Transit Asset Management at the MBTA: History, Present, and Future

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MBTA PROFILE

The Massachusetts Bay Transportation Authority (MBTA) provides commuter rail, heavy rail, light rail, bus, trackless trolley, bus rapid transit, ferry, and paratransit service to Boston and 174 other communities in eastern Massachusetts. It the fifth largest transit property in the United States, based on a ridership of over 1.3 million daily trips. The agency's asset inventory include more than 2,500 vehicles, 885 miles of track, 20 miles of tunnels, 467 bridges, and 19 maintenance facilities. A large segment of its infrastructure dates back to the end of the 19th century. The first MBTA subway line, which opened in 1897, is the oldest in the United States.

DEFINITIONS

There are many definitions of transit asset management (TAM) throughout the literature. The draft Asset Management Guide from FTA defines TAM as "a strategic and systematic process through which an organization procures, operates, maintains, rehabilitates, and replaces transit assets to manage their performance, risks, and costs over their lifecycle to provide safe, cost-effective, and reliable service to current and future customers."[1] Transit assets at the MBTA include rolling stock, right-of-way, stations, facilities, systems, and equipment. In following the definition, an agency would ensure that its assets are in a state of good repair (SGR). As a contributor to the APTA State of Good Repair Working Group, the MBTA has helped to craft the following definition: "SGR is a condition in which assets are fit for the purpose for which they were intended."

[1] Asset Management Guide: Focusing on the Management of our Transit Investments, FTA Report No. 0027, October 2012. www.fta.dot.gov/documents/FTA_Report_No._0027.pdf

The FTA Asset Management Guide also provides a maturity scale in terms of asset management for the agency as a whole and for different groupings of assets. This maturity scale includes five levels, ranging from having defined an asset management policy and strategy and defining objectives for asset management (Level 1 – "I know where I want to be") to conducting data-driven lifecycle management planning, including performance modeling (Level 5 – "I know how to optimally manage across the lifecycle"). Between these bottom and top levels, steps such as assembling an asset inventory, performing condition assessments, and integrating asset management into capital programming represent different parts of the maturity scale.

Finally, the MBTA has also modeled its asset management structure based on the recommended FTA framework in the Asset Management Guide. This framework, in addition to calling for lifecycle management of assets in different classes, integrates enterprise-level policy and strategy decisions for asset management and cross-asset planning and budgeting. The framework also calls for information technology systems to assist with asset management, though it is apparent that such systems represent an enabling function that are based on the enterprise- and asset-level goals and objectives. In addition, the structure notes how various other organizational aspects, such as the leadership and accountability procedures, training, communications, and an organization's values and culture, can also enable asset management.

RATIONALE

Moving Ahead for Progress in the 21st Century ("MAP-21"), the current two-year surface transportation reauthorization bill, requires public transportation agencies receiving federal assistance or grant money to develop an asset management plan. This plan needs to, at a minimum, include policies for guiding an asset

inventory, an assessment of asset conditions, and a decision support tool for capital project prioritization. FTA awarded the MBTA a $950,000 "pilot program" grant to develop a TAM program. The MBTA will report on its progress in developing a TAM program so that other agencies may learn from the MBTA's experiences.

Asset management is also the responsible action for an agency, such as the MBTA, that receives public funding. With capital budgets increasingly being tightened, public transit agencies must ensure that they are wisely spending the dollars that they do have in order to better maintain existing assets. In addition, agencies can better advocate for directing more funding to maintenance and asset management when their correlation to improved system performance and reduced maintenance costs is demonstrated.

HISTORY

In 1999, the MBTA began work on a State of Good Repair Study. This project was undertaken to inventory and determine the up-to-date state of all of the MBTA's capital assets. The Study also assigned to each asset a replacement value and a "useful life" after which the asset should be replaced. Useful life represents the amount of time that an asset can be expected to be in a state of good repair assuming scheduled maintenance is performed. Based on this information, the Study calculated the level of ongoing capital expenditures needed to achieve and maintain a state of good repair.

In addition to the report, the 1999 Study included the construction of what is known as the SGR Database. The database evaluates and quantifies the state of repair and needed level of ongoing reinvestment. It forecasts asset renewal and replacement needs over time, and allocates theoretical budgets to infrastructure needs on the basis of established capital program goals and objectives. The database estimates the "SGR backlog," which represents the total cost to renew or replace all assets that are currently beyond their useful life. The database also performs various "what if" scenarios by modeling how the size and composition of the backlog would change with different funding levels or policy decisions. The MBTA has shared the SGR Database with several other transit agencies such that it is now used throughout the industry to assist agencies with their asset management.

In 2004, the SGR Database allowed the MBTA to estimate the size of its SGR backlog as approximately $2.7 billion. According to the database, it was estimated that the MBTA could maintain its existing infrastructure in its state of repair at the time and hold the backlog steady over the following 20 years with an annual capital spending level of $470 million. To complete all backlogged projects over 20 years and begin normal on-time programmatic replacement of all its assets, the database estimated that the MBTA would need an annual capital spending level of $620 million.

The MBTA has used the SGR Database to report to the MBTA Board, the Secretary of Transportation, the Metropolitan Planning Organization, and the state legislature on its funding needs to address the SGR backlog. As a result, the MBTA is no longer responsible for funding expansion projects. All new expansion efforts are now funded by the state government and other non-MBTA funding sources. Today, the MBTA allocates over 95 percent of its capital budget to SGR projects.

The SGR Database has been updated recently. The update included a shift from a Microsoft Access–based platform to an SQL server, web-based system. Under the Access database mode, the data were collected from the various departments and then entered manually into the system. The upgrade to the SGR Database shifts the data entry responsibility to the managing departments. Now the responsible departments can enter their latest updates directly from their own terminals.

PRESENT

According to the most recent estimates from the SGR Database, the size of the existing backlog has increased to more than $3 billion. The size of the projected backlog over the next 20 years is also forecast to increase. As a result, the amount estimated to maintain the backlog steady over the next 20 years has increased to $694 million per year while the amount estimated to eliminate the backlog in 20 years has increased to $808 million per year. Figures 1 and 2 present graphical estimates from the SGR Database as to how the total backlog would change with an annual capital investment of $694 million and $808 million, respectively, starting in 2013.

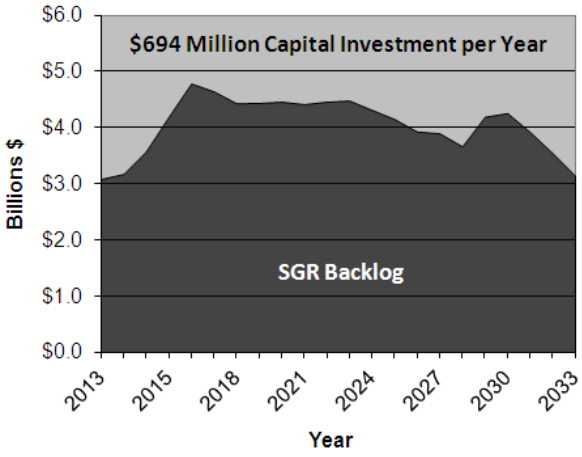

Figure 1

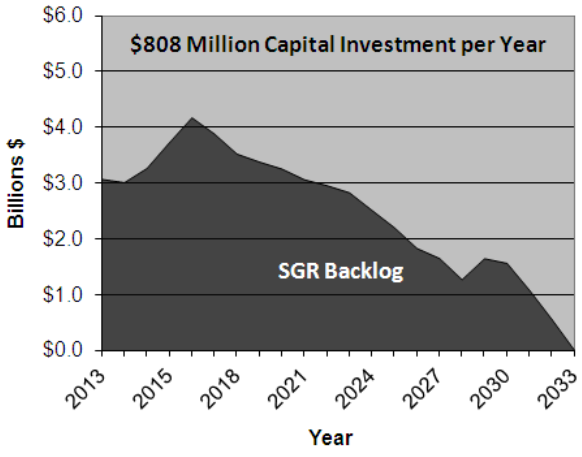

Figure 2

Over the next 20 years, the SGR Database estimates that the MBTA will face approximately $16.5 billion in needed capital investment. This value is greater than the estimated value of all current MBTA assets at $14.7 billion. The greatest percentage of these capital needs (nearly one-third) is for revenue vehicles. Track, bridges, and signals represent additional asset categories where the estimated 20-year needs exceed $2 billion (see Table 1). These needs generally reflect the relative current replacement values of each asset category (see Table 2).

20-Year Capital Needs by Asset Category

Asset Category	20-Year Capital Needs	
	$ Value	% of Total
Administration	$14,196,956	0.1%
Bridges	$2,219,874,924	13.4%
Communications	$187,416,760	1.1%
Elevators & Escalators	$137,845,614	0.8%
Facilities	$339,621,852	2.1%
Fare Equipment	$292,633,654	1.8%
Non-Revenue Vehicles	$223,537,454	1.4%
Parking	$341,848,703	2.1%
Power	$1,004,566,745	6.1%
Revenue Vehicles	$5,439,573,628	32.9%
Signals	$2,123,665,076	12.8%
Stations	$762,631,062	4.6%
Track	$2,539,941,169	15.4%
Tunnels	$81,933,687	0.5%
Yard & Shop	$820,984,872	5.0%
Total	**$16,530,272,155**	

Table 1

Current Replacement Value by Asset Category

Asset Category	Replacement Value	
	$ Value	% of Total
Administration	$2,908,200	0.0%
Bridges	$1,197,058,262	8.1%
Communications	$110,079,174	0.7%
Elevators/Escalators	$240,000,000	1.6%
Facilities	$513,577,257	3.5%
Fare Equipment	$157,742,369	1.1%
Non-Revenue Vehicles	$96,191,416	0.7%
Parking	$271,070,725	1.8%
Power	$1,000,609,285	6.8%
Revenue Vehicles	$4,147,372,808	28.2%
Signals	$1,721,314,046	11.7%
Stations	$998,695,783	6.8%
Tracks	$2,641,659,696	17.9%
Tunnels	$855,662,000	5.8%
Yards & Shops	$763,723,852	5.2%
Total	**$14,717,664,873**	

Table 2

Tables 1 and 2 demonstrate the variation that exists in terms of the MBTA's projected capital needs and existing capital assets. This variation makes capital planning more difficult, as the needs of multiple asset categories overlap and compete with each other for limited capital funds. In addition, variation in the age of the assets in each category prohibits the MBTA from performing category-wide renewals or overhauls, unlike a smaller transit agency where all assets were purchased at the same time.

The MBTA currently has no systemwide asset management plan in place to direct and manage its efforts. However, as mentioned previously, since the release of the State of Good Repair Study, the MBTA has made capital reinvestment a priority in its Capital Investment Program (CIP), the five-year, financially-constrained guide to the MBTA's capital budget. The selection process for projects to be included CIP involves the prioritization of all capital funding requests based on several metrics, including a project's impact on the state of good repair. In the CIP for the state fiscal years between 2013 and 2017, the MBTA allocated only 0.4 percent of its funds towards expansion projects, with the rest going to SGR projects for a total of $2.9 billion over the five-year period, or an annual average of $580 million.

In addition to using the concept of SGR in its capital planning process, the MBTA has also incorporated certain asset management strategies into its daily maintenance activities. The MBTA now generally employs a "fix-it-

first" strategy with a focus on less visible but more critical projects. Various maintenance management systems (MMS) are used by different groups within the MBTA to manage the daily maintenance and replacement of assets. The Operations division uses one system for revenue and non-revenue vehicles, bridges are part of a statewide asset inventory and inspection program, and certain asset categories, such as elevators and escalators, are also regularly inventoried and inspected. In addition, as part of the transition to a new commuter rail contract within the next year, an asset inventory and condition assessment will be undertaken, and the data will be incorporated into a more fully-functional MMS for commuter rail assets. However, the vast majority of MBTA assets do not currently have an MMS or any other asset management system in place in order to perform preventative maintenance. As a result, the maintenance, repair, and replacement of individual assets typically occur as the need arises. It should be noted that while the SGR Database collects data on all assets at the MBTA, these data are grouped and summarized at hierarchy levels above those which are needed for the daily management of assets as part of an MMS.

TAM PROGRAM

As mentioned previously, the MBTA received a $950,000 grant as part of FTA's "TAM Pilot Program." This grant will help the MBTA address the requirements of MAP-21. Work is currently underway, and it is envisioned that the MBTA's experience will generate "lessons learned" that FTA will provide to other agencies. The grant encompasses three separate initiatives:

- the development of an Asset Management Plan (AMP) to guide the MBTA's overall asset management strategies and policies;
- the development of a Decision Support Tool (DST) to guide capital project prioritization; and
- enhancements to the SGR Database, which include condition assessments, a refinement of the asset inventory, and the incorporation of modeled relationships between useful life, condition, and maintenance costs.

In support of the three initiatives in the grant, the MBTA has identified several "TAM teams" that will have responsibility for various parts of the TAM initiative:

- The "executive sponsor" is the MBTA's Chief Financial Officer. The executive sponsor encourages and empowers other managers to drive the asset management program forward; ensures that necessary resources are in place; and communicates with the General Manager, the MBTA Board, and other stakeholders as needed.
- The "Leadership Team" includes the General Manager as well as executive-level managers who help to establish the other teams and can ensure that the TAM program gets the required level of support from managers and staff. Members of this team will direct the overall goals and objectives of the TAM program.
- The "Asset Management Improvement Team" includes non-executive managers who represent all of the enterprise-level functions within the MBTA. Members of this team help with collecting information, developing goals and objectives for the future, and reviewing deliverables.
- "Asset class leaders" are managers and staff who represent all major asset classes. They support the Asset Management Improvement Team.
- The "Support Team" includes staff from other departments who do not directly manage assets, but whose responsibilities can affect asset management. This includes departments such as safety, accessibility, and environment.
- The "Project Management Team" coordinates and guides the TAM program, identifying team participants, scheduling and attending workshops and meetings, and reviewing and approving deliverables. The three individuals in this team are responsible for managing the three formal initiatives that are part of the FTA grant.

Figure 3 presents the organization chart that the MBTA uses for its TAM program.

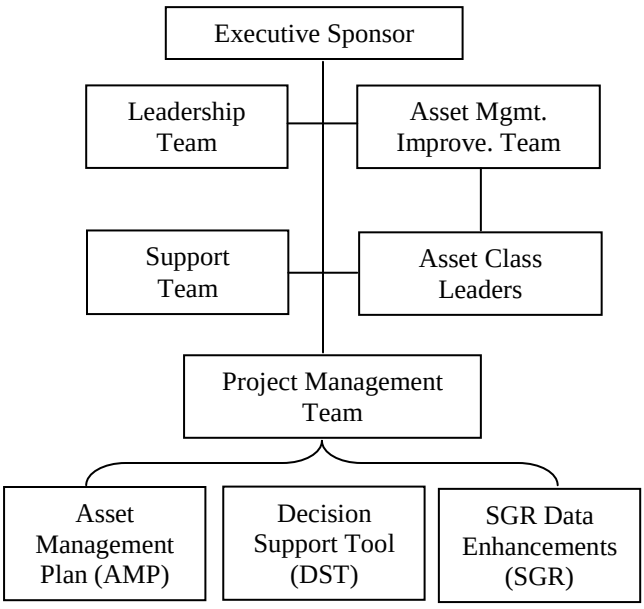

Figure 3

Asset Management Plan (AMP)

The preparation of a comprehensive and practical AMP is intended to improve MBTA business processes for the management of its assets and the allocation and utilization of its resources; bring the MBTA in alignment with industry best practices, international standards (e.g., PAS 55[2]), and the forthcoming FTA guidance on asset management; and serve as a model for other transit agencies. The first step in the development of the AMP is an assessment of the MBTA's baseline. The MBTA conducted this step in February and March 2013. This assessment determined the level of maturity for different business and engineering practices and for the various asset categories. The consultant team that is assisting the MBTA with the development of the AMP conducted the baseline assessment by providing an Excel-based questionnaire to members of each TAM team about their use of asset management practices, and followed this up with in-person interviews of the asset class leaders and members of the Asset Management Improvement Team. Generally, both the MBTA self-assessments and the consultant assessment rated the MBTA as having several effective processes, but an inconsistent use of these processes across the agency.

The second step was to establish the MBTA's goals and objectives for the AMP, and to determine the relationship to other agency-wide policies and strategies. The consultant team conducted a brainstorming session in April 2013 with the asset class leaders and members of the Asset Management Improvement Team to discuss overarching goals as well as the objectives associated with each goal. These stated goals and objectives were compared to the baseline assessment in order to identify gaps. This "gap analysis" was then shared with members of the Leadership Team before it was finalized.

The final step is the development of the AMP. The AMP will include implementation plans associated with each objective that identify the actions, responsibilities, duration, dependencies, and level of resources required to bridge the gaps. Examples of actions include combining departments' asset inventories, developing a comprehensive program for condition assessments, or developing a lifecycle management template. Most identified actions should be accomplished in one year's time, though longer-term actions will also be identified. Finally, the AMP will outline how this plan and all related business processes will be revisited and updated, as needed, to ensure that the MBTA is embracing continuous improvement of the asset management initiative.

[2] pas55.net

Decision Support Tool (DST)

As mentioned previously, the MBTA already uses a project prioritization methodology as part of its CIP process. However, the DST comes with consultant support for a collaborative, consensus-based approach to identify and weigh the criteria used to evaluate capital funding requests. In April 2013, selected members of the Leadership Team were convened, representing viewpoints from the executive, finance, construction, maintenance, information technology, and operations perspectives. Use of the DST will make the project evaluation process transparent, with it reflecting the consensus decisions of these various leadership perspectives across the MBTA.

After defining the project evaluation criteria and their weights, MBTA employees who are qualified in the subjects specified by the criteria will be identified. These employees will determine the rating scales for each criterion as well as score the various capital funding requests. These scores will be entered into the DST, which will rank requests as well as prioritize projects based on a fiscally constrained scenario that represents the capital budget. During the prioritization process, MBTA staff will have the ability to dynamically alter the criteria weights and instantly re-prioritize the project list. This sensitivity analysis will enable the capital planning team to rapidly perform "what if" analyses to better understand the underlying value drivers to the process. The consultant team will also work with the MBTA to develop a set of standard reports and an easy-to-use process for generating ad-hoc reports. Finally, most likely in the following fiscal year's CIP cycle, the DST will be provided to individual departments to permit them to use it for their own project prioritization needs, whether for submitting requests to the CIP or selecting projects out of their own operating budgets.

Enhancements to the SGR Database

This initiative in the TAM program enhances the SGR Database in several ways. First, it refines the database to quantify in more accurate or different ways the current state of the MBTA's capital assets. The asset inventory structure will be refined to provide the option of summarizing data according to the structure in the FTA Transit Economic Requirements Model (TERM[3]) and the National Transit Database (NTD[4]). The level of detail of the asset inventory will likely be increased, to better model assets with different characteristics. Several additional fields will be added to the database to better

[3] www.fta.dot.gov/13248_13251.html
[4] www.ntdprogram.gov/ntdprogram

understand the connections between SGR and environmental, risk, and personnel factors, among others. Among these new fields will be asset condition ratings and estimates of an asset's maintenance cost. These two fields will be connected with mathematical models for condition ratings (or decay curves) from TERM and maintenance costs from the Transit Cooperative Research Program (TCRP)[5] to project their future levels with respect to SGR and assumed funding levels.

A second component of this project is the update of all data in the SGR database, including the collection of all new data for new data fields. The MBTA is currently engaged in this process. At the completion of this update, the MBTA will be able to provide an "SGR rating" for any asset, group of assets, or the entire system that indicates the state of repair. The consultant will also assist the MBTA in developing MBTA-specific condition and maintenance-cost models for several asset categories. The database will then provide an option of using either the MBTA-specific decay and cost curves or the industry-standard curves from TERM and TCRP.

A third enhancement is to better link the CIP prioritization process with outputs from the SGR Database. As mentioned previously, the existing process includes a project's impact on SGR as one of the rating metrics; however, the scoring is largely qualitative in nature. One of the new fields in the database will allow users to assign selected assets to projects proposed for the CIP. The average SGR rating for a project's assets can then be pulled from the database and used in the prioritization process for the DST.

The enhancements also include a refinement to the prioritization methodology used in the SGR Database. Unlike the DST, which prioritizes projects, the SGR Database prioritizes assets, but only for purposes of analysis such as long-range financial projections summarized by asset category; that is, the SGR Database is not used for project-level funding decisions. Currently, the SGR Database's prioritization methodology uses three factors: the percentage of years beyond an asset's useful life; whether an asset has an operating impact; and a measure of the cost-effectiveness of an asset (in terms of its replacement value and associated ridership). The refined methodology will likely use the asset's age, condition rating, maintenance-cost rating, and a rating from the DST. This DST rating will be achieved by grouping assets from the SGR Database into theoretical "projects" that will be analyzed by the DST using the same criteria and weights as in the CIP prioritization process. In this way, the SGR Database's prioritization methodology will reflect the MBTA's capital project priorities as determined by the choice of evaluation criteria and weights in the DST.

Finally, the enhancements will also consider the potential integration of the SGR Database with the various maintenance management systems that are currently in place and planned for implementation in the near future. As mentioned previously, an MMS is intended to assist with day-to-day asset management while the SGR Database is intended only for long-range capital and financial planning. Therefore, an MMS would have a much more detailed inventory hierarchy and the integration of an MMS and the SGR Database would involve a summary of the data in the MMS for use in the SGR Database. The SGR Database may be able to summarize data from the MMS used by the Operations division and those used for bridges and elevators and escalators as well as the asset inventory and condition assessments that will become available through the transition to a new commuter rail contract. However, since most assets are not currently included in an MMS, this remains largely a task for the future. The Engineering and Maintenance division, which has ownership for most of these assets without an MMS, is currently planning to procure a new MMS that will permit it to do preventative maintenance and lifecycle planning. This MMS will manage facilities, power, signal, and track assets, among others. Given the desire to link the SGR Database with this MMS, the MBTA is endeavoring to build this into the construction of the MMS.

Integration of TAM Systems

One of the primary goals of the TAM initiative is to integrate the various TAM systems. This is likely a longer-term goal for the MBTA, as it relies on the inclusion of all assets in an MMS, even while the SGR Database, DST, and AMP initiatives are completed as part of the FTA grant. Ultimately, however, all four systems, as well as several other related factors, should work together.

Maintenance management systems include asset inventories at the level of components or subcomponents. These inventories list the service date and useful life, the replacement cost, the condition rating (based on periodic reviews), maintenance-cost data (tracked throughout the life of the asset), and manufacturer warranties and preventative-maintenance service data. An MMS focuses on providing preventative-maintenance scheduling and prioritization of work orders, warranty recovery, condition and performance monitoring, and life-cycle cost-optimization analysis.

Data from each MMS ultimately feeds into the SGR Database. This database is primarily a financial planning

[5] www.tcrponline.org

tool for capital assets. Like an MMS, the SGR Database includes an asset inventory, but the inventory is grouped at the level of an asset class or a more detailed level when the condition and maintenance-cost relationships are significantly different. The SGR Database also includes data, at this higher level, on remaining useful life, replacement costs, condition ratings, and life-cycle costs, while also performing a prioritization exercise that uses, among other metrics, output from the DST.

While the DST provides a rating of various asset groupings to be used in the SGR Database's prioritization methodology, the primary use of the DST is for capital project prioritization and selection. In order to use the DST, the MBTA must clearly define project evaluation criteria and their respective weights. Given the importance of SGR in the current capital planning program, it is likely that one of these criteria will be the SGR rating that comes from the SGR Database. The DST then prioritizes projects within financial constraints and provides this list to the CIP.

The CIP remains the MBTA's primary capital budgeting tool. It is supported by the DST. The CIP also groups projects into the asset categories used in the SGR Database for purposes of a general comparison between the two. The projects included in the CIP then affect assets in ways that should be updated in various maintenance management systems.

In addition, other asset-related databases also feed into TAM program. Data in the SGR Database should match data in the National Transit Database, the MBTA's capital management system, and the CIP, and help to tag new assets or equipment for FTA asset continuing controls and fixed asset accounting. Various performance measures, used for internal monitoring and reporting with an operations focus, potentially feed into the DST and maintenance management systems to help direct the project-selection priorities in those systems.

Finally, the AMP establishes the framework governing the integration of all TAM systems. It lays out the policies that govern how decisions are made to acquire, maintain, renew, replace, and dispose of transit assets. It describes responsibilities for the members of different TAM teams. It identifies the gaps between the current asset-management baseline and self-defined MBTA goals and objectives, and lays out implementation plans with concrete actions for achieving these goals and objectives. Unlike the various TAM initiatives, which involve different parts of the MBTA organization from individuals to departments, the AMP is the one opportunity in which to bring everything together and ensure that all MBTA employees are aware of and working together to promote asset management. While it does not directly provide a ready-to-use database, such as the SGR Database or an MMS, or assist with the prioritization of capital funding requests, such as the DST, the policies and strategies described in the AMP are a vital component of TAM in that they govern all TAM initiatives.

CONCLUSION

The initiatives supported in the FTA grant to the MBTA represent just a first step in the MBTA's overall TAM program. As outlined in the AMP, the MBTA is endeavoring to make a long-term change in how it fundamentally does business in moving from an asset management strategy of fixing needs as they arise to one that employs lifecycle planning to enable preventative maintenance. While tools such as the DST, the SGR Database, and maintenance management systems will assist the TAM program, the real measure of success lies in employees taking the steps today and institutionalizing an agency culture that supports asset management. Ideally, the MBTA can encourage this change by demonstrating to employees the benefits of asset management not only to the agency but also to their own individual performance.

Asset management can help a transit agency deliver higher quality service to customers in terms of reliability, comfort, and speed. The manner in which these services are delivered can also be done in a more cost-effective way when an agency successfully employs asset management. Employees spend less time responding to emergencies, giving them more time to accomplish their daily work activities, which include collecting the data necessary to perform preventative maintenance. Indeed, when an agency has successfully employed asset management, it will likely be seen less as an independent initiative that seeks to adapt an agency's vision, policies, and day-to-day activities, and more as simply the way in which an agency does business.