American Association of State Highway and Transportation Officials

AASHTO

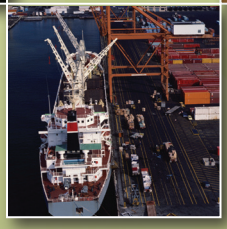
Developing Human Capital and Organizational Culture to Support Asset Management

A Briefing Paper







The information contained in this discussion paper was prepared at the request of the Transportation Asset Management Expert Task Group (TAM ETG). This discussion paper *is not* an official publication of the Federal Highway Administration (FHWA) or the American Association of State Highway and Transportation Officials (AASHTO). The opinions and conclusions expressed or implied in this discussion paper are those of the individual members of the TAM ETG and are not necessarily those of the member's organization, FHWA, or AASHTO.

TAM ETG Members

Chairman: Tim Henkel, Minnesota DOT

Members: Brad Allen, New York State DOT
Jennifer Brandenburg, North Carolina DOT
Chris Champion, Institute of Public Works Engineering Australasia (Australia)
Chris Evilia, Waco MPO
Moh Lali, Alberta Transportation (Canada)
Laura Mester, Michigan DOT
Randy Park, Utah DOT
Omar Smadi, Iowa State University

Liaisons: Steve Gaj, FHWA
DeLania Hardy, AMPO
Matthew Hardy, Ph.D., AASHTO
Dave Harris, FHWA
Tom Palmerlee, TRB
Neil Pedersen, TRB
Nastaran Saadatmand, FHWA
Francine Shaw-Whitson, FHWA
Mshadoni Smith, FTA

Authors: Gordon Proctor, Proctor and Associates
Katie Zimmerman, P.E., APTech

More information about the TAM Expert Task Group can be found here:

http://www.fhwa.dot.gov/asset/etg

More information about transportation asset management resources can be found here:

http://tam.transportation.org

American Association of State Highway and Transportation Officials
AASHTO

Developing Human Capital and Organizational Culture to Support Asset Management

A Briefing Paper

Sound infrastructure relies on more than solid roadbeds, strong footers, or deep pilings. It also relies upon people and culture. Agency staff and organizational culture may be the most important assets in an agency's asset management program. Staff's knowledge, training, and access to information may be the most important factors to ensure that infrastructure remains in good repair. The knowledge, training, and information may be short-lived and unable to survive leadership changes unless they are embedded in a culture that supports asset management.

This paper examines many skill sets that agency leadership will want to develop or sustain in their organizations to support asset management. Often, agency leaders see obvious gaps within one discipline and address them through buying an asset-specific management system, or investing in more training to develop a specific skill set, such as bridge preservation. However, this paper recommends an additional approach.

While each individual discipline discussed below is important, the most critical skill set is for staff to understand how to manage complex systems over a long period of time. It is not enough to know how to repair or maintain a pavement, a bridge, a bus, or a roadside asset. Because agencies manage thousands of assets spread across thousands of square miles, only a systems approach can ensure that all assets, in all places, are all being treated properly at all times. Creating a culture that values a systems approach may be a leader's most important contribution to asset management.

Systems Approach

A system is defined here as a set of interconnected components intended to create a result greater than the sum of their parts. A systems approach, therefore, is an organizing management framework to maximize the efficiency and effectiveness of a system.

Transportation agencies are familiar with systems. The Interstate Highway System, the National Highway System, and functional classification are examples of how the transportation network is organized by systems. Internally, agencies have management systems for pavements, bridges, roadway assets, and so forth. However, these management systems sometimes are operated by technical experts removed from organizational management decisions. The results of the management systems may or may not influence the daily decisions of which projects to select, what treatments to apply, or how to coordinate the activities of planning, design, construction, and maintenance staff.

Such coordination is critical to managing assets. Over the life of a pavement, bridge, bus, or transit facility, it will progress through predictable stages of construction, preservation, maintenance, repair, rehabilitation, and eventual replacement. From a life-cycle-cost basis, the timing and coordination of these activities are essential. Delaying or inappropriately applying one usually results in higher deterioration and higher costs to restore the asset to a state of good repair.

Perhaps the most important skill is for members of each discipline to understand they are part of a system that needs to coordinate with all the other parts to appropriately intervene with an asset at the appropriate time. An analogy is that treating assets is neither a sprint nor a marathon, but rather a perpetual football game or marching band performance that only succeeds if all units coordinate.

Operating in a systems environment requires both individual skills, and organizational or cultural ones. The agency leaders need to share the assumption that they are not responsible only for efforts within their silo but they are responsible to ensure their silo coordinates with others across the organization.

Some examples follow. With a systems approach, maintenance personnel would understand not only how to seal cracks, or maintain drainage structures, or fix guardrail. They would understand how many assets they have, what is their condition, when they need to be treated, and how. Most importantly, they would understand their role as part of the life-cycle of bridges, pavements, and other assets. Their pavement and bridge maintenance efforts would synchronize with the bridge and pavement management decisions. The pavement manager would be assured that pavement maintenance efforts planned for a pavement when it was designed would be applied as intended. Similarly, the bridge engineer could expect that bridge-preservation treatments are timely because the bridge team and maintenance teams work as part of the same system for managing bridges through every phase of their life cycles.

Similarly, planners, programmers, and budgeters would coordinate with pavement management technicians to link the outputs of the pavement management system to the pavement designs selected, the maintenance activities identified, and the budgets allocated. Without such linkages, the pavement management system outputs can be academic. They exist on paper without affecting activities on the highway.

A very different discipline but with a related issue is programming. Sometimes the projects that are programmed matriculate up from worst-first recommendations from districts, or the pavement, bridge, or safety program manager. The most immediately pressing projects are programmed without analysis of whether their scope is appropriate for the life-cycle of the asset.

Perhaps more critical than the projects that are selected in a worst-first environment are those that are not. Treating assets in "fair" condition with low-cost preservation treatments may be the most important life-cycle strategy an agency can adopt. However, without a system to identify the preservation candidates, they will not rise to the attention of field staff, who usually address already deteriorated assets. Field staff and program managers, who select projects need to understand that the most important pavement may not be the one with the most distresses. Within a systems approach, their most cost-effective and important project may be the one that sustains a good pavement or restores a fair one to good condition for minimal cost. Without a systems perspective, however, this more discerning project-selection approach may not be emphasized.

All the other disciplines discussed below will be less than optimal if they operate independently. An important asset management skill is the ingrained understanding that a systems approach is essential, that disparate agency units must coordinate, and disciplines must work "upstream and down" to optimize asset management efforts.

Forecasting Skills

Nearly every discipline involved in asset management must be able to forecast. This is true for budgeters, who must advise programmers as to how much revenue will be available not just this year, but in five years. The corollary to revenue forecasting is cost estimating. Forecasting construction-cost inflation trends influences asset-investment estimates. Because of the large numbers involved in statewide bridge and pavement programs, a small percentage change in construction inflation extrapolated over several years produces major effects on need estimates. Honing skills to monitor the precursors of construction inflation can be an important skill for a statewide asset-management program.

If an agency increases preservation efforts, it is essential to know how many bridges and pavements each year for the next several need preservation treatments. Without such a forecast, programmers do not know how many contracts to scope, how much money to allocate, and how many project inspectors are needed. If the work is to occur in-house, the labor hours need to be coordinated with other essential maintenance tasks, such as winter operations or roadside maintenance. These estimates are not possible if the bridge and pavement management systems operators cannot forecast how many assets will need preservation by year for the next several years.

Forecasting is inherent in the bridge, pavement, and maintenance management systems. Their strength is their ability to forecast what types and what amount of treatments are needed to sustain condition targets. However, these forecasts are most valuable when the treatments they call for and the spending they require are executed. The execution of them requires the management system forecasts to be linked to the programming, project selection, budgeting, contract letting, and inspection efforts required to build what the management systems suggest. Therefore, the forecasting need extends to every unit responsible for programming and delivering projects.

Risk Management Skills

Although forecasting is important, it also is risky. Forecasting revenue and prices is challenging for the most experienced staff because of the uncertainty surrounding what Congress will appropriate or how international markets will influence prices. Risk management skills can support sound forecasting. Risk management does not eliminate risk but it allows staff to clarify the degree of certainty and uncertainty a forecast contains. A person well-trained in risk management will develop contingency responses and monitoring procedures to keep abreast of changes that could alter key forecasts, such as revenue fluctuations, construction inflation, or asset deterioration.

Enhancing risk management skills can be an important adjunct to improving asset management skills. Asset management inherently requires forecasting, estimating, and anticipating events years in the future. With uncertainty surrounding every forecast, skills to measure, monitor, and manage risks are important.

Take just one example. A program manager is in charge of managing an agency's inventory of large bridges. If the state has 100 large bridges, all of different ages, it may need to develop a 20-year plan for when the bridges need rehabilitation or replacement. Developing plans for each bridge may need to start 5 or even 10 years in advance of construction. Therefore, the program manager balances forecasts of when bridges need treatment, what those future treatment costs will be, how public involvement or permitting will affect the project schedule, and how construction price inflation will affect the program budget. Also, because these large assets are disproportionately expensive, multi-year plans are needed for how to finance them. For some states, one of these large structures may equal half of one year's typical construction program. As the program manager develops a 10-year budget and schedule, significant risk surrounds every assumption, with greater risk associated with the later years.

If the program manager can measure and articulate the risks, agency management will better understand the contingencies they must plan for. The following graphic shows bridge expenditure amounts for the Florida Department of Transportation over a 15-year period. The large swings in spending reflect the years in which large bridges, or large numbers of bridges, needed investment.

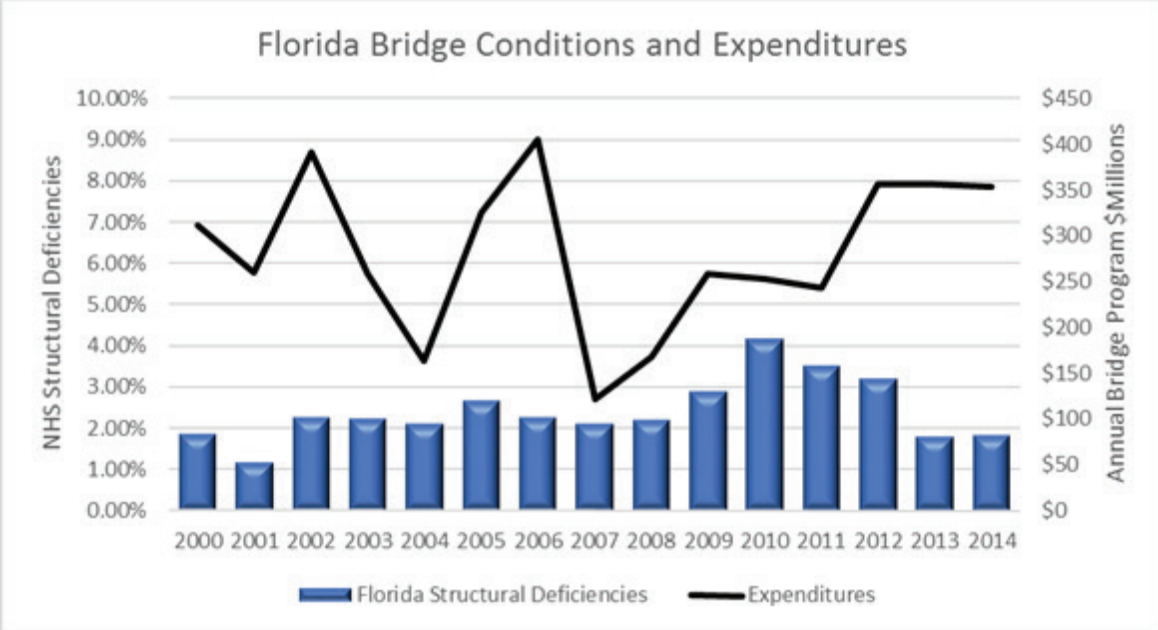


Figure 1. Florida NHS bridge conditions and expenditures by year, 2000–2014.

Figure 1 illustrates that spending levels fluctuate by $200 million or more year to year for this one program. This required substantial advance planning to coordinate the project-development activities necessary to sustain the sound bridge conditions Florida achieved. As seen in Figure 1, NHS bridge structural deficiencies never exceeded 4.1 percent, while the current Federal target is no more than 10 percent structurally deficient.

This Florida example represents a microcosm of why forecasting and risk management are important. To consistently sustain thousands of assets over 20 years requires advance planning, estimating, and forecasting that is inherently risky. However, risk management training can provide staff

with tools to anticipate and prepare for the uncertainties that come with managing thousands of assets over dozens of years.

Skills for a Matrixed Organization

Most transportation agencies are compartmentalized and hierarchical. However, managing assets requires cross-discipline coordination. A skill that individuals and entire departments can learn is how to operate in a "matrixed" environment. A matrixed environment is one in which units coordinate across the organization as well as up and down within their silos. To succeed in a matrixed organization, managers need to develop the skills to share the coordination of some of their staff's activities with managers from other units. The pavement management engineer may need to work with the field maintenance staff to ensure they know which pavement sections are most in need of crack sealing or chip sealing. Similarly, the bridge engineer may need to coordinate with maintenance staff for bridge preservation activities. Rigid hierarchies probably are not the best organizational structures for managing complex assets at different stages of their life-cycles. However, silos are unavoidable in large organizations. An important managerial skill is acceptance of cross-unit staff coordination, staff sharing, and sharing of asset management objectives between different management units.

Pavement, Bridge, and Maintenance Management

The earlier skill sets are important to enhance what are the most traditional asset management skill sets—pavement, bridge, and maintenance management. These three disciplines are essential to sound asset management; however, they are not the sum total of asset management. Asset management is much broader and includes setting of policy, allocating of resources, and articulating of agency philosophy and expectations.

Taking full advantage of management systems is an important skill. Surveys indicated that most AASHTOWare Bridge Management system owners used the system to inventory assets, not to forecast or prioritize bridge investments. The advent of new bridge management systems may provide additional opportunities to analyze bridge-investment scenarios that could produce higher bridge conditions for less money than an agency would otherwise expect. An important skill set will be to master the forecasting and scenario-analysis capabilities of newer bridge managements systems. Even if an agency does not purchase a bridge management system, being able to estimate approximate benefits from enhanced preservation is a worthwhile analytical skill. Some agencies routinely practice bridge preservation and well understand its benefits and limitations. Others rely more on bridge rehabilitation and replacement and have less history with the costs and benefits of preservation. Agency decision makers will benefit if their staff possesses the skills to robustly analyze bridge investment scenarios and bridge treatment strategies.

A similar important staff skill set is the ability to routinely analyze pavement-investment scenarios. Some agency staff are adept at producing scenarios while others find it cumbersome and expensive to produce even one or two. The risks and uncertainties surrounding revenue forecasts mentioned earlier may require annual updates to long-term pavement-investment programs. It will be an important staff skill to support updates through scenario analysis and the testing of sensitivity of inputs, such as changing investment levels or unit costs.

Skills to capitalize on maintenance management systems are as important as the skills to fully use pavement and bridge ones. Maintenance staff and maintenance budgets generally are stressed to complete all needed activities. When new assignments, such as bridge or pavement preservation, are added to their workloads, maintenance staff will have to prioritize their efforts. A useful skill will be to support agency decision making by capitalizing upon the scenario-analysis capabilities of maintenance management systems.

Data and Analytic Skills

Although management systems will produce network-level analysis, personnel in districts or within narrow programs may need to conduct ad hoc analyses. An example could be more detailed analysis within a district as to which pavements experienced higher-than-average degradation rates. Isolating these troublesome assets for forensic analysis can identify root-cause issues that may have plagued some assets for many years. Typical overlays on pavements with poor base or drainage conditions may not perform as expected. When one agency analyzed its pavements in detail, more than 15 percent of them perennially experienced higher-than-average deterioration rates. Several categories of issues created these early failures but each category could be addressed through standardized approaches. A decade of focus on these prematurely failing pavements led to steady improvement in their performance.

The analysis of these poor-performing pavements only was possible because of detailed, ad hoc data analysis. Frequency of pavement treatments were matched with pavement sections that experienced above-average deterioration based upon annual condition inspections. This data mining led to insights that were not apparent at a statewide level.

Supporting this analysis were a statewide data warehouse and standard query tools. This data and these query tools allowed district personnel to identify their perennially poor performing pavements. Once identified, project scopes were enhanced to address the structural problems that led to the persistent deterioration.

Employees with data-query skills are a valuable agency asset. They allow data mining of asset performance data sets to provide insights on how to improve performance. Supporting them are the information technology staff who provide the data sets, query tools, and training on how to use them.

Communication and Illustration

An important subset of data analysis is data illustration. Asset management data may best be understood by decision makers through maps showing trends over time, "infographics," or other creative means. For the agency that mined the data about poor-performing pavements, a key breakthrough occurred when the poor performing pavements were mapped with areas with poor aggregates. A high correlation was apparent immediately. Changes in aggregate specifications helped to reduce the rapid pavement deterioration that had been experienced for many years.

Agencies often struggle to convince legislators to adequately fund asset investments. A useful skill set is the ability to illustrate data and trends through easy-to-comprehend maps and other graphics. These graphics can become iconic when paired with convincing testimony about asset needs. As agencies seek to capitalize upon their asset management systems, they may also want to develop skills in how to translate their outputs into accessible formats.

Back to Basic Skills

Although this paper emphasizes new skill sets such as risk management and financial forecasting, it is important to retain the basic skills that traditionally have been important in transportation agencies. In an era of scarcity, it is as critical as ever to get the most out of the investments agencies are making.

Materials Testing and Acceptance

Among the most important factors in asset performance are the basic elements of materials testing, acceptance, and inspection. Highly refined pavement deterioration curves only are accurate if the pavement materials are mixed and placed as intended. These basic skills are particularly important in this era of downsizing, generational turnover, and outsourcing. As veteran inspectors and materials personnel retire, the decades of experience they bring need to be distilled and passed on to a new generation.

Roadway Maintenance

The same is true with maintenance personnel. Individual field staff possess unique insights into the performance of troublesome assets such as the culvert that frequently is overloaded, or the slope that is prone to fail when saturated. An emphasis on asset management should not diminish the focus on sound, basic maintenance. Instead it should enhance it. Assets will perform better for longer when ditches are well maintained, underdrains are clear, bridge expansion joins function, and pavements are well sealed. As agencies invest in their asset management human capital, they should not underestimate the critical need to keep front-line maintenance staff trained, equipped, and involved.

Geographical Information Systems

Inventorying and mapping are foundational asset management skills that should not be overlooked. Geographical information system staff support critical analysis of asset condition and performance. Their ability to overlay and compare attributes across the state allow for analysis such as for the poor-performing pavements mentioned earlier. Within an asset management-focused organization, the skills of GIS staff should be enhanced and supported.

Summary

A sound asset management practice is to inventory assets and assess their conditions. This is sound guidance if applied to human assets as well as to physical ones. As decision makers seek to improve their asset management practices they should start with assessing the skills of their employees. It is unfortunately common for agency staff to be viewed as an expense to be cut, not an asset to be enhanced. While staff can be expensive, poor decision-making is even more costly. Developing human capital is as important as developing the financial capital to sustain assets.

For more information on TAM, please contact:
Matthew Hardy, AASHTO, 202-624-3625,
mhardy@aashto.org, tam.transportation.org

American Association
of State Highway and
Transportation Officials
AASHTO

444 North Capitol St NW, Ste 249, Washington, DC 20001
Phone: 202–624–5800 • www.transportation.org