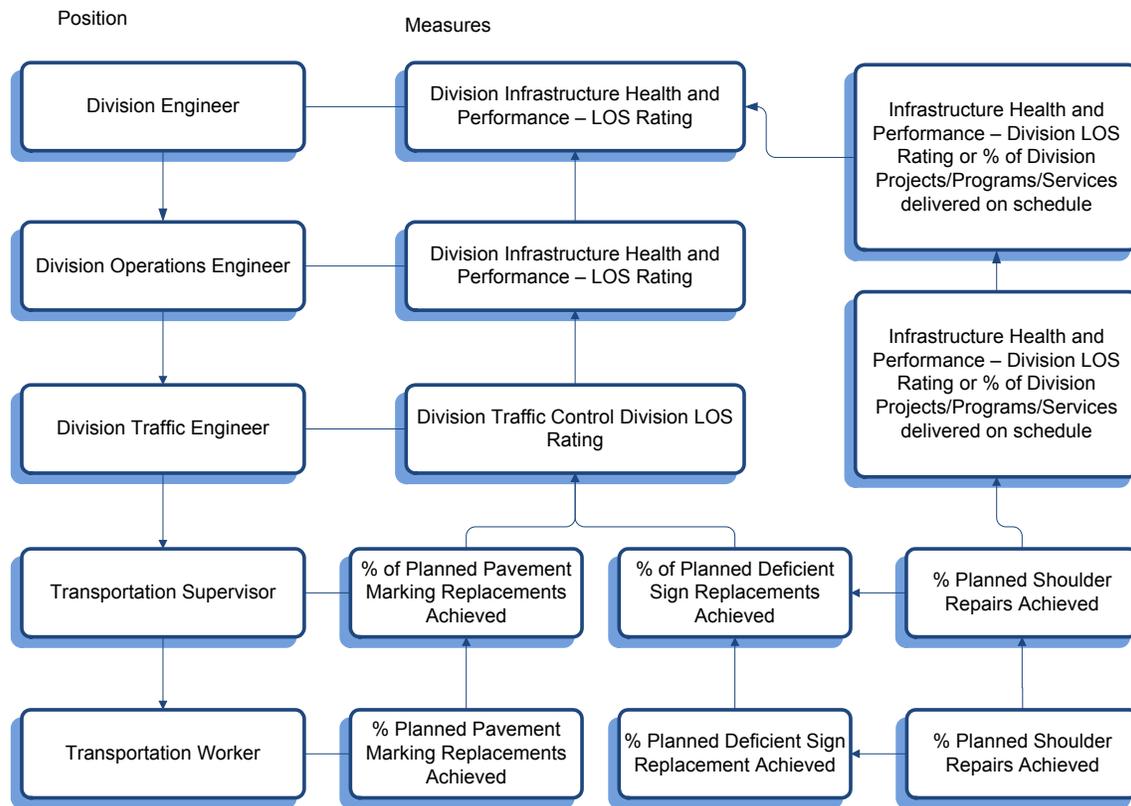


Figure 10 NCDOT cascading metrics for the Goals: Last Longer and Works Well

employee performance.

There is broad understanding in NCDOT of what is being measured and how measures are tied to the mission and goals of the agency. This transparency coupled with clear direction on how to contribute to meeting the agency’s performance targets makes employees take responsibility and motivates them to work toward accomplishing the goals.

Some examples of measures for the Chief Engineer for are:

- **System Reliability:** “Percentage of incidents cleared within 90 minutes,” with a target 70-85%;
- **Infrastructure Health:** is “Improve Index Score (3 year avg.) toward Goal,” with a Goal of 68-72.

The same measures apply to all positions but the weights of the measures vary depending on the job responsibilities and accountability of individual employees.

Figure 10 is an example of how each position in the

agency is tied to performance measures. Measures for each position are further related to the overall goals and targets of performance for the agency.

Role of Leadership Emphasized

In NCDOT the senior leadership is leading by example. They have embraced change and are holding themselves accountable and responsible for the performance of the agency. An example is seen in how the same performance measures are used to measure all the employees in the organization. This lends credibility to the use of the performance measures.

The systematic and logical approach of tying the performance of assets, projects, programs, initiatives and services to goals and relating each job to the measures selected, makes it easy to understand and help get buy-in from the employees. The process in NCDOT helps employees understand the actions they need to take to improve the performance of the transportation network.

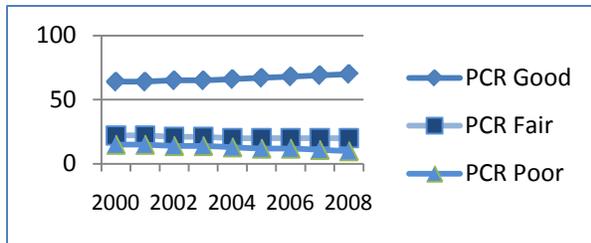


Figure 13 Overall pavement condition rating.

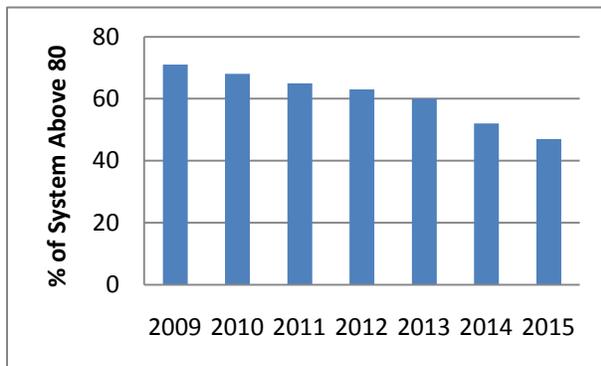


Figure 11 Projected PCR above 80

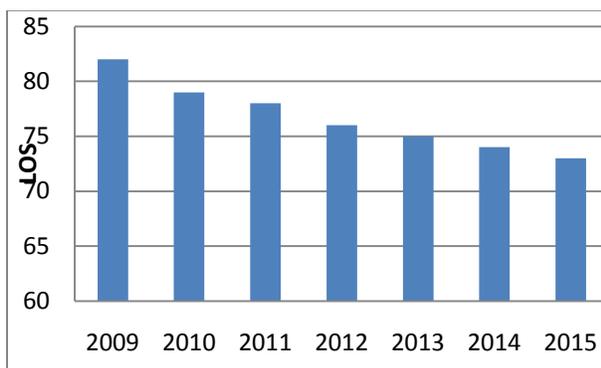


Figure 12 projected roadway level of service.

The approach used in the NCDOT is to:

- firstly, define clear goals linked to the condition of the transportation assets and services being provided;
- secondly, tie them to performance measures;
- thirdly, link the performance of all employees to the performance of the goals;
- fourthly have an on-going process of continuous reviews and corrections to align the goals.

Continued effective running of organizations cannot be

dependent on a handful of people. Leadership has to come from within the organization. Leadership and effective management styles have to be instilled in the culture. They have to be integrated in the good business practices and strategies throughout the organization.

To address continuity in leadership, NCDOT has focused on developing processes that ensure the on-going development of leadership and competencies. This is important for the long-term success of the organization and necessary as the leadership of the organization changes. With the focus on talent management, recruiting, employee development and succession planning, the agency expects to continue to be a model best practice agency delivering the transportation needs of its stakeholders.

Improving Assets through Changes in Preservation and Maintenance Strategies

For many years chip seals and crack sealing have been a core business function of the agency. Recently, the NCDOT has refined its Bridge Preservation, Pavement Preservation and Maintenance strategies. The agency included chip seals, slurry seals, microsurfacing and thin hot mix asphalt to its preventive and maintenance programs where the pavement conditions are in “good” to “fair” condition.

Based on the Pavement Condition Rating, the severity of distress and projected traffic conditions, specific treatments are determined and applied to each roadway. The agency’s goal is to apply preservation strategies early in the life of the pavement where possible, to extend the life of the pavement in “good” condition at a much lower cost.

Figure 11 shows the pavement conditions for the agency. The figure shows the good and fair condition of pavements in 2008 trending upwards. In 2009, the numbers of miles resurfaced by the agency declined due to the economic downturn. This is expected to lead to a slight decrease in the percentage of good pavements.

The North Carolina DOT faces the challenges confronted by many DOTs nationwide of rising material costs, aging infrastructure and reduction in funds to manage the transportation assets. With the changes

made to overall asset management strategies and the use of performance measures agency-wide, NCDOT expects to extend the use of dollars and make good decisions to improve the condition of all its assets within the constraints of the budget.

Outcomes of Better Asset Information and Forecasting

One of the important outcomes of implementing strategic performance measurements linked to the goals of the agency has been having better information to make decisions. It is important for an organization to make projections about the future condition of its assets. It allows the organization to develop strategic and tactical plans to address its transportation priorities systematically.

As shown in the Figure 12, based on the current data, the DOT is projecting that if the funding levels remain at current levels, the percent of pavements in good condition will fall to from 70% to 40% by 2015.

As shown in Figure 13, the agency is also projecting that if the funding levels remain at the current levels, the Roadway Level of Service will fall from a composite score of 82 to a score of 72 in seven years. Projections as shown in figures 11, 12 and 13 help the agency make informed decisions, educate its stakeholders and also collaborate with them to plan for and implement acceptable corrective action.

Summary: Leadership and Accountability Contribute to Successful Management of Transportation Assets

Based on the experiences of NCDOT, listed below is a summary of some of steps that contribute to the successful management of transportation infrastructure and efficient and effective delivery of transportation services:

- Have simple, clear, consistent Mission and Goals;
- Align strategic direction to Mission and Goals;
- Communicate direction, Mission and Goals repeatedly. Use multiple strategies to communicate;

- Create a culture where objectives of all business units are linked to the Mission and Goals of the organization;
 - Streamline core operations such as Planning, Project Prioritization, Project Design and Project Delivery;
 - Link Performance Measures to the organization's Mission and Goals;
 - Clearly link job and performance expectations to Performance Measures;
 - Link accountability and responsibility to performance starting at the topmost level of the organization and cascade them down to every employee;
 - Streamline project prioritization. Build simple quantitative models for prioritization. Keep the prioritization process transparent;
 - For good asset management, include projects, programs and services in the prioritization process;
 - Obtain feedback on the prioritization process. Review and revise the prioritization process, as appropriate, based on feedback;
 - Plan and prioritize for funding shortages;
 - Conduct quarterly or bi-annual meetings to discuss the overall performance of the organization;
 - Focus resources on strategic planning And Asset Management. To be effective, these resources should be high in the organizational chart;
 - Use and propagate data-driven decision making;
 - Ensure that there is horizontal and vertical integration across the organization;
 - Facilitate collaboration through tools, processes and use of data from a central source for decision making;
 - Centralize select activities for efficiency. Examples include data collection and data dissemination;
 - Focus on developing a productive organization. Recruit, retain and develop the workforce;
 - Facilitate cross-training of employees. Motivate and facilitate the sense of ownership in the employees;
 - Develop and plan for succession;
 - Review and revise Goals to keep current with the transportation needs;
- Incorporate continuous review and revision of all core operations and performance measures into the strategic planning process.



As the an agency moves in the direction of more sophisticated asset management practices, its form often changes as well. Positions and processes are often created to ensure that all parts of the organization are moving in the same direction to support asset management.

Chapter 3: Structures and Strategies for Asset Management

As can be seen from the North Carolina DOT example, the full-scale integration of Asset Management involves addressing most major operations in the organization. It is worth noting what Asset Management is not before describing how to adopt structures and strategies for fully integrating it into a transportation agency. Asset Management is not:

A particular information technology system or product. Although computerized information systems are a part of Asset Management, they are components of Asset Management, not the entire process themselves.

Asset Management is not a rigid checklist of mandatory steps that an agency must comply with. Rather it is a flexible framework which can be adapted to the unique laws, governance structures, information systems and historical developments of individual agencies.

Asset Management is not a rigid organizational structure that must be adhered to by all agencies. It has

become more common to describe Asset Management as a “program” or a “set of principals” rather than a “system.” Although a “systems approach” or “systems management” is generally used in management literature, in the transportation field those terms often have been confused with specific pavement, bridge, safety or maintenance management systems. This ambiguity has led to a lack of understanding of Asset Management and the practice of performance management.

Asset Management is broader than any one computerized management product or any one table of organization. There is not one perfect organizational structure that an agency can adopt to promote Asset Management. For instance, a state which operates with strong local government control over many assets, will need an outreach function to its Asset Management activities if it seeks to extend good Asset Management practices to the local highway network. A state which has a strong element of privatization will need to

consider contractual means by which contractors' preventive and reactive pavement maintenance activities are coordinated with the agency's long-term Asset Management system. A large state such as Texas or California is compelled to be decentralized by its huge geographic scope while a Rhode Island or Delaware may not be. In other words, one structure alone will not be sufficient for all states.

Many different functions and activities must work in concert for successful Asset Management. Important connections across these functions can be provided by Information Technology which must gather knowledge from each function and make it available to all others. The information systems become the linkage which supports the coordinated, seamless approach to Asset Management which is desired. An optimum organizational structure would be one in which all these various functions are commonly united with a focus upon how their activities contribute to Asset Management. The optimized structure for Asset Management would have all team members or divisions clearly understanding their role in the larger strategy, which involves a life-cycle approach to sustaining transportation assets for the lowest cost. The Transportation Asset Management Guide notes that:

“Transportation officials manage a wide range of “assets” to meet public, agency, and legislative expectations. These assets include the physical infrastructure of the transportation system (e.g., guideways, structures, and associated features, utilities, and appurtenances) as well as other types of assets: e.g., an agency’s human resources, financial capacity, equipment and vehicle fleets, materials stocks, real estate, and corporate data and information.”

This description recognizes that all of the organization's resources need to be managed with consideration of how they contribute to Asset Management. For instance, front-line maintenance crews can be trained to contribute significantly to Asset Management. Maintenance workers who fix potholes with proper full-depth repairs contribute significantly more to the pavement's performance than they would if they only performed surface patching. To conduct full-depth repair they need to be better trained and equipped for:

- Properly establishing a safe work zone;

- Using pavement saws to completely remove the old pavement;
- Stabilizing the base of the repair;
- Handling hot mix to keep it at the proper temperature;
- Conducting proper compaction;
- Sealing their repair.

If the crews are to perform such work, many divisions must act in sync. The policy division must make clear that maintenance crews are expected to be making full-depth repairs when possible. The training division must provide adequate training. The equipment management division must ensure maintenance crews receive the proper equipment, and therefore the department's equipment inventory becomes an adjunct of Asset Management. The Maintenance Management System or Cost Accounting System must not penalize them for the extra time taken to conduct full-depth repairs, versus surface repairs. The crew's recording of their work and its improvement to pavement structure requires support from the Information Technology unit. The purchasing rules need to accommodate the maintenance crew's acquisition of materials in a timely manner. In short, this one critical function requires an integrated network of cooperation and support. The transition from “throw and go” surface pothole patching to full-depth in-house pavement repairs requires a change in mindset, training, maintenance of traffic practice, equipment, materials, information and administrative support.

Structure or Process?

A senior leader who wants to embrace Asset Management will face a fundamental question first:

Do I *organizationally* restructure my department's table of organization for effective Asset Management or do I *operationally* restructure my department so that the existing divisions operate in a fashion which supports Transportation Asset Management?

In many cases, a department executive may not have the legal authority or political ability to restructure a table of organization. However, he or she can create internal processes and reporting structures to keep all units cooperating for Asset Management. In other cases, a decision maker may want to physically change



Figure 14 Leadership and data provide essential coordination of other functions in an asset management environment. Leadership points the way and common data systems keep all divisions communicating effectively.

the table of organization to optimize Asset Management.

In some instances, agencies pursuing Asset Management have created high-level Asset Management positions which elevate the status of the function in the organization. An international scan in Transportation Asset Management published in 2005³ found that in all the agencies visited there was a dedicated management position or office responsible for Asset Management. If such a structure is not possible, an alternative approach is to operationally assign all relevant divisions with Asset Management goals, objectives, responsibilities, reporting assignments and coordination assignments. In effect, everyone’s job is defined as contributing to Asset Management.

This concept of having disparate divisions all simultaneously focusing on their component of a larger process such as Asset Management has been referred to

³ FHWA, “Transportation Asset Management In Australia, Canada, England, and New Zealand” 2005.

as Horizontal Alignment. As most organizations are traditionally hierarchical, commands, control and coordination tend to flow from the top down and information flows from the bottom up. In a function such as Asset Management, coordination and cooperation also needs to flow “across” the organization as each division coordinates its timing and strategies with the related divisions. Each major division such as Maintenance, IT, or Design all are links in a chain of managing an asset over the various stages of its lifecycle. Therefore in an Asset Management organization, traditional tables of organization generally are supplemented with features such as Strategic Plans, on-going coordination meetings, reporting processes and other strategies to keep the disparate divisions focused upon cooperating for Asset Management. The requirement to coordinate horizontally needs to be ingrained into divisions, in addition to their normal requirements to coordinate vertically within their silos.

Some of the management tactics to ensure horizontal alignment include:

- Developing performance agreements with managers which are tied to the accomplishment of organizational Asset Management targets and functions. When managers have performance agreements that require them to coordinate with peer divisions on Asset Management, such cross-cutting coordination becomes a required way to operate;
- Conducting regular, formal team progress meetings in which managers review the organizational Asset Management metrics and report to peers and bosses their efforts to achieve them;
- Developing Balanced Scorecards, not only for the entire organization but for every unit and manager within the organization. These Balanced Scorecards can be based upon the competing Asset Management metrics that managers need to balance;
- Briefing central authorities such as the state budget office, legislative committees or the governor’s office on the organization’s Asset Management performance to ensure that the

Asset Management Roles and Responsibilities	
Planning	<p>Long-term strategic planning</p> <p>Resource evaluation and tradeoff recommendations</p> <p>Maintaining management systems (HERS, PONTIS, Pavement Management)</p> <p>Project selection</p> <p>STIP development</p> <p>Gathering system conditions</p> <p>Maintaining asset inventories</p>
Design	<p>Coordinating treatment designs and treatment timing with Asset Management staff</p> <p>Delivering those treatments on time</p> <p>Using current cost estimates</p> <p>Remaining current with proper mix design, treatment types</p> <p>Updating designs, standards, manuals to reflect current Asset Management strategies</p>
Construction	<p>Ensuring construction means and methods meet specifications</p> <p>Accept only materials which meet Asset Management specifications</p> <p>Recording as-built under drains and other items which will need on-going maintenance</p> <p>Write contract specifications for long-term asset performance</p>
Information Technology	<p>Operate department's Knowledge Management processes</p> <p>Quality Control/Quality assurance of data</p> <p>Understand Asset Management; Integrate and align IT systems to reflect Asset Management practices</p> <p>Provide standard and ad hoc reporting abilities</p> <p>Integrate legacy systems</p> <p>Develop new systems to support Asset Management</p> <p>Provide executive and user data reports</p>
Maintenance, Operations	<p>Conduct preventive maintenance</p> <p>Ensure reactive maintenance contributes to long-term life-cycle optimization of assets</p>
Human Resources	<p>Provide process for Asset Management training to maintenance staff</p> <p>Ensure that personnel categories reflect more sophisticated maintenance skills needed for front-line Asset Management practices</p>
Facilities, Equipment	<p>Ensure that maintenance equipment is adequate for proper full-depth pavement repairs and bridge preventive maintenance by in-house forces</p> <p>Ensure equipment is provided</p>

- central authorities are aware of the agency's performance, and its Asset Management challenges;
- Publishing regular reports, both internally and publicly, which track the achievement of key asset measures, and explain steps to improve performance when targets were not achieved;

Different Strategies for Different Structures

Asset Management has been found to flourish in a wide variety of states with different organizational structures. The following different organizational structures are common in the United States, yet each structure can accommodate Asset Management.

- Some states have highly centralized structures with decision-making residing in a central office;
- Other states operate with decentralized structures with great autonomy in the districts;
- Some states have jurisdiction over all roads including low-volume local ones such as in Pennsylvania, Virginia and North Carolina;
- Some state DOTs only have jurisdiction over the higher functional classes;
- Some states rely on privatized services for the management of large corridors, and their Asset Management strategies must incorporate their private sector partners;
- Some states operate under enterprise resource programs (ERPs) in which state IT systems are integrated into statewide ones for functions such as tracking time and equipment;
- Other states operate under legacy IT system structures in which asset information is pulled from a variety of existing internal systems;
- Some states have strong commissions which exert great influence over program budgeting and project selection;
- Other states have very active legislatures which select projects and decide on program funding allocations;
- At least one state has statutory requirements for equalized spending across geographic regions.

- Establishing Asset Management practices into law, or agency policy. This can “institutionalize” Asset Management so that its practice extends beyond one executive or one administration.

The Asset Management Guide notes that Asset Management is:

- Comprehensive;
- It is a philosophy or approach;
- It is driven by policy;
- It focuses upon the long-term;
- It is pro-active;
- It is driven by good information;
- It is explicit and visible;
- And it is viewed “as the way we do business.”

Each of these individually and all of them collectively call for an organizational structure and management practices that set clear Transportation Asset Management goals and then cascades them through the organization. The organization also needs a reporting or feedback mechanism which measures accomplishments and ensures accountability.

These needs call for both a “form” and a “function” for the department’s organizational approach to Asset Management. The structure of the organization needs to reflect the activities which must occur to effectively implement Transportation Asset Management. The functions need to complement and reinforce the cyclical and continuously improving steps the agency must take.

There is not one specific organizational structure which best suits such a cyclic process, rather such a process is

applicable to many types of organizational structures. While the organizational structure may differ, it is necessary to have a structure which includes the functions of: Setting Goals; Analyzing Resource Tradeoffs; Measuring Accomplishments and Adjusting Strategies and working collaboratively towards the same Asset Management goals.

It is important in the organizational structure to have all divisions processing their Asset Management efforts through a common goal-setting and resource-allocation process. Such a process has several elements which ensure cooperation and alignment of disparate functions. These include the setting of common strategic goals, the joint participation in the development of work plans for each unit, the common communication of results and the joint, common evaluation of accomplishments. Such processes accomplish organizational alignment and the cross-cutting cooperation needed for effective Asset Management.

The various divisions all have an important role in Asset Management. Their various units need to be working in concert and with common goals to achieve the optimum organizational outcomes. The successful highway agency which achieves such alignment generally operates with the following strategic approach:

- It has an emphatic and well-communicated Strategic Planning Process which clearly informs the organization about its intended strategic direction;
- Asset Management is clearly articulated as a Strategic Goal;
- The Strategic Goals are broken into annual or biennial Objectives, which are precise and quantified. They serve as milestones and interim goals toward the longer-term achievement of the Strategic Goals;
- The resource allocation and tradeoff process is formal, widely communicated and cyclical;
- Accountability is clearly and explicitly required. The Objectives are clearly assigned to people and units;

- Coordinating strategies, reports and meetings are required to keep the disparate units focused upon the common goals.
- Data is viewed as a key asset. All decisions are expected to be based on data. Units which generate asset data are held accountable for the accuracy, frequency and timeliness of the data;
- Leadership actively supports Asset Management and embraces it as a critical strategy for organizational success.

The Critical Role of the Leader in Asset Management

While the structure of the organization can vary, the role of the leader generally cannot. Generally, the establishment of a strong Asset Management ethos depends on leadership, either from the individual executive, from an executive body such as a commission or from legislative mandate. It takes leadership to overcome the organizational inertia which tends to prevent individual units from working seamlessly and selflessly together on initiatives which transcend the boundaries of any one unit. It takes leadership to adopt new practices which are not common in the organization. It takes leadership to get divisions and individual personnel to change past practices. It takes leadership to make difficult financial-tradeoff decisions.

For leaders to change an organization requires them to understand why organizations do what they do and what it takes to get them to adopt new practices. For the past 50 years, the field of organizational theory has offered increasing insight into why organizations, and particularly bureaucracies, either adopt change or resist it. Many organizational theorists propose some variation of the three overriding premises presented by Anthony Downs in his book, *“Inside Bureaucracy.”*

- Bureaucratic officials are rationale and will respond to incentives and disincentives provided by the leadership;
- However, bureaucratic officials have complex goals, only some of which relate to responding to the leadership and to fully cooperating with

peer units within their organization. Goals such as loyalty to their own units, simplifying their own decision making, and adherence to their original, narrow mission can outweigh obligations to the larger organization;

- The “social function” of the bureau will greatly influence the internal behavior of the individuals within it.

In other words, the various complex, interactions and cooperative functions which must occur *across units* in an Asset Management framework are not naturally occurring tendencies to officials whose normal incentives are to work within their own units. However, because division officials are rational they will respond more positively to peer units and cooperate more fully with them when the organization creates greater incentives for them to do so. Since, their peers are unable to create such incentives, it up to a higher level official – or a leader – to create the environment in which their incentives are to cooperate fully with the other units in a long-term approach to Asset Management. Only a leader or higher level official can create the new incentives and disincentives which are necessary for Asset Management.

To take a simple example, a maintenance official will have no rational incentive to crack seal if the long-term performance of pavements is not part of his or her incentives or disincentives. In the short-term, crack sealing provides few benefits to the maintenance official who may be pre-occupied with snow removal, clearing incidents, repairing damaged guardrail or addressing mowing. Furthermore, if the timing of crack sealing is critical, then the prescriptive timing of the crack sealing operations can become a new and unwelcome intrusion for the maintenance official, further complicating his or her schedule. By their nature, maintenance officials tend to be focused upon daily, short-term events – not long-term future scenarios. Therefore, in a traditional organization they have few rational incentives to focus upon the delayed benefits created by crack sealing.

However, when a leader re-defines units’ incentives and re-defines their “social function” their perspectives change. When the role of maintenance is re-defined to contribute to long-term pavement performance through crack sealing or drainage maintenance, then

Traffic Management Center Analogy

Twenty years few Traffic Management Centers existed. State DOT operations officials did not interact in real time with local city traffic officials, police agencies or emergency responders. Nor, did they provide real-time information to travelers.

When those same officials’ roles were recast by their immersion in Traffic Management Centers, the very nature of their jobs were re-defined from solo operations to collaborative operations with other similar stakeholders. As Downs said, their “social function” was re-defined.

This can serve as an analogy for Asset Management cooperation between divisions. By placing various disciplines within a common Asset Management system which requires frequent interaction, their behavior changes as their “social function” is re-defined.

maintenance behaviors change. Likewise, when the leader creates new incentives to cooperate with other units such as planning, design and construction then the rational behavior of the individual divisions changes further.

Organizational consensus and strong leadership are important because it takes nearly all the functions of a highway agency to effectively manage a pavement or a bridge through its lifecycle. This is because pavements and bridges require different maintenance, treatments and repairs at different times of their lifecycle. These activities all require different skills, therefore they reside in different organizational units of a state highway agency.

For instance, the construction or rehabilitation of a pavement involves planning, pavement selection, design, construction, materials acceptance and

recording of the pavement's completed condition. Then, the pavement should go through a 30-year predictable and collaborative process throughout its life as the disciplines of Planning, IT, Maintenance, Design, and Construction all collaborate to manage that individual pavement and its maintenance.

At least every other year of its life, a pavement should be inspected and its rate of degradation recorded. Deficiencies and conditions are fed into the Pavement Management System for a Remaining Useful Life forecast for the pavement. These deficiency data can assist the logic inherent in the Pavement Management System to predict the expected performance of the pavement – and importantly to identify pavements with accelerated degradation for analysis. Pavements which are degrading at a faster-than-expected rate can be culled for analysis as to why they are performing poorly.

This analysis can add to the institutional knowledge of the organization by determining if the poor performance is attributable to inadequate maintenance, design, construction, materials, drainage or vehicle overloads. Once identified, corrective action can be taken. Throughout this process, the Information Technology systems are key because they link the latent knowledge acquired by the pavement inspection with the decision makers who need to act.

Such analysis and prediction requires the insights of many disciplines – planning, IT, pavement design, maintenance, materials, and construction. In addition, as lessons are learned, periodic training of pavement designers, materials testers, maintenance crews and maintenance managers are needed to share the insight across the organization. Active learning and Knowledge Management are an important aspect of Asset Management

Interlocking Decisions

The activities of one division can affect the other facets of Asset Management. There are many fundamental intricacies between them such as:

- Programmatic decisions to under-fund pavements lead to accelerated degradation and increased reactive maintenance demands upon in-house forces;

- If in-house forces do not conduct full-depth repairs, the full benefits of their pavement-repair efforts are diminished;
- If maintenance forces do not maintain drainage such as under drains, ditches and outfalls, the accumulated moisture can damage pavements and decrease their longevity;
- If maintenance forces are not properly trained in crack sealing, or if their managers defer crack sealing, pavements can degrade at an unacceptable rate;
- If maintenance crews are not scheduled for basic bridge maintenance such as expansion joint cleaning, the washing away of salt or the cleaning of scuppers, bridges deteriorate more quickly;
- If design or construction lag in adopting advanced pavement specifications or other innovations it can reduce the cost-effectiveness of pavement investments significantly over time;
- If regional divisions are reluctant to “spec out” poor performing local aggregates they will continue to experience accelerated pavement degradation;
- If the IT division does not provide easily accessible and timely data, ad hoc analyses of trends such as identification of poor-performing pavements can be hindered;
- If bridge condition inspectors are not cross-trained to note maintenance needs, important bridge maintenance issues can go unreported;

Concurrently, the collaboration and consultation of different units can lead to synergies which significantly improve pavement and bridge performance beyond the level that any one unit alone could achieve. For instance:

- Systematic analysis of the root cause of poor pavement performance by multi-disciplinary teams can lead to innovations in pavement design, materials specifications, construction means and methods, and preventive treatment strategies;
- IT evaluation of user needs can lead to enhanced data-collection and reporting systems;

- Users' needs for forecasts can lead to improved pavement management forecasting systems;
- The critical need to schedule preventive and reactive treatments to precise time windows can lead to more reliable project-delivery strategies.

Resource Allocation Processes

It was noted in many of the case study agencies that the process of allocating resources across programs was often well documented and transparent. The process is often complex, difficult and sometimes contentious. It often results in some asset categories, some programs or some regions receiving fewer resources than they desire. However, this process also provides opportunity for institutional learning and communication in an Asset Management organization.

In several of the case study agencies, a multi-disciplinary team was involved in making resource allocation decisions. The team often included representatives from different programs, but also representatives from both central office and districts. The participation leads to increased understanding of all parties of the difficult trade-off decisions the department faces. It also increases understanding of the inter-related roles that each unit plays in Transportation Asset Management. It is important during the resource allocation decision process that there be coordination between the various divisions such as Planning, Design, Construction, Pavement Management, Bridge Management, Safety and others. All these groups can be included in the Resource Allocation Analysis. The data from their management systems and the outputs of the analyses from Pavement Management, Bridge Management, HERS-ST and others should form the basis for the resource allocation analysis. The resource-tradeoff analysis in these leading case study examples generally were:

- Open
- Formal
- Participatory
- Cyclical
- Data-driven
- Policy based.

In other words, when the resource allocation analysis was concluded, the major asset management participants had a role in making the complex and often difficult tradeoffs required.

Next, periodic tracking meetings and reports throughout the year further solidify the common understanding of the various divisions as to the progress the agency is making in managing its assets. In these open and inclusive performance-tracking meetings, a common institutional understanding of performance and outcomes can be achieved.

As system conditions are assessed and inventories are re-populated with a year's worth of projects and maintenance activities, then system conditions are reviewed to determine if goals were met. Again, the results of these steps were shared in open meetings or in widely disseminated reports so that all internal units share an understanding of how the resource allocation and Asset Management processes actually performed. Did they meet goals? Are conditions adequate? What asset problems were identified that the collective organization must address? The widespread publishing of system goals and the regular conduct of collaborative meetings to discuss progress towards meeting them keeps the organization focused upon Asset Management. Program managers for pavements, bridges, maintenance, safety and other programs could all see the results of accomplishments, and understand how resource allocation decisions and organizational focus on Asset Management resulted in improved conditions overall.

In summary, the organizational structure and operational strategies for Asset Management in the case study agencies were comprehensive and multi-disciplinary. As well, they involved many key management staff who play a role, either in Central Office or the districts. It was clear that leaders in the field of Asset Management have identified a variety of successful tactics to inculcate the cross-divisional cooperation that is required. These tactics can include:

- The public and participatory conduct of economic tradeoff analyses which explain why it is in the larger organization's interest to transfer expenditures to highest-return investments, even if it requires the diminishing of historical categories of expenditures;

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- Frequent cross-divisional meetings which are chaired by the leader in which the cross-cutting cooperative activities are monitored for success and impediments to their success are identified;
 - The leader formally redefines the roles of units and individuals to emphasize the cross-divisional cooperation with other units;
 - Shared institutional goals are set as common to all units, not only to some;
 - The long-term accomplishment of Asset Management goals are broken down into meaningful, short-term activities which are clearly assigned to individuals and units, then those individuals and units are held accountable for their accomplishment;
 - Published reports, Web pages, employee meetings and performance evaluations are used to communicate the department's embrace of

Utah DOT

Case Study

The following case study of the Utah DOT illustrates how one transportation agency successfully coordinated multiple functions across divisions and districts to create the cross-cutting collaboration needed to successfully deploy Asset Management. The Utah DOT experience with improving its information systems also illustrates practices which will be discussed in Chapter 4, following this case study.

Asset Management as the process it uses to make infrastructure decisions.

Utah DOT Case Study - Embracing New Structures and Strategies for Asset Management

When the Government Performance Project conducts its annual evaluation of the states, it has consistently rated the State of Utah as an 'A' for its infrastructure management practices.

The grade is in large part a reflection of the Utah Department of Transportation's comprehensive Asset Management process the agency has spent the past seven years developing. It cascades throughout the organization's infrastructure management practices and provides the maintenance workforce direction, performance goals, condition data and robust cost information with which to plan, conduct, measure and evaluate their work. The Utah DOT Asset Management System also extends through the pavement and bridge programs, allowing decision makers to conduct complex analysis of various funding and optimization scenarios. The Utah Asset Management System also links closely with the Safety Management System so that accident histories and crash trends are considered whenever a maintenance activity or a construction project is planned.

In short, the Utah DOT has developed a comprehensive and systematic Asset Management process that has ingrained Asset Management practices throughout the organization. Utah officials caution, however, that their current system is the result of continuous effort since at least 2002. They consider their Asset Management system to be a continuous work in progress. They say that their journey to deploying a comprehensive Asset Management process holds several lessons.

- High-level support and active leadership is vital. The top leadership's involvement gives the Asset Management effort visibility and legitimacy.
- The deployment of Asset Management dovetails naturally with the development of an agency's Performance Management System. In Utah, the two systems developed at generally the same time, with each complementing the other.

- Asset Management and Performance Management take time. The Utah DOT has been actively developing both since at least 2000 and still it considers itself to be on a continuous journey of improvement.
- Start with the data systems that you have and improve them as you go. The Utah DOT has developed a comprehensive set of management systems but they represent the continued evolution of earlier ones. The DOT began in 2000 with its legacy data systems and did not wait upon next-generation systems to start its Asset Management pursuit.
- Differentiate between the computerized asset management data systems from the Asset Management *business processes*. They stress that both data systems and standardized Asset Management *business processes* are required to be successful. The Asset Management data system may provide decision makers tools to use but the business process ensures that decision makers actually use the tools to improve their investment decisions.

Utah's Asset Management Beginnings

In preparation for the 2002 Winter Olympics, the Utah DOT completed a \$1.5 billion design/build reconstruction and expansion of I-15 through the heart of Salt Lake City. As the department's leaders readied the modern facility for its opening, they also pondered their long-term approach to ensuring it remains in sound condition throughout its service life. They describe having an epiphany in which it occurred to them that they should undertake the same comprehensive effort to maintain I-15 as they put into building it.

Department Director John Njord led the top management through a three-day workshop and self-evaluation of the department's Asset Management

practices. One of the participants described it as a painful process. It was painful both in the length and detail of the analysis as well as in terms of the team recognizing that it lacked a comprehensive Asset Management approach. From the process, however, the important seeds were sown to create a comprehensive Asset Management program.

First, the top-down involvement of the Utah DOT leadership served an important “change management” function. In change management, it is important to provide institutional legitimacy to a change, which the director’s involvement provided. Second, the effort was followed by monthly meetings until the Asset Management process was well under way. Those meetings helped to ensure that momentum was gained by the fledgling effort. Three, the workshop and subsequent efforts served as clear points of change for the department. They represented that one era was ending and that a new era of Asset Management was beginning. Such demarcation is an important feature of changing behavior in a large organization by clearly communicating that the organization has embraced a new direction. Without such emphatic “pivoting” of the organization, bureaucratic inertia can stifle change. Finally, the UDOT leadership insisted that Asset Management become “institutionalized” by creating the policies, manuals, organizational structures and data systems to provide common definitions, common understanding, and a common approach to Asset Management throughout the department.

Although the Utah leadership may not have described their efforts at the time as conscious “Change Management,” the actions they took with their top-level involvement and engagement were typical of classic “Change Management” strategies. Those actions appear to encapsulate the type of engagement necessary by Asset Management advocates to ingrain the practice in their organization.

Performance Management Linkage

Also in the early 2000s, the Utah DOT was embracing performance metrics and Performance Management, say its officials who were involved at the time. Like so many other officials in other agencies, they quickly

recognized the linkage between Asset Management and producing performance metrics for the transportation system. They began by setting goals for what level of pavement and bridge conditions they wanted to sustain for the highway system. The emphasis on both achieving and then sustaining those conditions over time with limited resources strongly influenced their recognition of the benefits of performance management. Among their initial targets were to have 90 percent of the Interstate System, 70 percent of the arterial system and 50 percent of the collector system meeting smoothness standards. Once steps are taken to sustain those goals, both Asset Management and the regular monitoring of performance inherent in Performance Management appear to be self-evidently logical to the organization, Utah officials said. Today, the department produces both extensive Asset Management data but it also produces an annual “*Strategic Direction and Performance Measures*” report. This report is like an annual corporate report in that it describes major issues facing the department and describes the agency’s performance in addressing these issues. Within the larger set of performance metrics that it reports in the *Strategic Direction* document are high-level performance metrics on how it is managing its highway assets.

Creating an Asset Management Structure

Over its seven year journey, the Utah DOT created both organizational structures and data systems to support its Asset Management approach. The two parallel efforts were closely linked and complementary, and they illustrate the duality of successful Asset Management efforts. Successful Asset Management organizations have not only sound data systems to provide decision makers good information but they have organizational processes which ensure that the logic of Asset Management is followed during the decision making process. To develop both the data systems and business processes, the Utah DOT pursued the following comprehensive series of efforts.

- It created a Transportation Asset Management Committee (TRANSMAT). This consists of the

UDOT senior leaders, members of the Asset Management Team and several Asset Management Groups. TRANSMAT is responsible for overseeing and approving all of the Asset Management efforts within the department. It ensures that “people, plans and processes” are in place to meet the asset management goals.

- It established an Asset Management Team under a Director for Asset Management. Within the Asset Management Team is an Asset Management Engineer’s position.
- It developed an Asset Management Strategic Plan. This outlined the goals and objectives for the continuous, incremental improvement of the Asset Management process.
- An Asset Management Implementation Plan was developed. This plan was intended to outline and track the steps necessary to achieve the objectives of the Strategic Plan.
- Reorganization to achieve the Asset Management objectives was completed. The pavement asset group section was reorganized to align with the new strategies and tactics.
- An Asset Management Manual was developed. It explains to department personnel how to implement the asset management practices within the department.
- A UDOT Asset Management Strategic Planning model was developed. This served as the guide to developing project recommendations within the UDOT Long Range Plan. It relied upon forecasting long-term needs and optimizing investment options between programs to achieve the highest system conditions possible with available resources.
- An Asset Management Data base was developed. It was created to facilitate optimizing both within various asset categories but also to allow for the first steps toward cross-asset optimization and tradeoff analysis.

- The pavement and bridge management systems were enhanced.
- Development of an Asset Management Strategic Analysis was completed. This enhancement to the computerized Asset Management System allowed “silo” or “stove pipe” analysis of five different classes of assets. These were pavements, structures, safety, maintenance and mobility. Initial example runs of cross-asset optimization analyses were conducted for demonstration purposes and to allow further investigation by the DOT.
- An Operations Management System (OMS) and a complementary Maintenance Management Quality Assurance System were created. The OMS was developed to manage the work program for maintenance forces, to schedule and report daily work activities, and to analyze the maintenance business processes. The Quality Assurance System measures conditions in nine different maintenance categories to allow continuous assessment of maintenance performance and conditions.

Lessons Learned: Engagement and Evolution

Utah officials say that their experience taught them lessons in how to achieve organizational acceptance of Asset Management. As already mentioned, the top leadership was engaged, clear messages of change were articulated and Asset Management was given emphasis until it became routine. An additional requirement that the Utah officials said they recognized over time was the need to fully engage mid-level region staff. These staff members were being exposed to new management philosophies, new pavement management tactics, new types of computerized pavement management reports and new demands to provide consistent data. Each of these new concepts required consistent, on-going training in order to achieve widespread understanding and acceptance of Asset Management.

The Asset Management staff faced skepticism in the regions because of misunderstandings about the

project-level outputs of the early phases of the pavement management model. As with most pavement management models, the output data, forecasts and budgets are more accurate over a long period of time and across an entire network. The accuracy of any one forecast for a particular pavement section in a particular year is much less valid. However, the pavement management reports were being generated and provided to the regions. Region personnel would find discrepancies between the pavement conditions they knew to exist in the field with what the conditions reported for individual sections by the pavement management model. Such discrepancies led to complaints that the pavement management system, and Asset Management, were “black boxes” that were unclear and unreliable.

The Asset Management staff went to every region to meet with the staff and to analyze the problems with the data, the system outputs and with the region personnel’s understanding of the pavement management process. The Asset Management staff said they found that many of the data inputs were incorrect, therefore the model outputs were incorrect. Because the pavement management system had not been extensively relied upon before for pavement funding and selection decisions, it was not maintained adequately. The estimates of how much treatments actually cost were outdated, or imprecise. The pavement condition assessments for the model were manually collected, and wide variability in the rating of pavements was found. They reported that one section of pavement over four years was rated as a 70, 100, 70 and 50, even though it had experienced no treatments over that time. They also realized that many staff did not understand the specific section treatment recommendations which come from a financially constrained optimization pavement model. Under one funding scenario, certain treatments of certain pavement sections were recommended. Under another funding scenario, other treatments were recommended. The logic behind the differing model recommendations was not fully understood, and therefore the entire process was viewed as unreliable, the Asset Management staff report.

At that time, the regions also were responsible for collecting some of the pavement distress data. Visual inspections were conducted of the first tenth of a mile

of sample sections. The Asset Management staff said they realized that some region personnel did not understand the rating process, they performed it inconsistently and they did not rely upon the data for their own decision process. “I know what was said,” reported one Asset Management staff. “ ‘Central Office wants this data and I don’t know why but let’s send them some data.’ That was the central problem, they did not see any benefit from this. It was only work.”

The Utah leadership realized that the journey of continuous improvement required additional training, as well as improved data processes. They changed from manual pavement condition assessment to automated assessment in order to get more frequent, comprehensive and consistent pavement condition data. Now, with their automated pavement assessment process they can get condition on a full mile of every section, as opposed to the one-tenth of a mile they could produce manually. Also, the data is more consistent, and frequent. The entire highway network can be assessed in two years. They analyze the interstate system in both directions annually.

The Utah experience also shows the importance of explaining what management systems can do well, and what they can’t. The use of a pavement management system was important to setting overall system goals and budgets. However, it became apparent that the short-comings of a pavement management system at the project level needed to be clarified. The pavement management system’s project-level recommendations were not consistent with what region personnel were seeing in the field, leading to skepticism about the validity of the management systems, say the Utah Asset Management staff. “The regions looked at the output and said this isn’t right,” said one Asset Management official.

The evolution of Utah’s Asset Management process illustrates the need to raise the understanding of asset management, and its components such as pavement management, across a broad spectrum of departmental staff. Most departments are decentralized in many aspects. The decentralization provides the benefit of keeping decisions rooted in the reality of what is actually happening in the field. Decentralization also

increases the complexity of the training process, particularly when management systems are deployed as a new tool in the decision-making process.

The department has evolved and refined important aspects of its pavement management, and pavement project-selection processes over time to improve its decentralized process. It has developed several institutional processes, groups and reports in order to perpetuate a continuous evaluation of how well the pavement process is working. In the decentralized Utah structure, each region has its own pavement management engineer who does pavement designs for the region. However, the region pavement engineer and the materials engineers participate in a statewide pavement team. This participation provides key region pavement decision makers access to information about statewide practices. The participation not only serves to disseminate statewide information to the regions, it allows peer exchange between the regions, as well as region feedback to central office. The intention of the statewide participation is to generate consistency in decision making, to solicit broad input into pavement issues and to provide feedback between field and central office decision makers. The continuous interaction provides information which is used to continually refine data elements, such as true project costs, the actual pavement conditions and accurate information about pavement performance compared to forecasted performance. This feedback continually improves the overall decision making process.

In addition to the periodic group meetings between region and central office personnel, the central office staff travel to each region annually for field visits. This allows the central office staff to review conditions on the roadway with the regions, and to evaluate the correlation between the reported and forecast conditions, and actual conditions in the field. These formal and informal exchanges are intended to create a broad consensus and understanding of the pavement management process. The central office asset management personnel said such visits have provided valuable insight and quality-control information. From such interactions and visits they determined that their model was providing poor forecasts of cracking. What the model showed to be good performing sections were actually found to be suffering extensive cracking when viewed in the field.

The Utah asset management officials said while communication is critical to instilling asset management in an organization, the communication needs to be two way. The central office experts need to communicate about the powerful analytic and decision-making potential of the pavement management system, and its data bases. At the same time, the central office personnel can learn a great deal from the day-to-day field experience of the region personnel. The continuous and open communication between central office and field personnel is an important component of continually improving the pavement management process, they noted.

Like with many other departments, the Utah asset management approach to optimization is a hybrid of both computational forecasts from the pavement management system combined with the professional engineering judgment of the staff in the field. The central office provides pavement program scenarios to each region illustrating an optimized program of projects generated from the statewide model. The regions review those lists of suggested projects but make the actual pavement selections. The consideration of both the model's optimized list of projects combined with the field observations and experience of the region allows the insights of both the management system and the field personnel to be captured in the final pavement program. Once the regions have identified a six year program of projects, the central office staff gives it a high-level review to ensure the program is consistent with the statewide goals.

Strategies for Adaption

The Utah officials say their ever-improving pavement management process has allowed them to adapt to two critical changes. First, as they experience turnover in region personnel, the existing pavement management process provides significant analytic and institutional support to the new personnel. They find that the new personnel are anxious for insights into past pavement performance, into their range of investment options and about the various program scenarios they could pursue. The central office officials say the pavement management process provides proven templates for new region personnel to follow as they master their new positions. To further ensure consistency in its

approach, the department created a Pavement Panel to help new region personnel select pavements. It consists of membership from the regions and central office. It acts like a peer review panel for the new personnel's program and project decisions. Suggested pavement treatments are explained and put up for a vote by email among the 10 member panel. If at least 7 panelists agree with the selection, it is approved. If fewer than 7 approve, than the individual recommendation is reviewed by Central Office. The process serves to standardize the approach to treatments across the department, and to ensure that extra elements which drive up costs are not included.

Also, the pavement management process has provided a rational and structured process for the department to use as it copes with the significantly higher material costs of recent years. Although its pavement program has not been reduced in terms of its overall budget, the purchasing power of that pavement budget has fallen by nearly half in recent years. The department was able to make rational – albeit difficult – tradeoffs in its pavement investment approach based upon its improved analytical capabilities.

The department classified its system into Level I routes which include the Interstate Highways and generally the arterial network. The collectors and other minor routes are categorized as Level 2 routes. Pavement treatment priority will go to the Level I routes which carry about 70 percent of the state's traffic volumes. Those routes will be actively managed and will receive the large majority of the department's pavement budget. The low-volume Level 2 routes will receive primarily low-cost treatments such as chip seals. In general, the Level 2 routes have average daily traffic of less than 2,000 vehicles, with fewer than 500 trucks.

The asset management staff said the difficult process of prioritizing the pavement program under such tight fiscal constraints has brought more region personnel to seek assistance from the pavement management system. The pavement management system has provided an invaluable assistance in providing various scenarios by which the regions can analyze which mix of projects can optimize their system with their limited resources. While the department has relied on its pavement management system for more than a decade

for functions such as forecasting overall investment needs, the system now is playing a more critical analytic role because of the intensity of the pavement preservation shortfall.

The Utah DOT's pavement management system and its logical, systematic approach to managing the network helped the department explain to the Utah Transportation Commission the department's approach to the dramatic increase in prices experienced between 2005 and 2008. Using the analytics from the pavement management system, the staff explained to the commission the department's intention to pursue a lower cost programmatic approach to sustaining pavement conditions. The logical and systematic process appealed to the Commission, which allowed the department to cope with rising costs by accepting a lower level of condition on the low-volume Level 2 routes.

Toward Comprehensive Asset Management

Although the examples discussed thus far relate to pavements, the Utah DOT has evolved on a parallel track to a more comprehensive Asset Management process which includes not only pavements but bridges, maintenance items and safety elements. Data from systems affecting all the highway attributes are collected in a central asset management data based purchased from one of the national Asset Management system vendors.

The pavement data includes friction data taken statewide on a two-year cycle. One lane was tested each direction, except on divided highways where both directions were tested. One test section was performed on each mile. The data base also was populated with falling weight deflection data taken system wide, with one reading taken per mile. This data was provided for project-level design inputs. A profiler van also collected International Roughness Index data, as well as rutting and concrete faulting data. Again, the data was collected annually on one directional lane, except for the divided highways which had both directions measured. For many years, cracking data was collected by the regions annually. Data was collected for one-tenth of a mile sections.

It was the variability of the manually produced cracking data that led to concerns about the accuracy, frequency and consistency of the data. The department has since moved to an automated distress collection process. It allows data to be collected statewide, not just on tenth-mile long sections. All the pavement data – skid, rutting, IRI, cracking and FWD – is populated into the central asset management data base.

The department relies on Pontis for its bridge data system. Bridge inspections are conducted every two years, except for structurally deficient bridges which are inspected annually.

Likewise, safety data is populated in a Safety Management System, which produces a Safety Index for each mile of roadway. The data includes information regarding crash severity and crash type by location. The system calculates a numeric ranking from the Safety Index for every roadway section. The sections which are elevated in their safety index are considered for additional treatments as part of the other programs including the pavement, bridge and maintenance programs.

The maintenance data comes from the Operations Management System (OMS). It stores an extensive amount of data for each section including:

- Maintenance section delineation;
- Station boundaries;
- A snow plan for each section;
- Shoulder dimensions and profile;
- Drainage and culvert information;
- Guardrail and barrier inventory;
- Sign inventory;
- Noise walls;
- Pavement markings;
- Vegetation management areas;
- Mowable area;
- Litter pickup area;
- Cattle guards and tunnels.

The Operations Management System manages the budget, the work programs for maintenance crews, it

helps them schedule and it helps measure their effectiveness. The effectiveness is measured by evaluating actual conditions against the maintenance targets, as well as calculating maintenance function costs. The OMS is used for planning, organizing and directing resources.

The maintenance functions interact with Asset Management in several ways. Departmental officials say the philosophy of preventive maintenance is deeply ingrained in the organization and its workforce. They believe front-line maintenance workers understand that well maintained roads cost less, and last longer, which complements the Asset Management approach. The integration of pavement condition data, safety data and maintenance data all can influence maintenance decisions. Where the central Asset Management data system indicates there are poor pavement conditions, poor skid numbers or an elevated safety index, the maintenance crews consider what operations they can perform to improve those sections. If the maintenance crews perform a chip seal or other significant treatment, that treatment is captured through the central data base and fed into the pavement system. In these different ways, the activities of the maintenance forces can be influenced by asset condition levels, and conversely, the activities of the maintenance forces can measurably improve asset condition and performance.

Not only do the Utah DOT management systems plan and record activities at the front-line maintenance level and the region project-selection level but they also provide comprehensive 20-year plans for the department. Both the bridge management system and the pavement management systems produce 20 year plans, both by region and statewide. They also suggest the treatment by pavement section and structure, treatment cost, overall budget needs and the commensurate level of condition that would be achieved by the forecasted program. The forecasts provide assurance that the asset management program being pursued by the department will achieve its long-term goals of asset sustainability. The department does not use the 20 year forecasts for project selection, but rather for planning purposes and to assess whether overall funding levels are likely to achieve the desired system conditions. The overall result of the various systems and processes is to produce for the Utah DOT

a comprehensive asset management process that considers pavements, bridges, and maintenance features and links them to safety considerations.

Lessons

The Utah officials say that many managerial strategies are important when developing a statewide Asset Management system.

- Leadership from the top is invaluable, particularly when the leadership consistently supports Asset Management until it is firmly in place.
- The Asset Management process needs to combine both computerized management system recommendations tempered by the field and engineering judgment of region personnel. Having just one or the other probably is not enough to optimize investment decisions.
- Expecting the developing of an Asset Management process to take time is important. Utah officials say they have been actively

pursuing their process for seven years and still are evolving.

- Open, continuous channels for communication between the asset management staff and the region staff are essential.
- An ethos of continuous improvement is fundamental. Because the management systems, their data and the organizational practices all evolve, a continuous improvement mindset is a fundamental element of long-term asset management.
- Accountability is helpful, if not mandatory. Setting standards of performance – both in terms of asset condition and in terms of asset management practice – help ensure that the on-going practice of asset management is sustained.
- Understand that both data systems and management practices are essential to successful Asset Management. Data systems provide good information. Sound management practices provide good decisions.



Data and information are among the most important elements of asset management. Sound condition information and the ability to predict future performance are essential components of asset management.

Chapter 4 Information Needs for Asset Management

After leadership, sound information and analysis is the single most critical factor in good Asset Management. It is difficult to overstate the importance of information to the many decisions which must be made at the program level, the project level and the organizational strategy level.

Needed information for the deployment of Asset Management falls into at least three major categories. They are Organizational Direction Information, Organizational Competency Information and Organizational Asset Data.

Organizational Direction Information - Is the organization's commitment to asset management clear? Has the organization bought in to the asset management approach? Does it understand the asset management approach? Is it cascading the approach actively throughout the organization?

This category of information is closely aligned with the Leadership component mentioned earlier. It is this

information about Organizational Direction which most directly involves the leader.

Organizational Competency Information - Does the organization have the technical and strategic competency to perform asset management functions? Does it have long-term goals and short-term objectives? Can it conduct resource-allocation tradeoffs and long-term forecasting? If the agency is only beginning to adopt preventive maintenance, do the front-line workers have the required training, equipment and materials? Do the information personnel have the tools and training to collect the needed data? Does it have performance measures? What is the competency gap to embrace asset management?

Organizational Asset Data - This is the category of data that is most often recognized as essential to asset management. In fact, a common misconception about asset management is that it involves only technical, computer programs such as Pavement or Bridge

Management Systems. In fact, asset management requires all three types of information listed here but it is the Organizational Asset Data that is the most technical, detailed and expensive to acquire.

Organizational Direction Information

Adopting or improving Asset Management approaches is about changing existing practices and implementing new ones. An exercise in Change Management is required. The theory of change management fills volumes of text books but in the case of Asset Management a few general principals apply. Understanding if these principals are at work will reveal a good deal to the leadership about whether the Organizational Direction is sufficient to ensure a successful transition to Asset Management or a successful evolution to the next stage of it. An evaluation of the following types of information can provide insight into whether the Organizational Direction is clear.

The "Case for Change" Information - To change an organization the leadership must clearly state the new direction and make a clear case for change. In *"Re-Engineering the Corporation,"* Hammer and Champy⁴ emphasize the need to make the case before an organizational transformation can occur. Hammer and Champy say the most compelling argument is when the leader clearly and factually notes the inevitable failure that will occur should the organization continue on its present path. In instances where asset management is lacking, the failures can be failure to achieve public support, failure to sustain infrastructure at acceptable conditions or the failure to receive additional resources. Probably the most important information needed to begin an asset management transition is the information leadership provides about the "where, how and why" the institution is changing.

Modes of Communication - Practitioners who measure human communication note that most communication is non-verbal. The most powerful non-verbal messages are body language, tone of voice and

degree of engagement. These same principals apply in terms of leadership communicating asset management to a large agency. Organizations are like people in that they intuitively understand the importance of the non-verbal messages that are transmitted along with the verbal ones. If the leadership issues memos about asset management but does not actively and personally engage in it, they are sending a powerful message that asset management is not truly important. To assess if the information is in place to affect a change in organizational attitude, the leadership must assess the tone, tenor, quality and sincerity of the messages it is sending to the work force. The leadership's active, personal engagement with asset management most effectively communicates its importance.

Sending and Receiving Information - Communication requires both the sending and the receiving of information. Merely sending information without ensuring it is received is broadcasting, but not necessarily communicating. To be understood, information must come in a fashion, context and vocabulary that can be understood. Discussions of "Asset Management" and "Performance Management" may be appropriate to planning staff or engineers accustomed to dealing with abstract systems or models. For front-line workers who are realistically focused upon the issue of the day, such terms may not be effective. Instead, it may necessary to speak in plain terms about better strategies to repair pavements, to sustain guardrail or to improve the condition of signage. Direct, concrete, unadorned examples about how maintenance forces fit into asset management are important. To evaluate the clarity of a message, the "ball cap and flannel shirt" test can be applied. "Would what we are saying be relevant to the front-line workers in ball caps and flannel shirts who are conducting our day-to-day maintenance?" If the leadership's message does not pass the "ball cap and flannel shirt" test, they may be creating an information gap.

Official Forms of Communication - In a formal organization many actions are influenced by legally sanctioned documents and processes. These include position descriptions, annual evaluations, promotional exams, a table of organization, union agreements and formal policies. Although a good deal of research has been conducted on how organizations operate in

⁴ Hammer, Michael and James Champy, *"Re-Engineering the Corporation,"* 2001

contravention or direct circumvention of these devices, they still play an important role. If the leadership wants to convey the importance of adopting asset management in an organization, it should evaluate whether these formal forms of information reflect the new organizational commitment. If leadership wants managers to adopt asset management, it should review whether such direction is clear in the managers' position descriptions, annual evaluations and in their divisional work responsibilities.

Organizational Success Information - To embrace an on-going change, the workforce must see and experience that the change is actually occurring. To continually communicate the evolving deployment of the asset management direction, the leadership should ensure that it is providing newsletters, websites, group meetings and other forms of feedback. This feedback needs to communicate continuously about the success achieved and the stages about to be undertaken in the organization's deployment of asset management.

Organizational Competency Information

If the organization possessed all the competencies necessary to conduct asset management, it probably would be doing so already. The fact that asset management is not fully deployed indicates that a competency gap exists. Assessing the size of this institutional competency gap and then devising a plan to close it is among the most important types of information needed to deploy asset management. The effort to assess the competency gap and then to close it, is in effect, an **Asset Management Implementation Plan**. The components of the Implementation Plan to assess and then close the competency gap would include at least the following elements.

The Strategic Basis for Asset Management - Asset Management is like Performance Management in that both are strategic processes intended to direct daily activities so that they contribute to the achievement of long-term institutional goals. The primary strategic foundation for asset management tends to be strategic, long-term organizational goals which include the following elements:

- "Preservation first" is an organizational priority;

- "Worst first" treatment strategies are secondary to life-cycle-cost treatment strategies;
- The organization values "fact-based decision making;"
- The organization values "continuous improvement" and "institutional knowledge management" which means it constantly evaluates its results, learns from them and disseminates that learning throughout the organization.

If a strategic foundation for Asset Management is missing in an organization, the leadership should consider developing a strategic plan or articulating a strategic vision which clearly states its long-term goals in support of asset management.

Short-Term Objectives and Performance Measures

- Most strategic processes evaluate their own success by devising short-term objectives and performance measures which are deployed as incremental steps toward the long-term goals. The achieving of the short-term performance measures ensures progress toward the goals. Failure to achieve the short-term performance measures triggers assessment or "learning" as to what needs to change in order to achieve the desired success.

If an agency lacks clear performance measures and a process to track them it probably lacks a critical element of Asset Management. Steady progress toward implementing projects, maintenance treatments and preventive maintenance operations are essential if the organization is to attain its multi-year, long-term Asset Management goals. Performance measures and a process to track them generally are essential.

Scenario Forecasting - One of the primary questions that asset management answers is, "Will the system be better or worse in the future as a result of what we are doing today?" To answer that question the planning functions need to be able to extrapolate different programmatic strategies and funding levels to determine their costs and benefits. The agency will need to evaluate different funding levels and treatment strategies. These forecasts can be quite complex and rely on state-of-the art computer systems in a mature asset management organization or they can consist of

straight-line extrapolations of spreadsheet and database information. The sophistication of the forecasts tends to increase with the maturity of the asset management program. However, an essential piece of information necessary will be to determine the competency of the department's scenario- forecasting capabilities.

Workforce Skills - People from the strategic planning offices to the front-line maintenance forces may well need new skills to implement asset management. If the agency intends to increase its emphasis upon preventive maintenance it must ensure that work teams, inspectors, designers and material testers are familiar with crack sealing, chip seals, thin overlays and other pavement preventive treatments. If the department has long relied primarily on reactive overlays, these preventive-maintenance treatments may not be widely understood.

Benefit-Cost Skills - A wider reliance upon benefit/cost analyses at both the program level and project level may require new institutional skills. Tools to easily conduct benefit/cost analyses so that they can be conducted on a wide array of program and project options probably will need to be provided.

An Asset Management Champion - One of the most important requirements is to have an asset management champion at a high level of an organization. If asset management is being driven by a Commission, a Legislature or by the CEO, it probably has an automatic champion. If those conditions do not exist, a champion should be appointed and the higher in the organization the better. This champion in many instances is supported by a broad-ranging committee representing all major departmental areas. This arrangement can spread the advocacy widely across the organization.

Organizational Asset Data

One of the common fallacies about asset management is that its practice is dependent upon state-of-the-art enterprise-wide computer systems. Such systems are extremely desirable and they are powerful adjuncts to mature asset management processes. However, as mentioned in past sections they are optional while other types of data are absolutely essential for asset management. The following section generically

describes the type of basic asset data that an organization will require. It should be stressed that the acquisition of sufficient data and information for asset management is a continuous journey, not a point of departure for the asset management effort. "Begin with what you have" is repeatedly stressed in asset management guidance worldwide. Spread-sheets, data bases and simple forecast curves are often the foundations of asset management information systems.

Organizational Asset Data - The International Infrastructure Management Manual identifies the following categories of data that underlie sound Asset Management.⁵ They include:

Asset Inventories - These are the basic data regarding the bridges, pavements, maintenance appurtenances, traffic control devices, equipment and facilities which comprise the total inventory of the department's physical assets. Generally, this information includes at least current condition and location information. Preferably, it would include past-performance history and detailed structural condition data so that remaining service life can be predicted. Although it may be simplistic, just knowing what assets exist and where they are can be important. Some assets such as culverts, under drains, signs, traffic signals and guardrail have been lacking in traditional asset inventories, which focused upon pavements and bridges.

Level of Service Data - Data as to the desired level of service compared to the existing level of service is clearly desirable in Asset Management information systems. When unit cost data is added to the existing and desired level of service information, financial gap analyses can be conducted. In addition, ad hoc trend analysis and exception reports can be conducted to look for trends in asset deficiencies, whether they occur geographically or programmatically.

Predicted Future Demand Data - This data is often volume-based such as traffic forecasts. This data is important for forecasting future demands, such as loadings on pavements or bridges.

⁵ International Infrastructure Management Manual, Version 3.0, 2006, pg. 2.10

Remaining Useful Life Forecasts - If the preceding data exists, it generally is possible to forecast the Remaining Useful Life of assets. The remaining useful life can predict failure scenarios and is fundamental to accurate forecasts of financial needs.

Risk-Analysis Data - The risk-sensitivity of items such as fracture-critical bridges or traffic control devices is quite high. Rather than accept high-degrees of risk regarding these asset classes, the desired asset data would include indicators of risk for structures or other asset items which need to be maintained with higher degrees of adequacy than would items of lesser risk such as low-volume rural pavements.

Treatment-Sensitivity Data - The relative effects of various treatments upon the remaining service life of assets is important and desirable data. These data preferably are derived from statistical analysis of a vast array of past examples but they can be generated by engineering judgment or “rules of thumb” in early Asset Management programs.

According to the FHWA Office of Asset Management the following analyses are the basic ones which will be conducted upon the Asset Management information systems mentioned above.

1. **What is the state of my assets?**
 - a. What do I own?
 - b. Where is it?
 - c. What condition is it in?
 - d. What is its remaining useful life?
 - e. What is its remaining economic value?
2. **What is my required level of service?**
 - a. What is the demand for services by stakeholders?
 - b. Are there regulatory requirements I must meet?
 - c. What is my actual performance?
3. **Which assets are critical to sustained performance?**
 - a. How does it fail? How can it fail?
 - b. What is the likelihood of failure?
 - c. What does it cost to repair?
 - d. What are the consequences of failure?

Benefit/Cost Data - Closely related to treatment-sensitivity data are benefit/cost data which can be used to generalize the return-on-investment of various treatments or strategies.

Fiscal Forecasts - Forecasts of predicted revenue based upon likely economic and political scenarios are necessary to evaluate potential investment options.

The Sensitivity of Maintenance and Operations - Tradeoffs in capital programs often are made in Asset Management as decision makers evaluate tradeoffs between asset classes such as pavements, bridges or maintenance items. Another class of trade-off decision is how to allocate maintenance and operations resources toward the maintenance of assets. Decisions on how to deploy people, equipment and materials relies upon the expected sensitivity of those resources when they are applied to the improvement of various assets.

Analysis for Asset Management

4. **What are my best “Operations and Maintenance” and “Capital Improvement” investment strategies?**
 - a. What alternative management options exist?
 - b. Which are the most feasible for my organization?
5. **What is my best long-term funding strategy?**
 - a. What revenue will I have?
 - b. What is my investment gap or surplus to meet asset condition goals?
 - c. What would be my optimum mix of:
 - i. Preventive Maintenance
 - ii. Reactive Maintenance
 - iii. Rehabilitation
 - iv. Replacement
 - d. If I cannot afford my optimum mix, what is the best mix of fixes I can afford?

Oregon Asset Management Case Study

The following Oregon DOT case study illustrates how one agency addressed the three types of organizational information needs as it evolved its Asset Management strategies. The Oregon DOT developed Organizational Direction information which served to focus the agency staff upon the path of Asset Management. It adopted both an Asset Management program plan and an Asset Management communication plan to fully convey its organizational direction to the work force. It gathered its Organizational Competency Information by assessing and then enhancing its organizational structure to support its Asset Management efforts. Finally, it also developed a strategic approach to producing the Organizational Asset Data it needs to fully capitalize on Asset Management for a wide range of assets. Although the Oregon DOT did not approach its Asset Management evolution primarily as a communication exercise, the steps it did take serve to illustrate the three types of information that an agency needs to consider as it adopts Asset Management.

The Oregon DOT case study also illustrates how an agency can use its Asset Management system to generate highway performance information to satisfy statewide performance measurement efforts.

Summary of Asset Management Development in Oregon

The development of Asset Management is often an evolutionary process within an agency and it was so at the Oregon Department of Transportation (ODOT). The roots of the ODOT Asset Management efforts can be traced to department policies which began as early as 1988 to set targets and to measure performance of the department's highway infrastructure assets. The agency set desired levels of service and began tracking its performance toward achieving those levels. Because the setting of performance targets is a common activity in both Asset Management and Performance Management, ODOT's early experience in setting performance targets allowed it to adapt more readily over the years to the practice of Asset Management as that became the agency's preferred approach to managing its highway infrastructure. Concurrently, through the years, the agency improved its systems for pavement management, bridge management and safety management. It also used the HERS-ST program to help determine optimum investment levels between asset classes. Eventually, the various performance measurement efforts combined with the agency's embrace of management systems led it to an Asset Management system that now has formal structures, a formal mission and formal policies.

As other agencies have found, the DOT's evolving Asset Management system could produce the data necessary to satisfy the state's desire for transportation performance metrics as part of a statewide Performance Management program. In a collaboration of the transportation department's Asset Management process and the state's performance measurement process, the ODOT performance targets for its transportation assets are tied directly to the state-level performance measures. These measures are presented annually to the state Legislature for review during the budgeting process.⁶ The transportation measures are tied strategically to four over-arching agency goals of: (1) Improve Travel Safety in Oregon, (2) Move People and Goods Efficiently, (3) Support Livability

and Economic Prosperity, and (4) Provide Excellent Customer Services. As a result, a direct linkage can be drawn between the Oregon DOT's asset management practices and the practices' contribution to the achievement of statewide performance goals.

Oregon DOT officials said this long history of strategically approaching the measuring and managing of transportation asset conditions has given the agency a firm sense of its organizational direction regarding Asset Management. The agency continues to evolve from setting infrastructure performance measures, to developing management systems to embarking on full implementation of an Asset Management program. Representatives from a majority of ODOT program areas are now involved in the decision making process. At the same time, the Legislature and the state executive branch can have confidence in the outputs from the Asset Management program to provide the information they seek to assure that transportation performance is sound.

Achieving Organizational Direction

As the Oregon DOT developed its Asset Management processes, it became increasingly clear and emphatic in communicating its asset management direction to its workforce, to the Legislature and to the public at large. The agency's formal evolution to embracing Asset Management included the adoption in January, 2006, of the "ODOT Asset Management Strategic Plan." That was followed by other systematic efforts to communicate the organizational direction including an Asset Management Program Plan, an Asset Management Implementation Plan and an Asset Management Communications Plan. All were intended to clearly and systematically convey that the organization was making a further, evolutionary shift in refining and enhancing its Asset Management practices.

The Strategic Plan says, "ODOT adopted the goals and principles of the AASHTO Transportation Asset Management Guide and is currently attempting to

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<http://www.oregon.gov/ODOT/CS/PERFORMANCE/>

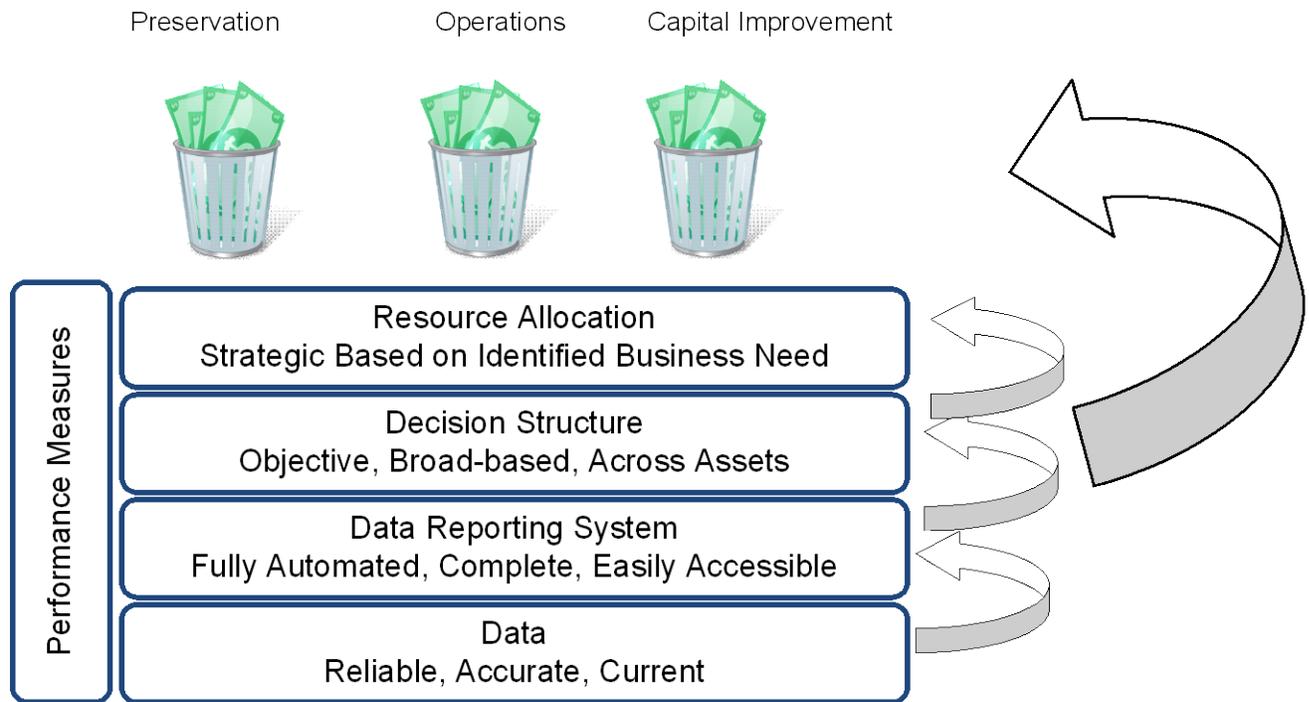


Figure 15 Asset management influences preservation, operations and capital improvements.

integrate the process of Asset Management into its everyday business processes and decision-making at all levels, and across all functions, of the organization. Its Strategic Plan includes Figure 15 which illustrates how Asset Management influences Preservation, Operations and Capital Improvements through the systematic use of data, reporting systems, decision structures and resource-allocation decisions.

The ODOT Asset Management Strategic Plan described the then-current state of Asset Management in Oregon - including its weaknesses - and laid out a concrete plan for how the agency would improve its Asset Management practices. The Strategic Plan said that the success of Oregon's Asset Management efforts would depend on whether it developed a program that met the business needs of the various core business areas of the department including management, planning, project development, operations and maintenance. It intended to make Asset Management the foundation to monitor the transportation system and to steer the preservation, improvement and replacement of its assets. It notes that the agency will build upon its strong management systems.

"The significant difference (between Asset Management and the other management systems) is

that, in many respects, existing ODOT management systems are used in a "tactical" manner, to identify specific projects. Asset Management is a "strategic" analysis and decision-making approach that selects projects and allocates funding by looking at a broad range of assets and their performance in the system as a whole," said the ODOT Asset Management Strategic Plan.

The Strategic Plan goes on to spell out the Core Principles to guide the organizational embrace of Asset Management. Those principles include that:

- Asset Management will add value and support the mission of the department;
- It will be done well and will be based upon the national and international best practices;
- Asset Management will build upon ODOT's existing good work of its management systems;
- Current efforts under way to gather and improve data will be supported;
- Asset Management will be part of the department's daily work function;
- Asset Management will use trusted and reliable data;

- It will be a management process that is regularly monitored with performance measures of the effectiveness of cross-asset decision-making, data monitoring, trade-off analysis reporting structure and other key elements;
- It will support broad-based funding allocation decisions;
- It will allow readily available asset reports;
- It will foster cross-asset communication.

The Strategic Plan candidly said in 2006 that, at that time, the agency's approach fell short of those comprehensive objectives. It noted that its data was contained in between 60 and 70 different data bases which did not allow the comprehensive analysis that the agency desired. To be strategically prepared for Asset Management, the Strategic Plan said the agency must implement processes to integrate capital and linear asset data into an Asset Management system. The system must then be strategically used to make policy, program and funding- allocation decisions.

To achieve its strategic ends, the Plan set three goals, each with several objectives and strategies. The goals were:

- Develop and implement a robust Asset Management Data Collection and Storage system that is consistent, unduplicated, understandable, reliable and accurate;
- Develop and implement a fully automated, flexible and complete Asset Management Data Reporting System that performs cross-asset analysis;
- Develop and implement an integrated, useable, and reliable Asset Management system that provides information and analysis for life-cycle cost management of ODOT assets so that funding allocation decisions are broad-based across various asset categories.

That plan says in part, "The Asset Management Program Plan has been developed to provide interested stakeholders a synopsis of Oregon Department of Transportation efforts to implement a strategic and pro-active Asset Management Program for all linear transportation assets under its responsibility."

The agency adopted a formal Vision for its Asset Management efforts which is: "ODOT's assets are managed strategically by utilizing integrated and systematic data collection, storage, analysis and reporting standards on a broad range of transportation system assets, optimizing funding and life-cycle decisions for operations, maintenance and construction business functions."

Its Asset Management Mission is: "Recognizing that Asset Management is a process or methodology that ODOT can use to cost-effectively deliver an efficient, effective, reliable and safe transportation service, the mission of ODOT Asset Management is:

- to put in place the plans, people, processes, and products that enable ODOT to implement accepted Asset Management practices in a timely and cost-effective manner, and;
- to continually monitor and improve Asset Management implementation over time.

We do this so that the benefits to ODOT in the areas of accountability, communication, risk management and financial efficiency can be realized." ⁷

ODOT's efforts to link "plans, people, process and products" to advance its Asset Management practices is reflected in the multi-disciplinary approach evident in its Asset Management Program Plan, and as illustrated in Figure 16, taken from the Strategic Plan. The Program Plan notes that the Asset Management efforts will build upon the Bridge Management System, the Pavement Management System, the Safety Management System but it also notes that its efforts must extend more broadly to include the organizational structure, the policies, the standards and processes of the agency. To advance the Asset Management Program, partnerships and collaboration must be forged with cross-cutting units within the department and across the districts. Areas as diverse as data collection, data management, data warehousing, planning, the project delivery system and maintenance need to be communicating and

⁷ ODOT Asset Management Program Plan, March 19, 2008, accessed at <http://library.state.or.us/repository/2009/200905131613413/index.pdf>



Figure 16 The Oregon DOT links "plans, people, processes and products in its asset management framework.

working in concert to advance the agency's Asset Management program, indicates its Asset Management Program Plan. "...a pro-active Asset Management Program is a key element in the strategic life-cycle management of these assets. This program must provide resources to the agency in the form of applications, tools, standards, processes and guidelines for decision making, data management and communication," says the Program Plan.

It goes on to identify the responsibilities of key areas within the department that need to collaborate and work across divisions to propel the agency along its Asset Management path:

- The Technical Services staff will operate the asset management systems, develop design standards and policies, collect data and contribute to decision making about Asset Management;
- The Transportation Development Division will provide foundational data such as the statewide transportation plan, and plans for highways, freight, and specific corridors. It also will provide advice to key decision makers such as the Oregon Transportation Commission about programmatic decisions;

- The Office of Maintenance and Operations has Asset Management responsibilities for updating design policies and standards and for leading asset maintenance activities;
- The regions and districts have responsibility for performing capital improvements, performing maintenance and making operational improvements to the transportation system;
- The Information Systems staff collaborates with the department to support Asset Management;
- The Asset Management Integration Section develops and implements the Asset Management Program, develops Asset Management policies and assesses the Asset Management program's success by monitoring its performance measures.

The close collaboration and unified organizational direction that is essential for Asset Management is evident in the Asset Management Program Plan's enumeration of roles and responsibilities. Each of six different functional areas are assigned roles and responsibilities in the common areas of Program

Coordination, Data Collection, Data Management, Data Analysis and Report and Decision Making. In other words, the various divisions and units all play a key role in the cross-cutting functions of coordination, data collection, data management, data analysis and decision making in the Oregon Asset Management framework.

Change Management and the Asset Management Communication Plan

Obtaining organizational buy-in is one of the primary concerns during asset management implementation, particularly at early stages. Without commitment up and down the organization, asset management remains only a set of principles written down on paper, no matter how elegantly phrased. To undertake this important component of implementation, the Asset Management Integration Section of ODOT developed an Asset Management Communication Plan. The primary goal of this plan was to increase understanding of the ODOT Asset Management approach. It includes a Change Management Plan, encompassing both communication and education/training plans.

The Change Management Plan aimed to set and communicate clear goals for Asset Management implementation, assess and respond to agency culture, and set up a framework that allows employees to understand how they fit into agency-wide efforts. One key message emphasized by the integration team is that asset management has been embraced by senior management. Demonstrating that the agency's leaders are active supporters of asset management is an important step in aligning the organization. Executive involvement in policy guidance and asset management committees further contributes to this aim.

In addition to the Communication Plan, the organization created an Asset Management Steering Committee to create a good internal governance structure. The Steering Committee is composed of staff from Highway, Information Systems, Motor Carrier, and other divisions. Integration between the Highway Division and the Transportation Development Division is extensive.

Organizational Competency Information

As seen in the preceding section, the Oregon DOT went to considerable lengths to ensure there was clear information regarding its organizational direction for Asset Management. As was also clear, the agency had a firm understanding of its Organizational Competency gaps regarding Asset Management. Those primary gaps regarded data availability, flexible data reporting and the ability to make life-cycle cost decisions at the project and program levels. In the ODOT Asset Management Implementation Plan, it set about to close those competency gaps and to provide the asset information it needed to achieve its Asset Management aspirations. Because its competency gaps related to data and information, there was a close connection between the final two types of information needs - the Organizational Competency Information Needs and the Organizational Asset Data Needs.

Implementation Plan to Close the Competency Gap

The Oregon DOT Implementation Plan lays out a clear approach to providing the information and analytic tools the agency desires for its Asset Management maturation. The implementation plan provides the agency specific steps to take for the successful integration of Asset Management principles, practices and processes into its every day work. It says that woven throughout ODOT's Asset Management program is the need for business processes, communication channels and system enhancements to support the integration of Asset Management. It appears from the ODOT Asset Management implementation plan that the agency believes it possesses many strengths in the management of individual assets but that it perceived a gap in the "connectedness" of its plans, people, processes and products to make the cross-asset tradeoffs that it desired. "Well defined roles and responsibilities, interrelationships within ODOT and external stakeholders and the ability to maintain a "learning" attitude are all vital attributes for a successfully institutionalized ODOT Asset Management system," says its Implementation Plan.

Its Strategic Plan included three broad goals.

Goal 1 was to have a robust Asset Management Data Collection and Storage System that contains consistent, unduplicated, reliable and current data. To achieve that, the agency identified the Objective of making data adequate for both project-level and strategic level decisions. It adopted the strategy of formally identifying "Business Line System Owners" for each management system or class of assets. Then the roles and responsibilities of those owners and their key stakeholders would be identified and documented.

Another strategy to support Goal 1 was to complete a formal assessment of the data used to support each management system or asset class. Then policies would be developed to identify what should be collected, how the data will be defined, how it will be collected, how it will be stored, the degree of precision it should meet and the practices used to identify the location of its related asset. In other words, the strategy would adopt a consistent process to ensure the quality of the asset data collected. A related strategy is to define a governance structure that has oversight and authority to ensure adequacy of data-collection efforts.

Goal 2 is to have an automated, flexible and complete Asset Management Data Reporting System that performs cross-asset analysis and which monitors the inventory, condition and performance of the assets. To move the agency toward that goal, it developed strategies to assess existing management system analysis software, to review key analytic inputs such as construction price inflation rates, asset deterioration rates and life-cycle models. Another strategy is to develop tools and processes to incorporate Asset Management principles into the ODOT planning and project-development processes.

To achieve Goal 3, which is to create a decision process that focuses on life-cycle management of assets, the agency identified the steps it needed to take. Among them were to implement Asset Management principles into the resource-allocation processes, to implement the Asset Management Communication Plan, to develop an Asset Management Training plan, and to implement performance measures to support and identify the use of life-cycle-based decisions.

Collectively, these steps and additional ones which were not included here, were identified to close the Organizational Competency Gap so the agency could achieve its Asset Management aspirations.

Developing Organizational Asset Data

Closely tied to the development of the organizational competency information in Oregon was the effort to provide the third type of information needed for Asset Management, that is the Organizational Asset Data. These data consist of the asset inventories, the management systems, and the related decision-support software, information technology networks and the human resource capital to fully utilize them. As mentioned earlier, ODOT had mature and robust individual management systems for pavements, bridges, and safety programs. However, ODOT identified that it had gaps in how to integrate this data for cross-asset decision making and trade-off analysis. It also was concerned that it lacked consistency in the quality of its data because of differing practices in the collection and storage of them. The third component of its information-building efforts related to Asset Management was to build the information systems necessary to support a mature, robust and reliable Asset Management process.

Asset Management Steering Committee

The enhancement of the Organizational Asset Data was pursued in a systematic fashion by the Oregon DOT. In its Asset Management Strategic Plan, it identified the need to create an Asset Management Executive Steering Committee and to have it coordinate the efforts of other key existing and newly created panels. These panels represented important practitioners or led important data-development efforts which were necessary to meet the demanding data needs which the agency identified. These include:

- Oregon Transportation System Steering Committee;
- Information Technology Executive Steering Committee;
- Community of Interest Committees (IT and Transportation);
- Linear Asset Management Steering Committee;
- A Technical Services Asset Management Task Force; and,
- A GIS Steering Committee.

These panels coordinated the many steps necessary to complete the ambitious data system tasks which had been identified in the ODOT Asset Management Strategic Plan. They worked from the comprehensive set of objectives and strategies in the strategic plan. One data strategy was to develop a corporate Data Model and System Model that defines the agency's data and its overall information system. The data strategy efforts included obtaining the input from asset system owners, asset class owners and key stakeholders. Included with that effort was development of a gap analysis of the current versus-the-optimal ODOT data and system for managing the data.

Another significant data initiative identified in the Strategic Plan was to review the adequacy of data necessary to conduct cross-asset analysis among major asset classes. The effort involved reviewing data from the current management systems to determine if they could serve in the cross-asset analysis. Related to the cross-asset analysis was an initiative to create a data-improvement plan for each priority class of asset.

The development of an Asset Management Data Reporting System that is easy to use, reliable and accessible, and which provides current and accurate condition and performance data, was another Strategic Plan initiative which was pursued and overseen by the implementation committees. Among the action items for this task was to perform a cross-asset demonstration project in preparation for the full development.

The information strategies included attempting to capture data generated during the planning process and the project-development process and

Linear Referencing

A particularly successful data strategy for the Oregon DOT has been the use of Linear Reference Methods (LRMs) across the agency. LRM is a technique used to identify a specific point along a linear feature (e.g., mile point). Through linear referencing, data from legacy management systems can be coordinated by linking all data to specific linear points on the highway network. LRM combined with the use of Data Warehousing breaks down the barriers between legacy systems which could not be easily coordinated in the past.

incorporating them into the asset management data bases. The agency identified the need to efficiently capture and communicate data during the planning, project development and construction phases.

Based on needs identified in an asset management pilot project in one district, data management and integration became the major focus of ODOT's asset management initiative. TransCOI, the Transportation Community of Interest, has assumed the role of "Data Council," providing strategic direction. Products produced by this committee include process guides and standards for linear asset data collection and field data collection. While the council began as exclusively committed to asset management, it will extend in the future to support other initiatives including integrated Systems and Data Warehousing.

The Asset Management Integration Section was set up under the Transportation Development Division to coordinate and facilitate agency-wide asset management efforts. It is working on developing standards for gathering and storing data and developing tools to help various business areas manage their assets. The Asset Management Integration Section serves as a conduit for communication across the agency, in particular among planning, design, construction, operations and maintenance business lines.

Decision Support: People and Tools

Although the Oregon DOT has invested heavily in improving its data systems, it also brings the engineering judgment of its staff into the decision-making process. For example, pavement leadership in Oregon is careful to practice a mixed approach to decision support. While systems such as the Pavement Management System (PMS) are very useful for forecasting, leadership emphasizes the importance of not discounting expert knowledge from the field. Pavement management in ODOT relies on both tools and people.

The Statewide Pavement Committee has been in operation for ten years and meets every two months. Its membership spans the geographic regions as well as a variety of roles related to pavement. While data drives decisions made by the committee it also was formed to capture the insight of the experienced department personnel.

A Way of Doing Business

ODOT leadership measures the Asset Management initiative's success quite simply: up and down the organization, everyone now understands that "worst first" is not the answer. This one simple but important concept is indicative of major progress toward establishing a culture of Asset Management.

Since the development and approval of the Asset Management Implementation Plan (April 2006), ODOT asset management staff said the agency recognized that in order to allow for successful implementation it had to reach out for wider involvement from all ODOT program areas. This resulted in an adjustment to the participation of the Asset Management Steering Committee. Part of the outreach included an effort to integrate and share previous asset data in an easily accessible format. This includes a tool that was developed to help employees by improving transportation data availability. The FACS-STIP (Features, Attributes and Conditions Survey – Statewide Transportation Improvement

Program) Tool offers both a map interface and a tabular method for getting asset information. For more information on the Oregon DOT Asset Management program and its efforts please contact Laura Wipper (Laura.R.Wipper@odot.state.or.us) or Laura Hansen (Laura.L.Hansen@odot.state.or.us).

'Words of Wisdom' in Developing an Asset Management Process

Leaders at ODOT offer a number of observations that may prove useful to other agencies at earlier stages in the asset management development process:

- Not everything must be figured out at the start. ODOT has been doing Asset Management for years without calling it that. The next step is to become more strategic.
- When ODOT first started performance measurement, it was a separate effort. More success resulted once performance management and Asset Management were viewed as intertwined.
- ODOT demonstrated the importance of good tools and data for managing assets by first implementing an Asset Management pilot program in Region 2, District 3.
- You are never done - it's a continuous improvement process.
- Sophistication of Asset Management can be based on the risk involved for different assets.
- There necessarily will be different levels of complexity for different assets. While it is important to have a central person in pavement because of the scale of the endeavor, there is no need to have the same model for all assets. For example, a \$35,000 budget for guardrail requires less sophistication.

Existing institutional culture (e.g. the organization's shared goals, understanding of responsibility and the decision making process, personal relationships) cannot be discounted when implementing Asset Management as the new way of "doing business."



Asset management has matured and become a well-defined framework to measure and manage highway assets. In its maturation, it has come to resemble other "quality" systems such as Six Sigma or ISO. These systems, like asset management, help to not only improve performance but demonstrate accountability.

Chapter 5 Asset Management as A ‘Quality’ Framework

Congress and many states are considering a Performance Management approach to their transportation programs as a means to measure results and to document accomplishments. Performance Management is useful in many settings because it can measure current results against agreed-upon targets.

However, Asset Management should not be overlooked as a system for demonstrating accountability and for producing results. In fact, Asset Management has come to resemble many of the world-renowned "quality" systems which leading corporations use to ensure the long-term sustainability

of their performance. These systems produce not only short-term performance metrics but they also measure long-term performance, which is particularly relevant for highway networks.

This section briefly summarizes these leading "quality systems" and compares and contrasts them to Asset Management. By adopting Asset Management, an agency will be using strategies to manage the long-term performance of its transportation assets in a systematic and documented fashion similar to the management strategies used by many of the corporate world's leading performers.

Development of "Quality Systems"

"What gets measured, gets managed," is one of the most common sayings in business. However, for more than 20 years, management authors and leading organizations have perceived that measuring only short-term performance alone does not ensure the quality of an operation, or the long-term sustainability of results. In fact, the performance literature has extensively documented that a focus only upon short-term results can lead to unsustainable long-term performance. In response, major organizations and leading management authors have developed a variety of additional management frameworks which not only produce performance metrics but which also establish an over-arching "quality" framework for the operation of the organization. As a result, the use of these formal, sophisticated and proven frameworks has become a common component of organizations which are seeking to demonstrate their long-term performance and accountability.

Some of these systems include the Balanced Scorecard, Six Sigma, the Baldrige Process, the Japanese Kaizen process, ISO and the Total Quality Management process which was common in the 1990s. A fully development Performance Management System also can be considered as a form of one of these "quality" systems if it includes elements which lead to the long-term sustainability of operations for the lowest life-cycle costs. However, management literature is rich with examples of "sub-optimization" or skewed organizational performance because managers were pursuing narrow performance targets which did not reflect the best long-term performance of their organizations.

Such concerns are particularly relevant to the management of highway assets. As every textbook about pavements indicates, a systematic, long-term perspective regarding preventive maintenance and rehabilitation - in addition to resurfacing - is necessary to sustain the health of an entire pavement network. Focusing only upon the current performance of pavements can lead to over-reliance on short-term surface treatments. These eventually will fail to provide the long-term structural integrity necessary to

guarantee the future performance of the pavement network. An agency which focuses only on current pavement surface conditions will eventually face a highway network with an overwhelming backlog of pavement rehabilitation and replacement needs.

Similar problems can develop with a transportation agency's bridge inventory. It has been well documented that the United States built a massive inventory of bridges in the 1950s and 1960s with the construction of the Interstate Highway System. After serving the nation well for decades, these bridges are creating massive future obligations for states because so many are reaching critical age at the same time. Without a systematic, long-term approach to managing this massive inventory, states can face "waves" of aging bridges which they currently cannot afford to repair. A performance measurement system which only focuses upon the current condition of bridges may fail to recognize the long-term performance issues that are looming.

Executives of leading corporations also found themselves facing similar issues when they relied upon only short-term performance measures. For instance, a company could be profitable in the short-term but face long-term insolvency if its major products are likely to become obsolete with the advent of new technology or new, competing products. Or short-term profitability can mask the long-term erosion of a company's market share.

To respond to these concerns, leading organizations and institutions developed frameworks such as the Balanced Score Card, or ISO, or Six Sigma. These not only measure short-term results but they also evaluate the organization's business practices against clear, proven, demonstrably sound performance frameworks. These frameworks measure how well the organization responds to its customers, how it controls its quality-assurance processes and how likely the organization's processes are to ensure future success. These systems address future success by include a "learning" or "continuous improvement" function. The systems are devised to respond to constantly changing conditions in the marketplace, and to changing customer requirements. Therefore, instead of measuring only the adequacy of current performance they evaluate attributes such as an organization's

ability to "learn" or to "manage knowledge" or to adapt to changing circumstances.

The ability to measure changing conditions, and to forecast different future scenarios as a result, is a particular hallmark of the Balanced Scorecard, the Baldrige process or ISO. Again, in an analogy to Asset Management, these functions would be similar to a highway agency forecasting the effects of higher material prices upon the long-term sustainability of asset conditions. Unless the highway agency "learns" from the rise in material prices it cannot adequately forecast that its future ability to invest in pavement treatments may not be sufficient to sustain pavement conditions. Looking only at current conditions would not provide insight into the effects of higher prices on future results.

Leading manufacturers often require parts suppliers or other business partners to be "ISO Certified" or to be "Six Sigma Black belts" to demonstrate their reliability as business partners. In addition to delineating contract specifications, or performance targets, these leading firms also require partners to have a quality system such as ISO or Six Sigma to underpin their continued performance as long-term partners.

Similarly, as British and Australian transportation officials developed long-term performance agreements for private operators of new toll facilities they required not only a set of performance targets to be met but they required the vendors to institute a set of long-term management frameworks including Asset Management and ISO processes.

In Brisbane, Australia, the City of Brisbane and the State of Queensland are each building massive tunnel projects through public private partnerships. The City of Brisbane has contracted for the \$2.8 billion (US\$) Clem Jones Tunnel while the State of Queensland has contracted for the \$5 billion (\$US) Airport Link Tunnel. The Clem Jones Tunnel concessionaire will build and then operate the tunnel for 35 years while the Airport Link Tunnel concessionaire has a 45 year contract. The two government agencies confront the need to ensure that their massive investments are adequately sustained for decades. The performance and accountability strategy they selected is to require up to 28 different management systems, including an

audited, peer-reviewed Asset Management System as a key component of the contracts. The concessionaires are required to operate sophisticated Asset Management systems that at the end of four decades assure that the highways are in sound condition when turned over to the government.

The Australian transportation agencies have extensive experience with managing Public Private Partnerships. They have come to rely upon Asset Management Systems as a primary contractual means for ensuring the ongoing, long-term accountability of their concessionaires' highway operations.

In Great Britain, the Highways Agency within the national Department for Transportation recently award a \$10.2 billion 30-year contract for a private concessionaire to widen and then operate the M25 beltway around London, the nation's busiest highway. To ensure the long-term performance of that project, the Highways Agency is not relying only on a set of performance targets. As in Australia, it is requiring the concessionaire to institute a series of "quality based" management systems, including a system to continuously sustain the condition of basic highway assets over its 30 year life.

What these experiences abroad illustrate, is that Asset Management has become a basic element of accountability. It has been relied upon by the experienced transportation agencies in Australia and Great Britain to not only produce short-term metrics but more importantly to institute a long-term, continuously monitored process to ensure on-going sustainability of the valuable asset.

Asset Management and Other Quality Systems

The following section briefly summarizes several of the most common "quality" systems and illustrates how they are similar to Asset Management. By briefly describing these systems it is possible to illustrate that they, like Asset Management, can serve as an important component of any accountability framework. Also, these systems have addressed many of the problems confronted within Asset Management. How these systems address issues of performance, account-ability and sustainability hold many important

parallels for Asset Management.

These frameworks evolved to provide a comprehensive, replicable systems approach to managing large organizations, and the individual processes within them. These models build upon the "Deming" framework of institutional learning and continuous improvement through:

- Planning to achieve clear objectives which can be measured accurately;
- Implementing strategies to achieve those objectives;

- Continuously evaluating the results, and;
- Acting to further refine and improve results based on the evaluation of earlier efforts.

The models all rely heavily upon the setting of performance measures, which are derived from larger strategic goals. The performance measures are often customer focused, or focused upon indicators of organizational performance or efficiency. The models all stress data analysis to precisely compare processes and results against desired norms.

Asset Management as a Form of Performance Management

As mentioned above, Performance Management has been increasingly proposed as a means or framework to improve performance and accountability in departments of transportation. The National Surface Transportation Policy and Revenue Study Commission strongly endorsed it, and AASHTO has developed a prominent Standing Committee on Performance Management.

Performance Management has been defined in many similar ways but for the purpose of this report it will be described as, “a formal, on-going process which translates strategic goals into relevant and detailed measures which are then tracked to ensure uniform achievement of institutional goals.”

Performance Management provides an organizing framework which includes at least 10 steps or components. These steps provide direction, organizational alignment, performance data and a continuous improvement process. The steps are:

A strategic vision is established which sets long-term goals for a decade or more. They are “stretch” goals but ones which are measureable, realistic and focus on core processes important to customers. These tend to be goals such as meeting customer requirements for providing smooth pavements, or sustaining a safe, stable inventory of bridges.

Shorter-term targets are derived which are annual or biannual components of the vision. These targets are quantified with actionable performance measures. They may include targets such as increasing the percentage of routes which meet pavement smoothness goals from 80 percent to 85 percent by 2012, or decreasing bridge structurally deficiencies to no more than 8 percent of the bridge inventory.

The vision, measures, and expectations are clearly communicated. This communication comes in the

form of speeches and newsletters but also in the form of personal action plans, divisional action plans and other meaningful and actionable agency documents. Some states communicate these expectations in annual Business Plans. The Missouri DOT uses its Tracker, while Washington DOT uses its Grey Book. In New Zealand, the Transport Agency produces a Statement of Intent each year which details its targets. In New South Wales Australia, the Road and Traffic Authority produces a Results and Services Plan including its annual asset condition performance targets. While in the UK, the Department for Transport produces a Public Service Agreement which provides details on its performance goals, including those for asset conditions.

Detailed requirements and specifications are established. These break down annual goals into the technical details necessary for specialized areas to measure their progress. These detailed requirements provide specificity to the front-line workforce as to what the organization means when it states objectives such as “good pavements,” “sound maintenance” or “efficient practices.” These detailed specifications provide the precise measures to define adequacy in meeting the organization’s performance measures. The Utah DOT’s Maintenance Management Quality Assurance document provides details to maintenance workers on the level of performance the department expects for each maintenance item. The Queensland Department of Transport and Main Road’s Pavement Maintenance Report describes details on how to measure, treat and evaluate pavements for the front-line workforce. Missouri’s Tracker and its Maintenance Performance Indicator Report provides definitions and standards for various types of pavement and shoulder distresses, as well as other asset sufficiency standards. The specificity provided by these supplemental documents provide an important link between broad agency asset targets and the detailed technical performance the agency requires of its assets.

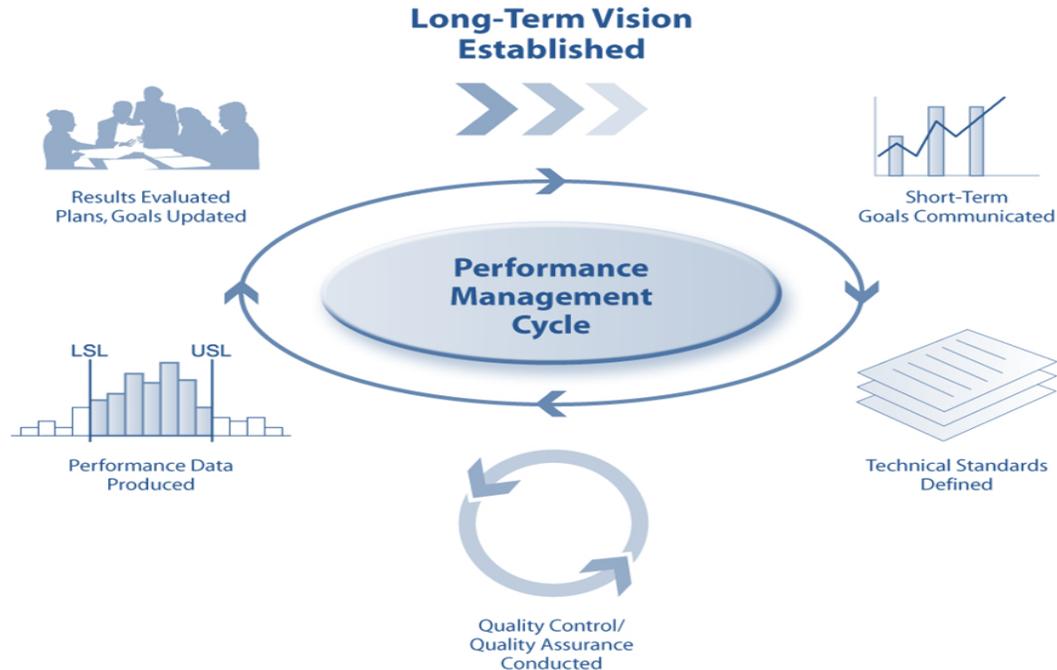


Figure 17 The major steps within Performance Management provide clear targets and a clear process for measuring accomplishment toward those targets. The later steps of reviewing results and updating strategies achieve the institutional learning process common in all of the "quality" frameworks.

A quality-control process is established. This process “field verifies” results by reviewing practices in the field. The Quality Assurance/ Quality Control process includes steps such as field reviews, consultation with district staff to receive their feedback on the process and the comparison of reported conditions with observed conditions. The field visits also allow the central personnel to observe district

practices and to identify best practices which can be shared organization-wide. Sometimes these include peer reviews between districts. These reviews ensure that the management system reports being used by central office personnel reflect the reality in the field. Another benefit is that the “quality control/quality assurance” process can identify best practices in the field which can be elevated to standard practices department-wide.

Meaningful incentives and disincentives are provided for each involved manager to achieve their assignments in the overall plan. Incentives can be as

simple as clear action plans for personnel, meaningful evaluations of their achievements, or promotions and praise. Disincentives can include disciplinary action, additional oversight or eventual reduction of duties. Some form of consequence for good and bad performance is tied to the department’s goals.

A clear annual cycle is established as to when results are expected, when results will be evaluated, when communication will be updated.

Continuous, accurate performance data is collected throughout the cycle. Personnel throughout the organization need to be able to access information as to whether their efforts are achieving the desired outcomes throughout the course of the year.

A periodic annual review is scheduled. Although data review occurs throughout the year, it typically culminates in an annual summation of overall progress and areas for improvement.

Finally, the active engagement of the leadership

throughout the process is essential. They set the tone, establish the goals, praise the accomplishments and address the failures. They also oversee the “institutional learning” by re-calibrating the annual and biennial goals based upon the feedback and assessment.

Short-Term and Long-Term Perspectives

There are significant nuances in the use of Performance Management to address highway assets over the long-term which should be fully understood. Care needs to be taken as to which performance targets and strategies to adopt to ensure the long-term sustainability of assets, which is a fundamental objective of Asset Management.

As long ago as 1993 in *"Re-Inventing Government"*⁸ and as recently as October, 2009, in the *Harvard Business Review*,⁹ authors have cautioned that a focus upon only short-term metrics can mask long-term performance consequences. In the case of managing highway assets, a focus upon only current conditions can lead to a "worst-first" or reactive maintenance approach which may not achieve the highest highway system conditions for the lowest cost over a long time frame, say of 20 years.

One of the common complaints about Performance Management is that it can encourage short-term thinking. Managers face pressure to achieve short-term metrics and therefore have little incentive for long-term investments or strategies. In Asset Management, the agency's physical assets are managed for the highest performance for the lowest overall cost over their multi-decade lifecycle. In an Asset Management framework, a manager would be encouraged to consider accepting lower network pavement conditions

⁸ Osborne, David, and Ted Gaebler, "Reinventing Government, How the Entrepreneurial Spirit is Transforming the Public Sector," 1993, Penguin Publishing, pps. 349-359.

⁹ Likierman, Andrew, "The Five Traps of Performance Management," in the *Harvard Business Review*, Oct. 2009, pps 96-101

today by reducing the miles of "worst-first" resurfacing if he or she instead adopted a more sophisticated pavement management approach which included more preventive maintenance, pavement rehabilitation or pavement replacements that provide longer-term benefits. The more sophisticated pavement strategy may not achieve the highest system conditions in the short term, but may well achieve the highest overall system conditions over the long term.

The concern that Performance Management may create a short-sighted or imbalanced approach to making decisions in part led Kaplan and Norton in 1991 to develop the Balanced Scorecard.¹⁰ The Balanced Scorecard is a Performance Management System but it includes many of the balanced tradeoff considerations evident in Asset Management. In the Balanced Scorecard, Kaplan and Norton grouped performance metrics into a smaller, manageable number. They also balanced them so that issues of both short-term performance and long-term organizational sustainability would have to be considered. In an Asset Management example, a Balanced Scorecard for pavements could include performance metrics which evaluate short-term metrics such as customer satisfaction, current ride quality, and skid resistance. Those would be balanced against long-term metrics such as remaining service life, and the lowest overall lifecycle cost of treatments. In a Balanced Scorecard approach, a manager could be making many of the same long-term, lowest-lifecycle cost considerations about pavements that he or she would make in an Asset Management framework if the Balanced Scorecard metrics include ones related to long-term sustainability and lowest lifecycle costs. Additional discussion of how the Balanced Scorecard performance management approach can be used for highway assets is included later in this chapter.

In a recent international transportation scan, *"Linking Transportation Performance and Accountability,"*¹¹ it

¹⁰ Kaplan, Robert S., and David P. Norton, "The Balanced Scorecard - Measures That Drive Performance," *Harvard Business Review*, as reprinted in "Measuring Corporate Performance," *Harvard Business Review*, 1998 pps. 123-145.

¹¹ An as yet unpublished report to be produced by the

was found among leading international practitioners of Performance Management that a strong focus on Asset Management operated in parallel. For instance, in the Swedish Road Authority, the highway agency strongly embraces Asset Management and adopts Asset Management policies and strategies to consider the lowest overall lifecycle strategies for managing its highway assets. However, it also operates a parallel Balanced Scorecard performance management system to address important issues such as Greenhouse Gas Emission reductions, gender equality, agency operational efficiencies, on-time project delivery and customer responsiveness.¹²

In the New South Wales Road and Traffic Authority in Sydney, Australia, the agency adopts a 10 year Transportation Asset Management strategy which is operated in parallel with the three year Performance Management strategy called the Results and Services Plan. The intention is to keep the shorter-term political budgeting process appropriately apprised of long-term highway asset management needs. The syncing of the budget process and the Asset Management plan has served to clearly illustrate long-term asset needs as part of the short-term budgeting and performance cycle in Sydney.¹³

In Queensland, Australia, the Queensland Department of Transport and Main Roads also operates a sophisticated Asset Management framework in parallel with a Performance Management framework. It adopts a Performance Management approach through a three year Service Delivery Statement which is similar to a Strategic Plan or Business Plan which states which performance targets it seeks to achieve in the short term. It then provides quarterly reports, which inform

Federal Highway Administration, AASHTO and NCHRP. Advanced copies were released in limited quantities at the 2010 Transportation Research Board Annual Meeting.

¹² Interviews with SRA officials as part of the "Linking Transportation Performance and Accountability Scan."

¹³ New South Wales Government Asset Management Committee documents accessed at <http://www.gamc.nsw.gov.au/tam/> and interviews with NSW RTA officials.

legislators, the ministry and the public as to how it is performing. Included among these short-term metrics are long-term Asset Management metrics, such as the amount of preventive maintenance that occurs. Also, employees are evaluated by their adherence to the agency's well-defined Asset Management procedures, manuals and quality assurance processes.¹⁴

¹⁴ Part 13, Queensland Treasury, Department of Transport and Main Roads, Summary of Departmental Portfolio Budgets, 2008, in the Service Delivery Statement and interviews with QDTMR officials.

Asset Management And Similarities to the Baldrige Process

The Baldrige Process is one of the oldest and most commonly used of the “quality” or “Performance Management” frameworks. Establishing customer requirements and then “managing by fact” to meet those requirements is a pre-eminent attribute of decision makers in the Baldrige organizations. The Baldrige Process relies on seven major areas of emphasis which are:

Leadership—Examines how senior executives guide the organization and how the organization addresses its responsibilities to the public. It also evaluates whether the leadership practices good citizenship.

Strategic planning—Examines how the organization sets strategic directions and how it determines key action plans.

Customer and market focus—Examines how the organization determines requirements and expectations of customers and markets; builds relationships with customers; and acquires, satisfies, and retains customers.

Measurement, analysis, and knowledge management—Examines the management, effective use, analysis, and improvement of data and information to support key organization processes and the organization’s performance management system.

Workforce focus—Examines how the organization enables its workforce to develop its full potential and how the workforce is aligned with the organization’s objectives.

Process management—Examines aspects of how key production/delivery and support processes are designed, managed, and improved.

Results—Examines the organization’s performance

and improvement in its key business areas of:

- customer satisfaction;
- financial and marketplace performance;
- human resources;
- supplier and partner performance;
- operational performance;
- and governance and social responsibility.

The Baldrige process provides a very detailed set of questions which agencies answer to help them assess themselves in terms of the seven categories. Agencies can follow the process further by making a formal application for a Baldrige review at either the state or national level. Certified examiners will review the application and meet with the agency to give it a formal assessment. Agencies can matriculate through an escalating series of increasingly complex applications and levels of sophistication. The ultimate level is to become a Malcolm Baldrige National Quality Award Winner, of which there are approximately six annually.

Table 4 below illustrates how the systematic self-analysis of the Baldrige process could be used as the basis for an agency's self-assessment of its own Asset Management practices. The Baldrige evaluation requires an agency to consider its operations from important perspectives, such as whether it has sufficiently ingrained essential training into its workforce, and whether it keeps its information systems robust and accurate. Although the Baldrige process was not developed for managing infrastructure, its categories hold many parallels to the functions conducted in Asset Management.

Table 4 Baldrige similarities to asset management.

Comparison of Asset Management and the Baldrige Process		
Baldrige Criteria	Baldrige Questions	Asset Management Guide Questions
Leadership	Are Vision, Values established? Do leaders create environment for improvement? Do leaders communicate direction to workforce? Do leaders review and act on performance measures?	Does the leader create strategic goals and measures for Asset Management? Does leader establish Asset Management “as the way to do business?” Is leader engaged in TAM?
Strategic Planning	Does the agency plan strategically? Are short-term and long-term goals set? Are strategic tradeoffs made?	Is a long-term TAM strategy in place? Are short-term objectives tied to long-term goals? Are scenarios evaluated and tradeoffs made?
Customer Focus	How does the ‘Voice of the Customer’ influence agency actions?	Can agency explain ‘best value’ decisions for managing assets?
Knowledge Management	How does information align activities to goals? Is performance data current, accurate? Does knowledge drive improvement? How does data support decision making? Does the agency have a process to ‘learn?’	Is knowledge management in place for asset data? Is asset data current, reliable? Does data drive analysis and action?
Workforce Focus	Is there a culture to create a high-performing workforce? How does agency foster cooperation between units? Does agency instill core competencies in staff?	Does the workforce have the tools for successful TAM? Do work units cooperate and coordinate efforts? Is staff trained in TAM?
Process Management	How does agency ensure its core competencies address strategic goals? Are processes adjusted for changing environments and events?	Do core processes create success in TAM? Do processes encompass life-cycle approach to TAM?
Results	Are organizational and customer goals met?	Are system-condition goals met, both short-term and long term?

The Balanced Scorecard Can Complement Asset Management

Another Performance Management or “quality-based” framework which is increasingly popular is the Balanced Scorecard. It was first described by Kaplan and Norton in the Harvard Business Review in 1992. They wrote that after decades of using performance measures to improve profitability and internal processes, executives realized such internal measures were not capturing the full complexity of the difficult tradeoff decisions that organizations need to make. How to balance the cost of a product with the quality it provided the customer was one such tradeoff. Or what value should a company place upon exceeding minimum environmental standards? How do they measure their ability to innovate? What value do they place on customer satisfaction in exchange for reduced profitability?

They created a four-point model which creates performance measures in four separate areas:

- The company’s financial perspective including profitability;
- The company’s internal perspective including measures of efficiency;
- The company’s measure of innovation and continuous improvement;
- The customers’ perspective including satisfaction, loyalty and corporate citizenship.

Simultaneously evaluating these competing and dissimilar needs requires the organization to take a holistic and balanced look at its performance, and not focus upon a narrow set of measures which could cause important functions to be devalued. In considering a Balanced Scorecard for an entire transportation agency,

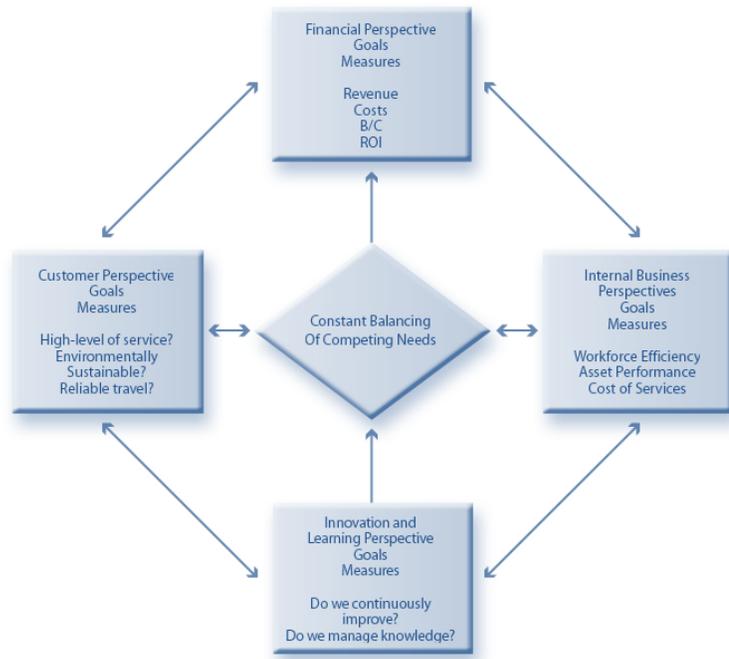


Figure 18 The Balanced Scorecard allows tradeoffs between competing needs, as does Asset Management.

factors such as Customer Satisfaction, Environmental Sustainability, Esthetic Enhancements and Safety could be balanced with infrastructure condition. In a narrower framework such as a Balanced Scorecard for Pavements, the factors of ride quality, remaining service life, lowest-cost lifecycle, and safety could all be measured with the preferred mix of investments being a rational balance between the competing values. In reality, Asset Management officials are making Balanced Scorecard decisions with pavements and other assets. They are balancing competing values in an attempt to reach the most rational overall set of investment decisions. A Balanced Scorecard template could be an effective means to illustrate the complex tradeoffs they make.

Six Sigma as a Subsystem Within Asset Management

Six Sigma began at Motorola in the 1980s. Engineers determined they could dramatically reduce manufacturing defects by carefully controlling production processes. They aimed for a virtually error-free manufacturing process that sought a 99.9997% success rate in producing products which met specifications.

Six Sigma is expressed in statistical terms and appeals to persons with a statistical or engineering background. Its concepts rely heavily, however, on the “continuous improvement” and “institutional learning” practices of the other systems. It trains a workforce in how to statistically and methodically evaluate the cause of defects and then to continuously improve production processes until they are virtually eliminated. It combines quantified analysis of results with a "continuous improvement" approach.

It is widely accepted in manufacturing sectors and would be highly appropriate for certain Asset Management functions or subsystems particularly conducting root-cause analysis of poor-performing pavements.

In a Six Sigma pavement framework, highly detailed analyses would be conducted on exceptional performing pavements, both good and bad. The analysis would seek to understand the root causes of such performance and then to standardize the processes which led to good pavement performance and to reduce practices which result in poor performance. Analysis of treatment timing, treatment appropriateness, materials acceptance, construction techniques and maintenance history would be conducted to determine why the “product” failed to perform to specifications.

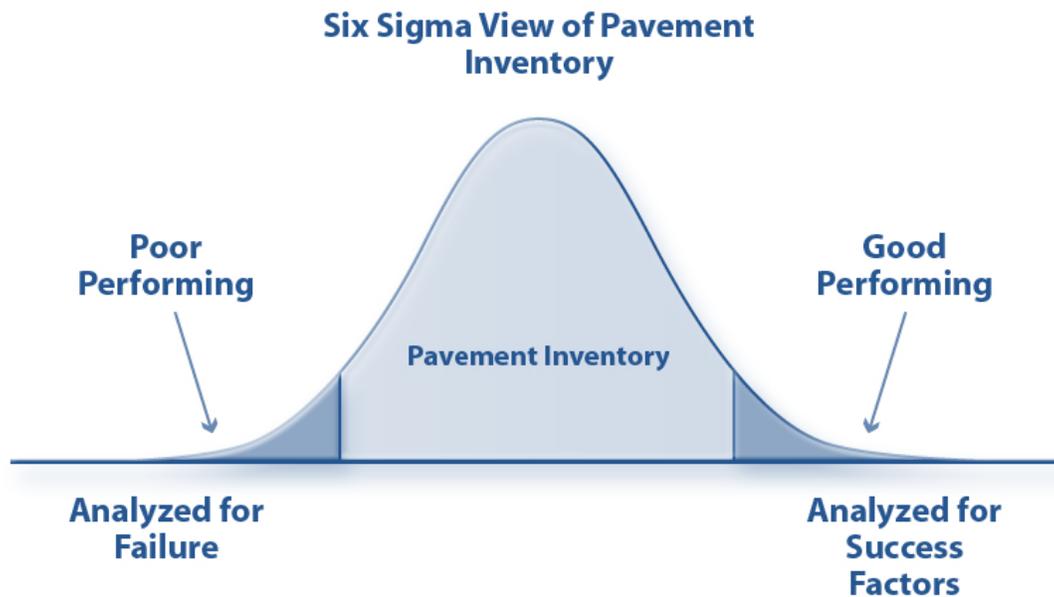


Figure 19 A Six Sigma approach to pavements would focus upon what causes pavements to perform exceptionally well or poorly. Lessons from that analysis would be used to improve pavement processes.

ISO, International Organization for Standardization

Founded in 1947, the International Organization for Standardization (ISO) has produced more than 17,000 international standards, which include quality-control and quality-assurance frameworks for managing processes. These voluntary standards are developed by more than 200 technical committees with membership from more than 150 companies. “ISO Certified” means that an organization has been evaluated and its processes comply with these internationally recognized processes for quality assurance.

Departments of Transportation in Illinois, Pennsylvania and Florida all have adopted the ISO framework for a variety of core business processes. The Florida and Pennsylvania DOTs rely on the ISO process to ensure their materials testing processes are sound. Illinois has used ISO processes for project management and other managerial functions.

Like these other systems, ISO provides a strategic, managerial system which can be applied to processes for managing almost anything, including processes related to highway assets. Its principals include:

Customer Focus – The organization begins with an understanding of its customers’ needs and it focuses all subsequent activities toward meeting them.

Leadership – Organizational leaders create internal processes that fully engage the workforce into meeting the organization’s objectives.

Involvement of People - The organization actively engages all levels of the organization with training and commitment so they can contribute to organizational success.

Process Approach – Internal processes are structured in an optimized and proven fashion to achieve results.

Systems Approach to Management - Identifying, understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its objectives.

Continuous Improvement – Continuous improvement of the organization’s performance is a permanent objective.

Fact-Driven Decision Making – Basing decisions on data and analysis is a key corporate attribute.

Mutually Beneficial Supplier Relationship – Producers and suppliers rely on one another and should have a relationship that increases value for both of them.

As with Six Sigma, ISO processes provide another means to document and to improve ongoing processes which underlies Asset Management. Processes in materials testing, design, maintenance or data collection all could be enhanced by adoption of ISO principles.

In a case study following this section, the use of the ISO framework by the materials testing laboratory at the Florida DOT illustrates the relevance of ISO to an important Asset Management component.

Summary

Asset Management provides executives with a comprehensive, rational and explainable model for managing their transportation facilities, their organizations and the resources they invest. By adopting Asset Management, they are also adopting management practices which are very similar to those which have been successfully deployed among the nation's leading corporations. The adoption of Asset Management requires not the use of any particular

computer program, or table of organization or specific set of performance measures. Instead, it requires a systematic, ongoing way of doing business which adopts a Plan-Implement-Evaluate-Act model which has been demonstrated to be successful in a variety of organizations around the world. Asset Management compares favorably to many of the leading systems, such as ISO or Baldrige, which are internationally recognized for achieving customer requirements.

Examples of Asset Management Practices Complementing “Quality” Systems in leading Transportation Agencies

Briefly, the report will cite key examples from leading international transportation agencies which have been documented to excel at both Asset Management and at using performance measures to improve their effectiveness. Transportation agencies in both Australia and New Zealand have been the subject of international scanning reports both for their Asset Management practices and for their wider use of performance measures to improve overall agency performance.

New Zealand

The New Zealand Transport Agency is the country's overall transportation agency which manages highways and other transportation facilities. It has comprehensive performance management and Asset Management programs which include a strong Pavement Management and pavement performance emphasis. The department has consistently reported achieving 98 percent of pavement condition goals for ride quality, friction and rutting. These goals and the pavement-management practices have clear foundations in a national and departmental strategic planning process which links pavement conditions back to customer satisfaction. As with the Baldrige, ISO or Six Sigma processes, the satisfaction of the customer is deemed to be the ultimate performance

measure in New Zealand. Customers are regularly surveyed about their satisfaction with ride quality. In addition, technical measures such as friction which may not be apparent to the driver are consistently measured because the department realizes the obvious contribution surface friction makes to safety.

New Zealand has a very “quality centric” Asset Management and Performance Management process. It not only reports on its outcomes in terms of the percent of the system which meets pavement goals, but it also reports how much it spent to achieve those goals. Annual expenditures are forecast by category to achieve the desired maintenance and pavement goals. Then at the end of the year the expenditures are reported with an explanation as to whether the input/output goals were met. The agency reports that 73 percent of the surveyed public rate overall highway conditions as “excellent” and that overall expenditures were within a few percentage points of what was forecast.

These pavement condition goals are also forecast into the future with a commensurate expected expenditure level to achieve those conditions. In this fashion, Transit New Zealand reports on the “sustainability” of its asset conditions with current available revenue.

Swedish Road Authority

The Swedish Road Authority uses the Balanced Scorecard and Asset Management as complementary systems to sustain a high level of system conditions despite the nation's harsh climate and declining maintenance budgets. For almost two decades, the SRA has used the Balanced Scorecard approach to balance competing national needs such as asset condition, with highway capacity needs, with environmental considerations. The two complementary systems provide a transparent governance structure which has served to provide accountability and to achieve results.

The Swedish Road Administration reports that as a result of this focus upon asset conditions and Asset Management it has sustained more than 95 percent of its major roads with smooth ride surfaces and high skid resistance for more than a decade. It has achieved similar high levels of conditions for its bridge inventory as well as for its maintenance conditions.

The Swedish approach relies upon seeking customer requirements, setting clear goals to meet those requirements, measuring accomplishments and reporting results.

Approximately one-tenth of one percent of the nation's population is surveyed annually to determine its satisfaction with pavement conditions and other Swedish roadway attributes. The customer input as well as the agency's own continuous review of its accomplishments has contributed to continued improvement in nearly all major areas of highway performance. Its pavement conditions are high, the bridge inventory is sound, and its crash rates are among the lowest in the world. So while the agency relies on an Asset Management system it augments it with additional input from its Balanced Scorecard, such as the percentage of the public which is satisfied with ride-quality conditions.

Queensland, Australia

Queensland is one of six states in Australia and its Department of Transport and Main Roads has a long history of performance management and strategic

planning. Its provincial planning and financial reporting process includes several elements indicative of a performance-based or "quality based" corporate management system for pavements and other assets. It publishes clear asset condition goals which are incorporated into provincial strategic plans, budgets and annual work plans. Its reporting process allows the public, legislators and the media to track accomplishments, and expenditures. In parallel with a larger Performance Management System, it operates a world-recognized Asset Management System which focuses upon the long-term performance of the highway system. The agency uses short-term performance targets to achieve its three-year metrics which are required for a government-wide performance measure report. But it uses its Asset Management Plan to ensure that the short-term decisions are conducted in accordance with its long-term horizon for its Asset Management Plan.

The department publishes a pavement management guide which includes guidance for the full life-cycle of a pavement from its design, construction, annual evaluation, preventive maintenance, reactive maintenance and rehabilitation. The pavement management process also includes an annual reporting of total network condition. Its manual notes that the role of the annual report is to provide transparency to outside stakeholders and to provide continuous improvement opportunities to the transportation department.

For instance, its annual report indicates that it intended to have no more than 15.6 percent of mileage exceeding its optimum seal-coat age but performance was less than that with 16.2 percent past its optimum age. By reporting on its preventive maintenance targets, it is measuring the short-term performance of tactics intended to ensure the long-term performance of the entire highway network.

As in the other quality systems, Queensland also reports measures on the overall customer satisfaction with the highway network, including ride quality. Ride quality met goal with 98% of urban pavements and 95% of rural ones meeting ride-quality standards.

As with the New Zealand model, the Queensland pavement management approach represents a comprehensive life-cycle approach to managing its

pavement network, and connecting the pavement system to a larger provincial Performance Management System.

The overall strategic pavement management process and its corollary reporting process serve to advise the public and policy makers as to the overall long-term prospects for pavement “sustainability.” The annual reports provide analysis of how long-term system conditions will decline if additional funds for pavement rehabilitation and replacement are not provided. Its annual report includes key measures such as:

- The percent of pavements which have exceeded the optimal age for a preventive maintenance treatment;
- The percent of the system which meets smoothness standards;
- The proportion of overall travel which occurs upon routes meeting smoothness standards;
- The number of lane kilometers of pavement rehabilitated compared to rehabilitation goals;
- Number of lane kilometers resurfaced or resealed compared to pavement management system goals;
- The level of investment actually expended compared to the level necessary for long-term sustainability of pavement conditions.

The Queensland metrics include targets which measure the current ride quality while also measuring the adequacy of long-term actions, such as whether the rehabilitation program is achieving its targeted goals. In this fashion it avoids the problem of focusing on targets which may not result in the best long-term performance. Its targets are taken directly from the Pavement Management component of its long-term Asset Management Plan.

New South Wales

The Roads and Traffic Authority in the state of New South Wales is the department of transportation for that Australian state. It, like in Queensland, incorporates its long-term Asset Management, Pavement Management, Bridge Management and Maintenance Management practices into a larger, state performance management framework. The RTA uses corporate strategic plans to link results and services with broader government priorities and to align internal business plans to deliver results. The plans used to communicate the RTA’s contribution to government priorities are the Corporate Plan, an annual Results and Services Plan and a Total Asset Management strategy.

The RTA files a formal Asset Management Strategy with the federal transportation agency and with the federal Treasurer annually.

The strategy is to submit a parallel Asset Management plan along with its performance management plans. The agency reports that the dual reporting keeps the transportation agency and the state government focused upon the longer-term horizon required for Asset Management. If the agency practiced only performance management, it would focus only upon asset conditions in the short-term horizon of the government budget cycles, which tend to look out no more than five years. That horizon is not long enough to capture the full lifecycle cost approach necessary under Asset Management. In the Total Asset Management strategy the agency reports upon its current activities which are necessary to sustain asset conditions for a 20 year horizon.

Its annual report indicates that for a five year period the percent of roadway network which does not meet ride quality standards has hovered at between only 4.4 and 4.6 percent of the network. The percent of the system which has excessive cracking has been between 8.8 percent and 11.2 percent of the network. Cracking is reported as metric because of cracking's importance to long-term pavement performance. By reducing cracking in the short term, it helps ensure the long-term performance of the pavement network.

Florida and Missouri DOT Case Studies

The following case studies illustrate two examples of how Asset Management can interact with these other "quality" systems. The first case study examines how the Florida Department of Transportation central materials laboratory became ISO certified. The second case study examines the Performance Management process at the Missouri Department of Transportation. The Missouri DOT officials discuss how they try to balance short-term performance targets with long-term asset sustainability. They caution that care and discernment must be used in setting performance targets to avoid long-term performance issues.

Florida Department of Transportation Office of Materials

The testing and acceptance of materials is a foundational aspect of ensuring performance of highway assets. Many steps of the Asset Management process rely on the assumption that treatments will be applied with the proper materials and construction techniques. A break-down in the materials and testing process can lead to reduced service life, decreased system conditions and higher overall costs to sustain the network. If an asset prematurely fails, the fore-casted service life which is so important in Asset Management will be unreliable.

The Florida Department of Transportation's Office of Materials has embraced the ISO process as its preferred system for ensuring consistent quality in its materials testing and certification processes. With the ISO process in place, the Office of Materials has a world-respected template to follow which ensures the continued high-level performance of its testing and acceptance processes.

The specific ISO certification which the Office of Materials has received is ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories. ISO/IEC 17025 specifies the general requirements for the competence to carry out tests and calibrations, including sampling. It covers testing and calibration in laboratories which certify products.

The Florida DOT Office of Materials believes it is the only state materials office to receive the full certification and is only one of four test facilities nationally to have received it. Other levels of ISO certification have been received by other testing laboratories but those certifications only apply to certain aspects of the laboratories' quality-control processes, not to their entire testing process.

The ISO audit and certification has two components, one which evaluates the quality of the laboratory testing process and a second which evaluates the comprehensiveness of the operation's business processes. The ISO certification goes significantly beyond the more common AASHTO Materials Reference Laboratory (AMRL) certification, which the Florida Office of Materials also has received. The ISO

certification evaluates all aspects of the operation including processes for calibrating equipment, documenting quality systems, training staff, preserving records and conducting root-cause analysis of any deficiencies.

The materials' office interest in ISO certification began in 2001 as a result of the team's interest in improving and in documenting its quality practices, said Thomas O. Malerk, Director of the Office of Materials. The effort requires a significant investment of time with one full-time and two part-time positions dedicated to the effort. Once they began to follow the ISO process, they developed a series of internal manuals for the office's Quality System process. Mr. Malerk and his team noted that the focus is upon the ISO applicant developing its own quality-control processes and manuals, and not following a prescribed or generic set of ISO manuals. Once their manuals and processes were established, they then trained all the staff in the use of the processes and in regular internal auditing to ensure the processes were followed.

A four-day ISO audit focused upon determining whether the operation follows its own processes. The staff members described the ISO audit as a "reality check" as to whether their own comprehensive systems were actually followed by the staff. They note that the internally developed ISO-compliant processes are integrated into the day-to-day practices of the front-line staff, as well as into all levels of management.

They said it took two years of preparation for the first ISO audit. They followed the ISO guideline documents for the 17025 process and worked closely with AMRL. They said the experience was very unlike the AMRL accreditation. They said the AASHTO accreditation focused upon watching to ensure that test processes were run correctly. They described the ISO process as, "Now that you've run the test, how do you know it's right?"

ISO is based on a systematic process of documenting a process, and continuously monitoring results and seeking the root-cause of any failure. This process cascades throughout the major functions of an ISO-compliant operation. The staff described the approach

of analysis as, “what happened?, Why did it happen? And what will we do to ensure it doesn’t happen again.”

For instance, in the FDOT materials office each piece of equipment needs to be regularly recalibrated, with a log kept of each test and re-calibration. Once received, new equipment is tested for proper calibration and entered into the office’s on-going equipment testing, calibration and documentation system. Recalibration regularly occurs, is documented into the quality system and is used to assure the office that all equipment is functioning as expected.

For major testing procedures, the degree of uncertainty or variance is measured by performing 25 tests upon a given sample over five days. The degree of variance or uncertainty is noted and either accepted or rejected as being within statistical expectations. Then, throughout the year the test is re-calibrated with the results logged into the quality system. Periodically, the 25 tests on a known sample are performed again, with the variance being recorded. If the variance is significantly different from the earlier tests, a root-cause analysis must be performed to determine why the test performed measurably different than before. With this sort of systematic, on-going process improvement under way, the office can operate with a high degree of assurance that its equipment and sampling processes are producing defensibly accurate results.

The materials officials said the first ISO audit documented that they had a good operation, which they always had known. However, it revealed to them that they have failed to systematically document their practices, ensure they learned from their continuous improvement, and ensure that all employees and stakeholders could find documentation that the materials operation was performing up to its own high standards. They learned, they said, that they had good controls but little that described and documented those controls.

The ISO findings led to process improvements throughout the operation, including into areas that may be considered routine, such as the filing system. The filing system must have a quality-assurance process, which includes proper training of all staff in its use. A complaint-resolution process must be in place and include documentation of how the staff is trained to

handle complaints, and documentation that complaints were handled in the appropriate fashion.

The overall Quality System adopts an overarching framework for the high-performing operation of the work unit. Then, the system must include evaluation of the workers’ knowledge of the Quality System and it includes evaluation that they are following the Quality System.

The materials office staff said the ISO process made them much more aware of the need for systematic training of their personnel. They noted that many of their personnel are hired out of high school or the military and do not have college degrees. The employees had always received training but the training has since become more serious and much better documented. They said once they were required to document their training process, they naturally became more cognizant of its shortcomings. The ISO certification process caused them to realize they needed more complete training manuals, and a process to refresh and re-certify employees’ training every three years.

The emphasis upon training and re-certifying their employees caused them to re-think the training required of the consultants and contract testing personnel. That re-focus led them to extend the re-certification to their consultant and contractor testing laboratories as well.

An overall emphasis on root-cause analysis of any negative trend is now pronounced in their operations, the staff reported. When they see a trend in customer complaints, or declining test results, it will trigger an analysis of the underlying cause, and potential corrective action. They used to be more casual about the proficiency samples necessary for the AMRL certification. Now, when they submit test samples which do not pass they are insistent upon analyzing the cause of the failure and identifying what needs to change in their processes to ensure the failure does not occur again.

The focus upon the Central Office materials operation then led to cascading improvements for the district and regional testing operations as well. Although the central office materials office in Gainesville is the only Florida DOT materials laboratory which is ISO

certified, the Quality System was extended to all of the testing operations. The central office staff perform quality audits of the district facilities which focus not only on the testing and acceptance processes but on other important areas such as purchasing, public communication and customer satisfaction. A customer

satisfaction survey is run continuously through a web-based survey and the results are used to improve performance.

Missouri DOT Performance Management Case Study

The Missouri Department of Transportation case study represents an insightful illustration of the contrasting yet complementary nature of Asset Management and Performance Management. As Congress and states consider adopting a Performance Management framework, the experience in Missouri illustrates important lessons which must be considered to preserve the full benefits of Asset Management while instilling Performance Management into the national and state transportation programs.

The Missouri DOT (MoDOT) has strongly embraced Performance Management, which is defined as *"an on-going process which translates strategic goals into relevant and detailed measures which are then tracked to ensure uniform achievement of institutional goals. Performance Management Systems include an "institutional learning" function in which the agency analyses the root cause of failure or success to achieve the performance targets, and disseminates the lessons of that analysis to perpetuate continuous improvement."*

In Performance Management Systems in Missouri and many other organizations, a great emphasis is placed upon achieving performance targets. In MoDOT, the senior executives hold themselves and their subordinates strictly accountable for achieving the agency's performance targets, including targets regarding the sustaining of highway infrastructure conditions.

The MoDOT experience illustrates that Performance Management can focus an agency, significantly improve performance and improve current infrastructure conditions. The percentage of major Missouri highways that are rated in good condition rose from 47 percent in 2004 to 83 percent at the end of 2008, according to the Missouri DOT "Tracker" report. This particular indicator considers both smoothness and cracking as components of the

measure. Likewise, the percentage of signs that met visibility goals rose from 70 percent on the major routes to 92 percent, while the percentage of acceptable pavement markings remained high, in excess of 93 percent between 2005 and 2008. Other MoDOT performance metrics drove substantial reductions in crashes as seen in Figure 21, improvement in on-time project completion, and adherence to project budgets. In all, the MoDOT "Tracker" records 115 performance metrics which provide a comprehensive and continuous assessment of the agency's performance. Included among those measures are numerous ones which illustrate the condition of the agency's bridges, pavements,

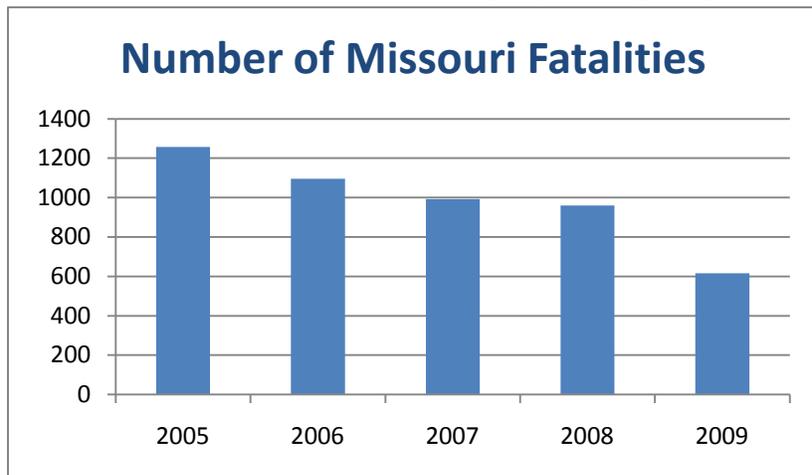


Figure 20 Missouri DOT has used its performance management system to focus on key indicators, such as fatal crashes.

maintenance appurtenances, fleet, buildings and other assets commonly addressed in Asset Management frameworks.

MoDOT officials emphatically support Asset Management and believe it is closely related to Performance Management - a sentiment echoed in nearly all of the case studies. MoDOT officials, however, don't use the term "Asset Management," nor do they have an Asset Management unit within the department. They believe that by measuring key elements of long-term sustainability of their highway assets that they achieve the same ends as Asset Management, only using different terminology.

Complementary Systems

The nuances between the two management frameworks represent much more than just a parsing of definitions or a debate over management system taxonomy. A failure to understand the differences can lead to missed opportunities to sustain asset conditions over the long term. If the adoption of Performance Management leads to an emphasis *only* on meeting short-term highway system condition targets, a significant benefit of Asset Management could be lost. For instance, if performance metrics focus only on short-term pavement ride quality, then the long-term, lowest-lifecycle cost strategies inherent in Pavement Management may not be recognized.

However, without a Performance Management system, an agency may not have a systematic and comprehensive management framework for other transportation agency functions beyond sustaining physical asset conditions. Functions such as on-time transit service, the satisfaction of customers while interacting with the transportation agency, the promptness of project completion or the reduction in workforce injuries are all critical transportation agency functions that can be addressed by Performance Management, but which do not fall easily within the umbrella of Asset Management.

The addressing of both Performance Management and Asset Management has been recognized as being so entwined that AASHTO seeks a close relationship between its new Standing Committee on Performance Management and its long-established Subcommittee on Asset Management. It has the chairman of the Subcommittee on Asset Management serve as the vice chair of the Standing Committee on Performance Management so that the two important management frameworks are considered in unison.

In a recent international transportation scan, "*Linking Transportation Performance and Accountability*,"¹⁵ it

¹⁵ An as yet unpublished report to be produced by the Federal Highway Administration, AASHTO and NCHRP. Advanced copies were released in limited quantities at the 2010 Transportation Research Board Annual Meeting.

was found among leading international practitioners of Performance Management that a strong focus on Asset Management operated in parallel. For instance, in the Swedish Road Authority, the highway agency strongly embraces Asset Management and adopts Asset Management policies and strategies to consider the lowest overall lifecycle strategies for managing its highway assets. However, it also operates a parallel Balanced Scorecard performance management system to address important issues such as Greenhouse Gas Emission reductions, gender equality, agency operational efficiencies, on-time project delivery and customer responsiveness.¹⁶

In the New South Wales Road and Traffic Authority in Sydney, Australia, the agency adopts a 10 year Transportation Asset Management strategy which is operated in parallel with the three year Performance Management strategy called the Results and Services Plan. The intention is to keep the shorter-term political budgeting process appropriately apprised of long-term highway asset management needs. The syncing of the budget process and the Asset Management plan has served to clearly illustrate long-term asset needs as part of the short-term budgeting and performance cycle in Sydney.¹⁷

In Queensland, Australia, the Queensland Department of Transport and Main Roads also operates a sophisticated Asset Management framework in parallel with a Performance Management framework. It adopts a Performance Management approach through a three year Service Delivery Statement which is similar to a Strategic Plan or Business Plan which states which performance targets it seeks to achieve in the short term. It then provides quarterly reports, similar to the MoDOT Tracker, which inform legislators, the ministry and the public as to how it is performing.

¹⁶ Interviews with SRA officials as part of the "Linking Transportation Performance and Accountability Scan."

¹⁷ New South Wales Government Asset Management Committee documents accessed at <http://www.gamc.nsw.gov.au/tam/> and interviews with NSW RTA officials.

Included among these short-term metrics are long-term Asset Management metrics, such as the amount of preventive maintenance that occurs. Also, employees are evaluated by their adherence to the agency's well-defined Asset Management procedures, manuals and quality assurance processes.¹⁸

Missouri officials say that the key elements of Asset

pursued a "worst-first" strategy to achieve their short-term pavement performance targets and that sustaining their long-term conditions is problematic. However, they point out that they address long-term sustainability by placing performance targets upon important long-term metrics such as the adequacy of their preventive maintenance program and whether their multi-year forecasts of future pavement

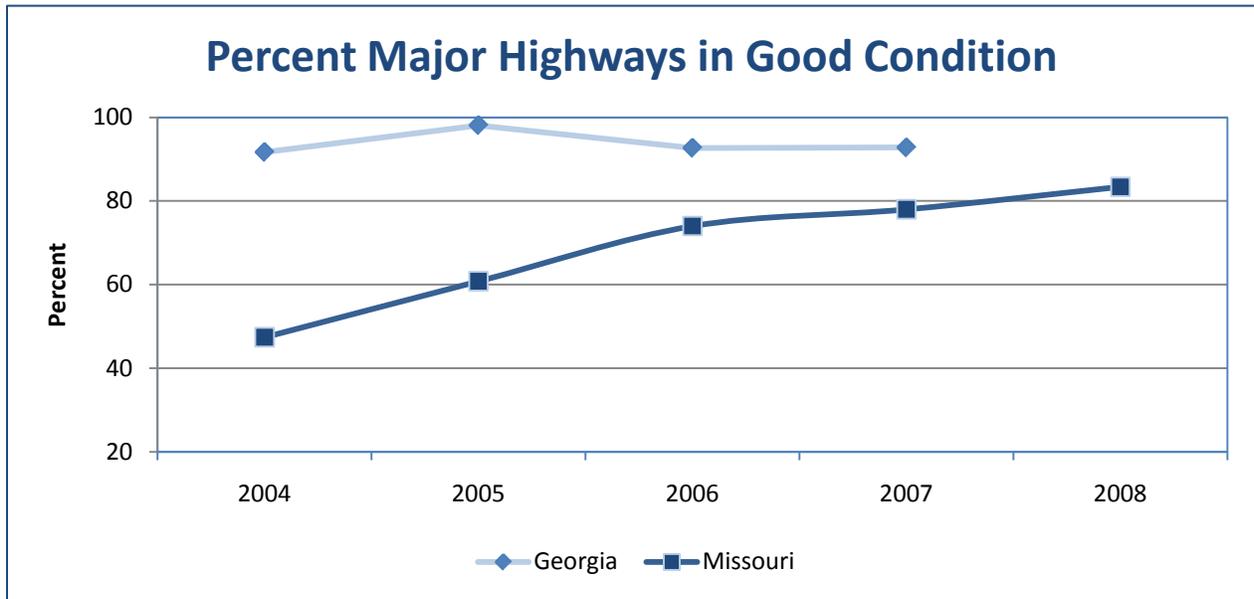


Figure 21 MoDOT has made substantial progress on pavement conditions on major routes.

Management are included in their Performance Management system. Their decision process includes elements of forecasting for the long-term, making strategic tradeoffs in investing limited resources and of using a mix of preventive, reactive, rehabilitative and replacement treatments. However, two unavoidable realities diminish their latitude in investing more resources in long-term rehabilitative treatments which could assure higher system conditions in the future. First, MoDOT officials are responding to strong public insistence that poor ride quality be improved quickly. Secondly, a lack of money limits their ability to afford more pavement rehabilitation and replacement projects.

The Missouri officials acknowledge they have often

conditions indicate that they will sustain their pavement targets into the future with their current pavement programs. They also provide mechanisms for their program managers to seek the highest overall rate of return by making informed investment tradeoffs between asset classes and treatment strategies based on which investments provide them the highest rate of return while also meeting performance goals. The Missouri officials agree that a simplistic focus upon only short-term pavement or bridge conditions may lead a department to adopt only resurfacing strategies and under-invest in long-term preventive maintenance, pavement rehabilitation or pavement replacement treatments. They note that any agency seeking to emulate their performance management approach needs to consider not only adopting performance targets for short-term system conditions but also must adopt targets which ensure that the long-term, lowest-cost strategies are considered.

¹⁸ Part 13, Queensland Treasury, Department of Transport and Main Roads, Summary of Departmental Portfolio Budgets, 2008, in the Service Delivery Statement and interviews with QDTMR officials.

MoDOT's Story - Changing a Culture to Embrace Accountability

It is apparent that Missouri's adoption of Performance Management has significantly improved performance in the department and improved the current condition of highway assets. Its experience is recounted here because it represents a pronounced example not only of Performance Management but also of a leadership team which transformed agency functions by using many of the Change Management, Organizational Communication and Organizational Theory strategies cited throughout this report.

Missouri DOT Director Pete Rahn is an ardent advocate of performance management, serving as chair of the AASHTO Standing Committee on Performance Management. He said Asset Management and Performance Management are closely linked and he believes it would be difficult for an agency to embrace Asset Management without incorporating some aspects of Performance Management such as the setting of targets and the analysis of results such as the pavement condition results in Figure 21 above. Performance Management emphasizes the type of data analysis, focus upon outcomes and continuous improvement that are essential to Asset Management, he said.

Director Rahn said several years ago when he went to his first Asset Management presentation it struck him that Asset Management complements the Performance Management framework that he instituted, both formerly at the New Mexico DOT and later at the Missouri DOT. The same logic of goal setting and continuous improvement which Asset Management applies to roadway assets was also applied to all DOT functions under Performance Management. He said once he understood what was meant by Asset Management, he knew his department's Performance Management process would naturally lead it to adopt many sound Asset Management practices.

The Missouri DOT Performance Management system sets clear goals for the condition of the highway system. Standards are set for the condition of pavements, bridges, roadside features, and traffic and

signage components. MoDOT officials try to ensure long-term highway network sustainability by not only meeting current condition standards, but by reviewing how today's treatments will affect network conditions in the future. By focusing upon keeping both current and forecasted highway network conditions meeting target, the long-term sustainability of asset conditions becomes an inherent part of the department's Performance Management culture.

Added to the focus upon sustaining satisfactory conditions over an extended planning horizon is the need to innovate. Districts are given finite budgets, which incentivize them to find cost savings and innovations. As a result, the districts themselves benefit when they find low-cost treatments, when they use preventive maintenance or when they innovate with new technologies such as cold mix resurfacing. The Missouri DOT officials say the combination of focusing upon assets' current conditions, forecasting their future conditions, and maximizing resources, naturally leads the staff to an "optimization" approach. The staff is attempting to invest limited resources into the programs, and mix of treatments, that will give them the highest return over time.

Many advocates for Asset Management have struggled to achieve institutional "buy in" for the Asset Management approach. They have noted that organizations and cultures are slow to change. The Missouri officials said that getting acceptance of Performance Management was helped when the leadership of the organization insisted upon a Performance Management approach that extends to all aspects of its operations. Director Rahn said he learned from his initial experience in New Mexico that a top-down approach will achieve results but it will take longer to convince the middle management to embrace a new direction, such as Performance Management. When he became the Missouri director, he intentionally engaged the middle managers in order to gain their strong commitment to and acceptance of a management system approach.

Tracking Performance

The heart of the Missouri DOT Performance Management system is accountability. The agency's Tracker is prominently displayed on its website, it is

widely used internally to ensure accountability, it explains the department's priorities and it is the focus of quarterly management meetings in which all managers are held accountable to explain their performance. The Tracker has 111 core measures, with four additional ones recently added to track expenditure of funds from the American Recovery and Reinvestment Act. (ARRA) It reports 19 categories of measures, including areas such as traffic flow, pavement and bridge condition, safety, roadway visibility, customer response, adopting innovations, project delivery, access to modal choice, value for money and attractive roadsides.

Performance Management has "teeth" in Missouri because the degree of accountability is so high, say members of the Missouri DOT staff. One agency veteran said the high degree of accountability has inculcated the management team with the understanding that asset condition goals are very important. Another official in the department said that since Director Rahn instituted Performance Management, no MoDOT district has had a decrease in highway asset conditions. If asset condition goals are not met, district officials are called in to explain their performance, "and that is a very serious thing."

Director Rahn said the emphasis on accountability has led to the demotion and removal of officials who did not achieve the performance goals. He said it is not enough for senior leaders to espouse good management but then to take no action when system condition goals are not met. Performance Management embodies the Plan, Act and Implement steps of basic quality management, he said. If the leadership does not act upon analysis which shows that targets are not met, then it weakens the Plan, Act and Implement process, he said.

The quarterly tracker meetings are high-profile, widely attended meetings in which managers know they will have to stand in front of their boss and their peers to explain their performance. The Tracker reports composite, statewide measures. However, other tracking reports disaggregate the performance data down to the front line operations of the department. Director Rahn and other officials said as they travel the state they find widespread awareness of the Tracker, and upon the Performance Management

System of the department. Concurrently, that creates a complementary awareness of the need to achieve all of its targets, including the long-term performance of the department's highway assets.

The Missouri DOT does not use the term "Asset Management" frequently with its staff, front-line workers or the public. However, it constantly reinforces the need for the department to achieve highway condition goals and to adopt sound infrastructure management practices. The department's management approach requires its staff to analyze system performance data, to forecast conditions, to evaluate tradeoffs, to achieve short-term system condition goals, to prepare plans to achieve long-term system conditions and then to act upon these plans by executing the projects which they include. The performance goals for Preventive Maintenance are an example of how Asset Management practices are ingrained in the Performance Management system, said Director Rahn. The delivery of preventive maintenance projects does little to achieve short-term improvement in the department's pavement-condition metrics. Because preventive maintenance treatments are applied to relatively good pavements, the miles of pavements which meet current ride-quality targets do not change significantly with preventive maintenance treatments. But the department realizes that preventive maintenance is essential for long-term system performance, so it requires the districts to meet Preventive Maintenance targets.

The department's approach is to communicate sound infrastructure practices into practical, everyday language. Its leadership talks about "keeping good roads good" or "keeping good bridges good."

"We had to think that we do more than just patch potholes....Once we got the (highway) system turned around, our problem is you can't keep a good road good with a shovel and a dump truck full of cold mix. You have to change your process, your mindset," said Director Rahn. "It became pretty clear that if we are going to preserve the value of our of long-term investment in bridge maintenance, we have to make (preventive maintenance) investments today. To make an investment that we won't see the benefit of for 40 years, is the right thing to do."

He cautioned other directors to not be deterred by a lack of complete data to support their Performance Management transition. When it comes to data, data improves through its use, he said. The best way to improve bad data is to start using it, and then the users naturally want to improve its quality. “It’s the old Nike saying, ‘Just do it.’” He said officials also should not be deterred because they fear they cannot identify the perfect metrics. “Beyond the common sense ones, the measures will either mature or be discarded and others will replace them. It should be a process to provide you with your needs for today.”

Once the CEO takes the lead on the Performance Management process, a natural progression begins in which the performance measures are refined, the data for them improves, performance goals are met, and the department team evaluates how they can re-calibrate the measures and targets for even better performance in the next cycle, he said.

One of the long-time department veterans said he had seen several unsuccessful attempts during his career at the Missouri DOT to install performance management practices. “The difference is now we meet quarterly in our tracking meeting. And now our Director, Pete Rahn, uses those for accountability. If someone is lagging behind he wants to know what you intend to do to fix it. ...It has had a profound effect on our operation that permeates down to the local (maintenance) sheds. ”

Keeping It Simple

The most important improvements come as a result of common-sense, obvious goals, Director Rahn said. In Missouri, as in most states, 80 percent of the vehicle miles of travel occur on the higher functional classes of roads. In Missouri, that equates to 5500 miles of what they have categorized as Major highways. On those roads, the department focused upon basic performance such as pavement conditions, roadside conditions, signage and pavement markings, bridge conditions, and the numbers of crashes. By addressing those core conditions on the major functional classes, overall system performance for the typical roadway user has improved demonstrably.

Missouri also has experienced significant safety

benefits, including a 25 percent reduction in lane departure crashes between 2005-2007. During that period it installed safety items such as rumble strips and cable median barrier, but it also improved sign and pavement marking reflectivity, improved shoulder conditions and improved pavement friction, which are believed to have contributed positively to the crash reductions.

Although the Missouri DOT relies heavily on fact-based decision making, it has not invested heavily in complex, expensive or sophisticated computerized management systems. It has relied upon its roadway asset inventories, its legacy pavement management system and its bridge inventory. It has not depended upon complex network optimization programs such as HERS-ST. Instead, it leaves investment optimization decisions up to its district decision makers who use data, forecasts and their own judgment to achieve the highest rate of return with their investment decisions. By arming those decision makers with clear short-term and long-term asset condition goals, by giving them flexibility in making tradeoffs, but holding them accountable for results, those officials have been compelled to make optimum use of their resources, say Missouri DOT officials.

The Missouri management structure relies on people called “Result Drivers” and “Measurement Drivers.” The Result Drivers are ultimately accountable for achieving the department’s targets. Those targets and Result Drivers are scaled throughout the department, with one ultimate Result Driver for a category of measures statewide, with corresponding district Result Drivers responsible for the results within their districts. The “Measurement Drivers” are responsible for measuring, tracking and reporting the on-going results.

Jay Bledsoe is a Missouri DOT Systems Analysis Engineer, but also is the designated Measurement Driver for the Smooth and Unrestricted Roads and Bridge category of MoDOT measures and targets. He and other MoDOT managers said the department’s pavement management process is simpler than many states', but it is highly focused on outcomes. While they may conduct less analysis than some states, they believe they are clearly focused on achieving measurable outcomes in terms of pavement conditions

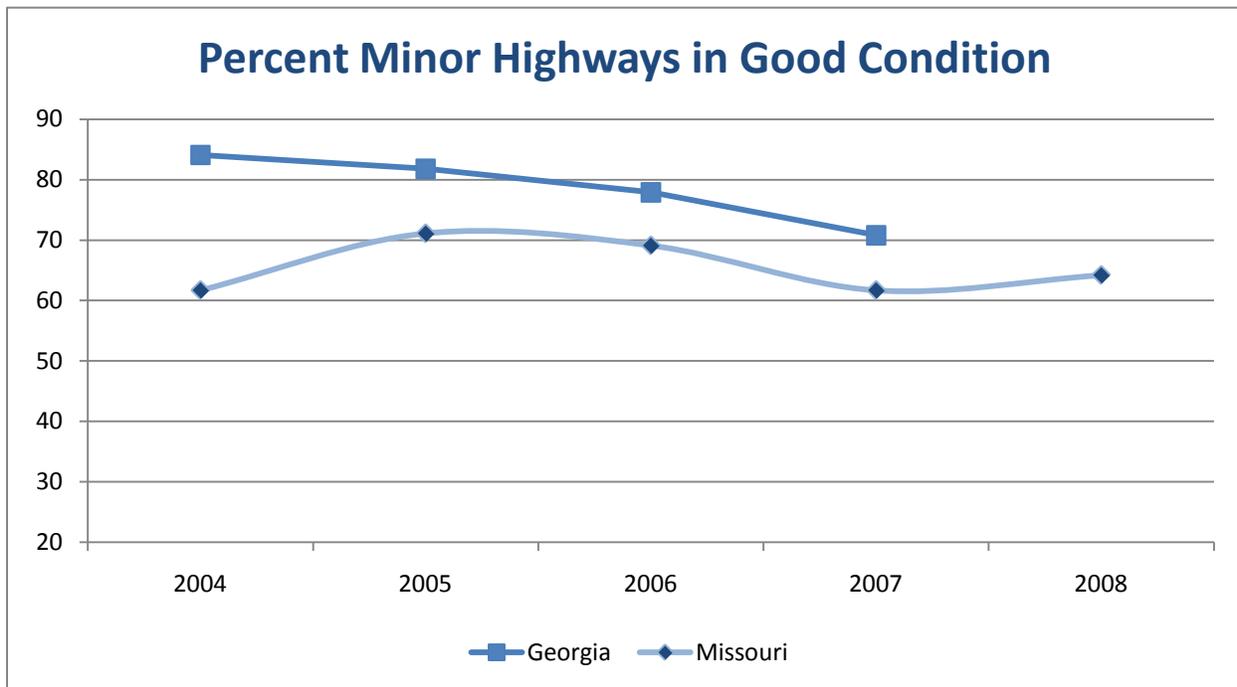


Figure 22 Limited resources compelled Missouri to make the difficult tradeoff of accepting lower conditions on the minor highways in order to increase investment in the major ones. MoDOT benchmarks its conditions against Georgia's.

and pavement performance.

They collect pavement data in two ARAN vehicles and record IRI and cracking distresses. The data is available to the districts both at the network and at 100 foot pavement section level. The data is given to the districts, as are budgets. Budgets are based on asset size, such as the number of lane miles and the size of a district's bridge inventory. Districts can choose on any given year how to invest their funds between asset classes. They also can retain any savings they achieve, roll them into future years and re-invest them into additional projects, or maintenance treatments. Overriding all of the district decision making is the need to achieve the department's system-condition goals.

The goal is to get 85 percent of the Major highways into "good condition" and then to keep them at that level indefinitely. As of the end of 2008, 83.4 percent of Missouri's Major highways met the Good target. The department forecasts that by 2011, it will achieve the 85 percent goal.

Despite its lack of a complex pavement management system, the department forecasts its future system

conditions. It requires the districts to develop multi-year programs of projects. These projects are then entered into a pavement relational data base. The system improvement contribution of the projects are forecast, as is the degradation of all the pavement sections which are not treated. The net change in system condition then determines whether the program of projects will achieve the desired pavement condition targets. From that point, the Tracker measures the districts as to whether they actually deliver the projects which are essential to achieving the system conditions. On an annual basis, the ARAN vehicles re-inspect the highway pavements and provides "field proofing" that the forecasted system conditions are achieved each year. The result of the overall pavement process is to replicate the Plan, Implement, Evaluate process which is fundamental to any quality-improvement cycle.

Resource Optimization

One of the objectives of Asset Management is to seek the overall highest rate of return by making informed investment tradeoffs between asset classes, and between treatment types within asset classes. These

resource analyses - or optimization exercises - can be conducted with sophisticated computer programs or through more manual and informal decision-making processes. At MoDOT, although computerized optimization analysis does not occur, practical district-level optimization decisions occur routinely, say the Missouri officials. Districts which were well below the 85 percent "good" pavement condition goals were investing primarily in short-term treatments in order to achieve their system condition targets. Once they had reached their targets, they could devote more of their budgets to preventive maintenance or to pavement rehabilitation projects to maximize their long-term, forecasted conditions. Districts which could sustain their good conditions with lower-cost preventive maintenance treatments could use any savings to invest in bridges or other assets which were below desired condition targets. The MoDOT process allows managers to move money from one class of assets which has reached its target condition to another which hasn't to achieve the highest overall system condition with the available resources. As seen in Figure 22 above, they also have prioritized between high and low-volume routes to put resources into routes which serve the most people. They have made the painful decision to accept lower conditions on minor routes to sustain conditions on the major ones. Therefore, after increasing conditions on minor routes from approximately 62 percent "good" to 71 percent "good" they intentionally transferred funds to major routes, allowing the minor routes to decline in condition.

Missouri officials are open about acknowledging that their focus of recent years on short-term pavement smoothness may not be the lowest-cost long-term treatment regime. They have consciously deferred more expensive long-term pavement rehabilitation and replacement projects in lieu of resurfacings. Their strategy was to demonstrate to the public that the department recognized customer complaints that ride quality was poor. The department strategy was to demonstrate significant short-term improvements, while concurrently opening a discussion of the state's need to invest more resources in pavement replacement and rehabilitation. They believed that without first demonstrating concern for the public, demonstrating results and demonstrating the department's ability to improve the system that they

could not convince a skeptical public to increase investment in transportation. The department leadership is publicly discussing at many opportunities the department's need for resources to reconstruct the critical but aging I-70 across Missouri, as well as to rehabilitate other major routes.

The Role of Maintenance

The activities of maintenance forces are an important component of the Missouri strategy to sustain asset conditions. Because of the need to focus capital funds disproportionately on the higher functional classes, maintenance personnel are relied upon to make a significant contribution to conditions on the local routes under Missouri's jurisdiction. In the State of Missouri, the DOT has jurisdiction over local roads, except those within municipalities. The 27,000 low-volume miles of road in Missouri carry only 17 percent of the state's traffic.

The pavement forces have been called upon to sustain conditions on the low-volume local routes by using full-depth pavement repairs, performing long patches to improve deficiencies such as edge cracking and to perform chip seals on structurally sound roads. The active efforts of maintenance forces are considered to be an important component of the state's preservation program.

MoDOT Director of System Management Don Hillis is the Results Driver for several maintenance and safety items, including numbers of crashes but also for safety-related highway attributes, such as pavement marking and sign reflectivity. He said the Performance Management approach has fundamentally changed the way MoDOT officials think about the contribution of maintenance. In the past, they may have measured the miles of chip sealing or other outputs they performed. Now they are measuring results and outcomes, such as whether they have achieved their overall network pavement condition targets.

Although much of the maintenance work is reactive, well-trained maintenance forces who perform high-quality work can be viewed as contributing to long-term asset condition goals, the Missouri officials said. Maintenance efforts such as the sustaining of adequate

drainage, the application of high-performing chip seals, and the proper placement of full-depth pavement repairs all can improve the longevity of a pavement. Culverts tend to be “out of sight, and out of mind.” In Missouri, they instituted a “culvert storm” in which crews statewide focused intensively on their culverts to quickly improve their overall condition. Crews removed obstructions, cleared vegetation, and improved wing walls and toe walls. Those maintenance activities will improve the drainage performance of the culverts and may also improve long-term pavement performance by reducing the opportunity for standing water to saturate roadway bases.

Proper training, combined with a renewed understanding of the importance of maintenance to long-term condition performance is important to capitalizing on the contribution of maintenance forces to sustain asset conditions over the long-term.

Mr. Hillis said the focus on long-term performance led to a change in mindset among maintenance forces. The old mindset was to perform maintenance as quickly and cheaply as possible. The new mindset is to invest more effort initially into a maintenance task such as pavement repairs in order to get a better, long-term performance from the activity.

Practical, understandable emphasis upon good Asset Management tactics at the maintenance level is more important than discussions of Asset Management philosophies, Mr. Hillis agreed. Practical asset management training at the maintenance level involves training in sound applications of chip seals, or full-depth pavement repairs or in performing sound drainage maintenance. Those maintenance activities are practical, understandable and meaningful to maintenance crews, but they also contribute to sound highway asset performance.

Increased Efficiencies as an Investment Strategy

In all of the Missouri DOT interviews, the officials indicated that finding increased efficiencies and cost savings is considered to be a significant strategy for improving and sustaining roadway conditions. Savings and efficiencies allow for more treatments to

be performed, further improving conditions. The tracking of costs encourages the application of new innovations. Mr. Hillis said a renewed emphasis on the cost accounting process among the maintenance activities provides additional insight into how maintenance crews can maximize limited resources. He noted that one district re-engineered its mowing process and was able to eliminate half of its mowers, while still achieving its mowing targets. The district personnel have started to systematically measure the costs of their 10 most common maintenance activities to provide a baseline for continuous improvement.

He said that achieving system condition targets alone is not enough. Finding ways to achieve the targets with increasingly greater efficiency is the ultimate objective of MoDOT. To that end, the department is increasing the focus upon its cost accounting system, he indicated.

Lessons Learned from MoDOT

The MoDOT experience illustrates that Performance Management can focus an agency, significantly improve performance and improve current infrastructure conditions.

The nuances between Asset Management and Performance Management represent much more than just a parsing of definitions or a debate over management system taxonomy. A failure to understand the differences can lead to missed opportunities to sustain asset conditions over the long term.

Missouri officials say that an agency needs to consider not only adopting performance targets for short-term system conditions but also must adopt targets which ensure that the long-term, lowest-cost strategies are considered.

The Missouri officials said that getting acceptance of Performance Management was helped when the leadership of the organization insisted upon a Performance Management approach that extends to all aspects of its operations.

Performance Management has “teeth” in Missouri because the degree of accountability is so high.

Finding increased efficiencies and cost savings is considered to be a significant strategy for improving and sustaining roadway conditions.

Don't be deterred by a lack of complete data to support the transition to Performance Management. When it comes to data, data improves through its use.



In conclusion, asset management has been shown to be an adaptable system which has assisted transportation agencies around the world. Its use provides agencies with a proven framework for defensible decision making.

Chapter 6 Summary and Conclusions

Asset Management principles have long been recognized as a means to sustain highway conditions over time for the lowest lifecycle cost. However, Asset Management also can be considered as the primary process by which sound, long-term performance metrics can be produced for a transportation agency. In an era of accountability, Asset Management practices can produce an abundance of sound performance metrics which not only satisfy short term reporting requirements but which also ensure that the long-term performance of highway assets are properly considered.

The increasing focus upon accountability in transportation programs is based in large part upon a growing need to demonstrate responsibility. Public agencies are under increasing pressure from skeptical taxpayers, legislators and the media to demonstrate they are acting responsibly with public resources. The achievement of performance targets is viewed as evidence that the agency is responsibly using its limited resources to achieve performance which serves the public.

However, more than 20 years of study of performance measurement has repeatedly illustrated that achieving

performance targets alone does not guarantee that an organization is making the best long-term decisions. Management frameworks such as the Balanced Scorecard, Six Sigma, Baldrige, ISO and Total Quality Management have arisen to provide a more holistic framework for examining an organization's processes. The adoption of these frameworks has been widely accepted as a representation of the agency's commitment to act responsibly toward its customers, to maximize the resources of its stakeholders and to ensure its long-term viability in a constantly changing business environment.

Asset Management can provide for a transportation agency the same framework of long-term viability and continuous improvement that these other quality frameworks provide for Fortune 500 companies and leading public sector agencies. Asset Management practices provide more assurance of accountability and responsibility than does merely the achievement of short-term targets. Achieving short-term targets alone does not guarantee long-term sustainability. However, when an agency selects its performance targets from among the critically important components of Asset Management processes, then the agency is far more likely to be measuring performance which will ensure

long-term sustainability of its highway networks.

The Australian states of Queensland, New South Wales and Victoria have been the subject of several international case studies of sound practices in both measuring performance and in managing highway assets. The transportation agencies in these states widely use performance metrics to illustrate the responsibility and accountability with which they undertake their stewardship of the highway networks. However, they select their performance metrics from their Asset Management analyses to ensure that what they measure will lead to the responsible management of the highway network. For instance, they measure activities such as their achievement of rational preventive maintenance programs or their delivery of well-planned pavement rehabilitation regimes. By measuring preventive maintenance and pavement rehabilitation programs they are measuring activities which will sustain their highway systems over time, not only in the short term.

In fact, these agencies could not have a responsible performance *measurement* system if they did not first have a responsible Asset Management system which identified the strategies and treatments which will sustain their networks into the future.

Another illustration of the use of Asset Management as a system to ensure accountability and responsibility lies in the contract provisions of the long-term, multi-billion dollar Public Private Partnership projects which are used in Great Britain and in Australia. These contracts are intended to ensure the continued, reliable sustaining of highway assets on these facilities for up to 40 years. Their long experience with writing PPP contracts has led the Australians and the British to achieve long-term accountability not through a proliferation of many performance targets but rather through the adoption of long-term Asset Management practices. Their contracts for the long-term sustainability of these expensive PPP projects rely upon adoption of audited, certified Asset Management systems to ensure that the highway facilities will be in sound and sustainable condition for decades to come.

Similar best practices in the selection of performance metrics can be found in the domestic case studies of transportation agencies which were documented in this

report. Agencies which adopt a long-term, Asset Management process first appear to identify the appropriate performance metrics which can lead to the on-going, lowest life-cycle cost performance of their highway network over time. Measuring activities which ensure long-term highway network performance are more likely to occur in an Asset Management environment than outside of one.

This report also illustrated how in an era of increasing accountability, highway agency officials can develop the systems, the processes and the attitudes to demonstrate the soundness of their short-term and their long-term highway asset strategies. Institutional inertia is one of the first issues that change agents face when they attempt to institute improvements within a large agency. Tactics borrowed from Organizational Communication, Organizational Theory and Change Management are manifested throughout the case studies of successful agencies represented in this report. By adopting these change-management tactics, an agency leader can increase the chances of success when deploying Asset Management principles into an agency.

Asset Management can be the framework for satisfying several mission-critical needs. First, it can provide an organization a long-term rational framework for making its infrastructure management decisions. Second, it can be a template that dispersed and far-flung agency staff can use to make repeated, and on-going day-to-day decisions about how to responsibly treat the assets under their jurisdiction. Third, Asset Management can be a framework for programmatic decision making which allows high-level executives to make rational tradeoffs in investments between classes of highway assets. Fourth - and perhaps of growing importance - Asset Management practices can provide highway executives with a defensible, long-term set of metrics with which to demonstrate that their organizations are accountable, responsible and seek to be sustainable. An unavoidable lack of resources may threaten the long-term sustainability of asset conditions, but with an Asset Management process in place the highway executive can demonstrate the limited resources are being invested within a rational, thoughtful and fact-based framework.

Maryland State Highway Administration

The final case study is of the Maryland State Highway Administration. Its experience illustrates the evolution of an Asset Management approach from earlier efforts to use the Baldrige and performance management processes to improve its highway operations. The experience of the Maryland SHA embodies many of the change-management and organizational-change examples illustrated throughout this report. It also illustrates the on-going and evolutionary change that many agencies experience when they transition to an asset management approach.

Maryland State Highway Agency Case Study

Like other agencies moving their business practices to asset management, the Maryland State Highway Administration (SHA) has experienced a process of symbiotic growth and development in performance management and asset management. Its initial efforts focused on establishing a performance management culture and using the Baldrige framework for internal performance measurement and business planning. The integration of asset management arose from the agency's belief that asset management is part of the larger performance management approach; in essence, performance expectations define the level of effort required to preserve the transportation assets. Because the agency's efforts began with the role of people, its focus on information technology in support of Asset Management has been more recent.

Leadership initiated the performance management effort by identifying vital performance areas and working with key individuals to establish goals for each asset category. Defining these goals and associated targets and measurements demonstrated leadership's intention to be accountable and to clearly communicate expectations of the entire staff. The agency intends for performance management and objectives to be used at all levels of the organization to ensure that a mechanism exists for concrete performance measurement and feedback. Currently, the top three levels of management have performance management plans; these are used as the basis for performance evaluation.

As performance management grew, SHA began developing asset management practices that will allow for effective trade-off decisions within and across asset types. The pavement program, and to a lesser extent, the bridge program have management systems in place. However the agency has many organizational silos and is still working toward integrating data across organizational stovepipes.

Although performance and asset management are still evolving at the Maryland SHA, the agency has already realized an important benefit: Legislative trust in SHA's approach to decision making has resulted in increased funding for system preservation.

Pavement Performance and the Organization

Pavement management and its organizational effectiveness have been the agency's primary focus areas because the level of investment in pavement is by far the largest amount of money disbursed under SHA: System preservation amounts to over half a billion dollars annually. Pavement management began in the mid 1980s with tracking of pavement performance. Substantial progress has been made in this area since then, including deterioration models that can produce projections with some level of confidence. The tool they have developed for determining return on investment (ROI) is considered one of the more advanced in the country, and is driven by where pavement treatments produce the best ROI.

Pavement management is currently separate from planning, project development, construction, maintenance, and information technology; however, some coordination is necessary for funding allocation. Planning manages the funding allocation process and sets the overall allocation for pavements, but district pavement specialists decide how pavement funding will be spent.

The maturity of the pavement management program in SHA's case demonstrates what works well for an aspect of asset management and can also highlight areas that need additional support. At SHA, this process has resulted in a continuous improvement in performance and asset management practices that the agency believes will keep expanding its ability to communicate funding needs and the impact of insufficient funding on transportation assets to the legislature and the public.

High-level transportation policy goals are presented in the Maryland Transportation Plan (MTP.) Each mode is then responsible for forming its own strategic plan to support these policies. The SHA sets the targets for statewide preservation and maintenance; these targets are incorporated into the business plan. For example, the target for pavement is at least 84 percent in

acceptable condition, with acceptable defined as IRI 170 inches per mile or smoother (whether the road is interstate or local roadway.) Cracking and rutting are not yet taken into account. The target of 84 percent was selected based on a public survey conducted in 2001-2002, which indicated people were happy with the level at that time. SHA is now above the target.

Based on the system preservation plan, each district gets lane-mile and benefit targets and a budget from the Central Office. Benefit targets are calculated based on the fundamental principle that a long-term fix must show more benefit than a short-term fix given current condition, traffic factors, and the pavement performance curve. The districts also receive suggested projects that will help them attain targets. These suggestions are generated by the Office of Materials Technology (OMT), which owns the PMS. OMT is currently acquiring data to substantiate the relationship between cost and outcome to support its suggestions and to offer options beyond overlays.

Allocations and Project Selection

One of the greatest challenges to achieving alignment in pavement management practices has been convincing district managers to accept data from the PMS rather than basing project selection on feedback from local politicians. To help build consensus, SHA adopted a strategy of combining staff experience and insight with reliable tools. The process begins with the SHA executives identifying strategic issues and soliciting input from senior managers for suggestions for solving problems. This approach encourages district engineers to take a global view of the state's transportation system rather than focusing solely on the needs of their district. Proposals from managers are always accepted, but they may be refined. The districts make the final determination of which projects go forward, with the only caveat being that the districts must meet the targets.

This approach gives Central Office responsibility for optimizing the overall system while districts use those guidelines to preserve the assets within their area. Money is allocated by fund based on the targets set in the business plan. Each fund has a fund manager who presents their needs case during an annual allocations meeting. Tradeoffs are considered in these meetings,

although in actual practice the allocations tend to be driven by historical patterns and a “worst first” approach. No formal tradeoff tools are used. Final decisions are made by the Administrator, Deputy Administrator, and Programming Manager and are based on an assessment of risk, funding gaps, and trends. The fund manager recommends allocations to each district. As explained above, this budget is then presented to the district, which makes decisions about how money will be spent.

Preventive maintenance is planned work, coming through the pavement management system recommendations, whereas reactive maintenance, such as crack sealing, is decided by districts. If reactive maintenance gets too costly, some districts may elevate the location to a project candidate, but there are no objective criteria for this and no policies that integrate this information into the formal decision making process.

SHA has discovered that district performance has been equalizing, so the allocations process appears to be working. However they are still considering improvements to their approach. For example, using a VMT-weighted objective function would help funnel additional funding to urban districts. An alternative scenario involves setting separate targets by functional class for pavement. This approach would incorporate VMT.

SHA staff feels the project selection process for pavement strikes the right balance between top-down and district selection, which facilitates buy in throughout the organization. Additionally they believe the customization of their PMS by strong internal people and consultants has contributed to the success of the system.

Performance Measures and Asset Management Results

Performance measures allow leadership to monitor whether selected projects are leading to the desired outcomes, thereby monitoring the effect of investment choices on overall progress toward goals. At SHA, the Chief Engineer monitors monthly expenditures and meets every two months with districts to ensure projects are on track to attain performance targets.

Progress is communicated through quarterly status reports that are released in association with the business plan, and through the statewide Annual Attainment report. A separate Annual System Preservation report focuses on pavements and is broken down by district. These reports provide tangible indication of what is or isn't working that can be used to modify strategies, targets, allocations, and performance measurement for future cycles.

The information also can be used to justify difficult funding decisions and to build a case for increased resources for the agency as a whole or for specific assets. During the annual fund review, for example, fund managers explain how funds are being used. The administrators review accomplishments, projected needs, and progress toward targets and goals and take this information into consideration when making future funding decisions. This process helps fund managers understand how their financial decisions relate to the business goals of the entire organization.

Information and Analysis

SHA has built its performance and asset management programs around the concept that goals and expectations must be clearly and visibly articulated. They have made significant headway in this through their agency-wide performance measures. Progress is communicated through the annual Attainment Report. For example, for the system preservation and performance goals, SHA set as a measure the percentage of the transportation network in overall preferred maintenance condition with the idea that this measure indicates how well management strategies and tactics are working to sustain existing roadways. By comparing this measure to prior years and reviewing the differences in conditions between years, they can determine what factors influenced changes in the metric.

The 2009 Attainment Report shows a drop in the percentage of the network in preferred condition between 2007 and the two prior years. Agency officials determined this drop resulted from, among other reasons, maintenance activities that had to be deferred due to budget cuts and increased costs and rising costs of litter removal. To respond to these issues, they set as future strategies a public awareness campaign

concerning litter problems and continued TAM efforts to link the budget to expected levels of service.

Decision support: People and Tools

To support decisions on which pavement sections need improvement, SHA uses an automated roadway analyzer, ARAN, to collect data on friction (skid truck), cracking, roughness, and rutting. This information is collected annually for roads at least one mile long. Pavement designers, districts and the chief engineer's office see the data, which is fed into the optimization system. This process generates the suggestions that are passed along to districts with targets and budgets. The process will also be used for long-term performance assessment of pavement performance and will eventually be used at the strategic level. A pavement life cycle cost analysis is performed for projects with at least \$50 million of pavement items to pick pavement type. This typically amounts to between two and six projects per year.

While this system has been working well, it is not without its issues. Recently the agency obtained a new ARAN, which caused the numbers to improve for reasons that had nothing to do with pavement condition. The new data is within the statistical variation of the prior level, but may have contributed to the agency being above its target for pavement condition. Additionally targets were changed two years ago, causing some confusion because legislative budget analysts usually compare year to year. A third factor influencing pavement condition assessment has been revenue from the stimulus funds, which is a situation that cannot be duplicated. For sound decisions, data collection, measures, conditions and models must all be consistent. These variables impact SHA's ability to make meaningful decisions from its pavement data.

SHA's PMS is primarily owned by the Pavement and Geotechnical Division, which is located within the Office of Materials Technology (OMT). The information is used by the districts (leadership for special projects and district maintenance), by designers, and by the Office of Traffic and Safety and districts seeking information on pavement friction.

The OMT runs optimizations based on targets and

available dollars. The state's pavement is categorized by pavement and road type, level of traffic, location, condition, and preservation history. The optimization assigns a level of treatment to a percentage of each pavement group, based on optimization runs over multiple years. The Chief Engineer's Office makes final decisions using one of the investment strategies output by the optimization as the basis for creating a system preservation plan. The plan may be modified at this juncture depending on agency resources.

OMT has developed pavement deterioration models that can make projections with some level of confidence. While this tool has helped with pavement management, the cost of ancillary improvements performed in conjunction with pavement resurfacing, such as drainage, sidewalks, and safety, skews the ROI calculations based on non-pavement costs. In addition, the system contains biases that the people interpreting the data need to keep in mind. For example, if the performance measure is based on lane miles in acceptable condition, the system bias will be toward rural areas since urban projects are more expensive.

Once the Central Office has delivered the budget, lane-mile and benefit targets, district engineers determine which roadways will be improved. The only stipulation is that districts must meet their targets. Selected projects are subjected to Chief Engineer approval (to ensure they are consistent with targets) and to benefit analysis. If the system shows benefit targets will not be reached, the districts are supposed to find alternative approaches.

SHA's approach to improving system preservation involved transforming their organization to a performance management culture. This process began at the top, with leadership understanding the importance of accountability to all stakeholders and that accountability is achieved by establishing and broadcasting goals, targets, and measures. Consensus was built by involving a team of senior managers in the development of these goals, targets, and measures. This buy in was critical to the long-range success since it will ensure commitment to long-term goals even in cases where district engineers receive lower funding than they would if they used the "squeaky wheel" approach. Additionally it set the stage for achieving alignment throughout the agency since it demonstrated

that leadership is unified on this approach.

This team identified the key performance measures, recognizing that system preservation is one of the fundamental responsibilities of any state DOT. They then established goals for each asset category and incorporated targets into the business plan. The need for integrating asset management was clear at this point, since asset management would ensure they had the right data to analyze various investment scenarios to determine how best to reach their goals.

Words of Wisdom

Be patient - educating employees about the value of individual pavement management tasks – such as filling a pothole – in the context of their contribution to the larger scale of system preservation takes time and effort.

Present a unified front – All senior managers must buy into objectives and targets.

Tailor communications – Simple graphics are an effective communication tool, particularly for busy executives.

Collaborative Decision Making and Support

In response to the need for an asset management structure that would ensure the availability of information needed for analysis of the investment scenarios, SHA formed an Asset Management Steering Committee in 2004. The Asset Management Steering Committee is made up of representatives from Planning, Maintenance, Materials, Construction, Traffic, and IT and Policy, and includes two District Engineers and the Program Development Division Chief from the Office of Planning and Preliminary Engineering. The purpose of the committee is to develop asset management within SHA. The committee's bi-monthly meetings ensure asset management initiatives are moving forward and are particularly helpful for maintenance since SHA does not have a strong maintenance system.

Because the agency already had a good bridge

management system and was confident of the information in the pavement management system, the committee focus is on developing an asset management approach for other asset classes. Limited resources have dictated a building-block approach to this asset management growth. Asset classes have been prioritized based on the business plan.

Currently the most developed asset management practices, besides pavement and bridge, exist for drainage. Targets in this asset area are driven by requirements for improved storm water management. The agency is also building asset management for traffic signals and ITS.

This group is also undertaking a data warehousing project. SHA has completed a scope document and request for proposal for development of this asset data warehouse system, which is intended to provide a central portal for agency access to asset information, including GIS location information. The agency is currently collecting asset data and GIS information for entry into the data warehouse. This inventory varies in quality and level of detail across asset classes and will require time and effort to mature to a useful tool. They have also recently advertised for a new Maintenance Management System that will support efforts in asset inventory/management for routine maintenance.

Achieving Organizational Commitment

Maryland's SHA believes that performance management and asset management are closely related. In their experience, asset management is the means by which DOT leadership ensure the right data is available to analyze different investment scenarios to determine the best approach for reaching long-term goals.

SHA's move to a performance management culture has made asset management more visible and easier to communicate to staff, the public, and the legislature. This, in turn, has had a positive effect on funding and on the agency's relationship with the legislature. These improvements have demonstrated the feedback loop value of performance management: improved performance leads to improved funding and extended

asset lifespan, which in turn improves both the private and professional lives of staff.

SHA has faced many of the challenges common to state transportation agencies building performance management and asset management within their organization, including aligning field staff. The agency needs to get people more involved in extending the life of pavements and make sure those districts who do not properly maintain pavements are not rewarded with budget increases.

While the agency is trying to move to outcome measures, they are experiencing external pressure to use output targets, such as number of potholes filled or linear feet of pavement drop off repairs.

Ownership and Accountability

SHA's funds are split by asset class (drainage, pavement, bridge traffic, etc.). Each fund has a fund manager whose responsibility it is to present and justify funding needs at the annual allocation meeting, allot funds to districts, and report on progress. This system has worked well for the agency, particularly in conjunction with a forum for accountability.

A Way of Doing Business

Maryland's SHA continues to improve its performance management and asset management practices, as well as the relationship between the two. Initially staff below the level of district engineer wanted more autonomy and resisted their targets. Resistance has subsided as the agency has had the opportunity to see success from its pavement asset and performance management approaches: Despite periods of funding variation, the agency has been able to make the case for investment in pavement preservation and has successfully obtained two revenue increases that both went to pavement preservation. This success is helping the transition from a "worst first" mentality to a mature asset management approach.

Communication with Stakeholders

The asset management approach has increased the Legislature's trust in the agency's ability to make

investment decisions based on a data-driven approach, and also allows the agency to clearly demonstrate the impact of decreased funding on the future state of the transportation system. Initially SHA had to educate decision makers about the value of preservation: SHA was challenged when it proposed resurfacing with a thin overlay before pavement showed obvious need for repair. It clarified the value of the approach by using analogies to making minor automobile or house repairs rather than waiting for major damage, which would be more costly to repair.

Maryland also learned that breaking each asset category down was more effective than trying to make the case for system preservation as a whole. For example, sidewalks needed funding to repair gaps and bring them into ADA compliance, etc. Pulling this asset into a separate category resulted in increased funding for this need. They had a similar experience with drainage, which they pulled into a separate asset category and explained that funding was needed to remedy water quality problems in drainage into Chesapeake Bay.

Once these obstacles were overcome, the agency secured revenue increases. Much of this funding is being directed toward preservation. The agency believes these increases reflect legislative trust in SHA's decision making process, which is grounded in asset management. The agency is making progress with demonstrating the value of asset management with other categories.

Maryland has legislated public involvement in developing the state's high-level policy goals and a

responsibility to communicate progress toward those goals. SHA's asset management program is a necessary part of this dialogue with the public.

Future Initiatives

SHA is continuing to build its asset management with the goal of facilitating tradeoff analyses across assets to optimize investments. This growth is occurring on both the technology and business front to accommodate increased information availability and coordination.

For example, the agency currently considers safety needs in conjunction with pavement preservation needs by tracking how much of the pavement money is devoted to actual pavement vs. safety assets such as guardrails and transferring money from one fund to the other if justified.

To accumulate data demonstrating the value of preventive maintenance, planning and maintenance are working to improve communication about patching and crack sealing projects. Although some pertinent data, including specific location information, is incomplete, progress is being made.

Data systems are segmented within business unit silos (pavement, bridge, etc.) with limited GIS. SHA is working toward a planned asset data warehouse system that will facilitate inventory data accessibility, coordination, and accuracy.

SHA does not plan to utilize a black-box approach to cross-asset allocation. Their goal is to understand the impact of a variety of investment strategies across all of the assets within their care.

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