



U.S. Department of Transportation  
Federal Transit Administration

# Asset Management Guide

Focusing on the management of our transit investments



#### Prepared for

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## Preface

For some time, the Federal Transit Administration (FTA) and the U.S. transit industry having been working to improve the understanding and practice of transit asset management. There is considerable evidence that this is a critical area of focus. Improving transit asset management is now a national policy. In its 2010 *National State of Good Repair Assessment*, the FTA found that more than 40 percent of bus assets and 25 percent of rail transit assets were in marginal or poor condition. There is an estimated backlog of \$50 to \$80 billion in deferred maintenance and replacement needs, of which the vast majority is rail related. The enactment of Moving Ahead for Progress in the 21st Century (MAP-21) places the requirement on transit agencies to prepare a Transit Asset Management Plan. Transit agency customers, policy-makers, and public agencies are holding agency management accountable for performance and increasingly expect more business-like management practices. The magnitude of these capital needs, performance expectations, and increased accountability requires agency managers to become better asset managers.

To advance transit asset management, this guide provides a transit-specific asset management framework for managing assets individually and as a portfolio of assets that comprise an integrated system. The guide provides flexible, yet targeted guidance to advance the practice and implementation of transit asset management.

To accomplish this, the guide:

- Explains what transit asset management is and what the business benefits to an agency are.
- Provides an enterprise asset management framework and business model that agencies can refer to as “best practice.”
- Describes the elements of transit asset management plan.
- Details, for each major asset class, the major enabling components of asset management: inventory, condition assessment, performance analysis and modeling, risk management, and lifecycle cost management.
- Guides organizations through the migration from their current baseline to high-performance asset management.

This guide makes accessible lessons-learned from those with “hands-on” experience with each asset class, and positions transit agencies to jump start the cultural change from a “find and fix approach” to maintenance/asset management to a “predict and prevent” approach that reduces cost and improves safety and reliability. This guide includes examples and practices that agencies can apply; it is intended to provide guidance for a transit agency interested in improving their asset management awareness and maturity. This guide is not an FTA requirement.

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## Chapter 1

### Introduction

*This chapter outlines the purpose, structure, and sources of this document. Additionally, it helps the reader navigate to the sections most useful to them.*

This guide is designed to increase the awareness and improve the practice of asset management in the transit industry in the United States. It provides a transit agency-specific application of asset management concepts, processes, and tools. The purpose is to support an agency's drive to increase the maturity of asset management practice and to provide tools and resources for agency managers and practitioners across the country.

In its 2010 *National State of Good Repair Assessment*, the Federal Transit Administration (FTA) found that more than 40 percent of bus assets and 25 percent of rail transit assets are in marginal or poor condition. There is an estimated backlog of \$50–\$80 billion in deferred maintenance and replacement needs, of which the vast majority is rail-related. Transit agency customers, policy-makers, and public agencies are holding agency management accountable for performance and increasingly expect more business-like management practices. The magnitude of these capital needs, performance expectations, and increased accountability requires agency managers to become better asset managers.

Asset management is a cornerstone for effective performance management. By leveraging data to improve investment decision-making, asset management improves reliability, safety, cost management, and customer service.



## 1.1 Objectives of this Guide

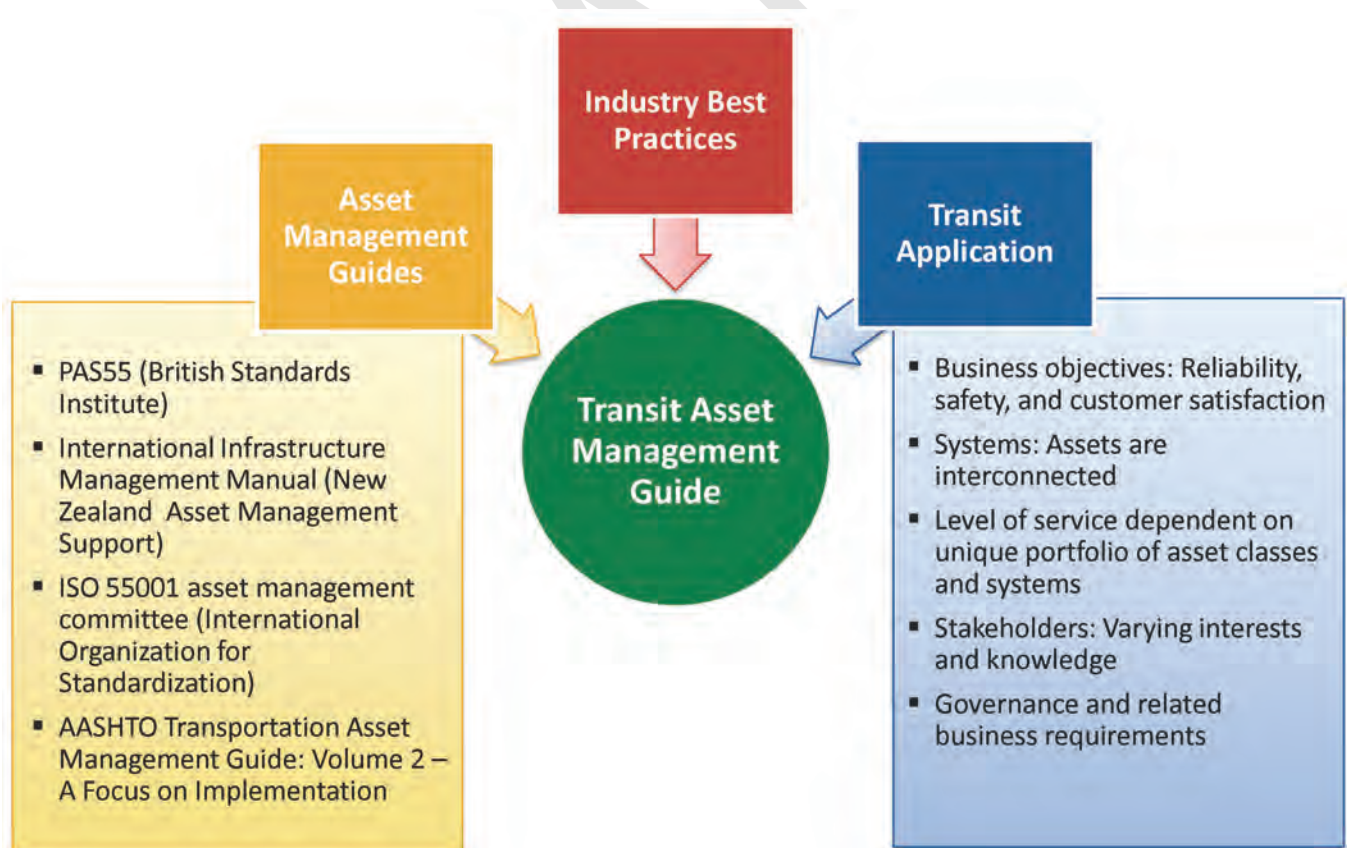
The guide can be used as a resource for agency managers to develop the management practices, tools, and procedures needed to improve investment decisions throughout their organization. This guide has the following objectives:

- Introduce key asset management concepts.
- Present an asset management framework and business model that define and communicate “best practice.”
- Provide guidance that can be used for assessing and advancing asset management maturity within any agency.
- Include tools and case studies that can support implementation.

## 1.2 A Guide Developed for the Transit Industry

The building blocks for this transit asset management guide incorporate relevant concepts from existing asset management guides, analysis of transit agency best practices, and the application of asset management practices to the transit industry as depicted in **Figure 1-1**.

**Figure 1-1.** Guide Building Blocks



There is a significant body of asset management knowledge and broad standards of practice for the infrastructure industry. These include the following:

- **PAS55** is the “publicly available specification” for the optimized management of physical assets published by the British Standards Institute.
- **International Infrastructure Management Manual** is an asset management guide for the public works industry developed by the New Zealand Asset Management Support (NAMS) group.
- **ISO 55001**—newly created in 2010—is the International Organization for Standardization (ISO)—approved project committee (PC251) to deliver an Asset Management Standard for Asset Management. Currently, drafts are being circulated.
- **American Association of State Highway and Transportation Officials (AASHTO) Transportation Asset Management Guide – A Focus on Implementation** provides a framework for addressing highway asset management. It includes two volumes of asset management principles that provide implementation guidance for advancing the state of the U.S. highway industry’s asset management practices.

The asset management guides described above originated in work done to address large-scale long-life fixed infrastructure. Our intent in this guide is to address the application of asset management across the transit portfolio of assets, which includes assets with a range of useful lives, replacement costs, and inter-relationships.

This guide applies and adapts these documents to address the requirements for successful asset management in the transit industry. Unlike many other infrastructure sectors, the transit industry manages a highly complex and diverse portfolio of assets that is required to function as a system. For example, for a passenger rail service to run, the track, communication systems, rail vehicle, and stations must all be working together effectively. Many of the transit industry’s assets are customer-facing, and the asset types managed by different U.S. transit agencies are highly variable because of significant variations in geography, weather, ridership, procurement practices, and regulatory requirements. As such, this guide incorporates relevant concepts from the existing research with a focus on what can be applied to U.S. transit agencies. To demonstrate its applicability, best practices from around the world are incorporated into the guide (see Figure 1-1). A full listing of research and document sources is available in Glossary of Transit Asset Management Terms.

## 1.3 Transit Agency Collaboration

This guide reflects input from transit agency managers from across the U.S. Throughout the development of this guide, the Parsons Brinckerhoff team presented drafts at a variety of forums, including American Public Transportation Association (APTA) and Transportation Research Board (TRB) conferences and the APTA State of Good Repair Standards group, the FTA State of Good Repair Roundtables, and the FTA State of Good Repair Working Group. The purpose was to seek feedback in addition to increase awareness regarding the state of the industry’s asset management practices. Many of these sessions involved compiling and sharing best practice examples, discussing the appropriate presentation of material, and brainstorming about how to address common industry challenges associated with asset management.

The Parsons Brinckerhoff team is grateful to the many transit agency managers that spent their time providing substantive input and who reviewed draft material. Their input and collaboration have made this a more valuable document.

## 1.4 Chapters Overview

The following describes the objectives and contents of each chapter and the *Asset Management Guide Supplement*:

- **Chapter 2: Introducing Transit Asset Management** – This chapter defines asset management for the transit industry, including which assets are included, how asset management fits into an agency’s other management processes, and what business processes are included. The chapter outlines the challenges the industry faces and the benefits of improving an agency’s asset management maturity. This chapter also provides “visuals” of a highly functioning asset management transit agency.
- **Chapter 3: Asset Management Framework Business Processes** – For each business process outlined in the asset management framework, an overview of “best practice” and how it fits into the broader asset management framework is included; key implementation activities and challenges and peer examples are also included. These business processes comprise the development and management of the asset management policy, strategy, plan, inventory, condition assessment and performance monitoring, lifecycle management plan, capital programming, operations and maintenance budgeting, and performance modeling. A reader will understand all the components of asset management, including how to improve them independently and how they work together.
- **Chapter 4: Asset Management Information Systems** – This chapter describes the industry’s current information systems environment, components of an asset management information system, and implementation principles. This chapter also provides a “visual” of a high-functioning asset management information system.
- **Chapter 5: Implementation Guidance** – This chapter provides guidance for assessing an agency’s current state of asset management maturity and then outlines potential implementation paths and change management considerations for how to advance from its current state towards “best practice” while considering the unique needs of that agency. To support implementation, accompanying this guide is a *Transit Asset Management Maturity Agency Self-Assessment Tool*.
- **Asset Management Guide Supplement** – This document identifies the fundamentals that should be considered in the lifecycle management of each asset class and provides information to support the development of an agency’s asset class-specific lifecycle management plan(s), including industry standards and lifecycle management principles associated with each asset class. The document identifies the building blocks from which an agency can consider the maturity of its practices and strengthen asset management for each asset class.

## 1.5 How to Use this Guide

The following provides an overview of which sections are likely to be of most interest to different categories of readers. Readers are intended to be managers and staff from all levels of an agency or external stakeholders.

The following list suggests how different people may approach reading this guide:

- **Agency Executives** – This group may be interested in understanding the key asset management concepts (Chapter 2) and how it is integrated within the agency’s business processes (Chapter 3). They also may be interested in understanding their agency’s current asset management maturity and how to improve it (Chapter 5).



- **Asset Management Program Manager** – This person is intended to lead the agency’s asset management initiative, including leading the development of the agency’s asset management plan, communicating to all stakeholders, and providing the necessary accountability. To be most effective in this position, the Asset Management Program Manager should probably read all chapters of this guide, with a significant focus on implementation guidance (Chapter 5).
- **Agency Management and Staff** – When fully implemented, asset management could affect managers and staff at all levels and in all departments of an agency. For that reason, agency management and staff should understand what asset management is (Chapter 2) and how it is integrated within the agency’s business processes (Chapter 3).
- **Agency “Asset Owners”** – This term refers to the agency managers who are responsible for “owning” an asset class (for example, railcar vehicles, stations, and communication systems) throughout their lifecycle. The asset owners are intended to develop lifecycle management plans for their respective asset class. To support this effort, asset owners may want to focus on the section on lifecycle management planning (Chapter 3) and the respective asset class section (*Asset Management Guide Supplement*).
- **Transit Consultants and Contractors** – Depending on their interests, transit consultants and contractors should be interested in many of the chapters. Suppliers may be interested in understanding the general requirements of asset management (Chapter 2) or the lifecycle management of specific asset classes (*Asset Management Guide Supplement*). Consultants supporting the development of an asset management plan and implementation strategy may be interested in the asset management business processes (Chapter 3) and the implementation guidance (Chapter 5). Information systems vendors may be interested in understanding the functional requirements of asset management information systems (Chapter 4). Change management consultants may be most interested in the implementation requirements (Chapter 5).
- **External Stakeholders** – External stakeholders may include oversight bodies (including metropolitan planning organizations), elected officials, and industry research groups. These stakeholders will likely be interested in the outcomes (reliability, efficiency, safety, accountability) associated with improved asset management, so they may be interested in a general introduction to asset management, including its potential outcomes (Chapter 2), an overview of the asset management plan (Chapter 3), and implementation requirements (Chapter 5).

**Table 1-1** summarizes which sections are likely to be of the most interest to different categories of readers.

**Table 1-1.** How to Use this Guide

	Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Supplement
Agency Executives	X	X	X		X	
Asset Management Program Manager	X	X	X	X	X	X
Agency Management and Staff	X	X	X		X	
Agency “Asset Owners”	X		X		X	X
Transit Consultants and Contractors	X	X	X	X	X	X
External Stakeholders	X	X	X	X	X	





Source: Florida Department of Transportation

## Chapter 2

# Introducing Transit Asset Management

*This chapter defines asset management for the transit industry, classifies transit assets, and describes the key business processes and how they can be embedded into an agency's management processes. It outlines today's asset management challenges and the benefits of improving an agency's asset management maturity. This chapter also provides the reader with a "visual" of a highly functioning asset management transit agency.*

This guide provides the following definition:

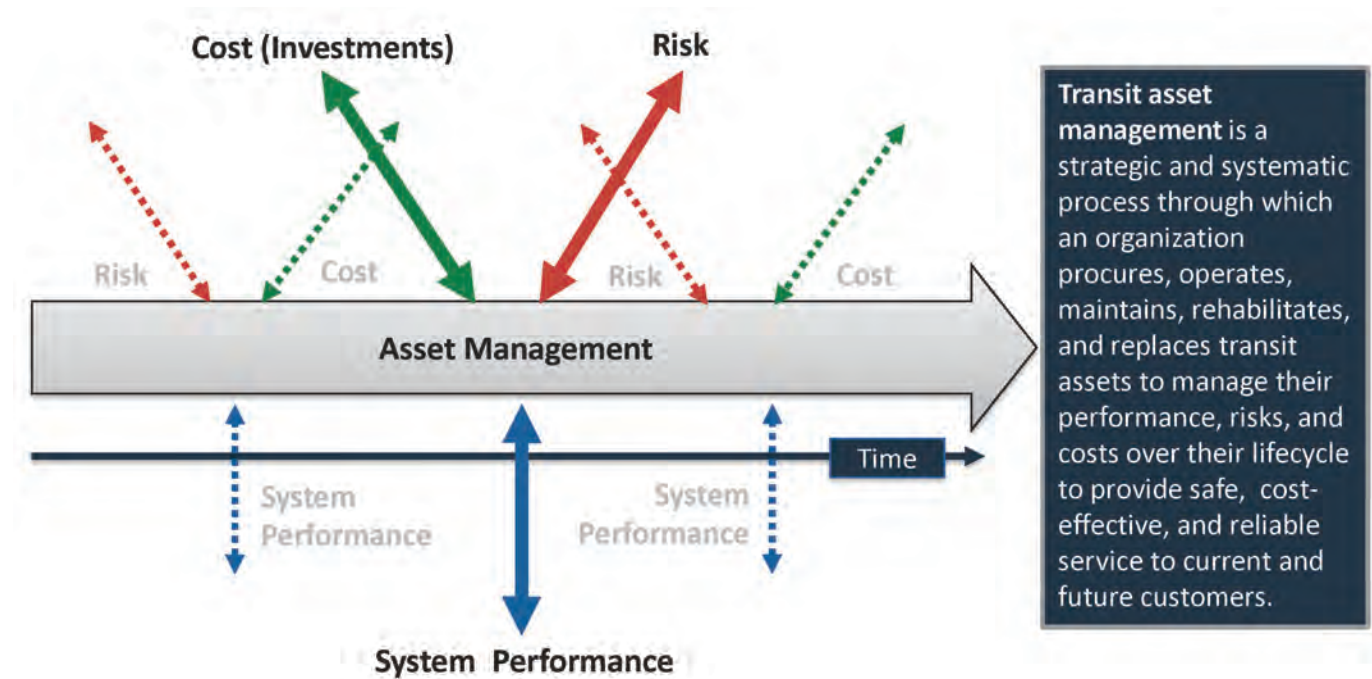
*Transit asset management is a strategic and systematic process through which an organization procures, operates, maintains, rehabilitates, and replaces transit assets to manage their performance, risks, and costs over their lifecycle to provide safe, cost-effective, and reliable service to current and future customers.*

Figure 2-1 shows how asset management processes are ongoing and involve evaluating and managing the relationships between costs, risks, and performance over the asset's lifecycle. Asset management addresses the following two concepts:

1. **Customer Level of Service** – Asset management can affect level of service by improving on-time performance and vehicle cleanliness, and by reducing missed trips, slow orders, and service and station shutdowns. It can also improve safety, security, and risk management. Asset management provides accountability and communicates performance and asset condition to customers.
2. **Lifecycle Management** – The core of asset management is understanding and minimizing the total cost of ownership of an asset while still maximizing its performance. Transit asset management integrates activities across departments and offices in a transit agency to optimize resource allocation by providing quality information and well-defined business objectives to support decision making within and between classes of assets.



**Figure 2-1.** Asset Management Defined



Customer level-of-service and lifecycle management are addressed at the enterprise level and for each class of assets. Enterprise level refers to management or decision-making activities that occur at the higher levels of an organization and apply across the entire organization (for example, capital funding allocations). Asset class-level activities, on the other hand, refer to the management activities that are associated with a particular asset class (for example, vehicles, stations, systems). See **Table 2-1** for examples.

**Table 2-1.** Asset Management at the Enterprise and Asset Class Levels

	Enterprise Level	Asset Class Level
<b>Customer Level of Service</b>	Establish, measure, and manage customers' level of service by using metrics like on-time performance, number of safety incidents, and overall customer satisfaction.	Measure and manage how individual assets perform using customer level of service metrics. Examples include measuring a railcar's mean time between failure or a station's cleanliness.
<b>Lifecycle Management</b>	Use accurate and consistent information about assets, current conditions, and level of service to allocate resources and maximize performance.	Understand and minimize the total cost of ownership of an asset while maximizing its performance. Produce a lifecycle management plan for each asset.

These concepts are further discussed in the Glossary of Transit Asset Management Terms.

## 2.1 Asset Management Benefits

Through asset management, transit agencies can more effectively use available funds to improve the physical condition and performance of their system. This, in turn, has the potential to increase ridership. **Table 2-2** highlights some of the benefits associated with improved asset management activities.

**Table 2-2.** Transit Asset Management Benefits

Transit Agency Business Benefits	Asset Management Approach
Improved customer service	<ul style="list-style-type: none"><li>Improves on-time performance and service operations, vehicle and facility cleanliness; reduces missed trips, slow orders, and station shutdowns</li><li>Focuses investments around customer-centered goals and metrics</li></ul>
Improved productivity and reduced costs	<ul style="list-style-type: none"><li>Maintains assets more effectively, using condition-based approaches and using predictive and preventive maintenance strategies (where these can be employed) to reduce costs while improving service delivery</li></ul>
Optimized resource allocation	<ul style="list-style-type: none"><li>Better aligns spending with an agency's goals and objectives to obtain the greatest return from limited funds</li><li>Incorporates lifecycle cost, risk, and performance trade-offs into capital programming and operations &amp; maintenance budgeting</li></ul>
Improved stakeholder communications	<ul style="list-style-type: none"><li>Provides stakeholders with more accurate and timely customer-centered performance indicators</li><li>Provides tools to communicate forecasted performance metrics (including level of service) based on different levels of funding</li></ul>

## 2.2 The Transit Asset Management Challenge

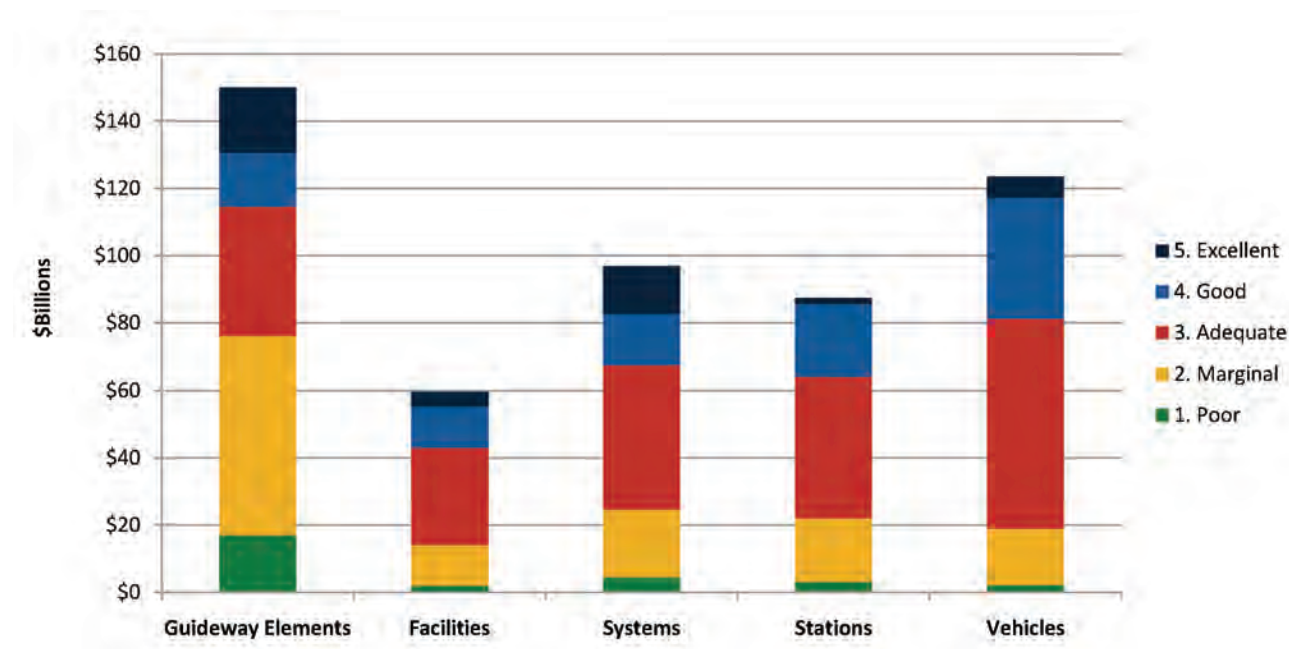
### 2.2.1 The Overall State of Transit Assets

In its 2010 *National State of Good Repair Assessment*, the Federal Transit Administration (FTA) found that one-third of the nation's transit assets are at or have exceeded their expected useful life. More than 40 percent of bus assets and 25 percent of rail transit assets are in marginal or poor condition. The level of capital investment required to attain a state of good repair<sup>1</sup> in the nation's transit assets is projected to be \$77.7 billion.<sup>2</sup> In other words, a "lump sum" investment of roughly \$77.7 billion would be required for the immediate replacement of all assets that currently exceed their useful life (see **Figure 2-2**). Transit assets exceeding their useful life can result in asset failures, which can increase the risk of catastrophic accidents, disrupt service, and strain maintenance departments.

<sup>1</sup> State of good repair was defined using the FTA's numerically based system for evaluating transit asset conditions: 5 (excellent), 4 (good), 3 (adequate), 2 (marginal), 1 (poor). This study considered an asset to be in a state of good repair when the physical condition of that asset was at or above 2.5.

<sup>2</sup> *National State of Good Repair Assessment*. FTA, 2010. page 19.

**Figure 2-2. 2010 Transit Asset Conditions**



Source: *National State of Good Repair Assessment*. FTA, 2010. page 15.

### 2.2.2 Asset Management is Critical for the Nation's Growing Transit Asset Inventory

Our investment in transit assets continues to grow—increasing the importance of efficient and fiscally responsible management of assets. Between 1992 and 2010, the number of vehicles in the nation's transit fleets increased by 63 percent (**Figure 2-3**). Over the past 10 years, almost universally, the average age of transit fleets has decreased or remained the same; however, this is not a result of better asset management. The average vehicle age has decreased mainly because new vehicles have been added to the fleets, while older vehicles were kept in service.

As shown in Figure 2-4, the largest backlog of state-of-good-repair needs is due to heavy rail assets. Commuter rail and buses are comparable in the size of their backlogs. These categories are discussed in the following sections.

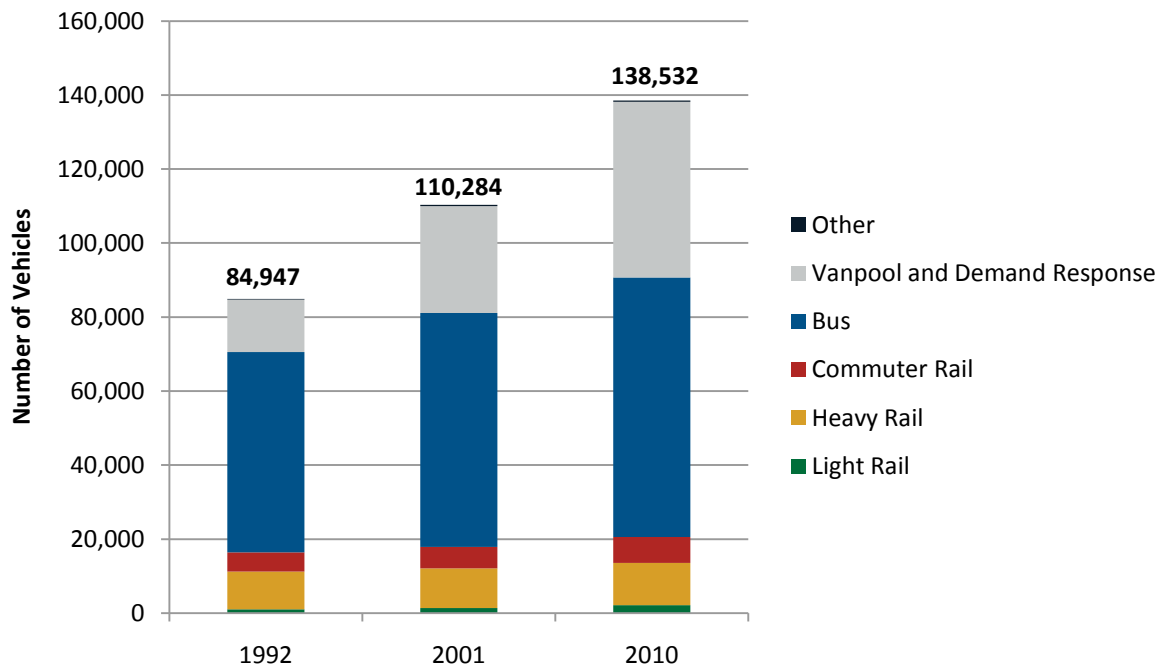
### 2.2.3 Light Rail Vehicle Fleets are Growing; Agencies are Now Managing Fleets of Different Ages

In June 2010, the level of capital investment required to attain and maintain a state of good repair for light rail transit assets was estimated to be \$3.6 billion. The newer systems like San Diego and Portland are now more than 20 years old, and the initial vehicle fleets are approaching or exceeding their useful lives. Nationally, the number of light rail transit systems and the size of the light rail fleet almost doubled between 1992 and 2010. During this time, the oldest vehicles remained in use while the new assets were being added to the fleet. This has created a mixed-aged fleet with vehicles at many different stages of their useful lives, sometimes being operated by the same agencies.<sup>3</sup>

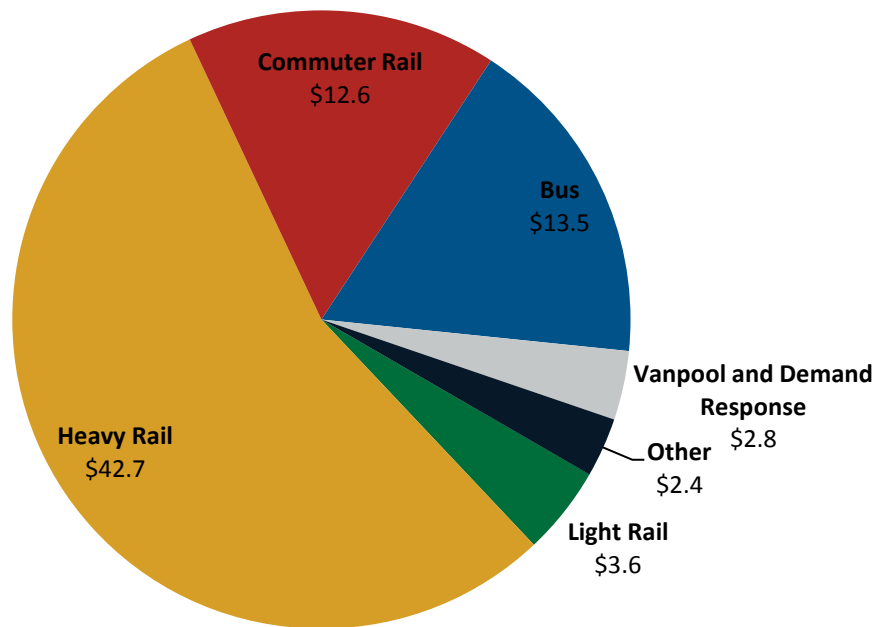
<sup>3</sup> National Transit Database. FTA. Accessed December 30, 2011. <http://www.ntdprogram.gov/ntdprogram>



**Figure 2-3. Growth in the Number of Vehicles in the Transit Fleet**



**Figure 2-4. Current (2010) Backlog of State of Good Repair Needs (shown in billions of 2009 \$)<sup>4</sup>**



<sup>4</sup> *National State of Good Repair Assessment*. Federal Transit Administration, 2010. page 19.

## 2.2.4 Heavy Rail Transit Assets are Being Used Longer Without Replacement

As of June 2010, the level of capital investment required to attain and maintain a state of good repair for heavy rail assets was projected to be \$42.7 billion. The number and types of systems have remained mostly the same while the average age of transit assets has gone up and down with large procurements of new vehicles by some agencies and few replacements by others. Because of the relatively longer in-service lives of heavy rail vehicles, procurement of new vehicles is infrequent, which has a significant impact on the overall age of the fleet. For example, in 2010 the average age of the assets on the two oldest systems was 36 and 39 years, respectively, meaning that these two systems will likely need to replace a substantial part of their fleets in the near future. Some systems' fleets have aged between 1992 and 2010 with no expansion or replenishment of new vehicles.

## 2.2.5 Commuter Rail Systems and Assets Have Grown, yet Conditions Have Remained Constant

Between 1992 and 2010, commuter rail systems grew by 33 percent, which means there was a significant growth in the number of commuter rail vehicles. The average age of commuter rail assets has fluctuated in that time but remained relatively the same as many of the systems have added new vehicles. As of June 2010, the level of capital investment required to attain and maintain a state of good repair for commuter rail assets was projected to be \$12.6 billion.

## 2.2.6 Quantity of Bus Assets is Growing and Average Retirement Age is Later than Intended

The average age of buses decreased from 8.1 years in 1992 to 7.4 years in 2010. Over the same time, the number of buses and transit systems grew by 25 percent. In its *Useful Life of Transit Buses and Vans* (2007), the FTA examined the optimal lifecycle for buses against how the bus fleet was actually being used. The study found that the average retirement age of 12-year/500,000-mile buses was 15.1 years—three years past the expected retirement age. Seventy-five percent of vehicles are 14 years or older when they are retired. The maintenance cost for vehicles beyond their recommended life is, on average, between 10 and 50 percent higher. The level of capital investment required to attain a state of good repair for bus assets was estimated to be \$13.5 billion.

## 2.2.7 Vanpool and Demand Response Operators and Assets have more than Doubled

Between 1992 (when transit agencies were just beginning to implement new or modify existing paratransit systems to meet the requirements of the Americans with Disabilities Act) and 2010, the number of vanpool and direct-response operators grew by 50 percent. Meanwhile, the number of assets in the fleet grew by 300 percent. This has been the fastest growth among any of the modes, showing the evolution of transit offerings over time. The backlog in maintenance was projected to be \$2.8 billion.

All modes of transit require continued asset management because of the direct link between age, condition, and maintenance costs of vehicles. As the number of agencies and the size of the fleet continue to increase, lifecycle asset management will be integral to cost-effectively maintaining the quality of public transit in the country. All transit agencies own assets and manage them, so they practice asset management in some fashion.

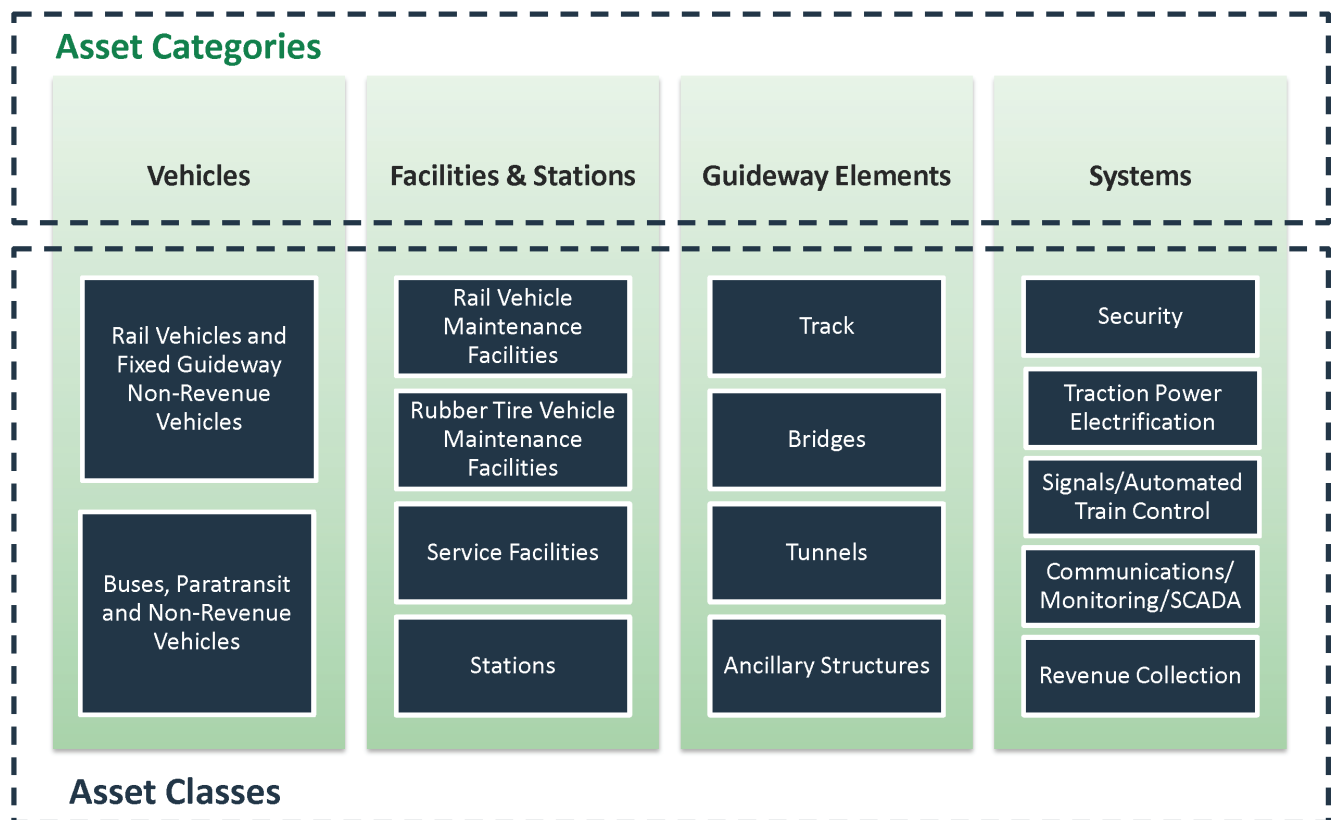
## 2.3 Transit Assets Defined

Transit assets include both fixed long-life infrastructure assets (including, for example, structures, tunnels, facilities, and maintenance of way) and equipment (that is, bus, rail, and paratransit rolling stock). This guide provides a transit-specific asset management framework for managing assets individually and as a portfolio of assets that comprise an integrated system. In this guide, transit assets include physical infrastructure elements,

equipment, and systems. Our definition of assets does not include “human capital” (the skills, training, goodwill and institutional memory of employees), financial assets, data/information, or intangible assets (for example, reputation, culture, and intellectual property). This guide also does not address roadway, park-and-rides, or administrative offices or other buildings whose lifecycle management requirements are not unique to the transit industry. It also does not include ferry or other maritime assets.

**Figure 2-5** provides the asset hierarchy used in this guide and provides a starting point to organize transit assets by broad asset categories (or groupings of asset classes, including vehicles and systems) and asset classes (or groupings of items with comparable asset management requirements, including track and signals).

**Figure 2-5.** Transit Asset Categories and Classes



Chapter 5 provides best practice guidance for the management of each of the asset classes, including peer examples.

## 2.4 Asset Management in Context

Asset management is an integral part of the business management of a transit agency. In a highly performing transit agency, asset management is a core strategic management process, along with risk management and performance management. Together, these are agency-wide management processes that support the accomplishment of the entire agency’s goals and objectives. None of the processes can be entirely effective without the others (**Figure 2-6**).

Asset management is most successful when it is integrated into an agency's existing management processes for establishing policy, strategy, and business plans, as well as connected to an agency's performance management and risk management processes. An agency's strategic plan is the starting point for developing asset management policy, strategy, and plan because the strategic plan provides the vision, mission, and values of the organization along with organizational goals, policies, and strategies. To be most effective, transit asset management activities should be integrated into existing strategic, business, and operational management processes.

**Figure 2-6.** Components of Agency Strategic Management



Asset management supports and enables the following elements of transit agency management:

- ▶ **Performance management focus:** Asset management integrates management activities across the agency's various functional areas to address customer level of service and performance outcomes.
- ▶ **Optimization of resources:** Asset management aligns investment decisions associated with operations and maintenance budgeting and capital programming to achieve levels of service that meet agency goals.
- ▶ **Fact-based management:** Asset management is data-driven and transparent.
- ▶ **Performance culture:** Asset management is outcome-based, establishes metric-driven management, and provides tools to adopt a "predict and prevent" or "reliability" culture as opposed to a "find and fix" culture.

## 2.5 Transit Asset Management Framework

The asset management framework in **Figure 2-7** offers a starting point from which to apply asset management concepts and implement the principles, processes, and practices depicted.

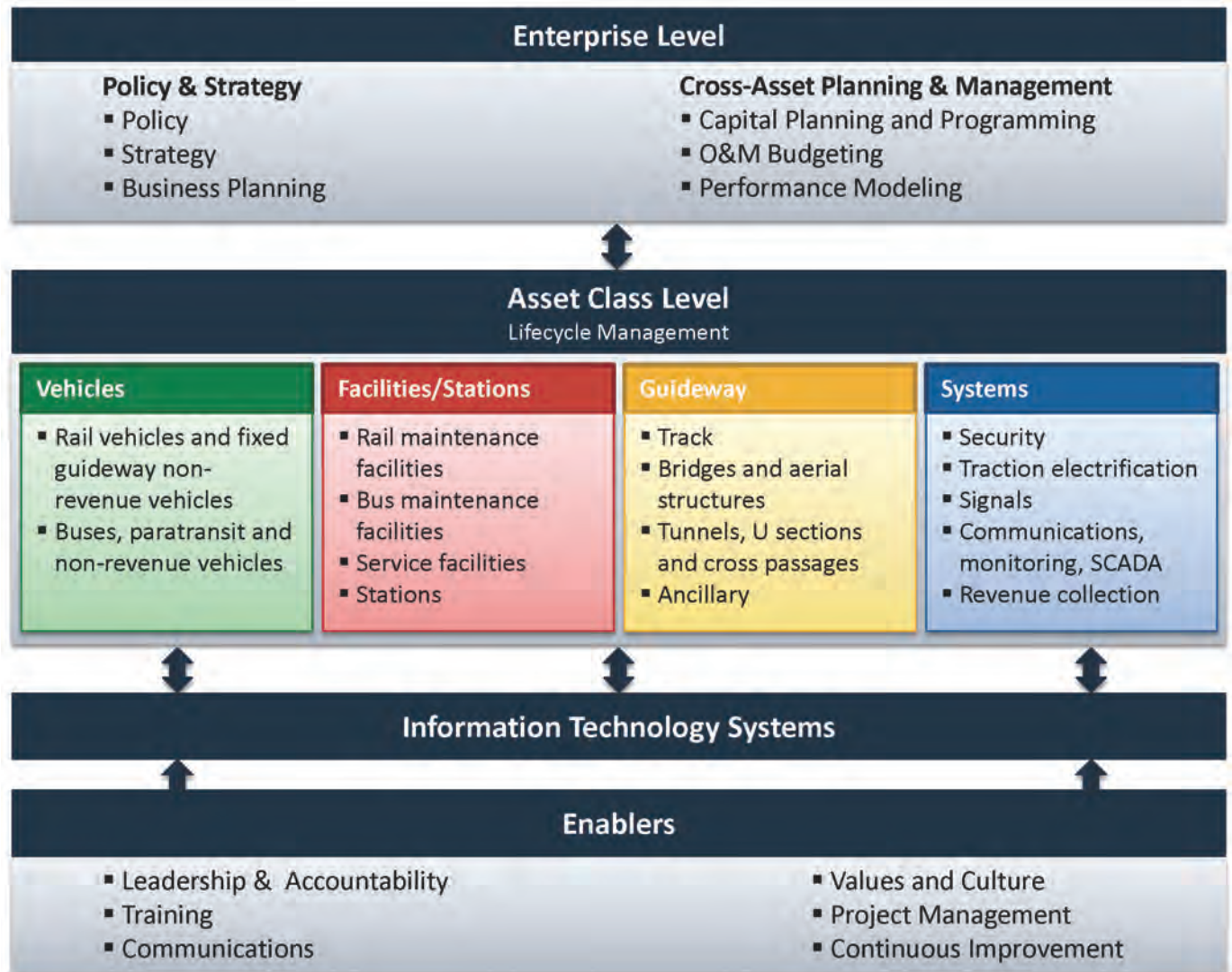
### 2.5.1 Asset Management Business Processes

The asset management framework depicts a complex set of business processes. The following sections and **Figure 2-8** introduce each of the three categories of business processes necessary to fully realize the benefits of asset management:

- Vision and Direction
- Lifecycle Management
- Cross-Asset Planning and Management

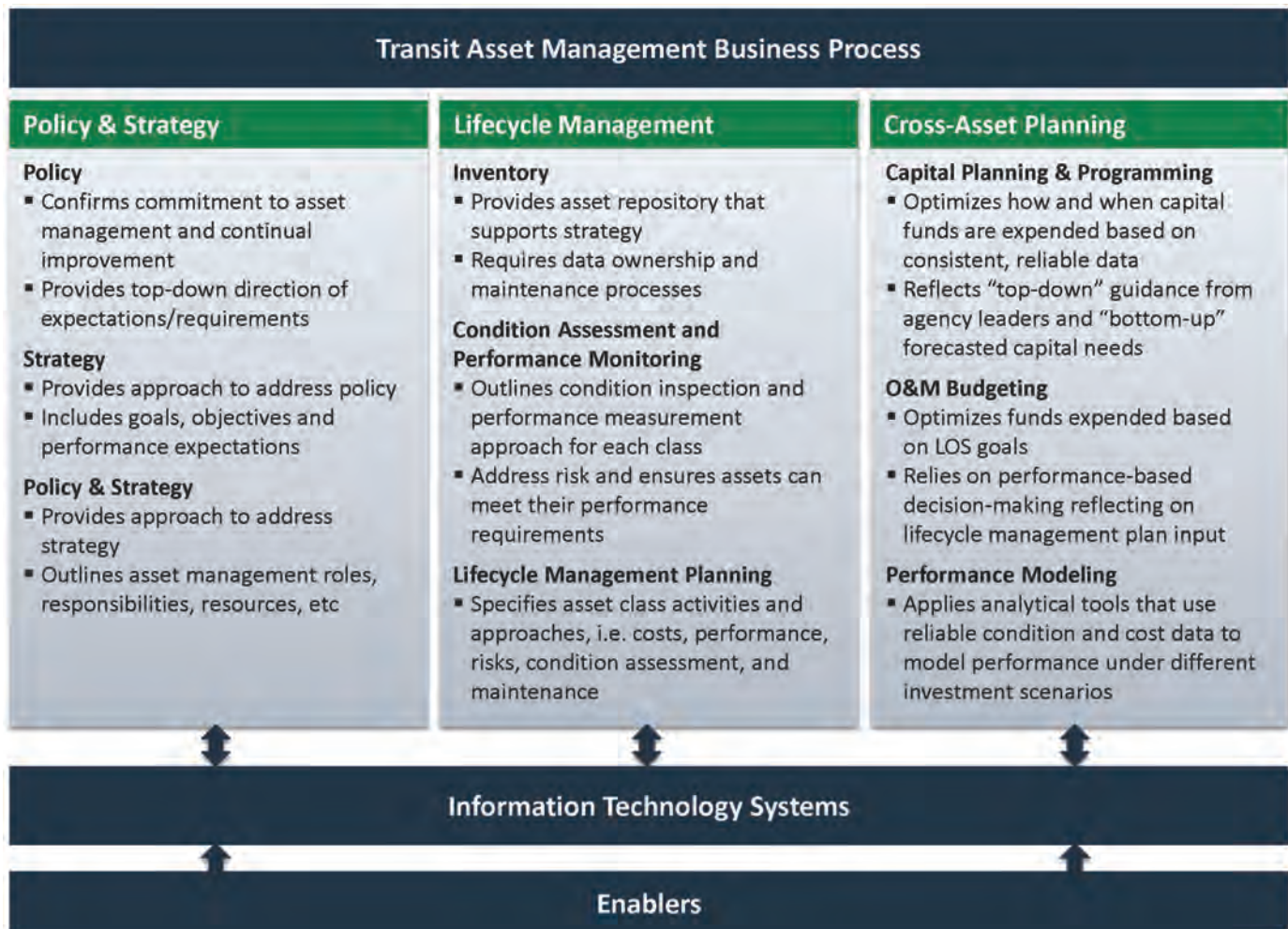
Detailed definitions, implementation guidance, and examples for each of these business processes can be found in Chapter 3. A brief introduction to the three categories of business processes are described below.

**Figure 2-7. Asset Management Framework**





**Figure 2-8.** Transit Asset Management Business Processes





## 2.5.2 Vision and Direction

An agency's existing policy and strategic planning processes provide the mechanisms to establish an asset management vision and direction. The key question to be addressed is: "What policy and strategic objectives should the asset management strategy advance?"

Asset management is most effective where there is a clear link between the agency's performance objectives and the goals and strategy set for asset management. Establishing an asset management policy and strategy helps to focus management and business processes on the agency's business objectives, which are usually the outcomes of most importance to customers (for example, safety, reliability, and cost effectiveness). This top-down connective thread is a key feature of an asset management system—the clear "line of sight" from organization direction and goals down to individual, day-to-day activities.<sup>5</sup>

Asset management planning is best addressed at the enterprise level as part of the agency's overall business planning. For agencies pursuing strategies to become better asset managers, asset management planning provides the implementation plan to accomplish this. This planning addresses coordination across departments to better work toward common goals. The asset management policy, strategy, and planning processes are discussed in more detail in Section 3.1.

## 2.5.3 Lifecycle Management

The lifecycle management of individual assets involves a common set of activities. Managers evaluate the lifecycle cost, condition, and performance of each class of assets—ideally during the design/procurement stage. They link lifecycle management expenditures, such as rehabilitation, preventive maintenance, and unplanned maintenance to asset performance such as mean time between failure and cost. This data-driven practice aims to maximize asset performance, minimize the total cost of ownership, and manage risks. These activities are common to all asset classes but differ in how they are performed, as discussed in the *Asset Management Guide Supplement*.

The common activities include the following:

- **Asset Inventory** – An asset inventory is a register, or repository, of an agency's assets and information about those assets. It is intended to provide accessible, consistent, and comprehensive information about that asset class. It is also intended to provide consistent information across all asset classes to support enterprise-level business processes, including capital programming and operations and maintenance budgeting.
- **Condition Assessment and Performance Monitoring** – Each asset class has different requirements for condition inspection and monitoring that depend on their performance characteristics, the risks, and impacts of failure. Gathering condition and performance data can be costly, so agencies often have strategic approaches to gathering the data that is most cost-effectively acquired and valuable. This information is used to improve reliability through an agency's ability to predict failure and address the root causes and proactively plan for the investments required to maintain good performance on the most critical assets. It also is used to manage risk and determine needs to be addressed in asset management plans.
- **Lifecycle Management Planning** – A lifecycle management plan documents the costs, performance, and risks associated with an asset class throughout its life. This plan can be used to ensure that the performance expectations of the asset are understood and fit within the agency's broader goals and performance objectives, and that all investment decisions are transparent, well-communicated, and support the agency's goals.

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<sup>5</sup> PAS55-2: 2008 Asset Management Part 2: Guidelines for the Application of PAS55-1, British Standards Institute, 2008

The lifecycle management processes are discussed in more detail in Section 3.2.

### 2.5.4 Cross-Asset Planning and Management

This guide incorporates asset management into a transit agency's enterprise-level decision-making processes, including capital planning and operations and maintenance budgeting. At the enterprise level, such plans are used to communicate the level of service that can be delivered at different funding levels, and make performance-based decisions in financially constrained capital plans and budgets. In this guide, a distinction is made between decision making across multiple asset classes—often referred to as “cross-asset” resource allocation—and the lifecycle management of particular asset classes. These processes combine asset data gathered and evaluated at the asset-class level for decision making at the enterprise level. For example, lifecycle cost and performance data gathered for railcars can be combined with comparable data for traction power systems to determine how capital and operations and maintenance funding should be programmed most effectively. Similarly, agencies can use asset condition data and other analysis in a predictive model to evaluate future costs and asset performance under different funding and level-of-service scenarios.

The asset management plan addresses cross-asset business processes, including capital planning and programming, operations and maintenance budgeting, and scenario evaluation and management described in more detail in Section 3.3.

## 2.6 Information Technology Systems

Information technology is a critical asset management enabler. Contemporary best practice—either at the enterprise level or during any aspect of lifecycle management for individual asset classes—is data driven and requires the application of information technologies. As explained in the asset management framework, information systems are foundational to any asset management initiative. Whether an agency is developing its asset inventory or using condition data over time for performance modeling, the asset data needs to be stored, managed, and analyzed in one or more information systems. Information systems can support all of the asset management business processes. Chapter 4 describes the use of asset management information systems and summarizes the implementation principles associated with these tools.

### Maintenance Management and Asset Management

The terms “maintenance management” and “asset management” are frequently used interchangeably in the industry when, in fact, they are separate. While the primary purpose of maintenance management is to manage maintenance activities (which activities are performed on which asset, cost of maintenance), the primary purpose of an asset management system is to provide a whole-life view of all assets, to allow monitoring, tracking, and analysis of how funding strategies affect asset condition, and to allow the agency to make policy and strategic decisions regarding funding (cross-asset decision making, investment decisions). Maintenance management is focused more on the short-term activities, while asset management is intended as a proactive approach to managing enterprise investments over the longer term. Maintenance management should be envisioned as a subset of asset management. The term “enterprise asset management” refers to asset management conducted at an enterprise level instead of just one section/ department of the agency/enterprise.

The maintenance management system, when integrated with business intelligence, condition tracking and forecasting, and other enterprise tools, forms a true enterprise asset management system/tool.

## 2.7 Other Enablers

Enablers are supportive processes and activities that are foundational items for a successful asset management initiative. Displayed as the bottom panel in the asset management framework, enablers ensure that the asset management business processes can be successful. Many of the enablers require dedicated resources (staff and/or funding); however, in many cases, they can be integrated into an agency's existing enabling processes. Enablers include leadership and accountability, training, communications, values and culture, project management, and continuous improvement. Enablers' importance and associated success factors are discussed in more detail in Chapter 5.

## 2.8 Asset Management and Sustainability

A sustainable institution supports the long-term viability of the community and environment. As such, sustainability represents a key subset of public transit's core mission. For transit agencies, sustainability aims to:

- Reduce resource use, pollution, and waste;
- Improve the efficiency of existing systems and processes;
- Establish transit as a central part of a robust set of sustainability transportation options;
- Support smart growth and livable communities.

These broad objectives represent another set of considerations for the management and operation of transit assets. At each stage in the asset lifecycle, sustainable asset management involves (1) using resources more efficiently to reduce the agency's environmental footprint, (2) managing waste responsibly, (3) building and supporting healthy spaces, and (4) planning for climate change. By focusing on these shared objectives, transit systems can benefit from energy price stability and cost savings, improved employee productivity, reliable service, improved integration of transportation modes, and supportive land use that provides mutual community benefits, aligned through a sustainability framework. The role of sustainability in asset management is discussed in more detail in the *Asset Management Guide Supplement*.

## 2.9 Strengthening Asset Management Practice – Implementation Principles

The fundamental concepts of asset management are straightforward; however, implementing the changes required to establish mature asset management processes can be challenging. Implementation requires managing across functional areas and integrating decision making across the life of often long-lasting assets. Strategies to consider to help meet these challenges are:

- **Understand an agency's asset management drivers** – Agencies undertake asset management for different reasons (response to a mandate, need for improved transparency, and need to improve performance, among others). Agencies should develop an implementation approach that maintains that focus; however, the approach should be flexible enough that it can shift as priorities change.
- **Build upon existing strengths and practices** – Agencies should leverage their departments' existing asset management activities, identifying their best practices and lessons learned with one asset class and applying them to others.

- **Provide value immediately** – Through incremental implementation activities, an agency can achieve results quickly that demonstrate the value of implementing improvements to asset management practice and provide momentum for future activities. A solid foundation can be created while still acknowledging the long-term nature of an asset management initiative.
- **Recognize that asset management is a process** – The guide identifies the core processes, which provide a starting point, but agencies should recognize the importance of continually improving processes and organizational learning.
- **Prioritize people, tools, and information** – Asset management, at its core, is about data-driven management, so managers should identify the people who can understand and lead this change initiative and the data and tools that best support the agency’s decision-making processes.
- **Invest smartly** – Identify the investments that will provide the best “bang for the buck” and only if these investments support the agency’s strategy.
- **Focus on human resources** – Identify the appropriate skillsets needed to implement the asset management strategy and invest in those people—with recognition, incentives, and training.
- **Assign clear ownership of asset management activities** – Agency leadership should provide top-down support to establish an asset management culture and mandate for managers, while asset owners should “own” and drive implementation by developing and implementing lifecycle management plans.

Chapter 5 provides guidance on implementation and resources, including an agency self-assessment from which to review “asset management maturity” and guidance for how to get started.

Improving asset management practices may seem too “long term” to be a priority, given the pressing, day-to-day operational realities and policy concerns; however, there are defined components with measurable outcomes that can put agencies on the path to a more business-like practice. This guide details these components and explains how an agency can implement them. This section describes the vision of a hypothetical agency after having successfully implemented asset management strategies. The following describes an agency—both before and after implementing the asset management strategy—from the perspective of many of the influenced stakeholders.

### General Manager

“As the General Manager, I have noticed a transformation in the culture of this agency. Inter-departmental meetings occur on a regular basis, staff members seem more invested in their jobs, and everything we do seems to have a basis in numbers—numbers that we actually trust! I can see that the employees understand how their job relates to our agency’s strategic objectives (better reliability, safety, and customer service). We better understand and are able to manage risk in each of these areas. My relationship with the board and other stakeholders seems to be improving every day, and our riders, generally, seem to be more satisfied.

This was an executive team initiative driven by our financial challenges and our desire to apply more business-like practices to improve performance. Together, we created a vision for how to change the agency so that our existing assets could be managed more effectively. We understood that it would require involvement and buy-in from staff in all departments and at all levels of the organization. It would also require some serious discussions with the Union, so we started the whole process by leading small workshops to get input from all of these people. Based on the discussions at these workshops, I created an asset management leadership team composed of staff from various departments that, from my point of view, seemed to “get” our vision. As a group, we evaluated our agency’s strengths, weaknesses, opportunities, and threats with regards to asset management. and in that regard, we developed goals that target safety, reliability, on-time performance, and cost

effectiveness. We talked about what kinds of performance measures would help us to see how we were doing in reaching our goals, and we developed a plan that outlined how to make it all happen.

Two years later, our agency is still working towards that vision, but we’ve come a long way. We take an entirely different approach to decision making. Now, we can pretty accurately predict all of our assets’ lifecycle costs because we involve engineering, operations, and maintenance people in developing asset-specific lifecycle plans for every asset class. We can show how an asset will under-perform without appropriate capital and maintenance investments. We also can show how this will impact our over-arching asset management goals. As time has gone by, all of our cost and performance data has gotten better and better. We understand our costs much better and have visibility to our future capital and operating expenditure needs.

All of this data has been put to good use. We manage based on what “we know” not “what we think we know.” Our operations and maintenance budget is built from the bottom-up based on real cost data that we trust, and our capital program is prioritized based on the needs that best serve the goals we established. Our staff members know and understand how their jobs relate to our overall goals, and they’ve got goals and performance evaluations that are supportive of these goals. Our Information Technology (IT) group has been a great partner in our recent successes. After mapping all of the systems and data that we were storing and maintaining in multiple locations, our IT group developed a strategy for integrating our asset inventory data and linking it to any tools that supported the analytics behind our asset management goals. Everything we did supported our goals in some way! Quantitative data (including both costs and performance data) are constantly being evaluated and updated in our asset management system. We know our predictive data will never be perfect, but operations, maintenance, and engineering staff are constantly looking for ways to improve it. Now, I can access high-level summary reports from our systems, and the maintenance group can download asset-specific maintenance and performance reports.

The asset management team continues to re-evaluate our strategy, monitor our performance

measures, offer training, and communicate with all of our departments. They know as well as I do that we can always do better, but we also know how far we've come!"

### Maintenance

"As the Chief Maintenance Officer, I was initially a bit skeptical about the asset management effort. We had pretty good, data-driven processes happening within our group before the asset management improvement effort was started. All of our maintenance jobs were tracked within a system, so we could tell you about every maintenance activity that occurred on all of the assets. Our maintenance managers usually noticed when we were fixing the same asset over and over, so we would request a replacement or a new manufacturer. We didn't really track the parts and supplies, but we have some very experienced mechanics who "just knew" when we needed to order supplies. I could always use more funding, but the finance group generally gave us the same amount each year. Also, I have a good relationship with the engineering and operations folks, so we would coordinate when we needed to.

Now that we've undergone all of this change, I can see why the asset management effort was important. Our group was keeping track of only the assets' maintenance costs. We never thought about it in terms of the overall cost and performance of the asset. Now, we have a "spot at the table" when our agency is introducing a new asset class or procuring something from a new manufacturer. We discuss the maintenance requirements of those assets and how capital investments throughout the assets' life can minimize the maintenance costs. We look at those kinds of decisions before we even procure the asset so that our finance people can make informed decisions later on. We are now exploring how to apply reliability-centered maintenance methods.

Also, our maintenance staff understands the importance of logging their activities, time spent, and the assets' condition as they complete their assignments. We share the performance reports with them, and they understand how their job contributes towards the assets' condition, which contributes to the assets' performance, which contributes towards the agency's goals. We

celebrate whenever we make big improvements or hit a target!

In addition, we are likely to realize savings as our spare ratio requirements are falling, and we are talking about how we've been able to realize millions of dollars in savings by taking advantage of our warranties. The transparency of our activities has given our group more credibility, so maintenance activities are now receiving a larger portion of the available funding."

### Engineering

"As the Chief of Engineering, I used to spend most of my days "fighting fires" and making sure that broken equipment was getting fixed as quickly as possible to minimize service disruptions. I used to get asked pretty regularly what my highest priority projects were because it was time for our annual capital planning process or because a grant became available. Thankfully, I have worked here long enough to know our highest priority needs, but I used to worry about what would happen when I and others retire in the next few years.

Since our asset management effort began, I've noticed that my job has changed significantly. We now have lifecycle management plans for all of our major asset classes, so I'm able to review all of the needs across the system and prioritize them with a clear rationale. I used to do this in my head before, which worked relatively well, but it wasn't very transparent. We now have a capital plan that clearly identifies where our priorities are in the short and long term. All of this information has actually helped to improve our procurement process as well. We're able to put much better definition around the scope of our needs (including asset condition and performance requirements), so contractors are able to provide us with better contract bids and design submittals.

Now that the board and others understand all of our project needs, we're actually getting more funding than before, so we have been able to address our backlog and proactively rehabilitate our assets based on their priority in the system. Our department still "fights fires," but we're doing that a lot less than before. I now feel like I could retire and a lot of my knowledge of the system is being preserved through updated asset management processes and tools.



## Operations

“As the Chief of Operations, I wasn’t sure how our group would be involved in the asset management strategy. I met with the Chief Maintenance Officer and Chief Engineer whenever we had consistent breakdowns or malfunctions. There’s a constant struggle over whether to spend capital money to replace an asset or spend operations and maintenance funds to maintain it.

Now, these decisions seem to be made entirely differently. Everyone, including the finance department, bases their decisions on performance. This means that, as an agency, we are looking very closely at whether we are meeting our pull-out schedule, how often there are failures or safety incidents, and what our customers are saying at public meetings and at our call-in center. We are quickly evaluating the source of our issues and measuring what the most cost-effective strategies are for improving our performance. I now have regularly-scheduled meetings with our maintenance and engineering folks, and these cross-departmental meetings are happening at the lower levels as well. Our operators are much happier and our on-time performance has improved significantly.”

## Capital Programming

“As the manager of Capital Programming, I am thrilled with the total transformation of our capital program prioritization process. For years, we have been trying to have a transparent, data-driven process for prioritizing the state-of-good-repair needs (our expansion needs are generally funded and prioritized separately). On an annual basis, our group would send out forms to each of the department heads so that they could list out all of their capital needs. We had significant issues trying to separate the highest need projects from the “wish list” projects, and we often had to trust what one or two managers told us. We also didn’t believe the cost estimates that were provided, since the majority of the projects ended up costing us a lot more than what we had budgeted. The worst part was that we would go through a tremendous effort to prioritize the needs as best as possible, and then our executive team would approve different projects!

Now the process is much more data-driven and transparent. We have outlined a clear process for identifying capital needs, getting input from all departments, prioritizing them based on our agency’s goals, and then letting the executive team make the final decision. The prioritization criteria are based on cost and performance data that are consistently compiled for all of the assets, so we’re able to compare assets throughout the organization. Also, our executive team understands the prioritization process and they trust the underlying data, so they generally support the recommended program that we develop. My team feels more connection to the agency, its goals, and the service we’re providing because we’re working so much better with the other departments and seeing our connection to the larger picture.”

## Long-Range Planning

“As the head of our long-range planning group, I was thrilled to be included in the asset management strategy. Our group regularly assesses the capacity requirements of our region—both in the short and long term—so it’s been helpful to participate in the asset lifecycle discussions. Most recently, the engineering group did not realize how our customer demand has been shifting and how that could influence the vehicle procurement. This led to a complete change in the size and type of vehicles being procured. I have also found that our group now incorporates much better asset lifecycle data into our expansion plans, which seems to have made them much more accurate than before. I can actually see how these cross-departmental discussions and data sharing are directly improving service to our customers.”

## Finance

“As the Chief Financial Officer, I am excited by how the asset management strategy has transformed the way we handle all of our financial activities. Generally, the department heads used to come to us when they had financial needs and we went to them when we needed information to support our budgeting processes. Now, our financial activities are much more closely tied to their processes, and we all understand how our decisions impact the agency’s goals. The operations and maintenance budget is

based on engineering and maintenance cost forecasts developed through the asset lifecycle management process. Our accounting system now receives information from the centralized asset inventory, so the accounting staff no longer needs to chase down paper records or asset managers to address accounting requirements. The biggest difference is that staffs understand how we're making financial decisions, so we're all functioning like a team."

### Board Member

"As a board member, I have been very impressed by the improved transparency and communications. We expect the agency to apply best practices, learn from other industries, and improve performance. I understand the importance of asset management in accomplishing this. At our board meetings, the

General Manager has been sharing performance reports that include explanations and mitigation strategies for all performance measures that are below our agency targets. We are seeing general improvements in all of our goals, and we understand the importance of additional funding in continuing this trend. This additional information has forced us to shift our focus from expansion to our existing assets."

### Customers

"As a regular rider, I have noticed significant changes in the transit system. The buses seem to be a lot more reliable; they show up when I expect them to, and they seem to be a lot cleaner than they were before. I feel more comfortable relying on the transit system to get me to where I'm going when I need to get there."



## Chapter 3

### Asset Management Framework Business Processes

*This chapter describes each business process in the transit asset management framework introduced in Chapter 2. For each business process, this chapter describes what best practice looks like, key implementation activities and challenges, and peer examples.*

The transit asset management framework has three categories of business processes (see **Figure 3-1**):

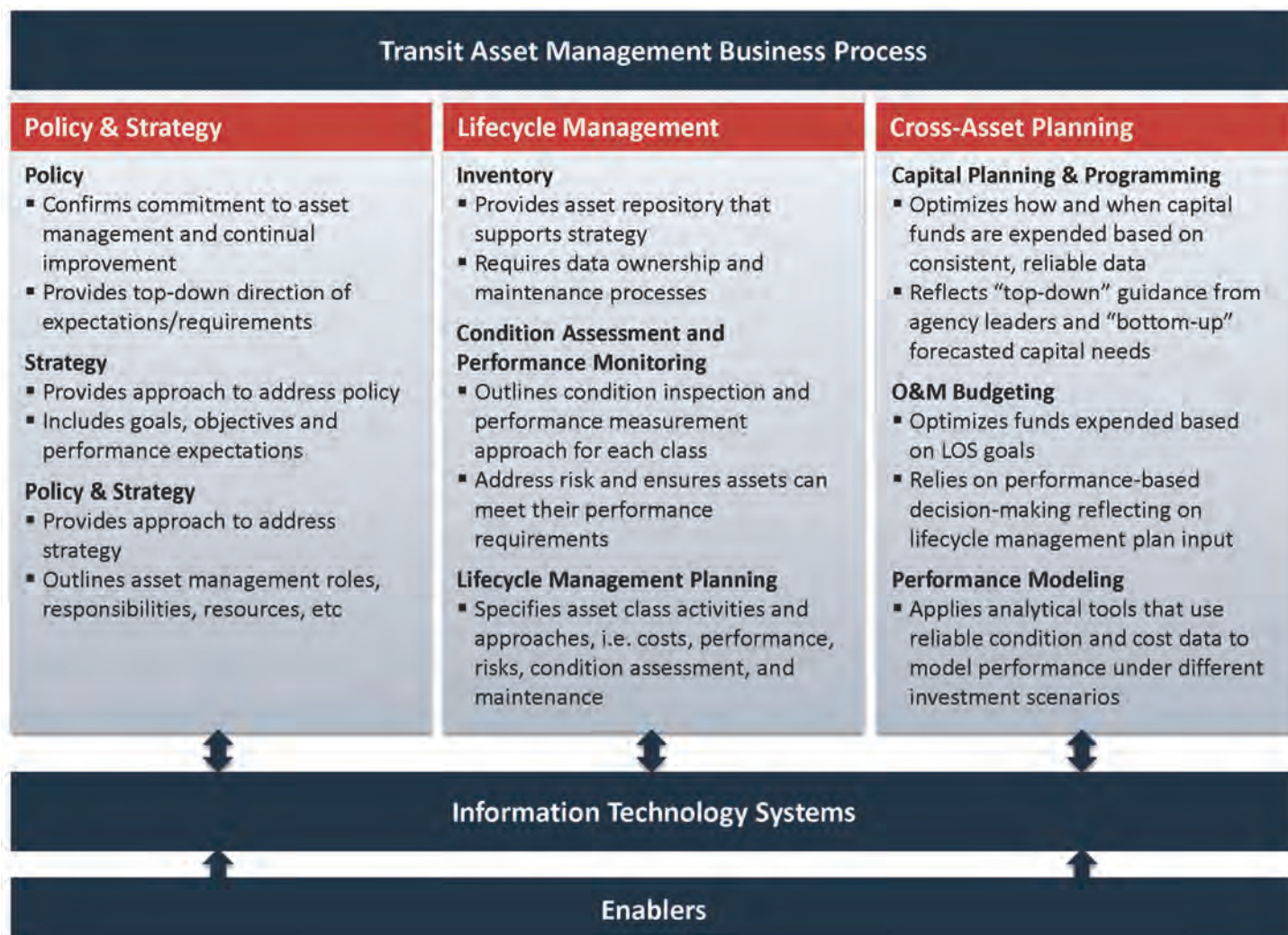
1. **Asset Management Vision and Direction** – These are agency-wide processes that establish the organization-wide asset management policy and strategy and drive resource allocation.
2. **Lifecycle Management** – These are the processes involved in the lifecycle management of individual asset classes. These include managing the data (inventory), monitoring the assets' condition and performance, and developing lifecycle management plans.
3. **Cross-Asset Planning and Management** – These are agency-wide processes that consider information from all asset classes to support the capital programming and operations and maintenance budgeting process.

Each of these categories of business processes are described in more detail in this chapter.<sup>1</sup>

<sup>1</sup> "Information Technology Systems" are discussed in Chapter 4 and "Enablers" are discussed in Chapter 5.



**Figure 3-1.** Transit Asset Management Framework Business Processes



## 3.1 Asset Management Vision and Direction

When effectively integrated into an agency's business practices, transit asset management crosses functional boundaries, such as operations, engineering, planning, and finance. It requires managing across classes of assets (including buses, rail maintenance facilities, and bridges) and looking beyond the current budget cycle.

Institutionalizing asset management and establishing an asset management culture through a clear, consistent policy and strategy is a critical component of the successful leadership and management of a transit agency. This is best accomplished when an agency's existing policy and strategic planning processes provide the mechanisms to establish an agency-wide asset management policy, strategy, and plan that address implementation responsibilities and accountability.

Asset management policy and strategy are typically set by executive management and adopted by the agency's governing body. These may be incorporated into an agency's existing policies and strategies or developed independently. The asset management plan can then be developed to include implementing actions that address the asset management policy and strategy.

Transit agencies' management processes have traditionally been siloed into functional areas and technical disciplines. For example, design decisions do not always address input from the operations department regarding actual operating costs. Similarly, capital investment decisions are sometimes made without consideration of the maintenance implications. Policy and strategy are important in setting expectations for managing across silos and set the tone from which to establish a strong asset management culture. They provide a link to planning, budgets, and day-to-day work performed across all departments. The roles of asset management policy, strategy, and planning are shown in **Table 3-1** and discussed in the following sections.

**Figure 3-2.** Asset Management Vision and Direction Business Processes

### Policy & Strategy

#### Policy

- Confirms commitment to asset management and continual improvement
- Provides top-down direction of expectations/requirements

#### Strategy

- Provides approach to address policy
- Includes goals, objectives and performance expectations

#### Policy & Strategy

- Provides approach to address strategy
- Outlines asset management roles, responsibilities, resources, etc



**Table 3-1.** Asset Management Policy, Strategy, and Plan – Definitions and Contents

	Policy	Strategy	Plan
<b>What is it?</b>	<ul style="list-style-type: none"> <li>Confirms agency's commitment to asset management and continual improvement.</li> <li>Provides top-down direction regarding expectations and mandatory requirements.</li> <li>Broadly outlines the scope of asset management through enterprise-level asset management direction.</li> <li>Links asset management to agency vision, mission, and goals.</li> <li>Specifies expectations for the role, focus, and level of asset management practice.</li> <li>May establish broad agency policy statements for asset management, such as: <ul style="list-style-type: none"> <li>Optimizing the use of funds across an asset's lifecycle</li> <li>Improving agency-wide reliability</li> <li>Incorporating environmental sustainability goals into asset decision making.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Outlines the agency approach for accomplishing the asset management policy.</li> <li>Addresses organization, business processes, and tools.</li> <li>Includes specific, measurable business objectives (for example, reliability, cost of service, such as <i>Increase the percentage of agency assets with a condition rating over 2.5 (out of 5) to 80% of all assets by the end of 2015.</i></li> <li>Provides high-level direction and expectation for asset management by asset class and functional managers.</li> <li>Provides clear direction for prioritization process.</li> </ul>	<ul style="list-style-type: none"> <li>Specifies the activities to be pursued to address policy and strategy.</li> <li>Sets performance management expectations for the various business areas in terms of preparing and implementing lifecycle management plans and delivering asset performance.</li> <li>Specifies implementing actions for improving asset management practice and increasing asset management maturity.</li> </ul>
<b>Typical Contents?</b>	<ul style="list-style-type: none"> <li>Organizational context (overall vision, mission, and strategic goals) and goals and roles for asset management</li> <li>Consideration of any mandatory asset management requirements (those things an agency establishes by policy as mandatory)</li> </ul>	<ul style="list-style-type: none"> <li>Asset management objectives and expected outcomes</li> <li>High-level description of asset management activities (people, information systems, processes, etc.), timelines, and responsibilities</li> <li>Asset management relationship to delivery of service and other business processes</li> <li>Asset management approach to stakeholder consultation</li> </ul>	<ul style="list-style-type: none"> <li>Detailed asset management activities, roles, and responsibilities, resources, and timelines</li> <li>Requirements and plan for developing asset-specific lifecycle management plans</li> <li>Process and tools required to manage and store asset data</li> <li>Asset management continuous improvement strategy activities, including resources and timelines. This includes enterprise-wide and asset-class specific improvement projects</li> </ul>

### 3.1.1 Role of Asset Management Policy

An asset management policy provides top-down direction for the entire agency. This direction can be vital for an asset management initiative because, depending on the selected implementation path, it can require organization-wide change. To be most effective, asset management policy provides specific, mandatory direction and guidance to be addressed in transit agency strategic planning, business plans, and day-to-day decision making.

An asset management policy is highly visible, frequently referenced, and used by leadership to communicate the direction and expectations for an organization; it is established alongside and with the same level of specificity as other agency policies. The policy addresses the role of asset management in gauging agency performance and meeting level-of-service objectives, and it broadly outlines the scope of asset management by providing the appropriate focus and expected level of asset management practice. In an agency with many different asset classes, policies provide expectations for consistent management practice across asset classes.

#### Asset management policy success factors:

- ▶ Highly visible and used by leadership to provide direction and guidance for all asset management strategy and activities
- ▶ Addressed in agency's policy and goal setting processes
- ▶ Adopted and integrated into agency's Strategic Plan
- ▶ Adopted and integrated into capital, operations and maintenance standard operating procedures
- ▶ Integrated into agency talent management and training efforts

The benefits associated with having an asset management policy include the following:

- Communicates agency's commitment to asset management
- Facilitates establishment of a culture that values asset management and makes it a priority
- Embeds asset management responsibilities and accountabilities into strategic planning activities
- Provides leadership and direction and builds a culture favorable to embedding asset management into ongoing capital, operations, and maintenance activities

Key implementation principles associated with the establishment of an asset management policy include the following:

- Policies are not just words—they communicate leadership directions, expectations, and agency requirements for success.
- Policies not only support an agency's goals, but also address the role of asset management in meeting the agency's objectives.
- Policies consider regulations and other business requirements established by outside entities (for example, the federal government, state government, city agencies, and lending institutions among others) that may or may not support the asset management goals.
- For each asset management policy, the agency understands its purpose and impact on goals, and how to ensure that it is followed.
- Agency management, staff, and the board have the opportunity to provide input and understand implications of the asset management policy.
- Broad participation and input to asset management policy is sought from management, staff, risk managers and other stakeholders, and the board. These parties are then engaged in the process, have a thorough understanding of the agency's processes, and are supportive of potential funding requests that may result.

### 3.1.2 Role of Asset Management Strategy

The asset management strategy addresses how the policy will be implemented. This guide considers establishing an asset management strategy to be an important driver of change that sets direction. Strategy is implemented through annual business planning and performance management practices. Specifying measurable objectives that are to be accomplished through the strategy provides accountability and focus for business planning and agency management. The strategy needs to be communicated clearly, and the relationship to other enterprise-level management processes, such as performance management, needs to be understood within the agency.

The asset management strategy includes high-level descriptions of the asset management activities necessary to address the asset management policies. The description of these activities includes an overview of the agency's staff, information systems, and business processes. While the plan addresses the day-to-day responsibilities and requirements, the asset management strategy highlights the overall timelines and milestones to be achieved, the relationships between various business processes, and the inputs and priorities for the budgeting process.

Examples of asset management policies are outlined below:

"Develop a comprehensive program that emphasizes cost-effectively extending the useful life of equipment, fleet, and facilities, and making capital replacement expenditures only when cost of maintenance warrants the expenditure."

—U.S. Transit Agency (Source: 2011 Parsons Brinckerhoff Survey)

"Our 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 lifecycle decisions for operations, maintenance and construction business functions." —U.S. State Department of Transportation (Source: AASHTO Asset Management Guide)

With a tag line of "fix it first," [the Agency] "will prioritize maintenance and capital reinvestment of its current system over major system expansion." —U.S. Transit Agency (Source: 2011 Parsons Brinckerhoff Survey)

The strategy includes realistic, achievable asset management objectives with the following attributes:

- **Specific** – Objectives are clearly described with details regarding what is to be accomplished, for what purpose, during what time period, and within what boundaries. (*What do I want to accomplish? Why do I want to accomplish it? Who is involved? How will it get done and when?*)
- **Measurable** – Objectives are able to be evaluated according to whether they have been achieved. (*How will I know I've accomplished my objectives?*)
- **Attainable** – Objectives are realistic and attainable under "normal" circumstances (including existing resources). (*How can these objectives be accomplished?*)
- **Relevant** – Objectives are supported, believed, and add value for the appropriate stakeholders. (*Are the participants willing and able to support these objectives?*)
- **Time-Constrained** – Objectives have a targeted completion date for the purpose of establishing urgency. (*When should these objectives be completed?*)

Rolling out an asset management strategy requires agency-wide change, which relies on leadership that can manage across traditionally siloed business processes.

The benefits associated with having an asset management strategy include the following:

- Sets agency-wide vision and direction that enables management across functions and different services
- Provides guidance and justification for investment decisions
- Establishes accountability and performance management expectations

“Implementing an asset management strategy at our agency is a goal that has been formally adopted by the Board of Directors. Having this direction coming from the Board conveys its importance.” —*U.S. Transit Agency Manager*  
(Source: 2011 Parsons Brinckerhoff Survey)

Key implementation principles associated with the establishment of an asset management strategy include the following:

- The asset management strategy is communicated clearly and articulated by leadership so that management, supervisors, and employees at all levels are able to understand and relate their responsibilities to strategy.
- The asset management strategy is developed in the context of performance and risk management, and by setting the level and quality of service objectives.
- The asset management strategy reflects input from relevant internal and external stakeholders to ensure that the strategy is clear, attainable, and most importantly, that these stakeholders feel buy-in towards achieving the strategy.

Examples of asset management objectives include the following:

- ▶ Increase on-time performance (defined as number of vehicles that pull out of maintenance facility within 2 minutes of scheduled departure time) to 90 percent for all modes by June 2014.
- ▶ Maintain customer service with elevator and escalator uptime at 99 percent throughout fiscal year 2014.
- ▶ Increase our customer satisfaction score by 20 percent in fiscal year 2013.
- ▶ Decrease number of safety incidents (measured per 1,000 vehicle-miles traveled) by 5 percent in fiscal year 2013.
- ▶ Decrease system maintenance time to 10 minutes or less on all lines in fiscal year 2013 (measured based on travel time impacts of slowdowns caused by track condition).
- ▶ Increase the percentage of agency assets in a “state of good repair” (that is condition rating over 2.5) to 80 percent of all assets by the end of 2015.

## Relevance of Case Study

This case study demonstrates how a highly mature asset management transit agency revolves all asset management activities and decision making around a clear, communicated strategy with associated measures.

## Agency Overview

London Underground (LU) operates “the Underground” or “the Tube,” providing metropolitan rail service for approximately 1.01 billion passengers per year. It is a subsidiary of Transport for London (TfL), which is responsible for London-area transportation services (urban and suburban). According to the Federal Transit Administration’s review of transit asset management practices, the LU has the following assets:

- ▶ 11 tube lines
- ▶ 243 miles of track
- ▶ 276 stations
- ▶ 4,070 rail cars

In 2003, elements of the LU operation were effectively privatized and divided into three private-sector infrastructure companies (InfraCos) that were managed by two providers: Tube Lines and Metronet. The InfraCos signed contracts for the maintenance, renewal, and upgrades of the rolling stock and infrastructure, including trains, tracks, tunnels, signals, and stations for a 30-year period. In 2006, Metronet went bankrupt, prompting the LU to take over management of two of the three InfraCos; in 2010, Tube Lines withdrew from the contract, selling its interests to TfL.

## Asset Management Approach

London Underground strives to uphold the asset management objectives of TfL, which include “ensuring current service levels are supported” and “achieving a state of good repair, addressing a backlog of maintenance or asset replacement.” LU established asset management measures in the following areas:

- ▶ Ambience (comfort/amenities) of trains and stations
- ▶ Availability of the infrastructure, with loss of availability measured by lost customer hours

- ▶ Capability of the infrastructure to provide service, measured by passenger journey time
- ▶ Fault rectification (resolution), measured by response time established by type of defect

London Underground’s business strategy optimizes maintenance and asset replacement by maintaining and replacing assets based on the practice of “best whole-life asset management.” Using the “best whole-life” management concept allows the LU to purchase and maintain its assets based on an understanding of the cost of ownership across the entire lifecycle of each asset.

London Underground has developed a system for measuring asset performance that helps to prioritize investments and streamline maintenance across the agency. Asset performance is reviewed every four weeks at an Asset Performance Review Maintenance meeting. Key measures include mean time and mean distance between in-service failures, as well as lost customer hours. Asset condition is summarized by the percentage of assets in each of four different residual life categories:

- ▶ Category A assets are estimated to have at least 10 years of residual life.
- ▶ Category B assets are estimated to have 6 to 10 years of residual life.
- ▶ Category C assets are estimated to have 1 to 5 years of residual life.
- ▶ Category D assets are estimated to require overhaul or replacement in less than 1 year or are time expired.

Any concerns (risks) relating to the condition of the assets are quantified financially and categorized between 1 and 4 relating to statutory non-compliance, safety, requiring extraordinary maintenance, or having a performance impact, respectively.

It is up to managers to understand the strategies for the assets that they are responsible for and communicate with their direct reports accordingly. Employees have access to business scorecards that have a series of measures, which, if delivered, will result in the successful delivery of the asset management plan. These are reviewed with employees on a daily, weekly, and monthly basis.



## Benefits/ Outcomes

- ▶ Capital and operating funding is directed at the assets and associated projects that have the greatest impact on our strategic objectives (e.g., customer service).
- ▶ London Underground takes performance and safety risks into account, which creates a focus on future performance that allows asset managers to optimize expenditures between different asset groups.
- ▶ Improved asset management processes have ensured a clear line between the agency's overall strategy, the asset management plan, and front line delivery.

## Source

Information provided by senior contact at the TfL.

### 3.1.3 Role of Asset Management Planning

Asset management planning is a process that establishes the activities necessary to address policy and strategy at the enterprise level and asset class level. At the enterprise level, the plan provides direction for cross-asset business processes. At the asset class level, the plan provides direction to line managers regarding oversight and accountabilities associated with their respective asset classes. An asset management plan is incorporated into the agency's annual planning and budgeting.

In this guide, the asset management plan addresses asset management processes, activities, tools, and annual asset management work planning and budgeting. The guide includes implementation plans for change initiatives that will improve asset management practice and maturity. This is distinct from the lifecycle management plan, which is the plan for the lifecycle management of asset classes and their integrated management (see the *Asset Management Guide Supplement*).

An asset management plan outlines the activities that will be implemented and resources applied to address the asset management policy and strategy. For transit agencies using this guide, the plan will address the activities and changes to be implemented to increase the maturity of asset management practice.

Asset management plans have two major components:

- Enterprise-wide implementation actions that provide enabling support and direction for asset management across all asset classes and services.
- Direction and expectations for asset class owners and department managers regarding lifecycle management planning and processes—with a focus on the lifecycle management plans (see Section 3.2.3).

"An asset management plan, even when complete, needs to be dynamic because the agency will evolve over time."  
—U.S. Transit Agency Manager (Source: 2011 Parsons Brinckerhoff Survey)

The plan outlines how people, processes, and tools come together to address the asset management policy and goals. The plan provides accountability and visibility for increasing the maturity of asset management practices, and can be used to support planning and budgeting activities, communicating to internal and external stakeholders, and as an accountability mechanism. **Table 3-2** provides the recommended contents of an asset management plan.

Benefits of having an asset management plan include the following:

- Increases the maturity of asset management practice, which can improve the agency's performance
- Improves stakeholder relations and accountability
- Establishes accountability for implementation

**Table 3-2. Asset Management Plan Contents**

Section Name	Contents Description
<b>Asset Management Policy and Strategy</b> (What are the asset management goals?)	States asset management policy and strategy and describes process for developing these. It also explains the relationship to agency-wide policies and strategies. This section explains the past year's accomplishments and planned progress toward goals and objectives.
<b>Implementation Strategy</b> (What needs to happen to implement asset management strategy?)	Outlines a plan showing the activities necessary to achieve the asset management goals (including all aspects of change management). This plan outlines a schedule with roles, responsibilities, accountabilities, tasks, and dependencies.
<b>Key Asset Management Activities</b> (What will be accomplished in the next year?)	Lists the key asset management activities that are planned to be accomplished in the upcoming year. If appropriate, this can be where the selected implementation path (see Chapter 5) is described. <i>Examples of activities include combine three departments' asset inventories, develop a lifecycle management template and populate it with information from three most-critical asset classes, or hire asset management program manager.</i>
<b>Financial Requirements</b> (What are the estimated capital and operations and maintenance costs?)	Specifies the resources (including internal staff time, consultant time, technology requirements, and materials) needed to develop and implement this plan. This information should be easily transferred to the agency's capital program or operations and maintenance budget, as required.
<b>Continuous Improvement</b> (How can we ensure we continue to get better at asset management?)	Outlines how this plan and all related business processes will be revisited and updated, as needed, to ensure that the organization is embracing continuous improvement of the asset management initiative.

Key implementation principles associated with the establishment of an asset management plan include the following:

- The plan is part of the agency's business planning processes (such as strategic planning or capital planning) and provides the process through which implementation budgets and accountabilities are established. This process addresses dependencies, including reliance on the hiring of new staff, funding availability, or software development. It also reconciles asset management priorities against other agency initiatives.
- Implementing activities are based on an assessment of how well they accomplish the business objectives. To the extent possible, the activities address specific problems or deficiencies that improve performance.
- The plan is established by a cross-functional team of managers (see Chapter 5) and is updated annually (or more frequently if it is newly developed or if there are significant asset management activities occurring in a shorter time period). The plan includes input from leaders from all affected departments and is approved based on the established accountability structures.

#### Asset management plan success factors:

- ▶ Commits the resources for asset management activities needed to address policy and strategy at the enterprise and asset class levels
- ▶ Links the organization's main business processes, including the performance management, risk management, and budget processes
- ▶ Provides specific accountabilities regarding scope and timing for implementation activities

## Relevance of Case Study

This case study demonstrates how a transit agency uses an asset management plan to plan and communicate the agency's asset management goals, how they are measured, and how asset data feeds into the capital program.

## Agency Overview

King County Metro Transit (Metro) provides bus service to all of King County, including the city of Seattle, and operates the Downtown Seattle Transit Tunnel, which is used by Metro and Sound Transit buses and Sound Transit light rail vehicles on the Central Link transit line. Metro acts as the operator of the Central Link line for Sound Transit. Metro's average daily ridership is more than 400,000 passengers and its assets include the following:

- ▶ More than 1,300 vehicles
- ▶ 130 park & ride lots
- ▶ 13 transit centers
- ▶ 7 operations and maintenance bases
- ▶ 6 support facilities
- ▶ 71 miles of trolley overhead wire
- ▶ 1 transit tunnel with 5 stations

## Asset Management Experience

In Washington State, as a condition of receiving state funds, publicly owned transit systems are required to submit a transit asset management plan (TAMP) to the Washington State Transportation Commission for certification. The plan must inventory all transportation system fixed assets and provide a preservation plan based on lowest lifecycle cost methodologies. The TAMP specifies actions necessary within a six-year window to maintain a state of good repair for Metro's fixed assets and includes the following:

- ▶ Mission statement
- ▶ Inventory of assets and definition of "state of good repair"
- ▶ Roles and responsibilities
- ▶ Related business processes, including condition reporting and capital program prioritization
- ▶ Asset management work plan, including budget and timeline

Within the current capital improvement period (2012–2017), TAMP expenditures will exceed \$10 million per year. The TAMP currently does not fully incorporate all asset information about the Downtown Seattle Transit Tunnel or the newly built structured parking garages. The TAMP also does not include the following asset categories: IT systems (hardware and software), revenue vehicles, and non-revenue vehicles.

The goals of Metro's asset management program are to "preserve existing King County Transit infrastructure and equipment to accomplish the purpose(s) for which they were constructed or purchased," and to "replace equipment and/or infrastructure as indicated by the facilities and equipment assessment, life cycle projections, condition inspections and maintenance reporting."

Metro defines a state of good repair as follows: "An asset is determined to be in a state of good repair when the evaluated asset (system, equipment, or component) is in a condition where/when it can continue to meet and perform adequately for the purpose to which it was acquired and be safely operated and maintained within the parameters set forth by the manufacturer." Assets included in the six-year window are inspected annually at a component and subcomponent level. Clear policies are in place for inspection, maintenance, and rehabilitation practices.

Metro produces an annual Facilities Condition Report (FCR). The FCR documents inspection results and project recommendations for replacement or refurbishment of fixed assets. The FCR is used in conjunction with maintenance records and information on asset lifecycles to determine the optimum timing for assets replacement. Metro annually selects projects from the FCR to include in its capital plan. A team approach is used to develop the FCR and prioritize project implementation. Team members are included from facilities management (the team lead), engineering, design, construction, project management, and budgeting. Also, the team solicits input from stakeholders, including operations and maintenance, long-term planning, and service planning.

## Benefits/ Outcomes

The TAMP has provided Metro with the following:

- ▶ Better understanding of assets' conditions
- ▶ Better-identified capital needs
- ▶ Better-informed investments (rational decision making and the best use of available funds and personnel)

- ▶ Increased staff understanding of the investments required to achieve a state of good repair
- ▶ Cost-effective management of assets (according to Metro's current knowledge)

## Sources and Other Resources

Information provided by senior contact at King County.



## 3.2 Lifecycle Management

This section describes a common set of processes that support lifecycle management for each class of transit assets. Lifecycle management is foundational for asset management; it involves inventorying, condition assessment and performance monitoring, and establishing lifecycle management plans for each set of assets (see **Figure 3-3**). These processes provide the building blocks for a data-driven approach to asset management by providing information on the relationships between work performed and expenditures on assets over their lifecycle and service outcomes.

The activities undertaken to implement these processes will differ between asset classes and agencies. The *Asset Management Guide Supplement* provides guidance, standards of practice, and best-practice examples on each of the lifecycle management processes for each major asset class, including, for example, rail vehicles, maintenance facilities, and security systems.

### 3.2.1 Role of Asset Inventorying

The asset inventory process is the approach a transit agency takes in maintaining a register of the assets it owns or is responsible for maintaining. An asset inventory is the first step in organizing and managing asset information. This guide emphasizes the importance of having a process to determine what should constitute the asset inventory, how the inventory should be organized, and the critical information that is needed to manage the items in the asset inventory over their lifecycle.

Regardless of an agency's asset management maturity, the inventory process is foundational. Asset management uses data from the inventory, including descriptive characteristics (such as estimated useful life, estimated remaining useful life, location, year of purchase, cost, quantity, condition, and maintenance history) to support decision making. The asset inventory process provides data that can be used to support asset class-specific

A mature asset management agency will have a managed process for inventory, condition assessment and performance analysis, and asset management plans in place for each asset class.

The asset inventory is structured to include a hierarchy of assets that comprise a specific asset class. The asset inventory and the associated asset hierarchy can provide the common basis for integrating this information and using it for multiple purposes across the agency.

**Figure 3-3.** Lifecycle Management Business Processes

### Lifecycle Management

#### Inventory

- Provides asset repository that supports strategy
- Requires data ownership and maintenance processes

#### Condition Assessment and Performance Monitoring

- Outlines condition inspection and performance measurement approach for each class
- Address risk and ensures assets can meet their performance requirements

#### Lifecycle Management Planning

- Specifies asset class activities and approaches, i.e. costs, performance, risks, condition assessment, and maintenance

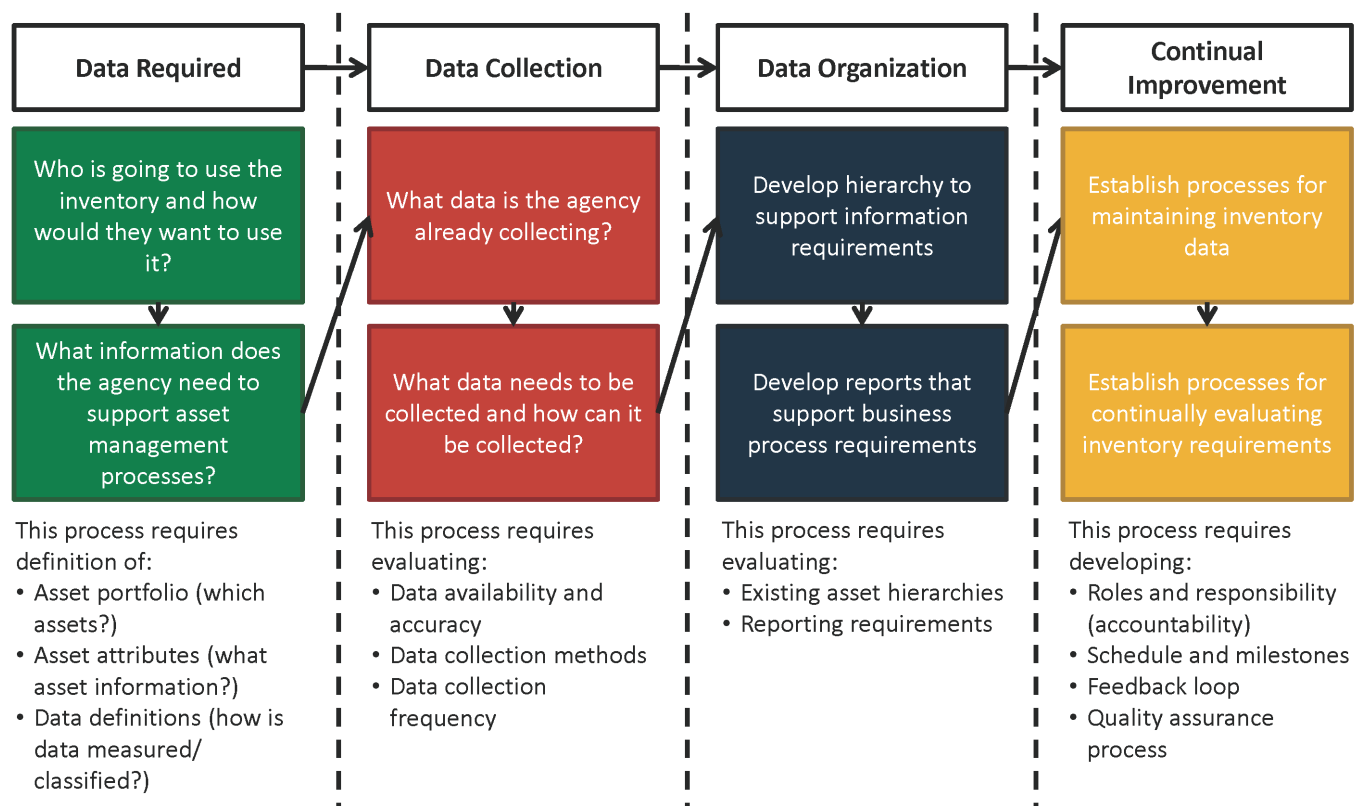
business processes (for example, comparing effectiveness of various maintenance practices on one asset class) and enterprise-level business processes (for example, capital programming and operations and maintenance budgeting). These processes require the integration and use of data from multiple sources.

Each of the asset management processes specified in this guide is data-driven and will create requirements for asset information needed in the inventory. These requirements will identify which assets to include, how they should be organized in an asset hierarchy, and what information is needed about the assets (for example, asset attributes).

“An asset breakdown structure [asset hierarchy] is critical as all data flowing from the software system will be based off of that. Take the time to develop an asset hierarchy that works for all business units as much as is practical.”  
 –U.S. Transit Agency Manager  
 (Source: 2011 Parsons Brinckerhoff Survey)

To develop a robust, data-driven approach to asset management, it is important for agencies to identify their data requirements and, once developed, maintain the data. **Figure 3-4** illustrates the activities associated with identifying, organizing, and improving upon asset information. Each of the following sections provides more details associated with these activities.

**Figure 3-4. Asset Inventory Information\***



\* This section focuses on the inventory data and how it is organized, updated, and used. The one or more tools used to manage the inventory are integral in the requirements gathering discussion; however, it is discussed in more detail in Chapter 4.

The following terminology used in this section is highlighted:

- **Asset information** – the information about the asset that is required for effective lifecycle management and asset management
- **Asset information systems** – the information systems or databases that are use to inventory, manage, analyze, and report the asset information used by asset managers

- **Asset portfolio** – the range of assets and asset systems owned by the transit agency
- **Asset hierarchy** – how the asset portfolio is classified and segmented. It provides the framework for managing the asset management business processes. This guide provides an overall framework or asset classification.
- **Data definitions** – For data to be used consistently across the agencies, it is important to have unique definitions of the data items that are used for asset information. It also ensures consistency across applications and databases; for example, what constitutes a station in one database is a station in another.

## Data Required

Successful transit asset management suggests transit agencies establish enterprise-wide policy and business requirements for the inventory process that results in a single inventory and data definitions for the various data items collected and maintained. The purpose is to answer the following questions: “Who is going to use the inventory and how would they want to use it?” and “What information does the agency need to support asset management processes?” This guide emphasizes focusing first on the user requirements (that is, determining “What information do I need to perform lifecycle management?”) and then once the requirements are defined, determining the system solution or technical approach.<sup>2</sup>

## Data Collection

For an inventory to successfully support the agency’s asset management business processes, the inventory requires certain data. Collecting data for asset management can be costly, and priorities need to be established. Depending on the types of assets and the information, 100-percent samples and a complete inventory are not

As stated in the *International Infrastructure Management Manual*, “As a general rule, 80% of the data can be collected for half the total cost of 100% completeness.”

common or necessarily encouraged. The agency can evaluate the data that is currently available or identify data that can be collected as part of regular business processes (for example, during maintenance activities). For the data not available, the agency can develop a plan for making it available in the future. The plan can also outline how often the data will be updated. These decisions will all depend on having an appropriate level

of resources to collect and upkeep the data. Asset owners play a role in this process since they integrate asset data into their lifecycle management plans.

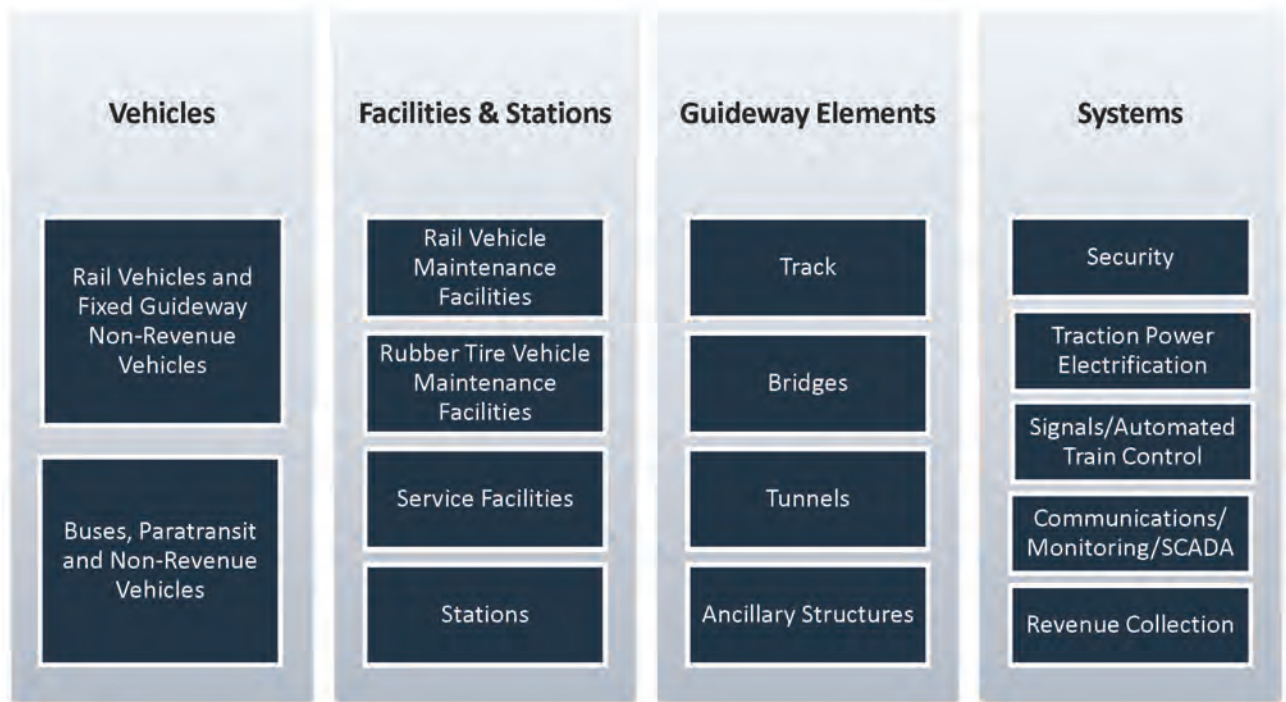
## Data Organization

The inventory process organizes the transit agency assets into asset classes and, within the classes, an asset hierarchy. This guide advises that assets are classified into maintainable units, which are organized into an asset hierarchy. This is because it is the maintainable unit to which the lifecycle management procedures (for example, inspections, predictive and preventive maintenance procedures, rehabilitation investments) are applied.

Agencies should establish their own asset hierarchies based on their asset types and business requirements. The 2011 *International Infrastructure Management Manual* defines an asset hierarchy as “a framework for segmenting an asset base into appropriate asset classifications. The asset hierarchy can be based on asset function, asset type or a combination of the two.” **Figure 3-5** illustrates, at a high level, the asset classification that this guide provides as a starting point for a transit agency.

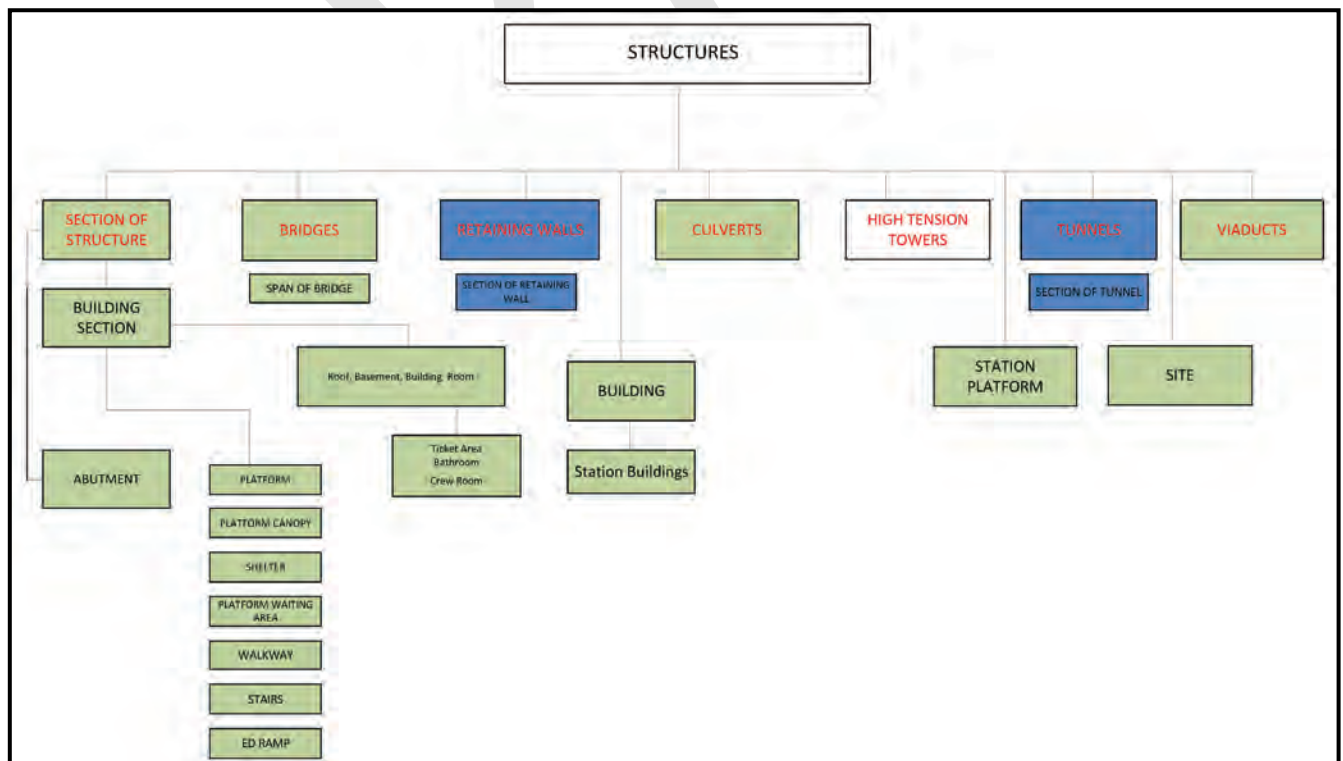
<sup>2</sup> The manual recognizes that the data available and information systems that implement this will vary considerably between agencies, and that many agencies will be limited or constrained by their existing technology environment and, over time, be interested in system solutions that better enable their asset management.

**Figure 3-5.** High-Level Asset Class Hierarchy



For each of the asset classes in **Figure 3-5**, this guide provides a starting point to develop lifecycle management plans (see *Asset Management Guide Supplement*). **Figure 3-6** outlines a sample asset hierarchy for structures from New York's Long Island Rail Road.

**Figure 3-6.** Long Island Rail Road Sample Asset Hierarchy (Structures)



Source: Engineering Assets Hierarchy, August 13, 2012



## Continual Improvement

An inventory that can be used to successfully support asset management relies upon established processes for maintaining inventory data. While the individual lifecycle management plans will define data requirements and include or reference the procedures that provide quality assurance for inventory data, the Asset Management Program Manager should have sound data administration processes in place so that the data is of good quality and appropriately supports the asset management business processes. Additionally, the Asset Management Program Manager and the asset owners should always be looking for more opportunities to cost-effectively collect more data when it is supportive of the asset management business processes. To ensure this continual improvement, these processes have clear roles and responsibilities, schedules with milestones, a feedback loop, and quality assurance processes.

Transit agencies in the U.S. often address their asset inventory problems (for example, siloed departments and obsolete data) by procuring new software. They have a history of focusing on technical solutions without first addressing their business requirements and then defining how technology can enable them to be more successful.<sup>3</sup> In reality, current agency practices require considerable organizational and cultural change, in addition to technology solutions. Chapter 4 – Asset Management Information Systems provides guidance on addressing data integration and technology solutions.

**Figure 3-7** depicts a snapshot of the Metropolitan Transportation Commission's (MTC') asset inventory reflecting sample track data from multiple agencies.

**Figure 3-7.** Snapshot of MTC's Asset Inventory

Operator	Category	Element 1	Element 2	Element 3	TCP Score	Unit of Measure	Quantity	Purchase or Next Replacement Year (Year)	Useful Life (Years)	Cost Per Unit (2007 \$)
AAA	Railway/Track	Heavy Rail	Embedded	Tangent	16	Track Mile	88	2000	12	2,500,000
BBB	Railway/Track	Trackwork	Special	Ballasted Derail	16	Each	8	1972	15	25,000
BBB	Railway/Track	Trackwork	Special	Ballasted Derail	16	Each	2	1996	15	25,000
BBB	Railway/Track	Trackwork	Special	Ballasted Derail	16	Each	4	1997	15	25,000
BBB	Railway/Track	Trackwork	Special	Direct Fixation Derail	16	Each	1	2003	15	25,000
BBB	Railway/Track	Trackwork	Special	Ballasted Diamond	16	Each	1	1972	15	366,100
BBB	Railway/Track	Trackwork	Special	Ballasted Turnout	16	Each	100	1972	15	100,310
BBB	Railway/Track	Trackwork	Special	Ballasted Turnout	16	Each	169	1973	15	100,310
BBB	Railway/Track	Trackwork	Special	Ballasted Turnout	16	Each	11	1974	15	100,310
BBB	Railway/Track	Trackwork	Special	Ballasted Turnout	16	Each	7	1996	15	100,310
BBB	Railway/Track	Trackwork	Special	Ballasted Turnout	16	Each	13	2003	15	100,310
BBB	Railway/Track	Trackwork	Special	Direct Fixation Diamond	16	Each	2	1973	15	579,410
BBB	Railway/Track	Trackwork	Special	Direct Fixation Turnout	16	Each	3	1996	15	290,910
BBB	Railway/Track	Trackwork	Special	Direct Fixation Turnout	16	Each	34	2003	15	290,910
BBB	Railway/Track	Trackwork	Switch	Manual	16	Each	6	1974	15	20,000
BBB	Railway/Track	Trackwork	Switch	Motorized	16	Each	115	1972	15	35,000
BBB	Railway/Track	Trackwork	Switch	Motorized	16	Each	12	2002	15	35,000
BBB	Railway/Track	Trackwork	Switch	Motorized	16	Each	49	2003	15	35,000

Some of the benefits associated with having an agency-wide asset management inventory and information include the following:

- Accessible, consistent, and comprehensive information about an agency's assets at asset class and enterprise level. This inventory allows the agency to understand and communicate its assets' current value, age, and condition. Depending on what data is tracked, it can assist in monitoring warranties, maintenance histories, and costs.
- Data integrity and accuracy can avoid the costs incurred from inconsistent, duplicate, and inaccurate data and can also improve an agency's credibility with internal and external stakeholders.

<sup>3</sup> Most of the asset management strategy-related Requests for Proposals (RFPs) issued by U.S. transit agencies in the last two years are focused on the procurement of information systems.



- Data is organized and structured in a way that it can support all asset management business processes. This means that appropriate levels of information are available and accessible to the right people at the right time.
- Accurate, current data to support data-driven, transparent decision making, which can improve an agency's decision making and stakeholder relations.

Key implementation principles associated with managing the data associated with an asset inventory include the following:

- There is no “one-size-fits-all” approach; the data collected supports the established asset management policies and goals. It also reflects any other data needs throughout the organization. For example, an asset inventory can be used to identify and locate assets to support the maintenance and operations of the assets. It can provide financial data in order to calculate maintenance and replacement costs. For more mature asset management organizations, the asset inventory may be used to review an asset's maintenance history and costs to support lifecycle optimization and the probability and consequence of asset failure for risk management.<sup>4</sup>
- Applying sound data administration practices is a fundamental building block for maintaining an asset inventory and is a part of normal business processes. An agency has documented processes in place to ensure that the data stored in the inventory is current, correct, complete, and consistent. Data collection and validation can sometimes be most economically collected as part of day-to-day operation and maintenance activities.<sup>5</sup> The *International Infrastructure Management Manual* states that data collection is the largest workload component of an asset management program, often constituting 80 to 95 percent of the setup costs. (Note: Many systems have the ability to validate data when it is entered.)
- There is no duplication of inventories; the expectation is that developing and maintaining an inventory is an enterprise business process. Multiple processes and other systems will draw on and require inventory information, including accounting and the FTA's National Transit Database reporting. If these reside in other databases, a process to replicate the data from the enterprise source—and only that source—may be necessary; however, an appropriately customized data architecture eliminates this need. This guide recognizes that many agencies have data in multiple locations and at times with differing data definitions. Agency asset management plans provide the direction to address this and migrate to enterprise inventory solutions that eliminate duplicate databases and inconsistent data definitions. A key to addressing the challenges associated with multiple inventories is to have a unique asset identifier associated with every asset.
- Managers in the organization ensure accountability for maintaining this asset data. Accountability may be tied to the quality of the data or to the asset performance (which is indirectly associated with the data).

#### Asset management inventorying success factors:

- ▶ Transit agencies establish enterprise-wide policy and business requirements for the inventory process that results in a single inventory and data definitions for the various data items collected and maintained.
- ▶ Inventories have established “owners” who are responsible for the management and quality of the data.
- ▶ Agencies establish their own asset hierarchies based on their asset types and business requirements.

<sup>4</sup> *International Infrastructure Management Manual*, Chapter 2.4

<sup>5</sup> *International Infrastructure Management Manual*, Chapter 2.4

## Relevance of Case Study

Valley Regional Transit (VRT, formerly known as VIATrans) has demonstrated how multiple smaller transit agencies and transit providers can work together to develop regional partnerships to improve transit asset management through a centralized asset inventory.

## Agency Overview

VRT was formed in 1998 to serve as the regional public transit authority for Ada and Canyon Counties in Idaho. VRT provides ValleyRide bus service to the city of Boise, along with Ada and Canyon Counties. VRT owns the ValleyRide bus system and manages the system assets. The agency also manages contracts for service in Boise/Garden City, Nampa/Caldwell, and inter-county routes. The entire ValleyRide system comprises 26 bus routes and paratransit services. The VRT fleet includes 6 vans, 58 buses, and 11 support vehicles. In FY 2011, the bus system provided 1.37 million one-way trips and 40,825 paratransit rides.

## Asset Management Implementation Path

In assessing its needs with respect to asset management, VRT established that it needed an improved system for tracking its asset inventory. In particular, the agency needed an improved system for prioritizing investment needs, supplementing the functionality provided by the existing accounting, work-order processing, and inventory tracking systems. Realizing that other local agencies faced similar challenges, VRT formed a regional partnership to implement a transit asset management system, and led the effort to apply for an FTA grant on behalf of the partnership to fund the initiative.

In establishing a regional partnership for improving asset management, VRT first approached stakeholders with common goals and similar assets. These stakeholders included Boise State University and its shuttle system, Ada County Highway District – Commuteride division, and Idaho Transportation Department, which distributes federal funds to a number of Idaho transit providers. Regular stakeholder meetings are held to provide each

partner with the opportunity to participate in the process.

As part of the process, each partner organization agreed to inventory its assets and record asset conditions. VRT plans to evaluate the quality and consistency of the data in order to determine the information that still needs to be collected. Methods for future data collection will be developed to ensure that all of the organizations are using a consistent approach and have comparable data. The combined assets of the participating organizations include transit buses, paratransit vehicles, vanpool and social service agency vans, university shuttle buses, support vehicles, park & ride lots, bus shelters and benches, operations and maintenance facilities, and transit centers. Given the range of different assets in the inventory, it is important that the participants continue to be active in the planning process to ensure that the resulting system is flexible enough to account for each organization's needs.

Ultimately, VRT and its partners plan to develop an asset management system in which all of the collected data will be stored and analyzed at an individual and regional level. VRT is particularly interested in developing a capability for analyzing which asset investments are the “best” investments.

## Benefits and Outcomes

The Regional Capitalization Plan is expected to establish a methodology for future efforts to improve data collection, analysis, and prioritization models for Idaho transit agencies and providers. This plan will help individual organizations to develop asset management strategies while providing an improved capability for regional analysis. The plan also has the long-term potential for developing a protocol for sharing assets between agencies, which could yield further efficiency gains. By pooling resources across multiple organizations, the partner agencies are implementing state of good repair practices and systems more cost effectively than a single agency acting alone.

## Sources

Information provided by senior contact at VRT.

### 3.2.2 Role of Condition Assessment and Performance Monitoring

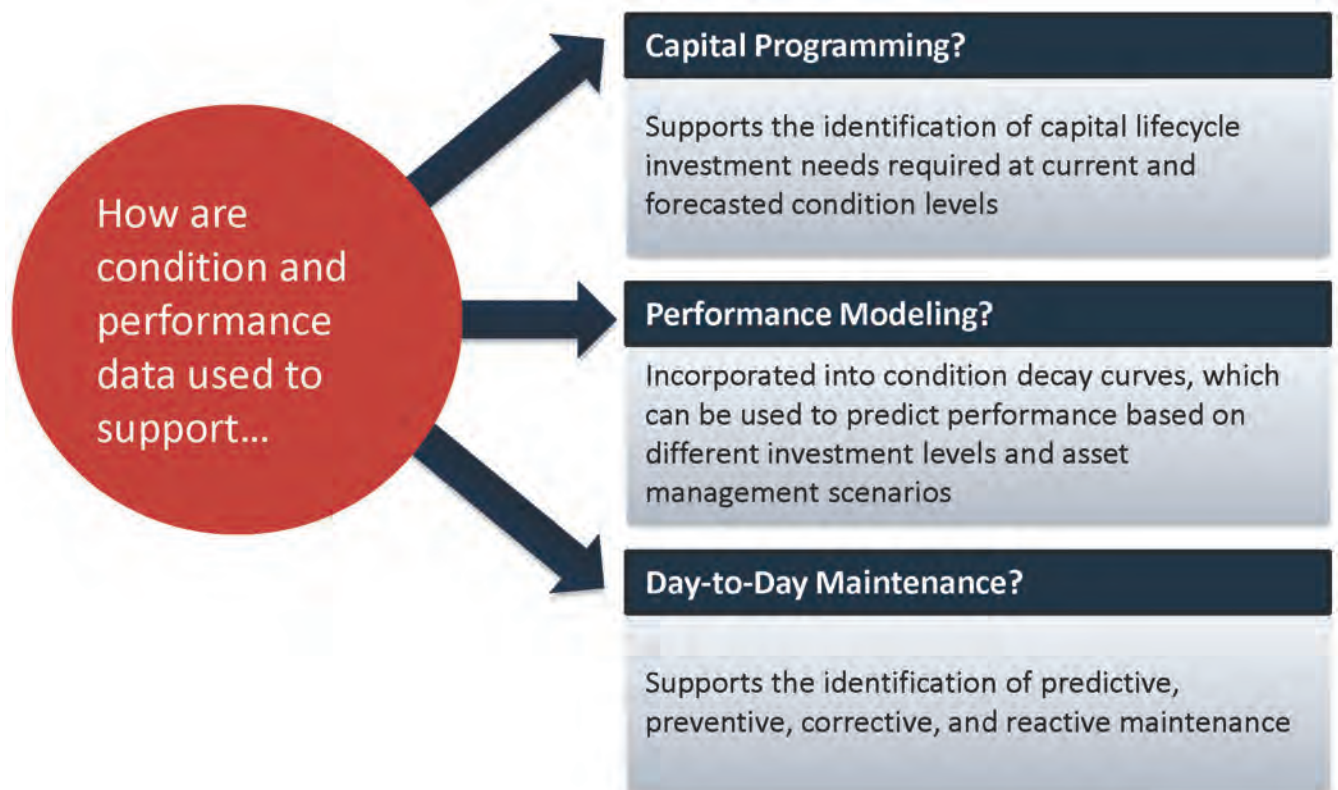
Condition assessment is the process of inspecting the asset to collect data that is used to measure condition and performance. The condition assessment process involves regular inspections that evaluate an asset's visual and physical conditions (for example, structural issues, faulty components). This process addresses risk, ensures the asset can meet its level-of-service requirements, and provides information from which assets can be managed across their lifecycle. Condition assessment and performance monitoring can result in the following activities:

- Address immediate issues by completing reactive maintenance activities.
- Proactively identify any predictive and preventive maintenance or rehabilitation necessary.
- Collect condition and performance data for scenario evaluation and performance modeling.

There are varying degrees of consensus and industry standards of practice for inspecting and monitoring condition. In many cases, only a sampling of the asset class needs to be inspected. The size of this sample and frequency of inspection should be directly related to the level of risk associated with this asset. The condition measure provides indicators of the likelihood that the asset will perform as intended. There are some condition inspection and assessment requirements that are mandatory, which means that they are required by law or as requirements from federal or other funding agencies. See *Asset Management Guide Supplement* for these and other asset class-specific inspection guidelines.

Condition assessment data can be used to support asset management–related decision-making activities, including capital programming, performance modeling, and day-to-day maintenance (see **Figure 3-8**).

**Figure 3-8.** Condition Data Requirements of Different Business Processes

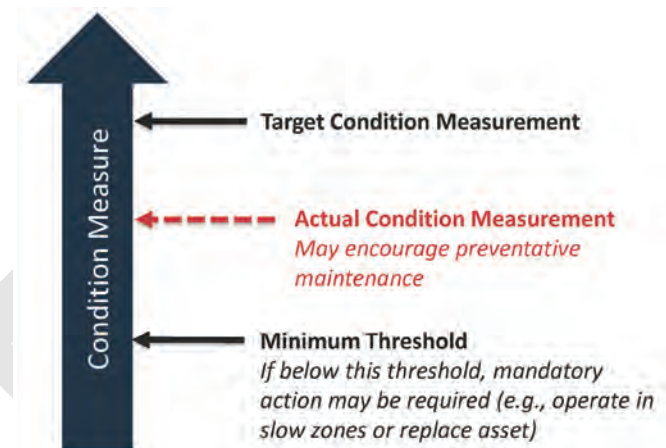


## Establish Target Condition and/or Performance Target(s)

This target is a singular measurement or a composite measurement. It can be complex, but it involves measures of the physical condition of the asset that provide indicators of its likelihood of achieving the asset's level of service requirements. These targets are usually set as standards—some of which can be mandatory (involving a pass or fail rating). These measures are indicators of the structural and functional condition, which relate to the ability to meet level-of-service objectives that are set.

In addition to establishing condition and performance targets, it is also important to establish the minimum tolerable condition of the asset. This refers to a minimum threshold below which a measured condition would result in a mandatory action by the asset owner to remedy the situation. For example, structural inspection of track or structures can result in establishing mandatory slow zones. **Figure 3-9** depicts how an asset's condition measure can be evaluated against a target condition measure and a minimum threshold.

**Figure 3-9.** Condition Assessment and Performance Monitoring Process



## Establish Condition Assessment Process and Measurement Procedures

The condition assessment process involves inspection and data collection to monitor and predict performance. The methods and procedures that are used and the frequency of the inspections should be specified as part of the lifecycle management plans. These will be specific to each asset class or, potentially, to an individual asset. The condition assessment process includes the following:

- **Specifying the Condition and Performance Measures** – This is technically driven and, in some cases, specified by laws or industry standards. Condition and performance measures support the other asset management business processes.
- **Procedures for Data Collection**– The approach to collecting the data includes the following:
  - Sampling requirements – These address how many of the assets or subcomponents require inspection.
  - Data collection frequency – This addresses how often the inspections should occur. Triggers for a condition inspection may be based on a time or mileage interval, criticality or risk assessment, or it may be based on a performance trigger (for example, a bus with a skyrocketing mean time between failure metric).
  - Inspection approach – For many asset classes, condition inspections can require appropriately trained and credentialed staff. Additionally, there is increasing interest and ability to substitute a visual or manual inspection with technology-enabled monitoring. Examples include using sensors to monitor structural conditions and switch performance. Moreover, some inspection data may be collected through day-to-day maintenance processes.
  - Quality assurance process – These are the processes used to verify the data and ensure quality. Quality assurance processes may require random data checks or formal audits.
  - Training – This is an important part of quality assurance for condition assessment and ensures that condition is being measured consistently and accurately.



These methods need to be specified as a defined procedure in the appropriate lifecycle management plan to ensure quality. The *Asset Management Guide Supplement* describes transit industry standards of practice for each major asset class.

Some of the benefits associated with having an asset management condition assessment and performance monitoring include the following:

- Improved ability to proactively invest in preventive maintenance activities to minimize premature asset failure (risk management) through targeted condition inspections and better use of condition data
- Improved capital and operations and maintenance budget forecasting based on more-accurate predictive modeling of an asset's condition (based on improved historic and current asset condition data)
- Refined maintenance strategies (based on improved understanding of an asset's condition throughout its lifecycle), which can improve resource allocation and asset performance
- Avoidance of premature asset failure (based on targeted condition inspections), which can improve overall reliability and cost-effectiveness goals
- Avoidance of premature asset replacement based on condition data that demonstrates the asset is meeting its level of service requirements

Key implementation principles associated with the establishment of an asset management condition assessment and performance monitoring include the following:

- Selection of an asset class' condition inspection approach depends on the costs and risk factors associated with that asset. Additionally, the inspection and measurement approach considers industry standards (see the *Asset Management Guide Supplement*) and how the information will be used. The extent to which condition inspections are conducted depends on the following factors:
  - The criticality of the asset (If the asset fails, what are the consequences? How safety-critical is this asset?)
  - The type, usage, and age of the asset (Is the asset close to the end of its useful life, so more likely to fail?)
  - The asset environment (Is the asset exposed to environmental conditions that might cause faster deterioration?)
  - The asset usage (How much is this asset used and how well is it operated?)
  - The ability of the agency to improve the asset's performance through maintenance activities
  - The ability to access the assets (Is the asset underground or in another remote location?)
  - The past performance of the assets reflecting level of deterioration

Asset management condition assessment and performance monitoring success factors:

- ▶ Condition inspection/monitoring program in place for all critical assets, prioritized by usage rate, risk, and other criteria outlined in the lifecycle management plans. Condition is evaluated consistently across all asset classes.
- ▶ Condition data collected supports the appropriate business processes (for example, lifecycle management, capital programming).
- ▶ Quality of the data is consistently evaluated and improved upon.
- ▶ New technologies for condition assessment and performance monitoring are integrated when cost-effective.
- ▶ Condition inspections/monitoring support regulatory requirements.

"[The agency] recognized the importance of identifying assets and their components that are most critical. The risk of these component failures is combined with a condition rating to develop an overall risk score. The outcomes of this risk score system include: Items with low scores force increased frequency of evaluation; failure of components in high risk area forces immediate inspection of all similar components; and if any accelerated aging is identified, all components of the same type are replaced."  
–U.S. Transit Agency Manager  
(Source: 2011 Parsons Brinckerhoff Survey)



- Condition inspections include the manufacturers' recommended preventive maintenance tasks; however, modifications can be developed and applied based on the condition and age of the asset, the particular challenges of the duty cycle, and the unique environmental conditions faced by each agency and asset. Manufacturers typically provide established inspection standards based on asset usage. Inspections can be adapted to an asset's condition to emphasize particularly challenging asset components, but the manufacturers' recommended preventive maintenance program forms the foundation to the inspection program.
- Condition is assessed in an established, consistent way. Approaches to obtaining condition data may include the following:
  - Periodic assessment of all assets
  - Statistical sampling based on asset attributes
  - Random sampling of asset class without consideration of asset attributes
  - Ad hoc data collection to support miscellaneous needs and unforeseen issues (for example, earthquakes)
- The measure (or rating) assigned to an asset's condition is intended to inform investment decisions that will affect the asset's performance. The approach to measuring an asset's condition is established for each asset class and its components. Consistency in evaluating the assets can be attained by ensuring team members work closely to ensure conformity in the interpretation and application of the condition measurements and by utilizing the same condition assessment process and definitions for all inspections.
- The assessment of the overall physical condition for individual assets is comprehensive—covering each of the asset's major components and subcomponents. A comprehensive evaluation is ensured by developing detailed inspection forms (ideally in electronic form) allowing inspectors to rate physical conditions for a wide range of asset components and subcomponents.
- Since condition inspections can be time- and labor-intensive, other data sources can be used as a proxy measure of an asset's condition, which will ultimately be used as a predictor for an asset's performance. Total asset usage (for example, miles or hours), subcomponent maintenance and replacement data, and asset age are supporting data points that can provide similar insight as condition data.

The condition value ratings for individual (sub-) components can be weighted—based on the component's percentage contribution to the asset's total lifecycle capital costs—to yield a “comprehensive,” weighted average measure of that asset's overall condition.

Long Beach Transit (LBT) provides public transportation to Long Beach and 11 other cities, incorporating a fixed-route service, free shuttle service, demand-responsive paratransit, water taxis, and community special services. An important aspect of LBT's asset management approach is that it is establishing a measure of asset criticality to help prioritize asset management decisions. LBT's asset criticality measure is being determined based on the likelihood of failure (using data on percentage of useful life consumed) and severity of failure (measured in terms of impact to people, environment, costs, and operations). At the conclusion of the agency's inventory development process, LBT expects to obtain data on condition and criticality for each of its vehicles and fixed assets, and will use this data to prioritize future maintenance projects.

## Relevance of Case Study

Demonstrates successful implementation of an agency-wide asset management program with policy, plans and processes that effectively utilize trusted and accessible asset data. The cornerstone of the program is a well-structured asset inventory that contains asset-specific priority and condition codes, detailed asset information and is kept current through the use of routine inspection and maintenance procedures.

## Agency Overview

The Metropolitan Atlanta Rapid Transit Authority (MARTA) provides heavy rail, bus, and paratransit (mobility) services to the Atlanta region. MARTA carries approximately 500,000 passengers daily. MARTA's assets include the following:<sup>6</sup>

- ▶ 48 miles of rail service (120 miles of track)
- ▶ 338 rail vehicles
- ▶ 3 rail yards
- ▶ 38 rail stations
- ▶ 590 buses
- ▶ 3 bus maintenance facilities
- ▶ 175 paratransit vehicles
- ▶ 450 non-revenue vehicles
- ▶ 1 non-revenue vehicle maintenance facility
- ▶ Over 100 ancillary buildings

MARTA's rail system began operation in 1979, and many assets are now approaching the end of their expected useful life. Furthermore, finances of the agency, which are largely dependent on local sales tax receipts, are severely strained. Thus, determining how to best use available funds to maintain a state of good repair is a significant issue for the agency.

## Asset Management Approach

MARTA uses a transit performance-based definition of state of good repair as a "condition of an asset where the asset, at a minimum, is capable of delivering the required performance safely and reliably for a predetermined period of time." By this definition, as of June 2010, approximately 97

percent of MARTA's assets were classified as being in a state of good repair.<sup>7</sup>

MARTA's investment in assets including their acquisition, operation, maintenance, renewal, and disposal is guided by the desire to provide best possible service to the riding public with safety at the top of the list. This means fewer service interruptions, increased customer satisfaction and reduced operating and maintenance costs. To manage its assets, MARTA uses a "systems approach" with an established mission, vision, plan, policy, and procedures that are integrated with their normal business processes. Their asset inventory hierarchy, asset-specific inspection and maintenance policies are tied to system performance. An Enterprise Asset Management (EAM) system is used to track data related to asset inventory, inspection, and work performed. MARTA's asset inventory, which they refer to as asset breakdown structure (ABS), comprises 16 major asset categories. For each category, the ABS identifies three additional subcategories: systems, components, and types. For some asset types, inspection and maintenance policies are highly formalized. For instance, for rail cars MARTA developed the Life Cycle Asset Reliability Enhancement (L-CARE) program, which details the maintenance actions to be performed over the lifecycle of a rail car for 11 different car systems. MARTA is consistently developing asset management strategies to efficiently manage inspection and maintenance data for all of its critical assets.

MARTA periodically performs comprehensive condition assessments of its assets. These assessments provide additional information, which can inform maintenance, rehabilitation, and replacement needs over time. For example, MARTA performs a visual inspection of its tracks twice per week and uses a track geometry car for each section of track one to two times per year. The data is stored in the EAM system). Data for more than 53,000 assets is stored in the EAM system and MARTA's intent is to integrate all relevant data electronically into their short- and long-term Capital Improvement Planning process.

<sup>6</sup> *Transit Asset Management Practices – A National and International Review*, June 2010

<sup>7</sup> *Transit Asset Management Practices – A National and International Review*, June 2010

## Benefits/ Outcomes

MARTA's asset management initiative has derived the following:

- ▶ Although MARTA's capital program was reduced from \$386M to \$185M over a four-year period, MARTA has been able to maintain a high percentage of its assets in a state of good repair. This results from having better information to target available funds where they are most needed, as well as from having the information needed to make the case for spending to maintain a state of good repair. Now, approximately 85 percent of the capital program is being used to address state of good repair needs—a significant increase.
- ▶ More-accurate estimates of its investment needs by performing periodic condition assessments and representing assets at the system, type and component level. MARTA's Office of Maintenance of Way tracks all wayside rail system assets through their EAM system. This includes description, location, in-service date, inspection cycles, cost, maintenance history, priority, and condition code. This information flows directly into Capital Reports, which are then used by stakeholders to make investment decisions. Within the Office of Rail Car Maintenance, the expected and remaining useful life of rail cars is tracked not just for the railcar as a whole, but for each of the major systems of

the car, which means performance and costs can be managed more effectively. MARTA, a 33-year-old system, is routinely achieving 98 percent rail on-time performance. This high level of performance is attributed to many things, but at its base is a well-maintained rail fleet, wayside systems, and infrastructure.

- ▶ MARTA's efforts to improve its asset management systems and approaches have made the agency more competitive in its efforts to obtain FTA state of good repair grants, and resulted in MARTA's winning several grants to provide needed funds.
- ▶ Trusted and accessible asset data has improved MARTA's ability to demonstrate compliance with local, state, and federal regulatory requirements, respond to audits and to support transit industry initiatives with peer agencies, consultants and the supply chain.
- ▶ The benefit of this well-structured asset management program is better overall agency performance. This includes improved service, safety, and environmental performance as well as optimized return on investment, more efficient use of resources (labor and non-labor), enhanced customer satisfaction and a positive agency perception.

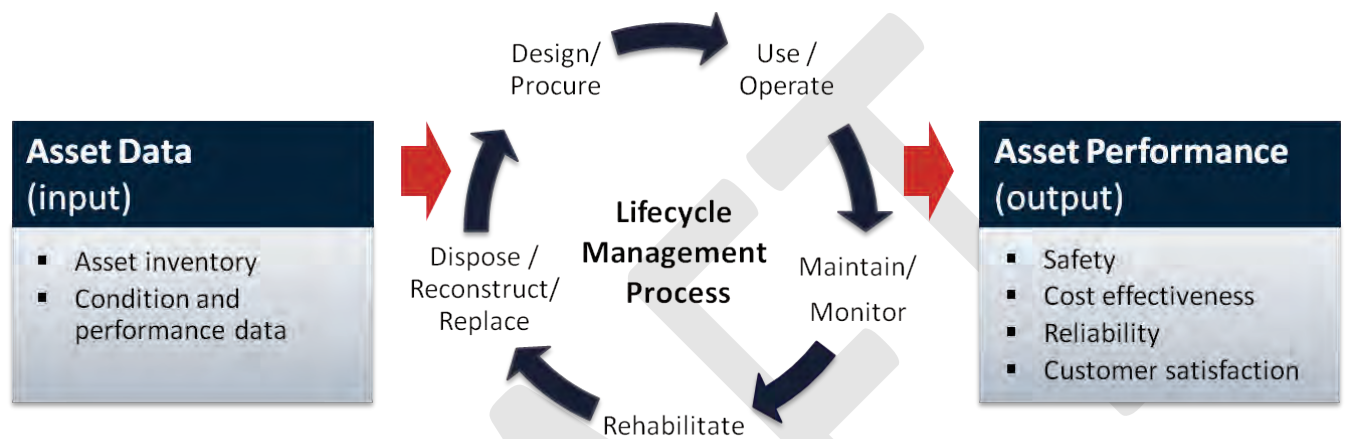
## Sources and Other Resources

Information provided by senior contact at MARTA.

### 3.2.3 Role of Lifecycle Management Planning Process

This guide recommends defined processes and procedures for the lifecycle management of each asset class and, as applicable, for individual assets—documented in a lifecycle management plan. A lifecycle management plan documents the costs, performance, and risks associated with an asset class throughout its life. As shown in **Figure 3-10**, good data regarding costs, performance, and risk throughout an asset’s lifecycle can improve asset performance because of better-informed decision making.

**Figure 3-10.** Lifecycle Management (Using Asset Data to Improve Asset Performance)



The contents of a lifecycle management plan will vary depending on the level of asset management maturity for the asset class. While a less mature lifecycle management plan will focus solely on developing an asset inventory, a more mature lifecycle management plan will include asset class-specific policies, condition assessment, and performance monitoring, level-of-service requirements, procedures and plans for preventive and reactive maintenance, and rehabilitation and replacement timing and costs. Ideally, a lifecycle management plan is created during the asset’s design/procurement stage to ensure it is designed and/or manufactured in a way that considers the asset’s performance requirements and total cost of ownership. A lifecycle management plan can be used to ensure that the performance expectations of the asset are understood and fit within the agency’s broader goals and performance objectives, and that all investment decisions are transparent and well communicated. **Table 3-3** provides the recommended contents of a lifecycle management plan.

Some of the benefits associated with the use of lifecycle management plans include the following:

- Improve the performance of assets throughout their lifecycle while ensuring the most cost-effective investment strategies.
- Minimize the risk of failures throughout the system.
- Make data-driven, informed investment decisions within an asset class and at the enterprise level.
- Improve internal communications by requiring cross-department coordination throughout the asset’s lifecycle.

Examples of asset class-specific policies include:

- ▶ Buses should be rehabilitated when in service for 6 years and then replaced when in service for 12 years.
- ▶ Maintenance facilities should be replaced after 40 years in service (or 70 years if rehabilitated).
- ▶ 95 percent of elevators should be available at any time.

**Table 3-3. Lifecycle Management Plan Contents<sup>8</sup>**

Section Name	Contents Description
<b>Roles &amp; Responsibilities</b> (Who is responsible for this asset's lifecycle management activities?)	Outlines roles, responsibilities, and accountabilities for the asset's lifecycle management, including the "Asset Owner."
<b>Asset Inventory</b> (What assets are included in this lifecycle management plan?)	Introduces this asset class, including: <ul style="list-style-type: none"> <li>▪ Inventory process overview</li> <li>▪ Asset risk assessment (overview of criticality)</li> <li>▪ Challenges the agency faces with maintaining asset class</li> </ul>
<b>Condition Assessment &amp; Performance Monitoring</b> (How will the asset class' performance be measured and monitored?)	Outlines the asset class' current condition and references the documented asset class-specific approach to condition assessments and performance monitoring. This includes outlining when the asset should be inspected, how inspections will be conducted and condition measured, and what actions should be taken based on the rating assigned.
<b>Preventive Maintenance Plan</b> (What activities can be proactively completed?)	Outlines the predictive and preventive maintenance approach <sup>9</sup> to maximizing the performance and minimizing the costs of this asset class. This describes the resources needed (costs, staffing, materials, etc.) and links to performance.
<b>Rehabilitation and Replacement Plan</b> (What capital investments are needed?)	Outlines the rehabilitation and replacement approach <sup>10</sup> to maximizing the performance and minimizing the costs of this asset class. This describes the resources needed (costs, staffing, materials, etc.) and explains and links to performance.
<b>Asset Policy and Strategy</b> (What are the asset management goals for this asset class?)	Outlines any policies and strategies related to this asset class. It also explains how the asset's lifecycle management activities support the broader asset management policies and goals (including level of service requirements and sustainability outcomes).
<b>Asset Lifecycle Management</b> (What are investment activities necessary for maximizing the performance of this asset?)	Outlines all lifecycle management activities, including considerations and strategies regarding procurement, warranties, operations, maintenance (preventive and reactive), rehabilitation, and disposal. This section identifies the total cost of ownership for this asset class, with the focus on lifecycle management activities that maximize the asset's performance (including sustainability outcomes) while minimizing risk and costs.
<b>Capital Programming &amp; Operations and Maintenance Budgeting</b> (How will asset management support capital programming and operations and maintenance budgeting?)	Forecasts the capital and operations and maintenance budget needed to address the lifecycle needs of this asset class. The budgeting timeframe should match the agency's overall capital and operations and maintenance budgeting timeframes.
<b>Performance Modeling</b> (How will asset condition data support scenario evaluation?)	Identifies how available data can be used to evaluate how well an asset class is achieving its level of service, sustainability, and other performance goals. Historic data (compiled into decay curves) and current data can be used to monitor performance over time and forecast how different funding levels can impact performance in the future.
<b>Continuous Improvement</b> (How can we ensure we continue to get better at managing this asset?)	Outlines how the asset owner should be monitoring the performance of this asset class to ensure that this plan is being followed and, ultimately, the asset class' performance is being maximized. This section should capture any lessons learned associated with managing the lifecycle of this asset class. Additionally, it should reflect the process for maintaining the lifecycle management plans.

<sup>8</sup> Lifecycle management plan contents will vary depending on the level of asset management maturity associated with the asset class.

<sup>9</sup> This section may be developed based on the manufacturer's guidelines; however, adjustments should be made reflecting past experience and local requirements.

<sup>10</sup> Ibid.



Key implementation principles associated with lifecycle management include the following:

- Lifecycle management plans can be developed for the most-critical assets first, and details can be added as the agency's asset management maturity increases.
- When possible, require the manufacturer/contractor to include the lifecycle management requirements as part of the asset's procurement/creation. An agency's operating environment and funding availability may require something different; however, the manufacturer can provide a useful starting point for effective lifecycle management practices.
- Lifecycle management plans are developed with input from all departments that are involved in that asset's lifecycle. Represented parties likely include procurement, engineering, operations, maintenance, and capital planning.
- While many parties will likely provide input into the plan, the asset owner is responsible for coordinating the development and upkeep of it.
- Lifecycle management plans are continually updated to reflect changes in the operating environment, condition assessment technologies, and manufacturer guidelines.
- Lifecycle management plans are made available on an agency's intranet (or other shared file location) so management and staff can access the information as needed.
- An agency evaluates cost, risk, and performance to determine the optimal amount of preventive maintenance for an asset. There is an optimal amount of planned maintenance for assets that minimizes the cost of planned versus reactive maintenance. This evaluation requires experience, understanding of asset behavior, repair methods, and, ideally, the use of analysis tools.
- Evaluate the costs, risks, and performance data of all asset management lifecycle activities associated with an asset to determine the optimal investment strategy. Table 3-4 outlines these lifecycle activities.

#### Lifecycle management plan success factors:

- ▶ Asset investments consider the benefits and trade-offs associated with capital versus operations and maintenance solutions.
- ▶ Lifecycle management plans provide a clear link to agency goals and performance expectations.
- ▶ Lifecycle management plans are managed by the asset owner; however, they reflect input from throughout the agency.

**Table 3-4. Potential Lifecycle Activities**

Lifecycle Activities	Activity Description
Create or Acquire	New assets or created or procured to increase capacity, meet current demand, and address performance objectives
Do Nothing	Assets are operated until they fail or can no longer deliver the required performance
Examine Operational Procedures	Operational management is changed to manage stress on the asset, such as reducing a vehicle's exposure to hills
Routine Maintenance	Conducted to keep assets in a serviceable condition and address performance requirements
Renew or Replace	Replace an asset when it is insufficient to keep the asset serviceable or when it is more cost-effective to replace
Upgrade	Improve existing asset to address performance requirements
Dispose	Decommission and/or demolish and/or recycle and/or sell obsolete assets

Source: Adapted from Whole-Life Infrastructure Asset Management: Good Practice Guide for Civil Infrastructure, Ciria 2009

## 3.3 Cross-Asset Planning and Management

Cross-asset planning and management refers to agency-wide processes for managing performance through the capital planning and budgeting process across the portfolio of transit assets. It is addressed in a transit agency's capital planning and operations and maintenance budgeting processes. A transit agency's capital plan and operating budget are the mechanisms through which competing goals and objectives are assessed and implementation priorities established through funding decisions.

A mature asset management process involves integrating lifecycle management plans from the different asset classes to do the following:

- Communicate asset condition and the resources required to meet level of service objectives to policy-makers, stakeholders and customers
- Allocate available funds in a performance-based budgeting process that considers the level of service that various resource allocation decisions allow the agency to purchase with the funds they have available

This guide emphasizes the role for asset management in providing information that can better link budget decisions to performance. Agencies typically develop one-, two-, or five-year capital programs and one- or two-year operations and maintenance budgets on an annual basis. More mature asset management organizations may use scenario evaluations as a tool through which transit agency boards and the general manager can consider “what if” scenarios in terms of the impact on performance of different levels of investment and budget allocations. Cross-asset planning and management business processes are outlined in **Figure 3-11**

### 3.3.1 Role of Capital Planning and Programming

The capital planning and programming process determines how and when capital funds are expended. It is typically an annually recurring process by which a transit agency's capital needs are specified as improvement projects that are prioritized, budgeted, and scheduled over a multi-year time period. More often than not, an agency's available funding is insufficient to cover identified capital needs, so the agency has a process for selecting the highest priority projects. The intent is to prioritize the capital projects that best address the agency's goals, which typically involve replacing worn out assets, reducing cost, and enhancing performance. Transit agencies have been prioritizing their capital needs for as long as they have been in existence; this guide addresses how to

Capital programming that utilizes asset data to drive decision making will contribute significantly towards an agency's performance management focus.

incorporate asset management into existing capital programming processes. In general, the business model outlined in this guide conforms to best practice, which is to link outcomes—the performance of the agency—to the planning, programming and other decisions that are made.

**Figure 3-11.** Cross-Asset Planning and Management Business Processes

#### Cross-Asset Planning

##### Capital Planning & Programming

- Optimizes how and when capital funds are expended based on consistent, reliable data
- Reflects “top-down” guidance from agency leaders and “bottom-up” forecasted capital needs

##### O&M Budgeting

- Optimizes funds expended based on LOS goals
- Relies on performance-based decision-making reflecting on lifecycle management plan input

##### Performance Modeling

- Applies analytical tools that use reliable condition and cost data to model performance under different investment scenarios

Capital programming processes typically involve input from two directions:

- **Top-Down** – The leadership team decides the high-level priorities and sets policies to address these. In order to support their asset management goals, it is important for the leadership team to consider the relationship between the allocation of capital dollars to existing assets' investments that address performance reliability and other asset management-related performance objectives (as opposed to capital enhancements or expansion investments). Best practice involves scenario planning that considers the impact on performance of alternative programmatic allocations of funding. Additionally, best practice considers a risk assessment across the entire asset portfolio. Assets with the highest risks (typically related to assets whose failure would lead to safety issues or significant performance impacts). Agency leadership may also provide direction to focus the capital program on sustainability investments.
- **Bottom-Up** – Asset owners and staff who use the assets provide input on their forecasted capital needs. Asset management best practice suggests that this information comes from lifecycle management plans that are data driven. Inputs from the lifecycle management plans include detailed cost and schedule forecasts on the capital renewal and replacement needs specific to each asset class. Additionally, asset owners likely need the ability to use their own discretion regarding how dollars are allocated within the asset class, especially if their asset class requires significantly higher reactive maintenance funds.

This balance of incorporating top-down asset management focus with bottom-up capital needs information to prioritize a capital program is characterized in **Figure 3-12**.

The lifecycle management plans specify the comprehensive capital needs associated with meeting the desired level of service objectives; however, it is unlikely that funding is available to address all of these needs. Prioritizing across all of the asset classes is one of the more complicated aspects of the capital programming process. There are two types of prioritization decisions:

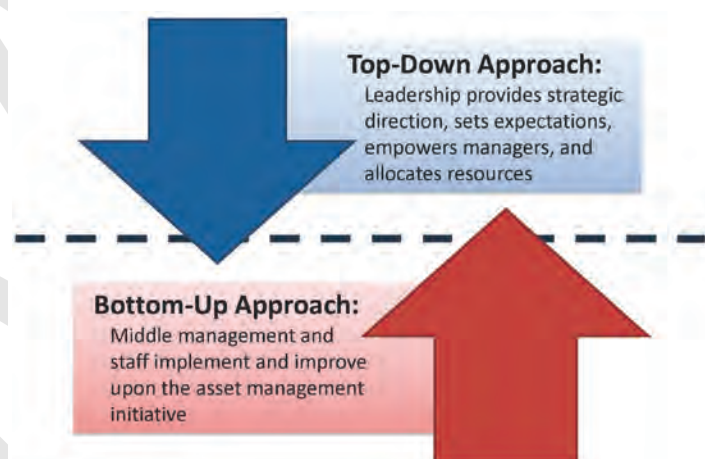
- Allocation between asset classes
- Allocation within the asset classes

For the former, the Capital Programming Manager (likely with input from the executive team) makes prioritization decisions based on the criticality of the asset class, how important it is towards supporting the agency's level of service goals, and the risk of not investing. For the latter, lifecycle management plans prioritize capital investments within an asset class, and this feeds directly into the capital programming process.

The following are important cross-asset prioritization considerations:

- **Consider programmatic policies and goals** – The prioritization of capital needs focuses on outcomes and may need to consider how the capital needs are packaged. For example, an agency may invest in all of their stations' stairwells to support a safety goal instead of upgrading all assets within one station.

**Figure 3-12. Asset Management-Focused Capital Program Prioritization Inputs**



- **Identify mandatory projects** – Before undertaking any prioritization process, a handful of projects can likely rise to the top of the list. Examples of these mandatory projects may be projects with committed funding, projects that will satisfy a safety, performance, or other mandate, and projects that the general manager is requiring.
- **Understand project dependencies** – Some projects may need to be completed before another can begin (for example, procuring articulated buses before facilities are retrofitted to accommodate larger vehicles). Others may not be useful unless done in conjunction with other projects (for example, upgrading fare gates may also require the replacement of all ticket vending machines).
- **Consider realistic project timelines** – Staff availability, procurement schedules, and right-of-way access may limit the ability of an agency to invest in assets up for renewal or replacement. It is important not to prioritize capital needs if it is not realistic to spend the funding in the budgeted year.
- **Consider the interconnected nature of transit assets** – In many cases, it may make sense to replace or rehabilitate assets before their lifecycle management plan dictates. This may be because of a bulk procurement opportunity, labor availability, or geographic proximity to other investments. Lifecycle management plans address these types of considerations.

On an annual basis, [this agency] uses data from its enterprise asset management system to update its 10-year Capital Improvement Plan (CIP). [This agency] has issued guidance for development of the CIP that specifies the decision-making criteria, including existing asset conditions, maintenance costs, remaining service life, and lifecycle costs for proposed capital project alternatives. —*U.S. Transit Agency Manager (Source: 2011 Parsons Brinckerhoff Survey)*

Some of the benefits associated with incorporating asset management more effectively into an agency's capital programming process include the following:

- State-of-good-repair investments are considered on the same footing as system development or expansion. Lifecycle cost, risk, and performance data are incorporated into the agency's existing capital programming process to make objective, informed cross-asset investment decisions.
- Internal and external stakeholders are provided with clear performance-based justification for funding decisions. This process helps communicate the link between service outcomes or performance and funding levels. Capital programming decisions made in conjunction with operations and maintenance cost estimates can help to reduce the overall lifecycle costs of assets.

Key implementation principles associated with establishing an asset management-focused capital programming process include the following:

- The capital program reflects input from the executive team, management, and asset owners.
- When possible, asset owners communicate the potential negative consequences, or risks, associated with not prioritizing their asset class' needs. The more clearly an investment can be tied to an agency goal or performance objective, the more compelling the case will be.
- While information systems can support the capital program prioritization process, tools cannot replace the multidisciplinary discussions that are required for effective capital programming.
- If scenario evaluation is available, the capital programming process can incorporate findings associated with the relevant analysis and discussions.
- The capital program and operations and maintenance budget are developed in a coordinated, interactive fashion at the same time each year. This allows for the consideration of implications to the operations and maintenance budget when the capital program funding is increased or decreased (and vice-versa).
- Ideally, an agency can show how each capital investment supports its goals at any time during a capital project's lifecycle. For example, the replacement of track and its subcomponents may allow for trains to operate at a higher speed, which may have a direct impact on agency-wide goals like on-time performance. Ultimately, this kind of performance measurement demonstrates the value of the investment.

Capital planning and programming success factors:

- ▶ Shared responsibility, including the executive team, management, and asset owners, in developing the capital program
- ▶ Established policy for the agency leadership to make programmatic decisions (for example, what percentage of the budget should be focused on state-of-good repair needs versus expansion needs)
- ▶ Complete, up-to-date, and accurate lifecycle management plans that outline the agency's assets' capital needs
- ▶ Simple, quantifiable, agreed-upon prioritization criteria that demonstrate the link between capital investments and agency outcomes. These criteria will provide a transparent, consistent way to evaluate state-of-good repair needs across all asset classes



## Relevance of Case Study

The Regional Transit Authority (RTA) performed a comprehensive assessment of the condition of transit assets in the Chicago area, and is developing a decision support tool to help prioritize state-of-good repair investments. RTA's experience illustrates the importance of developing a structured approach for prioritizing state-of-good-repair investments.

## Agency Overview

The RTA was created in 1974 to provide public transportation in the surrounding Chicago and the six-county northeastern Illinois regions surrounding Chicago. Today it oversees the third-largest public transportation system in the U.S. The service boards are as follows:

- ▶ Chicago Transit Authority (CTA), which operates the bus and rail systems serving Chicago and neighboring suburbs;
- ▶ Metra, which provides commuter rail service in six northeastern Illinois counties; and
- ▶ Pace, which provides bus service for the Chicago suburbs and supporting routes into Chicago. Additionally, Pace provides paratransit services in the region and is the regional administrator of the vanpool program.

Together, RTA and the service boards include:

- ▶ A service area spanning six counties including 9 million and 3,700 square miles
- ▶ 650 million annual riders and over 2 million daily rides
- ▶ 5,640 bus and rail cars
- ▶ 400 routes between 380 stations and totaling 7,200 route miles
- ▶ 650 vanpool vehicles
- ▶ More than \$42 billion dollars in combined assets (\$142 billion including the subway tunnels infrastructure)

## Asset Management Approach

RTA is working to improve its asset management practices both to help allocate resources as efficiently as possible, and in response to legislative requirements. Illinois' RTA Act, as amended January 2008, requires the RTA to use performance

measures to assess whether the transit system is meeting the needs of citizens and the region, and requires the RTA to develop criteria for evaluating capital projects. In response to these requirements in 2009-2010, the RTA completed a Capital Asset Condition Assessment (Baseline Assessment), and is in the final phase of completing the first year update to the baseline condition assessment (the Update), and is now developing a Capital Decision Prioritization Support Tool (the Decision Tool).

The Baseline Assessment was performed to estimate the RTA's capital needs over a 10-year period, including anticipated replacement, rehabilitation, and maintenance needs that would need to be addressed to bring all RTA assets to a state of good repair. To perform the assessment, the RTA began by working with the service boards to define a consistent set of asset types and categories for which data were to be collected, established data types and naming conventions by asset type, and determined specific data items to be collected. The data collected included basic inventory information, in addition to asset age, useful life, past maintenance, lifecycle, and condition data. During the Baseline Assessment, it was determined to use age as the "predictor" of asset condition. The Baseline Assessment provided a limited verification of straight age-based ratings by conducting a limited sampling effort (1% of assets), which was used to compare actual asset condition against the age-based condition estimate.

With the Update, the RTA decided to move beyond age only as the predictor of asset condition and to adopt several strategies to move towards physical asset condition assessment. The primary feature was the Federal Transit Administration (FTA)-established asset condition decay curves. The FTA has developed transit asset decay curves for every major asset type over multiple years, using a national basis for development (including, but not limited to, Chicago region assets). Additionally, the RTA will continue to utilize the TERM 1-5 condition scale for characterizing asset condition for all assets.

RTA projected that a total of \$24.6 billion dollars would be required over a 10-year period to address the backlog and perform normal replacement and capital maintenance actions. Based on these calculations, the RTA estimated that there was a

\$19.9 billion dollar discrepancy over a 10-year period between projected funding and the funding that would be required to bring all assets to a state of good repair.

Given the significant gap between state of good repair needs and available funds, an important aspect of RTA's asset management approach is the development of a decision support tool to help prioritize state of good repair projects based on available condition data and objective criteria. The RTA's goal for the system is to prioritize the projects in its 10-year plan to help maximize results given available funding. The RTA developed a pilot version of the the Decision Tool to use existing asset data and help support the existing capital plan development process adopted by the RTA in 2008. Following development of the pilot, the RTA secured FTA funds for use to enhance and document the capital asset condition assessment process and to develop an updated version of the tool. The TAM project will provide the service boards and the industry with improved asset management methods and advanced prioritization criteria practices. The TAM project will include condition assessment methodologies, data collection, asset assessment and analysis activities that will help the transit industry prioritize their asset maintenance, recapitalization, and replacement needs in order to obtain a state of good repair.

The first version of the Decision Tool was released in 2011 and the revised version is expected to be released in 2012. It uses a multi-criteria decision analysis (MCDA)-based approach to score candidate projects based on the following criteria:

- ▶ Asset age and condition
- ▶ Riders impacted, based on riders served by the asset location
- ▶ Service reliability, based on risk of service failures
- ▶ Safety and security, based on reduced risk of damage to passengers or assets
- ▶ Operating and maintenance costs

For each candidate project the tool calculates a weighted average total investment score, combining scores for each of the above categories. The tool is expected to yield a prioritized set of projects that is consistent with RTA objectives for its assets. The RTA intends to use the tool to better allocate constrained funding for the achievement of state of good repair and will allow the RTA to prioritize projects, analyzing each service board's projects separately. The tool will be available for both the RTA and service board use.

## Benefits and Outcomes

The asset management has yielded significant benefits for the RTA and its service boards:

- ▶ There is a consistent approach to defining and characterizing transit assets for RTA's three service boards. This effort has improved the quality of RTA's asset data, and provided more complete and consistent information regarding investments required to achieve a state of good repair.
- ▶ The Decision Tool, once fully implemented, is expected to help prioritize projects consistent with agency objectives, and maximize effectiveness of transit asset investments. It will integrate long-term asset needs with the region's project selection based five-year capital planning and annual budgeting processes.
- ▶ The enhancement of the asset inventory includes the development of an asset-to-project numbering convention within the context of the RTA's Capital Decision Support Tool.

## Sources

Information provided by senior contact at the RTA.

### 3.3.2 Role of Operations and Maintenance Budgeting

#### Current Industry Practice

For many agencies, the link between maintenance budget and level of service is implicit but does not drive the budget process. Many agencies do evaluate the cost components of an operations and maintenance budget; however, these are rarely created with a “bottom-up” approach. Agencies are often aware of their cost per revenue hour (or revenue mile) to provide service; however, the budget process is frequently siloed between capital and operations and maintenance investments, which can limit managing cost across the lifecycle.

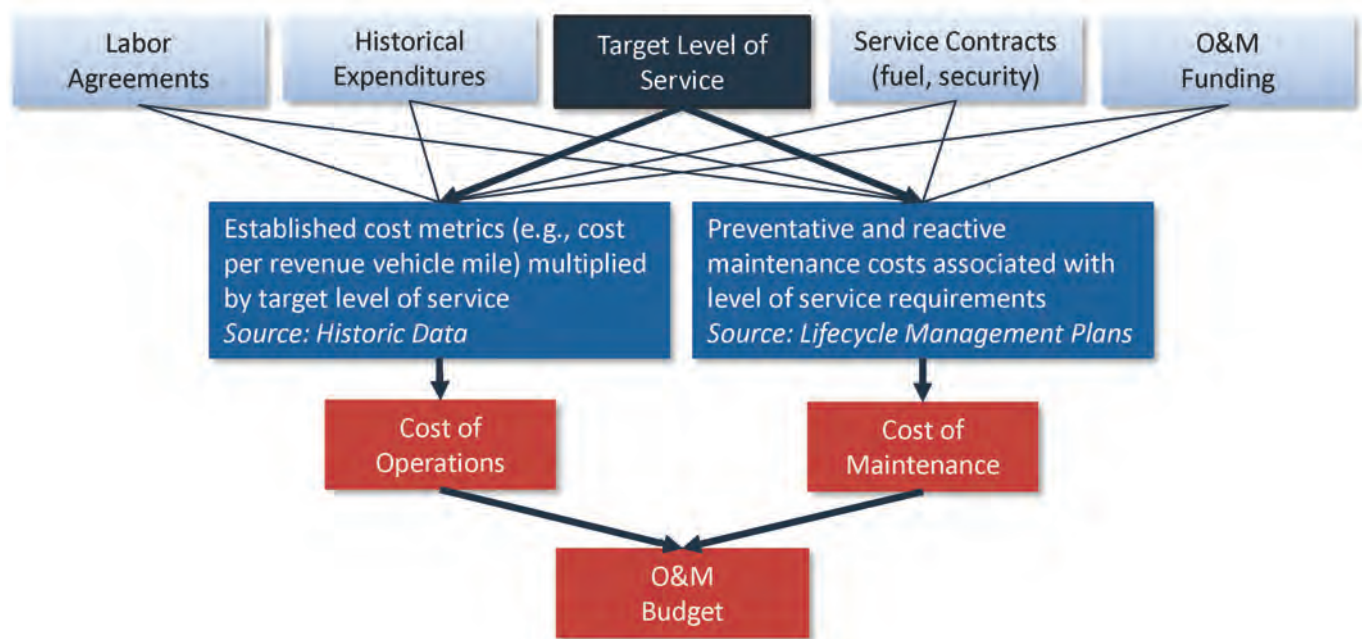
The operations and maintenance budgeting process allocates operating funds to maintenance activities across all assets. Similar to the capital programming process, adopting an asset management perspective encourages performance-based decision making. This guide is focused on the maintenance portion of the operations and maintenance budget and promotes the following:

- **A maintenance budgeting model that explicitly links the maintenance budget to level of service or performance in a process that considers the relationships between maintenance activities and asset management objectives.** As a result of this approach, at the agency level and by asset class, an agency is able to describe what “level of maintenance service” is “bought.” This is based upon the maintenance budget that is created to support specific asset management outcomes.
- **Maintenance requirements that are identified when an asset is procured or created.** This would specify the preventive and related maintenance activities required for the optimal lifecycle management of the asset. This encourages integration of procurement, maintenance facilities design and management, project management, parts management, maintenance, and capital functions because these are all related. Building on and addressing the link between design and operations, maintenance, and rehabilitation is a key component of transit asset management.

The Toronto Transit Commission (TTC), on behalf of Metrolinx, provides an example of an agency considering the lifecycle costs of a light rail line before it is constructed. The agency is working to design and engineer the Eglinton-Scarborough Crosstown Rail Transit (the Crosstown) project. While still in the design phase, the TTC developed an operations and maintenance cost model to estimate the initial 30-year lifecycle costs (including operations, maintenance, and capital rehabilitation costs). The model uses level-of-service metrics, including revenue vehicle kilometers, revenue vehicle miles, and number of vehicles to drive the lifecycle cost estimate. This modeling exercise is allowing Metrolinx and TTC to better understand the financial commitments that will be required to keep the Crosstown in a state of good repair to support safe, reliable transit operations. Additionally, the early implementation of operations and maintenance planning can identify opportunities that will inform the system designers to make appropriate design adjustments, which could reduce the overall lifecycle costs as the Crosstown system matures.

An asset’s lifecycle management plan outlines the estimated maintenance costs associated with maintaining a specified level of service for that asset. This level of service supports the agency’s target level of service. As **Figure 3-13** shows, best practice suggests that operations and maintenance budgets be developed from the “bottom-up” based on input from the lifecycle management plans (with consideration for other operations and maintenance budget cost drivers, including labor agreements and service contracts).

**Figure 3-13.** Establishing the Link between Level of Service and the Operations and Maintenance Budget



In many cases, an agency's operations department has a much stronger influence on the operations and maintenance budgeting process than maintenance. In many cases, an agency chooses to maintain its existing level of service but defer maintenance to compensate for funding shortfalls. This can have significant long-term performance implications. The types of linkages between maintenance budgets and level of service advocated in this guide can be used to support performance modeling and to facilitate stakeholder communications regarding the short- and long-term impacts of under-funding maintenance (see Section 3.3.3).

Some of the benefits associated with having an improved operations and maintenance budgeting process include the following:

- Improves the transparency and understanding of the overall maintenance budgeting process.
- Provides clear link between agency goals (target level of service) and operations and maintenance budget decisions.
- By maximizing the balance between routine and preventive maintenance activities and capital investments, agencies can maximize performance and minimize costs and risks over time.
- Provides internal and external stakeholders with clear justification for funding trade-off decisions.

Operations and maintenance budgeting success factors:

- ▶ Performance-based cost data from the lifecycle management plans used to develop an operations and maintenance budget from the bottom-up
- ▶ Performance-based culture and approaches to maintenance budgeting
- ▶ Complete, up-to-date, and accurate lifecycle cost, risk, and performance data combined with a clear understanding of the agency's level of service goals
- ▶ Trade-offs associated with investment choices identified by involving members of the capital programming team in the operations and maintenance budgeting process

Key implementation principles associated with the establishment of an effective operations and maintenance budgeting process include the following:

- Similar to a construction review, the agency can require a maintainability review during the design and procurement process to ensure that assets being procured or constructed can be maintained in a cost-effective manner that supports the agency's goals. This includes addressing procurement contracts, warranty management, and other factors that affect managing across the lifecycle.
- The maintenance budget reflects input from the executive team (regarding the targeted level of service) and asset owners (regarding their respective asset's maintenance costs).
- If scenario evaluation is available, the operations and maintenance budgeting process incorporates the findings associated the relevant analysis and discussions.
- When possible, asset owners communicate the potential negative consequences associated with deferred maintenance. The more clearly an investment can be tied to an agency goal or performance objective, the more compelling a case will be.
- In many cases, the capital program and operations and maintenance budget are developed independently. When possible, agencies develop these budgets on the same schedules and consider implications to the operations and maintenance budget when the capital program funding is increased or decreased.



## Relevance of Case Study

This case study demonstrates how an outsourced, highly mature asset management program considers the total cost of ownership of its assets by agreeing on cost and performance requirements during its competitive bidding process.

## Agency Overview

The Victoria Department of Transport (DOT) is responsible for the public transport system in Victoria, Australia, including rail, trams (streetcars), and buses. Annual ridership in Melbourne is approximately 262 million passenger trips. The system includes the following services:

- ▶ The rail system in Victoria comprises 17 routes operated on more than 5,000 miles of track. Trains serve passenger routes, as well as intrastate and interstate routes throughout Victoria, carrying a mix of passenger and freight traffic.
- ▶ The tram system in Melbourne consists of 26 routes with more than 150 miles of track. Tram service is provided using approximately 530 trams and 1,740 tram stops.
- ▶ Passenger rail service in Melbourne is provided using approximately 900 rail cars (operating in 6-car trains) and 209 stations.

Victoria's public transport system was privatized in 1999. Following initial financial issues and a restructuring in 2004, the Victorian Rail Track Corporation (VicTrack) now owns the railway land and infrastructure and leases it to Victoria DOT. Victoria DOT, in turn, contracts with a number of franchises to provide transportation services.

## Asset Management Approach

Victoria DOT has a comprehensive asset management approach that is documented through government policy and franchise agreements. The organization has a policy of no single-order failures affecting operations—failures in the system should never be evident to users. This requires a focus on condition-based interventions to fix potential issues before they arise.

Victoria DOT requires an asset management plan from each franchise holder. The plan describes the franchisee's approach to asset lifecycle management, including inspection, maintenance, and quality assurance, as well as performance standards and response times. In addition, each franchisee submits an Annual Works Plan specifying planned capital projects. Franchisees report quarterly on a set of key performance indicators for infrastructure and rolling stock, including condition indices and other measures.

The operations and maintenance budgets are developed by the franchisees as part of the competitive bidding process and are agreed to at the start of the franchise. The only reason these can change is if the state introduces a major capital project (such as a line extension) that fundamentally changes the operating costs of the railway. Ultimately, the franchisee has a day-to-day performance obligation for a safe and reliable railway. They also have a longer-term obligation to achieve a minimum scope of renewal and replacement work that is agreed at the start of the franchise and must be delivered unless agreed otherwise.

Capital purchases are chosen carefully based on lifecycle costs and performance of assets. An effort is made to map all costs of an asset—most importantly the costs of risk-to-service as maintenance needs arise years after purchase. In one recent instance, Victoria DOT chose a monitoring company that offered to install equipment for free, and that company guaranteed that the maintenance and usage fees over the life of the equipment would amount to less than the overall savings.

An important component of Victoria DOT's lifecycle management approach is to maintain an asset inventory that details the inventory and condition of the rail infrastructure, compiled in the Privatized Assets Support Systems Assets Database. The management of existing assets is driven by the lifetime output required of the assets. Franchisees' payments can be withheld if this inventory is not updated.

## Benefits/Outcomes

- ▶ Operations and maintenance budget that guarantees maximized asset performance for the term of the franchise agreement
- ▶ Established performance measures that can ensure Victoria DOT's goals are being managed and met

- ▶ More cost-conscious organization
- ▶ Comprehensive, integrated web-based inventory of rail infrastructure

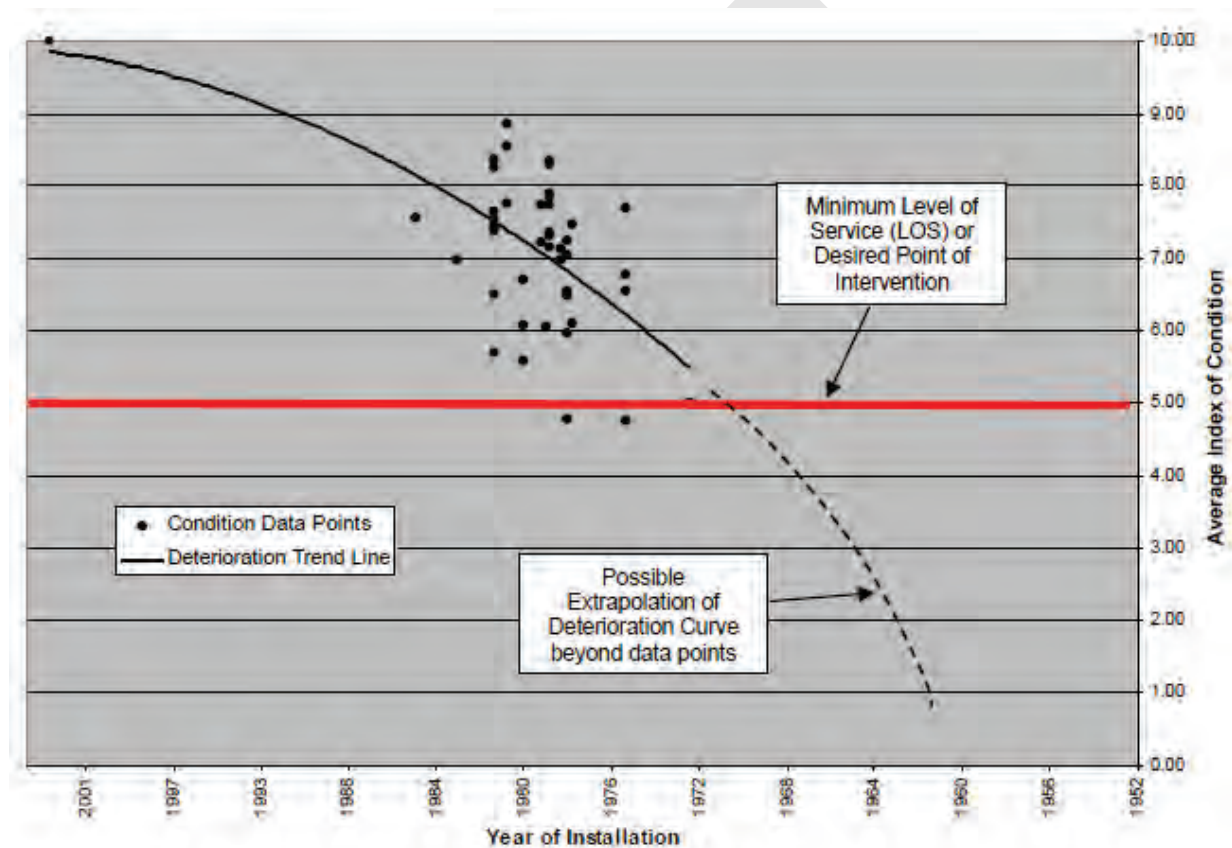
## Sources and Other Resources

Information provided by senior contact at Victoria DOT.

### 3.3.3 Role of Performance Modeling

In this guide, performance modeling refers to the practice of monitoring and predicting asset condition based upon different funding decisions. It is a data-driven process that applies analytical tools and procedures designed to forecast the performance impacts of different budgeting decisions, finance plans, and lifecycle management plans. This can occur with varying degrees of sophistication. Many agencies use basic spreadsheets to model the condition or performance of one asset class over a period of time (see **Figure 3-14**). On the other hand, only a small minority of agencies are conducting scenario evaluation of their agency-wide assets (see MTC example on following page).

**Figure 3-14.** Sample Asset Class-Specific Example – New Zealand Railways Hardwood Rail Tie Condition Index by Age with Fitted Decay Curve



Source: Rushbrook and Wilson, 2007

These modeling approaches all, to some degree, are informing the stakeholder communication, budgeting, or lifecycle management processes:

- **Stakeholder Communication** – Performance modeling enables the impacts of various levels of funding on asset condition (state of good repair) and performance to be considered. Current use of such information tends to focus on communicating condition and “needs” across assets in a consistent way. It increases the understanding of the performance and fiscal consequences of not meeting optimal lifecycle management requirements for capital and/or maintenance work. Similarly, the information can be used to communicate the fiscal and performance benefits from increased state-of-good repair funding.

As asset management practices mature, the link to performance (for example, system reliability) is increasingly made and communicated. In this way, performance modeling provides data-driven information to communicate the impact on reliability, asset condition, asset value and other outcomes of asset investments.

- **Budgeting** – Performance modeling for budgeting involves using data-driven analysis to link resources applied to level of service. Information from performance models can be integrated directly into the capital and operations and maintenance budgeting process as discussed under Section 3.3.2 – Role of Operations and Maintenance Budgeting. Since this process requires a mature asset management organization and analytical capabilities, most transit agencies in the U.S. are not using these types of processes to build their budgets; however, it is a key component of performance-based management. (See Massachusetts Bay Transportation Authority (MBTA) case study at the end of this section.)
- **Lifecycle Management** – Performance modeling enables asset owners to evaluate the effectiveness of specific strategies to evaluate performance implications. For example, an agency can monitor how different cleaning techniques or rehabilitation timing might affect performance by modeling that asset’s performance over a specified period of time.

The Metropolitan Transportation Commission (MTC) is the Metropolitan Planning Organization (MPO) responsible for the nine-county San Francisco Bay Area. The MTC is not a transit operator, but is the agency responsible for transportation planning and financing for 25 transit agencies in the Bay Area, including the San Francisco Municipal Transportation Agency (SFMTA), Bay Area Rapid Transit (BART), AC Transit, and Santa Clara Valley Transportation Authority (VTA). These agencies provide commuter rail, heavy rail, light rail, bus transit, trolley bus, cable car, and ferry service to the Bay Area. Together the Bay Area transit systems carry more than 1.6 million passengers per day, operating more than 4,400 vehicles on approximately 580 routes.

Data on Bay Area transit assets is important for long-term planning and supporting project prioritization decisions. The MTC’s major source of asset data is the Regional Transit Capital Inventory (RTCI). The RTCI was developed in 2007 to support analysis of long-term investment needs based on the inventory of transit assets rather than a defined set of projects. The MTC populates the RTCI with data provided by each transit agency. For the first phase of RTCI development, the MTC obtained data on approximately 80,000 assets, including vehicles, guideway, track, roadway, stations, facilities, and systems. For each asset, the RTCI predicts needs for asset rehabilitation and replacement based on the existing age of the asset and predicted service life. The system predicts unconstrained needs over time, as well as the dollar value of the backlog of deferred replacement and the Percent of Assets Over Useful Life (PAOUL). MTC’s goal for Bay Area transit assets is to achieve a PAOUL of 50%, which is the value obtained if assets are uniformly distributed in age and replaced at the end of their useful life. The RTCI is used to analyze long-term investment needs, but is not a project prioritization tool.

Performance models are used to communicate to customers, policy-makers, and stakeholders the relationship between state-of-good-repair investments and asset condition and performance. Performance modeling enables data-driven approaches to optimizing the nature and timing of preventive maintenance and rehabilitation. Performance modeling at the agency level involves the following steps:

1. **Measure and communicate the current asset condition baseline.** The first step involves establishing a baseline analysis of current conditions and level of service. This is data-dependent and, ideally, uses information provided from the lifecycle management plans, such as asset age, condition, and performance. It also relies on asset decay curves, which can be used to predict an asset’s condition over time. Asset decay curves can be based on industry data<sup>11</sup> or, ideally, an agency’s actual data. Establishing the baseline also relies upon one or more consistent condition and/or performance metrics to communicate the baseline. So, for

<sup>11</sup> Industry data for asset decay curves is available through the FTA’s TERM model

example, the baseline may be communicated with a state-of-good repair measure (for example, the percentage of assets with a condition measurement of 3 or better out of 5) or a performance measurement (for example, on-time performance or mean distance until failure).

2. **Confirm Direction and Level of Service Target** – The agency-wide asset management policy, strategy and plan provide the starting point for specifying the objectives for asset level of service and condition. These objectives provide direction for evaluating the baseline against a desired state. For example, the agency's asset management policy may require 98 percent on-time performance.
3. **Evaluate Alternative Policy and Investment Scenarios** – Scenario analysis involves assessing the impacts, influences, or effects that various scenarios have on the asset management objectives. The scenarios provide a common framework for all parties to discuss the impact of alternative investment decisions while taking future uncertainties into consideration. Ideally, this information is incorporated into the capital programming and operations and maintenance budgeting processes (see Sections 3.3.1 and 3.3.2).

Through the use of financial analysis, predictive modeling, and forecasting tools, scenario evaluation can improve decision making and communications by predicting asset condition and performance based on varying funding levels, capital and maintenance budgeting, and policy changes. This provides a valuable mechanism for communicating with and providing accountability to policy-makers and the public.

Some of the benefits associated with a performance modeling process include the following:

- Enables policy-makers to understand the implications of different resource allocation decisions and support prioritization across goals
- Optimizes decision making through the use of comprehensive and reliable forecasts.
- Improves stakeholder understanding of link between state-of-good repair investments (or dis-investments) and performance.

Performance modeling success factors:

- ▶ Agency is committed toward establishing robust performance management processes
- ▶ Defined level of service goals for the agency and assets
- ▶ Completed lifecycle management plans that clearly outline the link between condition and performance
- ▶ Agency-wide, consistent condition assessment monitoring and reporting

"Our deterioration curves will probably be based on industry data at first, but, as time goes on, the goal is that our agency will be able to define our own deterioration curves for different asset classes."  
—Transit Agency Manager  
(Source: 2011 Parsons Brinckerhoff Survey)

Key implementation principles associated with the establishment of a performance modeling process include the following:

- An agency communicates how performance modeling is intended to be used (that is, planning versus budgeting) so that there are clear expectations.
- Performance modeling relies on significant amounts of data, including, for example, age, condition, useful life, operating statistics, and historic condition data (decay curves).
- Lifecycle management plans for individual asset classes are developed consistently so that uniform asset data can be incorporated into the performance modeling analysis.
- The agency has a method for performance modeling using data from multiple sources.



## Relevance of Case Study

This case study demonstrates how an agency uses asset age and lifecycle data and a scenario evaluation tool to forecast its state of good repair needs and support capital programming.

## Agency Overview

The Massachusetts Bay Transportation Authority (MBTA) provides commuter rail, heavy rail, light rail, bus transit, trackless trolley, bus rapid transit, and ferry service to approximately 1.3 million passengers per day in the Boston area. The MBTA has an extensive inventory of vehicles and fixed assets, including the following:

- ▶ More than 2,500 bus and rail vehicles
- ▶ 275 stations
- ▶ 885 miles of track
- ▶ 20 miles of tunnel
- ▶ 476 bridges
- ▶ 19 maintenance shops

The MBTA's system has been in operation for more than a century. The subway opened in 1897 and is the country's oldest. The system went through a period of rapid expansion in the 1970s, '80s, and '90s, with extensive new commuter rail and rail transit service added to the system.

In 2000, the MBTA moved to a different funding approach that provided a dedicated funding stream but required the agency to operate within a budget. The shift in the MBTA's funding approach forced the agency to assess the condition of its existing assets and determine its needs over time for keeping the expanded system in a state of good repair. Achieving a state of good repair is recognized as a major challenge for the system.

## Asset Management Approach

The MBTA's efforts to implement an asset management approach began in 1999 in conjunction with the shift to forward funding. At this time, MBTA initiated a state of good repair capital programming effort, recognizing the need to better characterize the condition of existing assets and shift from expanding the system to maintaining it in an state of good repair. As part of this effort, the agency

improved its asset inventory, assessed the conditions of its assets, and defined, for the first time, what constitutes a state of good repair. The MBTA currently defines state of good repair as the "condition where all assets perform their assigned functions without limitation." For the purposes of modeling state of good repair, this translates to an asset age being less than or equal to its useful life.

Since 2006, the MBTA has used its state of good repair database for validating whether its capital programming is in line with its state of good repair investment needs. The state of good repair database is a comprehensive database and analysis model that includes the following:

- ▶ Information on more than 2,900 assets
- ▶ Ability to synthesize capital needs information received manually from managers throughout the organization
- ▶ Ability to objectively generate reports that depict "what if" scenarios

The state of good repair database analyzes individual capital asset records using cost, age (and condition, indirectly), useful life, renewal activity and other user input. Based on user-specified weights, the system simulates allocation of a specified budget to investment needs over time. The system creates and reports on scenarios involving 5-year capital improvement programs and 20-year strategic capital investment plans, predicting the number of assets that are within their useful life, and distribution of funds given a budget.

In the near future, the MBTA staff will be evaluating the potential for incorporating the following into their state of good repair system:

- ▶ Condition data (as opposed to just age-based decision making)
- ▶ Decay curves
- ▶ Web-based capital needs form
- ▶ Integration with capital programming decision-making software
- ▶ Improved data management practices

## Benefits/ Outcomes

- ▶ The MBTA has used state of good repair data to report to the Massachusetts legislature on its funding needs to address the state of good

repair backlog. As a result of its emphasis on state of good repair concerns, the MBTA has shifted its capital spending to focus almost exclusively on achieving state of good repair (as opposed to expansion projects). In the 1990s, only 60 to 70 percent of the capital budget was allocated for projects related to state of good repair. In the 2012–2016 capital plan, more than 95 percent of MBTA capital funds were allocated to projects related to achieving state of good repair.

- ▶ The MBTA now has the ability to prioritize projects based on a transparent process using objective data. The reports generated from the state of good repair system helps inform the capital programming process.

- ▶ The state of good repair system has also helped the MBTA communicate its asset conditions and investment needs to other stakeholders, including the Massachusetts legislature, metropolitan planning organizations, and the public. Furthermore, through better communication about the conditions of its assets through the state of good repair database and Scorecard, the MBTA hopes to strengthen accountability and public support for the system in the future.

## Sources and Other Resources

Information provided by senior contacts at MBTA.





## Chapter 4

### Asset Management Information Systems

At its core, asset management applies rigorous, fact-based decision making, using information about the performance of an asset across its lifecycle. Integrated asset information that can be analyzed and readily reported is fundamental for effective performance assessment and asset management.

Contemporary best practice—either at the enterprise level or during any aspect of lifecycle management for individual asset classes—depends upon the application of information technologies. Converging information and operations technologies enable real-time monitoring of condition and performance, providing new opportunities to employ technology to improve asset management outcomes. This chapter presents the following sections to help agencies make informed system decisions:

- Transit agencies and asset management information systems
- Components of an asset management information system
- Implementation principles
- Vision of a high-functioning transit agency asset management information system

While this chapter demonstrates the scope and complexities involved in integrating information systems to support asset management in larger agencies, smaller agencies—many with bus-only systems—can apply the same principles using well-developed components (such as fleet management systems) that incorporate the principles of the asset management information system demonstrated in this chapter.

Chapter 5 provides detailed guidance on implementation steps.

As explained in the asset management framework introduced in Chapter 2 (Figure 2-7), information systems as well as management practices are the foundation of any asset management initiative, where the systems support the asset management process and practices. Whether an agency is developing its asset inventory or using decay curves<sup>1</sup> for performance modeling, the asset data needs to be stored, managed, and analyzed in one or more information systems for effective management. Information systems can support all of the asset management

Asset management information systems provide data in a timely and easy-to-understand manner for management decisions and in support of engineering, capital programming, and risk management decisions. Integrated data and access to historical data enables an agency to manage across functions and over the lifecycle of long-lasting assets, resulting in better-informed decision making and decision support processes.

business processes. **Figure 4-1** functionally depicts an integrated asset management system. The arrows on the left depict key actions that support asset management functions (shown in the triangle). The boxes on the right present key functionalities provided by the asset management system.

## 4.1 Transit Agencies and Asset Management Information Systems

All transit agencies have information systems of one type or another (with differing levels of automation) to support asset management and related activities. Improving them offers both opportunity and a significant management challenge.

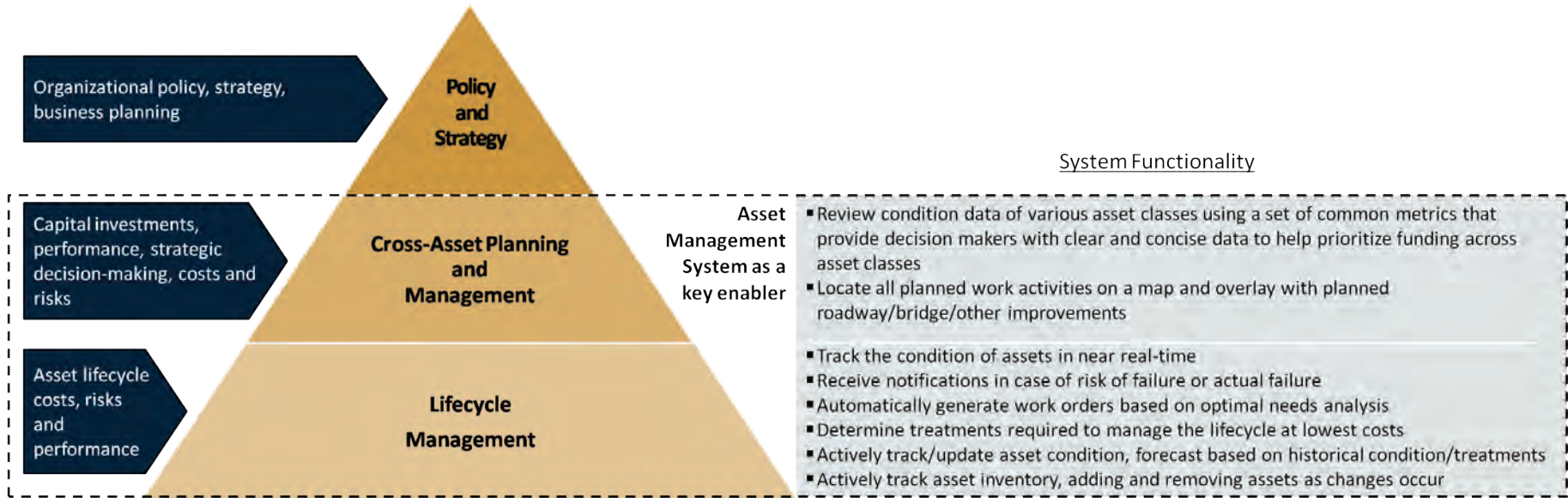
Many agencies are confronted with a legacy environment of data management practices, information systems, and processes, which (while they support business as conducted today) do not provide the information required for mature asset management. This situation is frequently compounded in agency business environments where information technology investments have not been agency priorities. This presents many challenges related to asset management information systems.

While many Commercial Off The Shelf (COTS) asset management-related software exist, each software product has its own strengths and weaknesses. No single commercially available system appears to address all aspects of the asset management framework outlined in this document. Transit agencies with multiple modes and a diverse asset portfolio are likely to require combinations of systems, or, at a minimum, substantial product customization to meet the types of needs addressed in this transit asset management framework.

<sup>1</sup> Decay curves or deterioration curves refer to a graph that shows the condition of an asset against its age. Such curves help to effectively predict the future condition of an asset. Different assets have different deterioration curves based on location, weather, usage pattern and other factors.



**Figure 4-1.** Functional Depiction of an Asset Management System



Source: Adapted from the Institute of Asset Management’s *An Anatomy of Asset Management*.

## 4.2 Asset Management Information System Components

The fundamental asset management activities and how they are enabled by the various components of an enterprise asset management system are shown in **Figure 4-2**. For each basic management action (shown in blue), a corresponding function or component of an enterprise asset management system is shown in green. A description of each component follows the figure. When referencing the figure and considering the following sections, it is important to note that there are different technical systems solutions for providing the components of an asset management information system (the green elements of the diagram).

### 4.2.1 Asset Inventory

The asset inventory component of the asset management system identifies all critical assets, their location, and important attributes such as age, expected useful life, cost, and type of asset. As discussed in Section 3.2.1, this guidance suggests that the asset hierarchy should go down to the “maintainable unit” to meet business process needs. The asset inventory system/tool should either provide the capability to record asset condition data, including history, or allow for a mechanism to seamlessly link to this data. Also, the system should allow for the

#### Asset Management Information System Challenges

Many agencies have developed tools internally within divisions based on their specific needs. These tools may, individually, provide the required functionality; however, they generally do not integrate or exchange data with other systems, severely limiting their ability to support enterprise or department-wide decision making. Also, many times, the systems that met an agency’s needs on a small scale cannot support the agency’s needs as the departments grow. Many agencies have a well-defined strategic IT direction to replace their aging system architectures, but implementation has been slow.

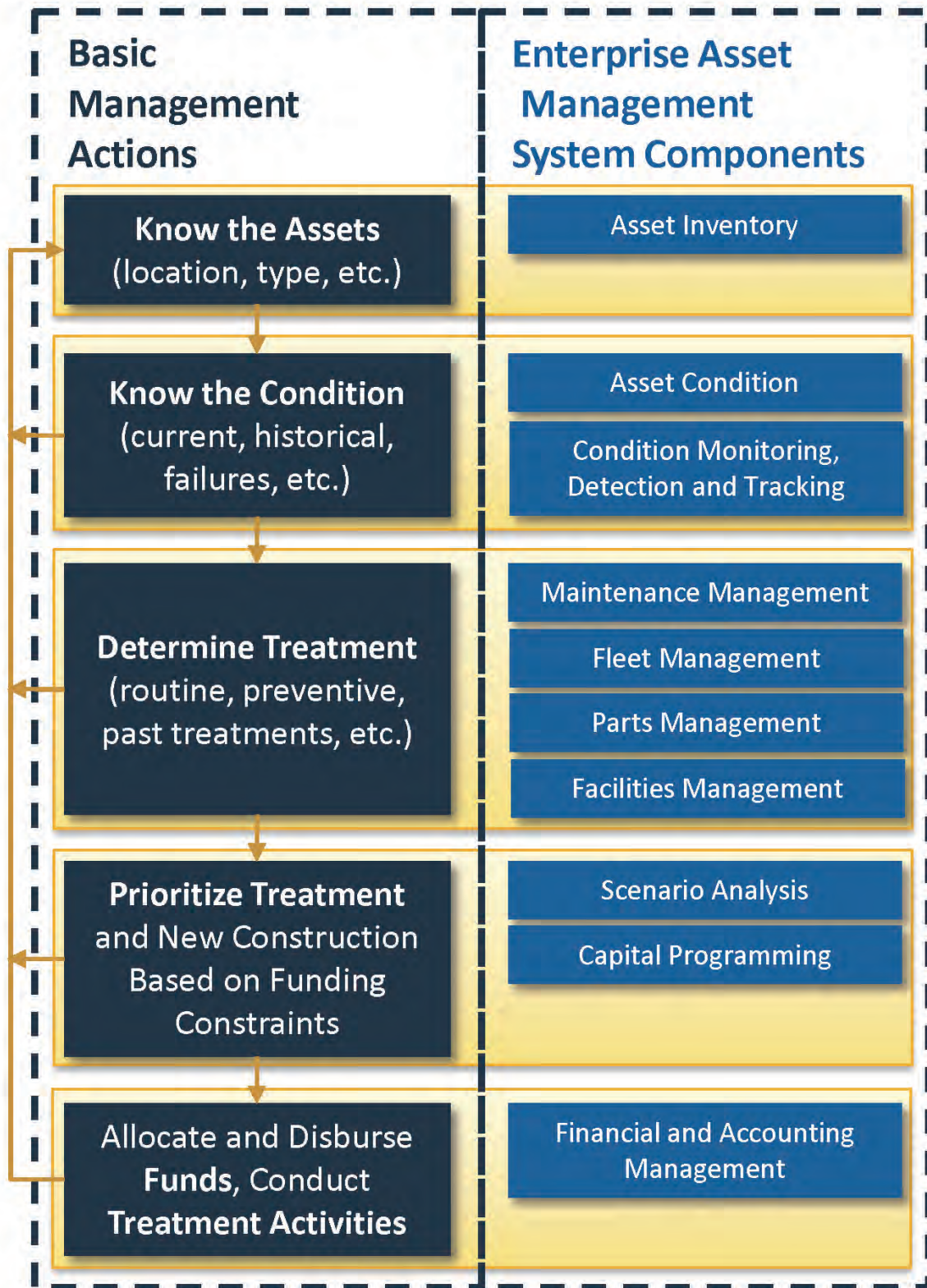
data to be not only stored but also easily recalled for reporting and analysis. Having a comprehensive inventory depends not just on the tool but on the quality of data in the system—it is important for an agency to have an up-to-date inventory, correct categories, and hierarchy (data relationships between key elements). (For more information on asset inventorying, see Section 3.2.1.)

### 4.2.2 Asset Condition

The condition data component provides a location to store raw condition data, aggregate condition data (converted to level-of-service measures/metrics), and ratings for the assets based on thresholds in the system. This dataset largely makes up the fundamental performance characteristics of assets within the system or agency.

Some of these asset condition tracking systems can also track deterioration/decay curves based on not only agency data but data available from other transit agencies. Tracking decay curves allow agencies to forecast the conditions of various assets at a granular level based on current asset condition and age, thus helping to make and justify programming decisions. Asset inventory and condition data is generally stored in the same system to allow for clear “connections” between the two. (For more information on asset inventorying, see Section 3.2.1.)

**Figure 4-2.** Asset Management System Components and Functionality



### 4.2.3 Active Condition Monitoring, Detection, and Tracking

Active tracking systems track and provide asset condition data in real-time/near real-time. Such tracking provides significant benefits for managing various assets, especially fixed assets. Such systems include rail track monitoring systems that track rail stress and earth movement; bus monitoring systems that monitor condition of vehicle components such as brakes, electrical, oil pressure; and subway monitoring systems that track the state of subway doors (closed, ajar, etc.). Such systems allow an agency to record up-to-date condition information (in asset condition components listed above), and when linked to inventory and historical condition, conduct preventive maintenance activities when required, which have the potential to reduce lifecycle costs. This link between traditional business intelligence (data mining and assessment) and asset management is a key value to many agencies that remains largely untapped within the industry.

#### Maintenance Management and Asset Management

The terms “maintenance management” and “asset management” are frequently used interchangeably in the industry; in fact, they are quite different. While the primary purpose of maintenance management is to manage maintenance activities (which activities are performed on which asset, cost of maintenance, etc.), the primary purpose of an asset management system is to provide a whole-life view of all assets, allow monitoring, tracking, and analysis of how funding strategies affect asset condition, and allow the agency to make policy and strategic decisions regarding funding (cross-asset decision making, investment decisions). Maintenance management focuses more on the short-term activities, while asset management is intended as a proactive approach to managing enterprise investments over the longer term. Maintenance management should be envisioned as a subset of asset management. The term “enterprise asset management” refers to asset management conducted at an enterprise level instead of just one section/department of the agency/ enterprise.

The maintenance management system, when integrated with business intelligence, condition tracking and forecasting, and other enterprise tools, forms a true enterprise asset management system/tool.

The largest benefits from such systems are derived when the data is seamlessly tied to historical asset condition and past work activities. These benefits also allow an agency to conduct root-cause analysis of the failures, and, in some cases, review the trends to identify and forecast problems to monitor. This information significantly increases an agency’s capability to conduct targeted, effective maintenance activities. Technological improvements have allowed agencies to acquire new assets with condition tracking systems, but older assets (for example, older buses) may not have the same onboard technology.

Details about condition monitoring systems specific to each of the transit asset classes are provided in the *Asset Management Guide Supplement*.

### 4.2.4 Maintenance Management

A maintenance management system/component helps schedule and track the work orders for assets, when the work is conducted, associated labor and equipment costs, materials management, and in some cases, the condition of assets forms an important component of the asset management system. Various agencies use COTS packages for maintenance management, while some agencies use tools that were developed in-house. Maintenance management systems designed specifically for transit agencies generally include fleet management, fuel management, and other components listed separately here.



### 4.2.5 Fleet Management

Agencies are also increasingly adding fleet management systems to track warranties, claims, and any vehicle accidents/other incidents. Such data can significantly reduce an agency's cost by claiming in-warranty repairs from the manufacturer and analyzing any trends in vehicle accidents. Many fleet management systems also include parts inventory management capabilities. Some maintenance management systems designed for transit agencies provide fleet management capabilities.

### 4.2.6 Parts Management/Inventory Control

A parts management system/component allows the agencies to track the number of parts available for mission-critical assets, and allows the agency to maintain an optimal number of parts. This ensures that the critical assets do not suffer from downtime because of lack of parts, while the agency does not have too much cash tied in stored parts. It enables better service and better performance and allows for modern supply-chain management practices.

### 4.2.7 Facilities Management

Fixed assets, like buildings and equipment, are significant components of an agency's asset portfolio. Stations, stops, transit centers, and train and bus maintenance facilities are critical to meeting customers' needs. Tracking and maintaining these facilities is important for agencies, and a facilities management component provides the correct tool for such management. Facilities management is often a component of maintenance management or enterprise resource planning (ERP) systems.

### 4.2.8 Scenario Analysis and Decision Making

After the data from the various components of an asset management information system are integrated (and with the right analysis and reporting capabilities), this data can be used to communicate in a consistent way the state-of-good-repair needs of the agency across all asset classes. It allows the agency to review and describe scenarios for the future state of good repair under different capital programming and funding scenarios. This type of capability allows for a transparent consideration of trade-offs and their implications in the planning and budgeting process. This provides decision-support information that allows the agency to select and prioritize among assets and projects, including expansion and state-of-good-repair projects.

Further analysis of completed projects allows the agency to improve its prioritization process and update its asset condition forecasts. An agency's decision-support system can provide comprehensive analysis of all enterprise data, and provides a capable scenario analysis tool. This tool can provide flexible reports and data to understand the impact of various funding (and other) decisions, and support such decisions with data.

### 4.2.9 Financial, Accounting Management, Engineering, and Other Systems

Financial, accounting management, human-resource (HR) management and other similar systems provide agencies with the capability to use a central system for tracking various costs, benefits, invoicing, and other financial, accounting and HR functions. These systems have a wealth of data surrounding labor, material, and equipment costs. In addition, such data allows for improved financial planning—leading to significant organizational benefits. Linking cost data to the asset across its lifecycle requires integration between these systems, adding a further technical challenge in today's transit agency technology environment.

Such data, as well as maintenance management and project management systems, allows stakeholders to obtain a complete picture of the total costs of a maintenance activity (including labor and materials), activities performed on an asset, and any budget/schedule overruns. Agencies generally use an ERP system that integrates the aforementioned financial, accounting, and HR data.



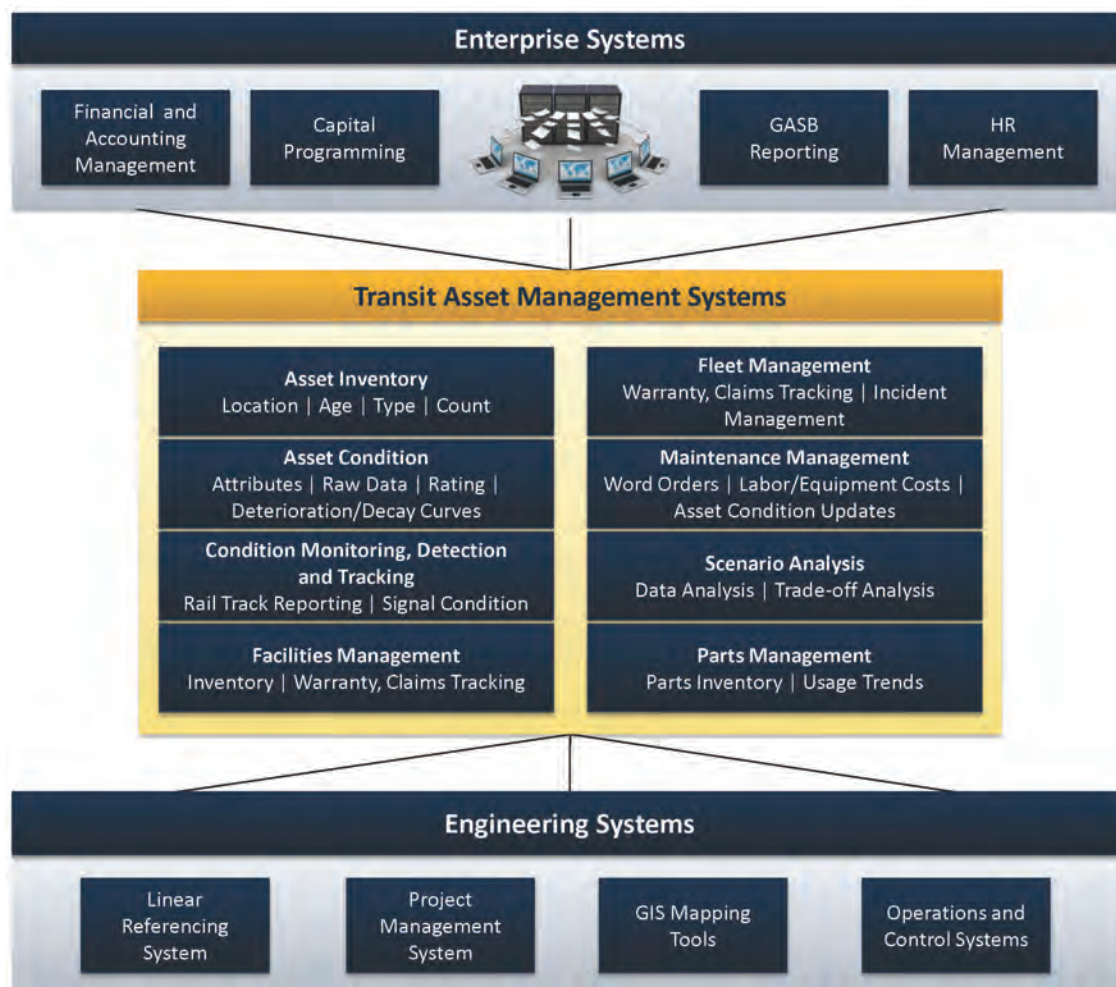
The use of engineering systems, such as GIS and spatial data tools allows the agency to understand the physical location of its assets. Integrating asset inventory and fleet management data with GPS (location) and GIS data aids in real-time transit reporting (for tracking and reporting, say, bus location and estimated time of arrival to the public).

#### 4.2.10 Technical Solutions to Integrating Asset Management System Components

The asset management system components, when tightly integrated, form an agency’s enterprise asset management (EAM) system. How this is accomplished varies between agencies, and the technical architecture for an information systems solution that supports asset management will be determined by a series of context-specific decisions. For transit agencies, these will be driven by the portfolio of assets and the legacy environment of processes, practices, and information systems.

The intent of this guide is to address functionality—the attributes of mature transit asset management practice—and provide information to agencies with asset management improvement programs. Therefore, while this guide does not provide systems solutions, it does provide a conceptual architecture for integrating the basic components of asset management information systems. Figure 4-3 presents the components and links for an ideal asset management system in the form of a conceptual architecture.

**Figure 4-3.** Illustrative Conceptual Enterprise Asset Management Architecture



The functionality of many of the components listed separately here can be met by one system. That said, the goal of an agency need not be to have just one system for all the functions, but a series of well-integrated systems that allow all stakeholders to perform the required functions. The number of integrated systems largely depends on an agency's current and/or planned architecture, systems in place, any state or local mandates, and any planned upgrades.

## 4.3 Implementation Principles

The following key principles are associated with successfully implementing an EAM system (refer to Chapter 5 for more implementation guidance):

The most useful information systems are those that are business-driven, supporting the agency's day-to-day and longer-term needs.

- **Recognize that tools support the process** – The asset information system supports and enhances asset management practices, but is not a substitute for those practices.
- **Provide executive sponsorship and leadership** – Executive sponsorship and leadership are crucial in influencing the project's process, progress, and the final outcome. Executive sponsorship will ensure that project team members and subject matter experts fully support the project efforts and are accepting of changes that may result from this project.
- **Define and follow clear system requirements** – Firm and consistent basic requirements provide clear and obtainable goals that will reduce the effect of change. User input will play an important role in establishing firm, basic requirements.
- **Involve users** – User involvement early on and throughout the project helps ensure that the system meets real needs and will be used. Users should include organizational leaders, asset owners, and maintenance staff. These users generally have different individual needs within the corporate goals as well as varying levels of software experience.
- **Ensure effective data governance** – It is important to ensure that data terminology is clearly defined, and that data collection and storage practices are standardized and well understood throughout various divisions. (Key implementation principles associated with managing the data are presented in Section 3.2.1 in Chapter 3.)
- **Commitment to data updates** – Information systems are only as good as the data they contain. As time passes, updating inventory and condition data is critical and agencies need to explicitly commit to keeping data up to date in the system to keep it useful.
- **Build upon existing system infrastructure** – An agency should evaluate the age, functionality, and flexibility of existing system infrastructure and attempt to use existing systems to the extent possible. A review of how the EAM architecture could be built using some of the existing components, along with new components that are necessary, is important to ensure maximum benefits for incurred costs. This does not mean that the architecture should include all, or even most, existing systems, but that the existing systems should be properly reviewed for their current and future abilities.

Similar to the Visioning Section in Chapter 2, this section is intended to describe how improved asset management information systems can impact many functions in a transit agency.

### General Manager

“On a regular basis, I get asked by stakeholders, ‘What is your on-time performance and how has it changed over time?’ or ‘If we find you additional funding, how would you spend it?’ In the past, I was never able to answer these questions on my own. In fact, these questions required significant data compilation and analysis. I would ask my management team for assistance and they would ask their teams to spend hours, if not days, pulling together cost, project, and performance data. I know it was disruptive, but what else could I do? Sadly, our board members and customers were not impressed by our slow response, and they often found that we were sharing out-of-date and inconsistent information. Now that we have integrated systems with comprehensive data that is updated on a regular basis, I’ve got data at my fingertips to provide immediate, accurate responses. This has improved our ability to communicate our successes, justify our needs, and save both time and money.”

### Capital Programming & Finance Manager

“My job is to facilitate the process of prioritizing how we spend our capital and O&M [operations and maintenance] dollars. Most of our budgeting decisions were based on using the past year’s cost estimates combined with input (mostly anecdotal) from managers. Many of our managers have been doing this for decades, so they have a good sense of system needs and project costs, but I knew most of

them are going to be retiring soon. Now that we have a comprehensive asset inventory with detailed information about the asset’s criticality and condition, we are making better informed decisions than ever. Not only that, but we are using a decision making tool that utilizes the asset inventory data and incorporates the prioritization criteria that best supports our agency’s goals. Some of our managers argue with the outcomes, but we’ve now got reliable policies and data to defend our decisions.”

### Railcar Maintenance Manager

“We have always had a maintenance management system that specified what work needed to be completed when, so I was quite skeptical about any system changes. Our team, basically, fixed things when they broke and the system seemed to run just fine. Now, I understand how different things can be. We still have to fix things when they break, but the majority of our work is focused on preventive maintenance. We use handheld computers to track the condition of the railcars and we can easily look up the maintenance history for the railcar as a whole or any of its components. Just recently, the system alerted me that we kept having to replace the same part in all railcars from a certain manufacturer, so now we’re proactively replacing that component in every railcar in that series. This is different than the manufacturer’s recommendations, but it makes sense because of our region’s climate. I’ve been excited to see how this approach has had a direct impact on our on-time performance and mean distance between failure performance metrics. And, we are able to use our cost savings to fund additional maintenance staff, I don’t know why we didn’t see the net benefits before this and improve the system earlier.”





## Chapter 5

### Implementation Guidance

*This chapter provides guidance on planning for and implementing the process and practices described in the rest of this guide. This chapter also introduces key implementation concepts, provides an agency self-assessment for determining the agency's maturity level, and outlines potential implementation paths for incorporating into the agency's asset management plan. Finally, it outlines implementation considerations and lessons learned.*

The fundamental concepts of asset management are straightforward; however, implementing the changes required to become a mature asset management organization requires careful planning and execution. An agency's current portfolio of assets and management practices is the result of decades of decision-making in environments with many institutional factors that limit the ability to integrate decision-making across asset classes and lifecycles. An agency that is organized to integrate decision-making across the entire asset lifecycle will be better positioned to apply the asset management processes and practices described in Chapters 1 through 4.

Institutionalizing asset management requires a true shift in an agency's management and culture—toward outcomes that focus on reliability, total cost of ownership, and performance or level of service. A central theme for this implementation chapter is that attention to change management and building an asset management culture in the agency are critical. Becoming a highly performing asset management organization takes time and requires considerable change, but en route, significant near- and long-term performance improvements can be realized.

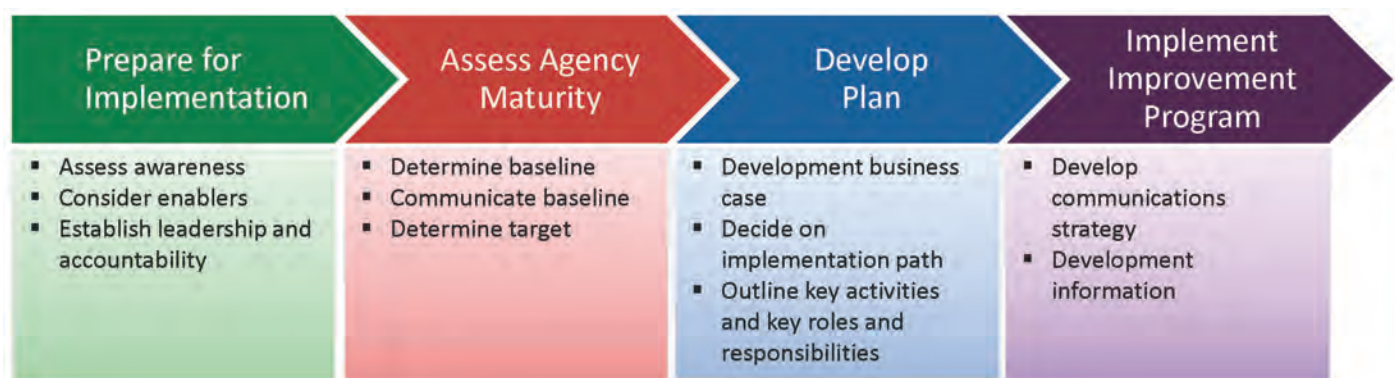
## Summary of Implementation Principles

- ▶ **Understand your agency's asset management drivers** – Agencies undertake an asset management improvement program for various reasons (for example, a response to a mandate, a need for improved transparency, and a drive to improve performance and more business-like management, among others). Your agency should develop an implementation approach that maintains that focus; however, the approach should be flexible enough that it can shift as priorities change.
- ▶ **Build upon existing strengths and practices** – Your agency should leverage its departments' existing asset management activities, identifying best practices and lessons learned with one asset class and applying these practices and lessons to others.
- ▶ **Provide value immediately** – Through incremental implementation activities, your agency can quickly achieve results that demonstrate the value of implementing improvements to asset management practice and provide momentum for future activities.
- ▶ **Recognize that asset management is a process** – This guide identifies the core processes that provide a starting point for developing an asset management process that will pay dividends in improved service delivery and asset sustainability; however, your agency should recognize the importance of continually using your organization's experiences and those of its peers to improve asset management processes.
- ▶ **Prioritize people, tools, and information** – Asset management is, at its core, about data-driven management, so your managers should identify the people who can understand and lead this change initiative and establish the data and develop tools that best support your agency's decision-making processes.
- ▶ **Invest smartly** – Your managers should identify the investments that will provide the best “bang for the buck” and only if these investments support your agency's strategy.
- ▶ **Develop your human resources** – Your managers should identify the appropriate skillsets needed to implement the asset management strategy and invest in those people with recognition, incentives, and training.
- ▶ **Provide top-down leadership and assign clear ownership for asset management activities** – Strong leadership will set expectations and accountability for implementation, while your asset owners should “own” and drive implementation by developing and implementing lifecycle management plans.

## 5.1 Implementation Approach

As a starting point, this guide identifies four basic steps for planning, implementing, and institutionalizing an asset management improvement program (see **Figure 5-1**).

**Figure 5-1.** Asset Management Implementation Program Approach





These steps include:

- **Prepare for Implementation** – The best starting point for developing an asset management improvement program is to know the level of asset management awareness and understanding within your agency. By establishing a leadership and accountability framework and considering the change management required in the areas of training, communications, and values and culture (all implementation enablers listed in **Table 5-1**), the agency can establish a foundation for the asset management improvement program.
- **Assess Agency Maturity** – An important next step is completing an appraisal of the maturity of your agency's asset management processes. This means assessing which elements of the asset management process outlined in this guide you have in place and what role they play in your organization. This can provide a baseline describing your current process and be used to set improvement targets.
- **Develop a Plan** – The plan specifies the implementing actions for increasing asset management maturity, and outlines exactly how the agency will improve asset management processes and outcomes. The plan addresses your agency's awareness of asset management, readiness for change, and ambitions for the asset management improvement program. The plan should include funded improvement projects; therefore, to accomplish this, the plan must be coordinated with or addressed in the budget process.
- **Implement Improvement Program** – With all foundational items in place, the asset management improvement program can be implemented.

### What is an Asset Management Implementation Program?

Establishing progress towards the routine use of the business processes in the Transit Asset Management framework

- ▶ Based on direction provided by transit agency management
- ▶ Implemented by staff responsible for the lifecycle management of all transit assets
- ▶ With a focus on activities that are cost-, risk-, and performance-driven agency-wide, consistent condition assessment monitoring and reporting

The rest of this chapter describes each of these activities in more detail.

## 5.2 Prepare for Implementation

The foundational activities associated with implementing and institutionalizing an asset management improvement program includes the following:

- Assess the asset management awareness in the agency.
- Consider asset management enablers.
- Establish a leadership and accountability structure.

Each of these steps is described in more detail below.

### 5.2.1 Assess Asset Management Awareness

Asset management awareness refers to an agency's board, management, and staff understanding of what asset management is, why it is important, and how their activity supports it. All transit agencies manage assets; however, the degree and depth that lifecycle asset management is understood throughout an organization informs the level of asset management awareness.

Do all of these staff members understand that they are supporting the asset management initiative?

- ▶ A general manager regularly asks for performance metrics around some of the more critical assets' performance.
- ▶ A procurement officer checks with engineering to see if lifecycle data (reflecting, for example, maintenance requirements) are incorporated into vehicle procurement.
- ▶ A maintenance manager decides to proactively replace all of the light bulbs in a facility at once because one failure likely means the others will fail soon.

The level of asset management awareness in an agency directly correlates with how ready the agency is for implementing an asset management improvement program. The more agency managers and staff understand what asset management is, its potential for improving performance, and how it relates to their job, the more likely they will be to support and encourage it. Establishing a common understanding of what asset management is and having a common language within the agency are prerequisites for success and should be addressed as foundational building blocks in implementation planning.

## 5.2.2 Consider Asset Management Enablers

Enablers are supportive processes and activities that form the foundation of a successful asset management improvement program. Displayed as the bottom panel in the asset management framework introduced in Chapter 2 (**Figure 5-2**), enablers ensure that the asset management business processes can be successful. Many of the enablers require dedicated resources (staff and/or funding); however, in many cases, these resources can be integrated into an agency's existing enabling processes.

**Figure 5-2.** Asset Management Enablers

Enablers	
<ul style="list-style-type: none"><li>▪ Leadership &amp; Accountability</li><li>▪ Training</li><li>▪ Communications</li></ul>	<ul style="list-style-type: none"><li>▪ Values and Culture</li><li>▪ Project Management</li><li>▪ Continuous Improvement</li></ul>

**Table 5-1** describes the importance and success factors associated with each enabler. An agency should consider whether the enablers described in this table are in place and fully supportive of the asset management improvement program.

**Table 5-1.** Asset Management Enablers

Enabler	Relationship to Implementation	Success Factors
<b>Leadership and Accountability</b>	In many agencies, focusing the business practices around improved asset management can require a change in the way the agency does business. This means leadership provides clear direction regarding people’s responsibilities. They also provide appropriate accountability mechanisms and develop and follow a structured communications strategy.	<ul style="list-style-type: none"> <li>Define asset management roles, responsibilities and accountabilities.</li> <li>Document expectations for asset management in performance plans and applicable job descriptions.</li> <li>Hold all stakeholders accountable for achieving the agency’s asset management goals.</li> </ul>
<b>Training</b>	Training enables staff to understand what asset management, why it is important, and how it can be improved.	<ul style="list-style-type: none"> <li>Train agency staff on the benefits of asset management and what it entails.</li> <li>Develop asset management competencies within the organization.</li> <li>Document asset management business processes to ensure that asset management skills and quality are maintained.</li> </ul>
<b>Communications</b>	The asset management change initiative requires effective communications by leadership regarding their expectations, the implementation steps, and progress.	<ul style="list-style-type: none"> <li>Develop a communication plan that uses, to the extent possible, existing communication channels.</li> <li>Encourage two-way dialogue and engagement that enables effective implementation.</li> </ul>
<b>Values and Culture</b>	Culture in many ways is linked to an agency “saying what is important” and “doing what it says is important” and then “rewarding and recognizing supportive actions.” Culture is established and/or reinforced by the leadership’s actions and values. This includes how the agency recognizes and rewards positive and negative behavior, communicating and learning from negative feedback, and using data to drive management decisions.	<ul style="list-style-type: none"> <li>Before undertaking any asset management improvement program, take stock of the agency’s current culture and values. Acknowledge those aspects of the existing culture that are supportive and those that could interfere.</li> <li>Encourage and incentivize positive behaviors.</li> <li>Hire management and staff who embrace the culture and values that are important to your agency. For example, an agency may focus on hires that have strong communication skills or have experience working across multiple departments, in addition to the other qualifications necessary for the position.</li> </ul>
<b>Project Management</b>	Ensure that the asset management improvement program is managed based on sound project management practices. Emphasis should be focused on having strong tailored governance and communications. Adaptive program and project management may work well for your agency; this means applying lessons learned elsewhere.	<ul style="list-style-type: none"> <li>Assign project managers who have a strong grasp of asset management.</li> <li>Encourage project managers to “own” asset management and drive change.</li> </ul>
<b>Continuous Improvement</b>	Asset management is a process and requires a constant focus on improved performance and managed risk. To institutionalize this mindset, management and staff work to improve their data management and decision-making processes.	<ul style="list-style-type: none"> <li>Monitor outcomes and progress towards meeting asset management goals.</li> <li>Empower and motivate staff to be innovative and feel ownership over their jobs. Staff can be empowered by asking for their feedback, incorporating their ideas into the solutions, and celebrating their successes.</li> </ul>

### 5.2.3 Establish Leadership and Accountability

Leadership and accountability are important enablers. As part of preparing for implementation, the governance structure must be established for the asset management improvement program. The nature of the governance structure will differ between agencies, but it should provide clear direction regarding responsibilities, accountability, change management, issue resolution, and roles for communications strategy. This is important because an asset management improvement program is, ultimately, a linked series of smaller projects that drive agency-wide change. To be successful, an agency must have the leadership and governance structure in place to manage these projects.

Asset management implementation is most successful with an Executive Sponsor and Champion. Whether these individuals exist in your agency, the person or department leading the efforts to establish and implement an asset management improvement program should evaluate the following questions:

- Is the asset management initiative going to be an agency-wide change initiative or is it likely to “start small” and grow more pervasive over time?
- Does the asset management improvement program have board support?
- Does the asset management improvement program have Executive Level support and/or a Champion?
- What resources are required to support the asset management improvement program, are they available, and how can they be budgeted?

The answers to these questions will determine the level of resources needed for the asset management improvement program. The following are some of the key leadership roles and responsibilities for managing implementation:

- **Asset Management Executive Sponsor** – From the Executive Team, the asset management executive sponsor encourages and empowers other leaders and staff in the organization to drive the asset management improvement program forward. The executive sponsor communicates with the rest of the Executive Team, the board, and other stakeholders, as needed, to ensure that asset management is getting the attention and resources needed to ensure its success.
- **Asset Management Champion** – Agencies with successful asset management improvement programs have noted the importance of having an executive sponsor; however, if there is no or limited executive sponsorship, an Asset Management Champion can still drive the asset management improvement program. An asset management champion, not necessarily from the Executive Team, may become the “face” of the initiative and provide a resource for others in the agency as obstacles and challenges are confronted. This is an important position in the earlier stages of an asset management improvement program and should, ideally, remain so until changes have been institutionalized.
- **Asset Management Program Manager** – The Asset Management Champion may also own the management of the asset management improvement program. Whether he or she is partially or fully dedicated to the asset management improvement program, the Asset Management Program Manager should have asset management responsibilities written into their roles and responsibilities. They may be the same as the Asset Management Champion listed above. This person should be held accountable for developing and maintaining the asset management plan, communicating with the Executive Team, leading the Asset Management Improvement Team (defined below), and managing internal and external communications regarding the asset management improvement program. Ideally, this position, reports to the most-senior level to ensure the appropriate decision-making authority across departments and to ensure that the plan reflects enterprise-level priorities. Key competencies required to perform this role include the following:

- Strong leadership, change management, collaborative, and project management abilities with broad respect throughout the agency
- Broad transit exposure/knowledge to operations, maintenance, capital planning, and/or engineering
- Knowledge about assets' lifecycle needs, including costs, performance implications, and risks
- Excellent communication skills, including experience with board presentations, strength in facilitation, and experience in persuasion and influencing others
- Political acumen and ability to relate well to stakeholders and staff at all levels within the agency
- **Asset Management Improvement Team** – Comprising representatives from maintenance, operations, engineering, finance, capital planning, information technology, and other related departments, this group should be the asset management knowledge and practice leadership for the organization. Reporting to the Executive Team, the members of this cross-functional team represent their department's technical expertise and interests; however, they will likely not be dedicated solely to the asset management improvement program. With clearly communicated performance and time expectations, this group's role is to manage across transit agency departmental silos, support the change management initiative, and improve communications both within and between departments. This group is responsible for vetting the asset management plan, leading its implementation, developing lifecycle management plans, compiling and communicating best practices, and supporting all enterprise-level asset management activities, including capital programming and operations and maintenance budgeting. They will likely be the owners of improved processes or have the changes incorporated in the work of their units.

The roles and responsibilities for an asset management improvement organization are described in Table 5-2, which provides a starting point for defining asset management implementation roles and responsibilities by function.



**Table 5-2.** Asset Management Implementation Program Roles and Responsibilities

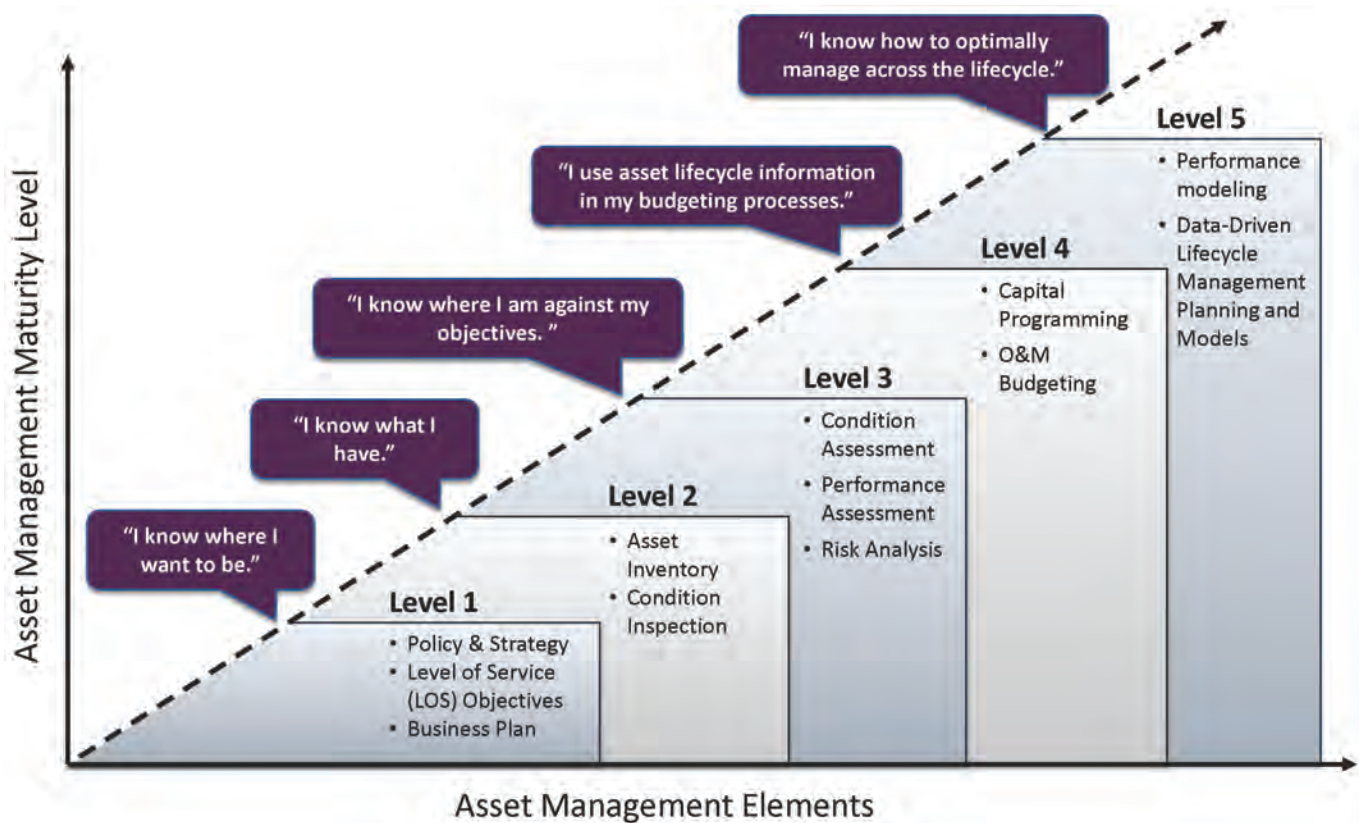
Organization Function	Roles and Responsibilities
Board Members/General Manager	<ul style="list-style-type: none"> <li>▪ Approves the asset management policies, strategy, and plan.</li> <li>▪ Provides overall accountability for addressing the asset management objectives.</li> </ul>
Executive Team (including Executive Sponsor)	<ul style="list-style-type: none"> <li>▪ Establishes the policies, strategies, and level-of-service requirements for the organization.</li> <li>▪ Dedicates appropriate resources to ensure asset management improvement programs can be successful.</li> <li>▪ Provides the leadership necessary to drive organizational change and communicate the benefits of asset management.</li> <li>▪ Enforces strong accountability measures to encourage follow-through of the asset management strategy.</li> </ul>
Asset Management Program Manager	<ul style="list-style-type: none"> <li>▪ Leads the development and implementation of the asset management plan.</li> <li>▪ Coordinates all enterprise-level asset management activities and ensures all asset-level activities are supportive of the overall asset management strategy.</li> <li>▪ Leads the Asset Management Improvement Team to ensure cooperation and liaising between the different departments and business functions.</li> <li>▪ Communicates asset management activities, accomplishments, challenges, risks, etc to relevant stakeholders.</li> </ul>
Asset Management Improvement Team	<ul style="list-style-type: none"> <li>▪ Asset management experts and leaders in their respective disciplines.</li> <li>▪ Responsible for developing and sharing asset management best practices throughout the organization.</li> <li>▪ Responsible for vetting the asset management plan, leading its implementation, developing lifecycle management plans, compiling and communicating best practices, and supporting all enterprise-level asset management activities.</li> </ul>
Asset Owners	<ul style="list-style-type: none"> <li>▪ Leads the development and implementation of the asset lifecycle management plans and ensures these plans support the overall asset management strategy.</li> <li>▪ Collects and maintains appropriate asset data to support asset management business processes.</li> </ul>
Department Heads (for example, Engineering, Capital Program Development, Budgeting, Planning, Finance)	<ul style="list-style-type: none"> <li>▪ Provides the leadership and accountability to ensure that all business processes associated with asset management are supportive of the overall asset management strategy</li> </ul>
Line Staff	<ul style="list-style-type: none"> <li>▪ As the key asset management plan implementers, these individuals should conduct day-to-day responsibilities with an understanding of how they support the asset management strategy.</li> </ul>

## 5.3 Assess Agency Maturity

Asset management maturity refers to an agency's level of asset management practice. To build the asset management improvement program, it is necessary to establish a basic understanding of the level of asset management maturity within the agency.

An agency's asset management maturity may be as basic as understanding what assets it owns; however, a more mature asset management agency will be able to use that asset information to model different funding scenarios and optimally allocate funding to its assets. **Figure 5-3** depicts a simplified approach to characterizing an agency's asset management maturity with five levels. Each level is described in more detail below the figure.

**Figure 5-3.** Understanding Asset Management Maturity in the Transit Industry



*Note:* A complete asset management program will have all levels functioning well; however, it is not unusual for an agency to conduct asset management activities that span all of these maturity levels at one time or to have skipped some levels while performing activities at another level. For example, many agencies have one or more asset inventories in place without any asset management policies or strategies.

The following list provides an overview of the asset management maturity levels:

- **Level 1** – At this basic level, an agency has a clear asset management vision. This includes a policy statement that provides top-down direction regarding asset management expectations, a strategy that outlines the approach for accomplishing the policy, and a plan that details the people, activities, and resources needed for addressing the policy and strategy.

- **Level 2** – At this level, an agency has one or more asset inventories with condition data that support multiple business processes. All of this data has a clear owner and process for maintaining its integrity.
- **Level 3** – At this level, an agency can conduct a risk analysis and/or performance assessment to evaluate the assets' current performance to evaluate how well the policy and strategy objectives are being met.
- **Level 4** – At this level, an agency can set priorities among and across all asset classes based on risk and performance data. This can inform the development of the capital program and operations and maintenance budget.
- **Level 5** – At this level, an agency can utilize performance modeling and other analytical tools to optimize how funding is allocated across and within all asset classes.

### 5.3.1 Determine an Agency's Asset Management Baseline

As its name suggests, the *Transit Asset Management Maturity Agency Self-Assessment* provided in this guide was created to address the unique attributes of the transit industry. The assessment is designed to be used by an agency to determine its current state of asset management maturity.

This assessment evaluates asset management maturity on three dimensions:

- ▶ Level of understanding
- ▶ Awareness
- ▶ Deployment of the process and practices of the asset management framework described in this manual

Assessing the agency's current state of asset management maturity provides a baseline that characterizes the current state of practice. This type of maturity assessment can be used to identify the gap between current practices and best practice, as identified in this guide. The gap will likely be different for different asset classes. This type of gap analysis can be used by an agency to identify the next steps and build an implementation path for improving maturity. This provides the basis for developing an agency's asset management plan.

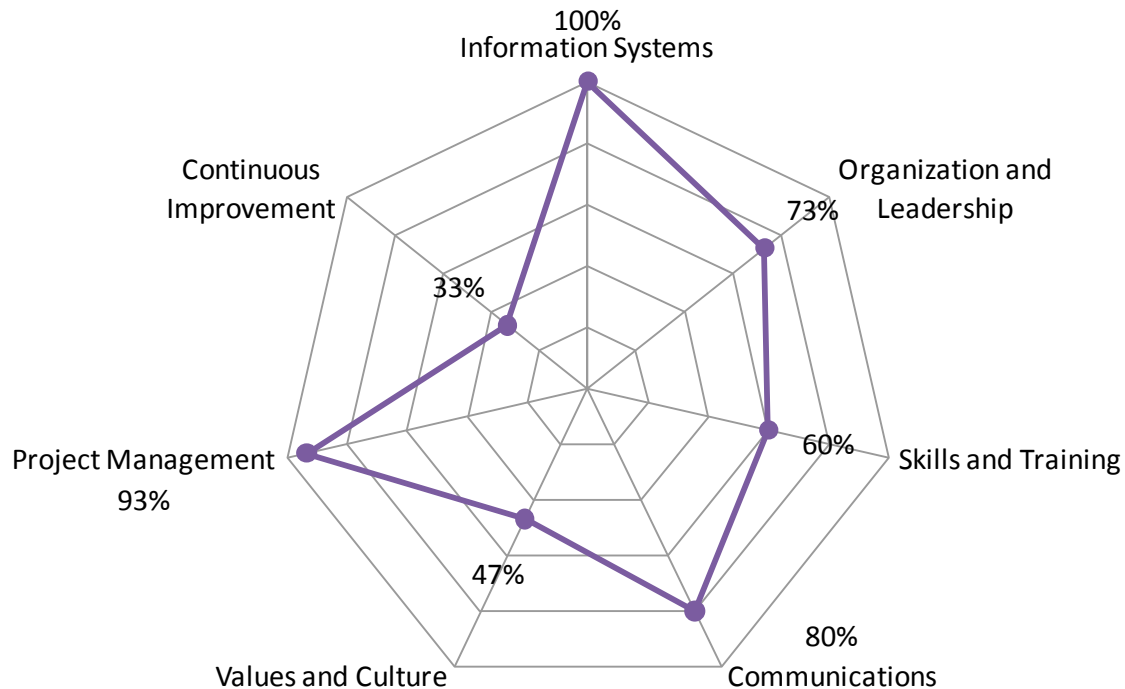
To support this analysis, this guide's appendix provides a *Transit Asset Management Maturity Agency Self-Assessment*.<sup>1</sup> The assessment is designed to be used by an agency to determine its current state, or baseline, of asset management maturity. The self-assessment is intended to be taken by the Asset Management Improvement Team to ensure it reflects input from departments throughout the agency.

The *Transit Asset Management Maturity Agency Self-Assessment* provides assessments in three major areas:

- **Overall Maturity Score** – The self-assessment tool presents an agency's score in each of the five maturity levels described in Figure 5-4.
- **Enterprise-Level Framework Scores** – The self-assessment tool presents an agency's maturity score in each of the nine business processes outlined in Chapter 3, and information systems and each of the enablers discussed in Chapters 4 and 5, respectively (see Figure 5-4 for a sample output).
- **Asset Class-Level Framework Scores** – The self-assessment tool presents an agency's maturity score in each of the asset classes presented in Chapter 5.

<sup>1</sup> PAS55, published by the British Standards Institute, has been adopted by utilities, transport, mining, process, and manufacturing industries worldwide. It provides an asset management self-assessment tool. While this tool will likely provide useful insight into an agency's level of asset management maturity, it was created to support a broad array of industries.

**Figure 5-4.** *Transit Asset Management Maturity Agency Self-Assessment Sample Output*



### 5.3.2 Communicate the Asset Management Baseline

As described in Section 5.2.1 – Assess Asset Management Awareness, the increased level of asset management awareness in an agency directly correlates with how ready the agency is for implementing an asset management improvement program. The Asset Management Program Manager can enhance the management and staff’s asset management awareness by sharing the results of the self-assessment. This will educate staff on what asset management is in the context of existing agency practices, and it is intended to get everyone “on the same page” using a common language. By potentially supplementing the communication of the baseline with broader asset management training, it will also provide the basis for the business case (presented later in this chapter).

It is important that this information is communicated in a way that recognizes the agency’s existing good practices and presents shortfalls as opportunities for improvement. Asset management is a process and is performance-based, so agencies should always have opportunities for improved reliability, customer service, and cost savings.

### 5.3.3 Determine an Agency’s Asset Management Target

As stated in Level 1 of the asset management maturity scale, an agency should have established expectations regarding “where the agency wants to be.” An agency’s target may be to achieve a maturity rating of Level 4 within 5 years, or have all of its assets having a minimum condition score of 3 out of 5, or to have a “best in class” process or to be a “global leader” in transit asset management. Ideally, this agency’s asset management target is established by the Executive Team and may be memorialized in the form of an agency-wide policy statement. No matter what the objective is, or who is generating it, it is important for an agency to have and communicate a target that it can be evaluated against as resources are invested and progress is made.

## 5.4 Develop the Plan

As described in Chapter 3, the plan specifies the implementing actions for increasing asset management maturity. It outlines exactly how the agency will meet its target in the context of the agency's awareness of asset management, readiness for change, and ambitions for the asset management improvement program. This section provides guidance on developing the business case for asset management, selecting an implementation path for an agency, outlining the key activities, and assigning roles and responsibilities for the planned year. These are important steps for an agency at the beginning of an asset management improvement program. It is good practice to reassess the implementation plan periodically and update the plan to align with the budget process.

### 5.4.1 Develop an Asset Management Business Case

An asset management business case is the statement of the anticipated impact that the implementation of the asset management improvement program will have on the performance of the agency. A compelling business case demonstrates improved productivity, cost savings/avoidance, and risk management. Peer examples can help to "make the case."

An asset management business case explains how the expected outcomes provide a cost-effective accomplishment of reliability, safety, customer service, and cost performance management.

Business case analysis "makes the case" to management for approving and allocating resources to the implementation of the initiative. Such analysis is important because it ensures that the implementation supports the business objectives of the agency and can provide an effective mechanism for building support and communicating the importance of the initiative.

This is an important step because it brings rigor to the development of the implementation program and provides accountability for the investments required for implementation, especially if there are any near-term impacts on productivity caused by reallocation of staff time to asset management activities. Additionally, the communication of existing agency issues and risks and the potential outcomes associated with an asset management improvement program will likely prove to be very powerful as the initiative requires significant stakeholder support.

An agency may already have a standard approach to developing a business case, return on investment analysis, or feasibility study for new initiatives. In general, the following elements or analysis considerations are typical components of a business case:

- A concise description of the "deliverable" resulting from implementation, with other supporting description of what is to be implemented.
- Implementation steps.
- Major business changes required.
- Required resources (including staff and funding).
- Estimated benefits expressed in terms of the resultant outcomes. Ideally these align with the agency's performance management objectives and address, reliability, safety, customer service, and lifecycle cost metrics.
- Risks to the accomplishment of the outcomes. This is an important consideration because risks can arise from a variety of internal and external sources. An approach that identifies risk, assesses the risks, and identifies a risk management plan is a recommended practice.



The business case analysis enables management to consider the benefits, costs, and risks of assigning resources to implement the asset management improvement program and its constituent projects.

### 5.4.2 Decide on Implementation Path

The prior steps provide the basis for developing an overall implementation program. With a common understanding and agreement regarding the current state of asset management within the agency, the Asset Management Improvement Team can develop an implementation path comprising individual asset management improvement projects.

The implementation paths are characterized in **Table 5-3**. The following pages provide more detail, including an overview of that path's characteristics, benefits, attributes of agencies that may be best suited for this path, and a high-level implementation schedule with key activities.

In general, Path #1: Enterprise-Driven provides the most comprehensive opportunity to improve overall asset management practice, institutionalize its use, and yield all of the business benefits. However, it is understood that organizational context may make this a higher risk option due to lack of resources, limited executive sponsorship, lack of a champion, or other considerations. If that is the case, elements of this implementation path may be incorporated over time as an agency accomplishes success through a different path.

The resource requirements to implement an asset management improvement program will vary between agencies depending on their size, maturity, and implementation paths. This guidance cannot estimate resources necessary to complete an implementation task; however, the identified timeframe provides general guidance on the level of complexity and resources required to complete that activity. These will vary significantly depending on the size of the agency, the agency's level of asset management maturity, and the level of resources committed to the asset management improvement program. An agency should develop the level of resources and timing for all projects that comprise the asset management improvement program and use this information in its business case analysis.

Agencies will approach asset management implementation in varying ways; this guide identifies three general implementation paths to consider when getting an asset management improvement program started. A key to success in implementing change of this type is clarity on the vision, the outcomes to be accomplished, and having the flexibility to be adaptive as the agency learns and an agency's operating environment changes. Over time, an agency will establish its own path but may use these as a start.

Three potential implementation paths are identified in this guide as a starting for developing a path for your agency (Path #1: Enterprise-Driven, Path #2: Asset Class-Driven and Path #3: Capital Planning-Driven). They are provided as strategies for implementing a series of improvement projects that individually and in concert will improve asset management maturity.

**Table 5-3.** Potential Asset Management Implementation Paths

Potential Implementation Paths	Path Characteristics	Attributes of Agency Interested in Path
<b>#1: Enterprise-Driven</b>	<ul style="list-style-type: none"> <li>Enterprise initiative that starts by establishing asset management policies, strategy, and a plan that ensures a well-integrated and aligned organization.</li> <li>Uses consistent, up-to-date, and increasingly complete asset inventory data to align with the agency's performance management requirements and support all enterprise-level asset management business processes.</li> <li>Requires strong executive sponsorship commitment to asset management being one of the agency's top strategic objectives.</li> <li>Staff at all levels increasingly understand how their job supports asset management.</li> </ul>	<ul style="list-style-type: none"> <li>Any size agency with any mix of modes or ages of assets.</li> <li>Asset Management Champion is the Executive Level sponsor.</li> <li>Staff dedicated to the asset management improvement program (full- or part-time, depending on the size of the agency).</li> <li>Dedicated resources available to drive implementation, including software investment.</li> <li>Agency management and staff understand.</li> </ul>
<b>#2: Asset Class-Driven</b>	<ul style="list-style-type: none"> <li>Driven by the managers of individual asset classes who champion asset management; it does not require enterprise-level direction.</li> <li>Improvements focus on the lifecycle management of individual asset classes.</li> <li>Key to this implementation path is the development of lifecycle management plans for those assets within the classes involved (starting with the most critical assets).</li> </ul>	<ul style="list-style-type: none"> <li>Single- or multiple-mode agency with assets of any ages.</li> <li>Asset management champion does not necessarily exist at Executive Level.</li> <li>Staff are most likely not dedicated to an asset management improvement program.</li> </ul>
<b>#3: Capital Planning-Driven</b>	<ul style="list-style-type: none"> <li>Focuses on providing information on asset condition from a centralized asset inventory in a consistent way across all asset classes. Information can be used to improve programming and prioritization to improve asset management outcomes.</li> <li>Capital improvements required to meet the level of service commitments are systematically identified and communicated.</li> <li>Focus of this implementation path is more at the planning level, but it can provide a springboard for increasing awareness and then driving initiative and methods to reduce lifecycle costs.</li> </ul>	<ul style="list-style-type: none"> <li>Single- or multiple-mode agency with assets of any ages.</li> <li>Asset management champion does not necessarily exist at Executive Level.</li> <li>Staff are most likely not dedicated to an asset management improvement program.</li> <li>Agency management and/or staff recognize the need to prioritize the capital program in a more transparent, systematic way to more effectively use capital funds.</li> <li>Some consultant support and software investment may be required.</li> </ul>

### 5.4.3 Implementation Path #1: Enterprise-Driven

This path requires an executive commitment that makes asset management one of the agency's top strategic objectives. Ideally this is not seen as an "asset management improvement program"; it is just the way the agency does business. It is an enterprise initiative that starts by establishing asset management policies, strategy, and a plan that ensures a well-integrated and aligned organization. This path uses consistent, up-to-date, and complete asset inventory data to align with the agency's performance management requirements and support all enterprise-level asset management business processes. Staff, at all levels, understand how their jobs support asset management and the agency as a whole is constantly looking for opportunities for improvement. **Figure 5-5** illustrates the broad elements and timeline for the enterprise-driven implementation path.

#### Potential Short-Term Improvement Activities Associated with Implementation Path #1

- ▶ Detailed plan provides transparency for stakeholders and clear direction for all staff and management
- ▶ Clear business targets can improve accountability and performance
- ▶ Centralized inventory provides simplified access to comprehensive, reliable data to support agency decision-making and asset valuation
- ▶ Centralization of processes requires traditionally siloed departments to work together, which can improve coordination and communication
- ▶ Lifecycle management plans (focusing on the most critical assets first) can help an agency to minimize the lifecycle costs and improve assets' performance

#### Implementation Path Characteristics

- Requires Executive Level direction-setting and guidance.
- May require significant agency change, including changes to roles and responsibilities, business processes, and overall culture.
- Requires consistent, dedicated staff and funding resources over long term.
- Full benefits will likely not be realized for a number of years; however, short-term benefits exist.

#### Benefits

This implementation path has the potential to provide an agency with the following benefits:

- Improve an agency's performance and cost-effectiveness.
- Optimize funding allocations in addition to improving stakeholder communications.
- Transform the entire agency's culture towards an asset management focus.
- Drive cultural change by causing a ripple effect of staff empowerment and accountability.
- Provide transparency in decision-making at all levels.
- Improve communications both within the agency (internally) and with stakeholders (externally).

#### Attributes of Agency Interested in this Implementation Path

- Asset Management Champion exists at Executive Level.
- Full-time staff dedicated to the asset management improvement program (level of staff resources dependent on maturity of agency's asset management activities and number of agency's assets).
- Dedicated resources available to drive implementation, which will likely include software investment.

Examples of short-term “wins” might include the following:

- ▶ Collaboration in decision making across traditionally siloed groups (for example, engineering, finance, operations, maintenance, and procurement) to elevate consideration of lifecycle costs (supportive of all Implementation Paths).
- ▶ Aligning maintenance, operations and capital planning and programming to improve reliability.
- ▶ Managing against enterprise performance metrics for reliability.
- ▶ Updating asset inventory to include all critical assets first and sub-components (supportive of all Implementation Paths).

The enterprise-driven implementation path will likely take more than three years to fully realize its benefits, as illustrated in **Figure 5-5**. Leadership is needed to drive the change and communicate internally and externally, resources must be dedicated to ensure the strategy is supported, and information systems will likely be developed and integrated to manage the data and analysis. A successful agency will be one that holds itself accountable for improving performance continually whether the focus is on improving reliability, reducing lifecycle cost for delivering the same level of service, and/or improving customer service.

**Figure 5-5.** Implementation Path #1 (Enterprise-Driven) Summary Activities and Schedule



## Relevance of Case Study

This case study illustrates how the Chicago Transit Authority (CTA) is implementing a comprehensive asset management system for use in managing its facilities and track-related assets. The improved system, once implemented, will provide CTA staff with better data on their assets, and reduce the extent of duplication between multiple management systems implemented for managing different assets.

## Agency Overview

The CTA is the second largest public transportation system in the United States, serving 3.8 million people within the city of Chicago and 40 neighboring suburbs. The agency was formed in 1947 with the acquisition of the Chicago Rapid Transit Company and the Chicago Surface Lines. In 1952, the CTA expanded to include the Chicago Motor Coach system. Today, CTA's assets include:

- ▶ 1,781 buses traveling 140 routes and covering 1,959 route miles.
- ▶ 1,200 rail cars traveling along 224.1 miles of track between 145 stations.
- ▶ Numerous maintenance and support facilities.

The CTA ridership averages 1.6 million rides per weekday and 516.87 million rides each year.

## Asset Management Implementation Approach

Through the 2010 Federal Transit Administration (FTA) Bus State of Good Repair Program CTA received a \$5.4 million grant to implement an improved transit asset management solution. The grant initially focused on bus facilities, but following conversations with FTA, CTA expanded the scope of the effort to incorporate other fixed assets, most notably rail maintenance facilities and stations. Four phases of work are planned as part of this effort:

- ▶ **Phase A (Ongoing): Enterprise asset management system enhancement and data migration.** Assets from the 1992 inventory and existing database are being incorporated into the enterprise asset management system. As part of this effort, CTA established a hierarchy for its assets, choosing the level at which each item should be considered an asset versus a

component of an asset. For each asset required fields, such as age, quantity, location, and replacement costs were added to the database structure, along with placeholder fields for condition data that can be tracked over time. CTA began the project by focusing on facilities data, but has expanded the effort to incorporate rail maintenance facilities and stations, which will be used as a template for incorporating additional data into the system at a later date.

- ▶ **Phase B (Ongoing): Facility asset inventory and assessment.** The engineering field condition assessment portion of this project provides for multi-disciplinary teams of engineers to survey and rate the current condition of select facilities. Engineers will also develop recommendations for future data collection, suggesting standardized methods, timeframes, and triggers that should prompt further reviews. During this time, CTA will develop asset maintenance cost estimates that can be incorporated into the database. This phase is scheduled for the summer of 2012.
- ▶ **Phase C (Planned): Create reporting and modeling capabilities.** CTA will add reporting capabilities to use in making policy and planning decisions. The reporting and modeling tools will allow CTA to assign priorities to projects based on criteria such as age, condition, safety and reliability impact. CTA also intends to incorporate information in the reports on maintenance work orders, including actual maintenance costs and measured maintenance impact on operations.
- ▶ **Phase D (Planned): Develop a plan to maintain asset information over time.** During this final phase, CTA will prepare a plan to ensure that the data in the enterprise asset management are maintained and do not become obsolete. Data owners will be assigned to manage subsections of the data, allowing discrepancies to be reconciled and ensuring that the data are carefully updated. This will allow CTA to use the system to its utmost benefit in the decision-making process.

CTA began work on the project in 2011, and has committed to an overall project schedule of twenty-four (24) months from grant award (May 9, 2011) to delivery of required deliverables. All four phases,



including training end-users and recommendations for ongoing maintenance, are to be completed within that time period.

## Benefits and Outcomes

In the past, CTA has used multiple management systems concurrently, creating a fractured system for data collection, storage, and analysis. By eventually combining asset data into a streamlined set of systems, CTA expects to improve its asset data, better support a data-driven approach to asset maintenance and management, and minimize the costs of data management.

The expectation is that the following will be accomplished during the project:

- ▶ Develop enhancements to the enterprise asset management system to allow for a centralized data repository that multiple departments can access and utilize
- ▶ Consolidate appropriate CTA facility asset information from legacy sources into the enterprise asset management system
- ▶ Perform assessments of critical assets for facilities under study and migrate the information into enterprise asset management
- ▶ Provide functionality within the enterprise asset management system to create reports that summarize collected asset data

- ▶ Review and make recommendations for CTA process improvements associated with the use of the enterprise asset management system
- ▶ Develop and train CTA staff regarding the approach for CTA to update the information on a rolling basis

## Lessons Learned

CTA's experience has demonstrated the importance of having a plan and information systems established to maintain asset data. Without these crucial elements it is unlikely that agency staff will fully utilize asset inventory and condition data that are collected. Further, absent a comprehensive asset management system, there is a tendency for information systems to proliferate, resulting in multiple, costly, overlapping information systems. At the same time, however, CTA's experience shows that it is often possible to leverage an existing asset management system to customize what data they store, and expand these systems to multiple asset types, reducing the need for duplicative systems.

## Sources

Information provided by senior contact at the CTA.

## 5.4.4 Implementation Path #2: Asset Class-Driven

This implementation path is most likely driven by one or more of the managers of individual asset classes or a department who provides leadership and champions asset management. The implementation path does not require enterprise-level direction. A line manager can apply the principles in this guide to their sphere of responsibilities and apply the leadership and influence they have as a “good manager” to move the agency forward and drive change in their sphere of influence. The focus is less on the enterprise-level activities and more on the lifecycle management of individual asset classes. The key to this implementation path is the development of lifecycle management plans for each asset (starting with the most critical assets).

While this implementation path is not an agency-wide initiative, it can support an agency-wide initiative if and when that decision is made. An agency that has a good example of asset management happening for one asset class can use that to demonstrate the positive outcomes of improved asset management. Additionally, they can replicate that model for other assets and communicate both the challenges and lessons learned.

### Implementation Path Characteristics

- Asset owners lead the asset management improvement program for their respective asset class by establishing a team that manages across that asset’s lifecycle.
- Cultural change is necessary for the managers and staff who “own” the asset class.
- May require some dedicated resources, but much less than Implementation Path #1: Enterprise-Driven.
- Benefits specific to the asset classes addressed may be realized in the short- to medium term.

### Benefits

This implementation path has the potential to provide an agency with the following benefits:

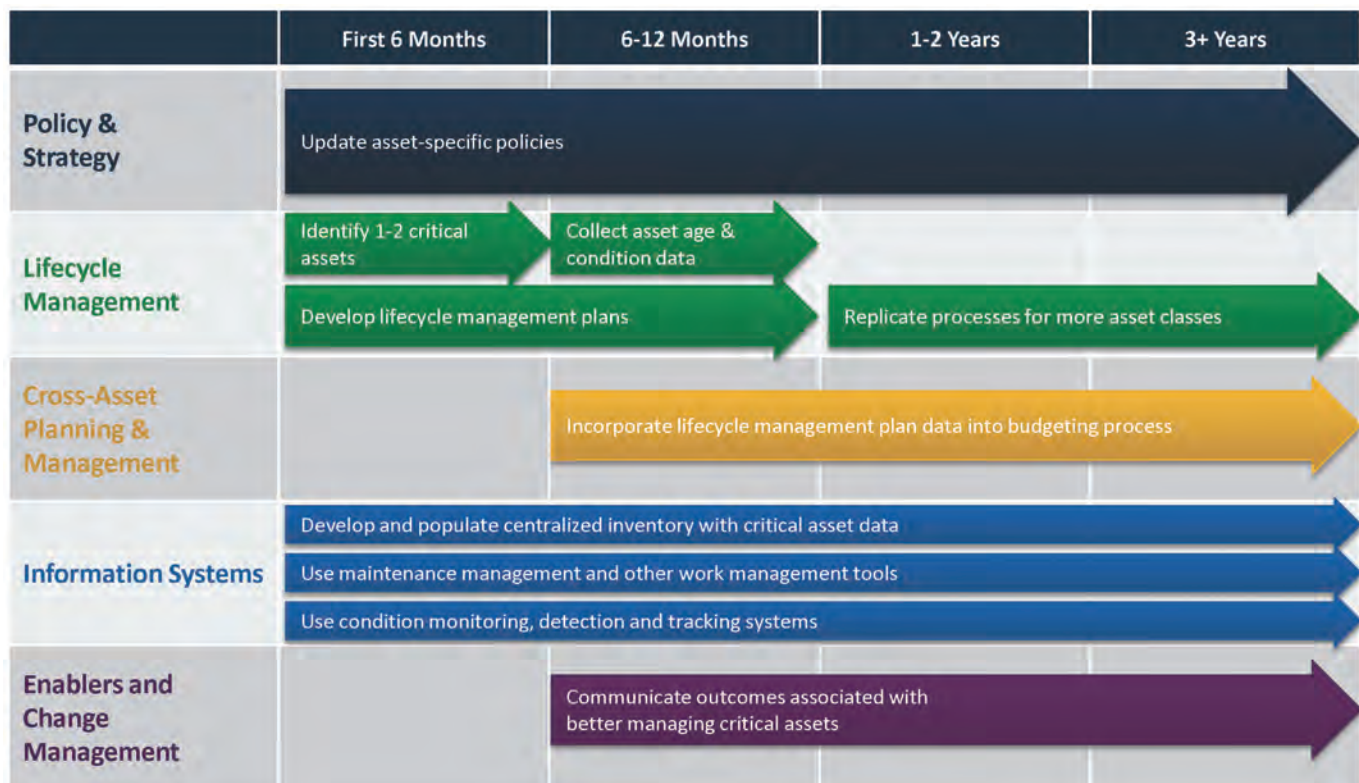
- Improve the safety, reliability, and/or total cost of ownership of selected assets throughout their lifecycle while ensuring the most cost-effective investment strategies.
- Minimize the risk of failures associated with the selected asset classes.
- Make data-driven, informed investment decisions within that asset class.
- Improve internal communications by requiring cross-department coordination throughout the asset’s lifecycle.
- Provides opportunity for establishing internal agency asset management best practice examples and demonstrates to other asset owners the benefits of an asset management initiative.
- Empowers middle managers to improve asset management practices, which can elevate their visibility and built support for a broader asset management improvement program

### Attributes of Agency Interested in this Implementation Path

- Single or multiple-mode agency with assets of any ages or may begin based on new initiative (for example, new railcar procurement or rail line extension).
- Agency culture supports Managers and technical leaders who innovate and drive business improvements.
- Executive Level leadership may be necessary to ensure consistent lifecycle management plans across multiple asset classes.
- Staff are most likely not dedicated to an asset management improvement program; however, one or more staff may have a broader job description that requires them developing cross-functional groups with the responsibility of managing an asset throughout its lifecycle.

This initiative is driven by “asset owners,” so it can start in one department where a manager champions and provides leadership or it can be implemented across multiple asset classes. It may begin with a focus on one asset class and, when the business benefits can be demonstrated for that asset class, the agency may decide to replicate that model for other asset classes. Or, the increased awareness across the agency may lead to a broader implementation program based on a different implementation path. The asset owners will need to develop lifecycle management plans (see Section 3.2.3) that reflect input from multiple departments. The agency may begin to realize the benefits of cross-departmental coordination and communication within months. Depending on the number of asset classes included in this initiative, it can take anywhere from 6 months to 3 years. **Figure 5-6** index the type of implementing activities and schedule an asset class-driven implementation path that starts with one or more asset classes.

**Figure 5-6.** Implementation Path #2 (Asset Class-Driven) Summary Activities and Schedule



## Relevance of Case Study

This case study illustrates how one agency department can lead a successful asset management improvement program focused on one asset class. The Bay Area Rapid Transit District (BART) Railcar Maintenance group transformed the way their group conducted business to improve many performance metrics.

## Agency Overview

BART is a heavy rail transit system serving the San Francisco Bay Area. BART operates five lines on 104 miles of track with 44 stations in four counties. With an average weekday ridership of 379,300 passengers, BART is the fifth-busiest heavy rail rapid transit system in the United States.

BART currently maintains 669 rail vehicles. This is the oldest fleet in the nation and has a utilization rate amongst the highest in the nation (based on peak commute hours). The agency is currently working on a \$2.2 billion procurement of 750 new rail vehicles expected to be in production in 2017.

## Asset Management Implementation Approach

In 2006, BART's started the Strategic Maintenance Program (SMP) in an effort to modernize processes and capitalize on lessons learned from the private sector. The desire to make change was driven by the realization that business as usual would not position an aging, heavily utilized railcar fleet to meet growing ridership and increasing service demand.

When initiated, the SMP vision was "To implement a continuously improving reliability-based maintenance process, which brings world-class maintenance practices to BART and its customers." The fundamentals of SMP were centered on the principles of reliability-centered maintenance (RCM), lean production efficiency, and continuous improvement. As SMP evolved from an initial program to new business as usual, the scope would grow to include a push towards more scheduled maintenance with expanded planning and scheduling capabilities; improved documentation, processes, and decision-making capabilities; expanded and targeted employee development and training; an evolution from quality control to quality

assurance; and instilling a culture of ownership and responsibility at all levels of the organization. To that end, improvements were initiated in four key areas: people, processes, parts and systems. Each of these is described in more detail below.

- ▶ **People** – The SMP has put significant emphasis on staff development and ownership. Tamar Allen, Chief Maintenance Officer, stated "We changed the dialogue with the employees. We started to get the problems on the table and discuss them openly and freely without blame or recrimination. The objective was always about engaging the employees and ridding ourselves of the culture of "us against them". We encouraged our employees to be part of the solution, not part of the problem." Working together, the SMP team identified ways to improve maintenance processes, including changes to their work stations, tools, communication methods, etc. As part of this initiative, the SMP program formalized a centralized training program that has a curriculum-based training plan. Additionally, to encourage staff ownership, BART monitors and posts reliability performance by team. Each team lead is responsible for their performance. BART has clarified roles and responsibilities to improve accountability, supported by additional leadership training.
- ▶ **Processes** – The SMP has transformed the group towards an RCM program. This means that they have switched from a purely reactive maintenance philosophy to a planned production philosophy. Staff use data to establish maintenance cycle times and determine root cause of failures so that the maintenance program is continually improving. The group has reduced the time spent on unscheduled maintenance from >80% to <40% (even though they are still striving to achieve their target of 20% unscheduled and 80% scheduled). So, instead of constant "firefighting," staff works to scheduled work plans, which has created a more stable work environment and allows the work to occur most efficiently. Most processes have been documented in standardized work procedures, after thorough evaluation to determine best practice.

- ▶ **Parts** – BART’s past procurement process took too long and had significant variation in the parts quality. Improvements include:
  - A supplier pre-qualification program allows BART to audit its suppliers and give BART recourse to address issues and reward good performance
  - A transformation to a demand-based stocking and distribution system, so parts are “pulled” from shops and not “pushed” from stores
  - Parts are centralized in a kitting area so filling a customer order now takes 3 minutes per caliper instead of 56 minutes.
- ▶ **Systems** – BART’s desire to measure performance was limited by its information systems. In 2011, BART implemented a maintenance management system, integrated with its financials and administration system. The system is now stable, and beginning to produce beneficial performance reporting essential to the SMP strategy.

Another key system improvement was the installation of wireless network enabled kiosks on the maintenance floor. These kiosks, along with wireless connectivity for technician laptops are providing the portal for immediate up-to-date documentation access for all employees, and has greatly facilitated adoption and utilization of the maintenance management system in the shops.

In addition to the focus on the maintenance of BART’s existing vehicles, the SMP group has also provided significant input into the design of BART’s new railcar procurement. The SMP group’s input has focused on reliability, maintainability, and availability improvements that will support the agency’s goals throughout the rail vehicles’ lifecycle. The supplier will have to provide railcars that are “SMP-ready,” which means they will facilitate on-boarding into the maintenance management system, and make sure the car configuration and parts work with their maintenance strategy. Other

specifications include a detailed weight control program, energy efficiency program, vehicle climate chamber testing, and performance-based requirements, including minimum mean time to repair and availability requirements.

## Benefits and Outcomes

BART’s SMP has had significant measurable outcomes since the program’s inception:

- ▶ Car maintenance issues went from being 45% of all system delays to 15%
- ▶ As of 2012, car availability improved by 7.5% from 533 cars to 573
- ▶ As of 2012, car reliability (measured based on mean time between service delays) improved by 180% from 1,444 hours to 3,216 hours
- ▶ As of 2012, the number of maintenance workers (including mechanics and technicians) decreased by 26% from 442 employees to 350
- ▶ As of 2012, the railcar maintenance program has shifted from >80% unscheduled/reactive work to <40%.
- ▶ Much of the repair work formerly outsourced is now done in-house; better, cheaper, faster.. Examples include: AC traction motors, cables, and HVAC.

Qualitative benefits include:

- ▶ Improved morale and employee ownership due to the collaborative work environment and forward-focus
- ▶ Improved, more efficient work environment, designed by employees
- ▶ Inherent succession planning due to leadership training, Team Lead positions, and process documentation
- ▶ Inventory levels and lead times have been set to appropriate levels
- ▶ Improved partnerships both internal to BART and with external agencies

## Sources

Information provided by senior contact at BART.



### 5.4.5 Implementation Path #3: Capital Planning-Driven

This implementation path begins asset management improvement in the capital planning and programming process. The general approach is to provide systematic information on asset condition and capital needs required to meet the level of service or performance targets established for the asset condition (this is often referred to as the state of good repair). The approach to varying degrees establishes a link between condition and reliability performance. This implementation path focuses on providing information on asset condition from a centralized asset inventory in a consistent way across all asset classes. In this way, the capital improvements required to meet the level of service commitments are systematically identified and communicated. This provides a way to “tell the story” regarding the condition of an agency’s assets and the performance consequences with different capital funding levels. This involves the development of a centralized inventory, the application of consistent condition measures across all assets, and the use of tools that prioritize all capital needs based on different levels of funding.

“Because of the time and resources involved to migrate an asset class into a formal asset management system, our agency has been undergoing this migration on an asset-by-asset basis.”

—U.S. Transit Agency Manager  
(Source: 2011 Parsons Brinckerhoff Survey)

The focus of this implementation path is more at the planning level, but it can provide a springboard for increasing awareness and then focusing more on other aspects of asset management. While this path involves enterprise-level direction, it does not necessarily consider the operations and maintenance costs or require organization-wide change. It does, however, identify the improvements required to address preventive and reactive maintenance backlogs and rehabilitation requirements—all of which can reduce lifecycle costs. This information allows for explicit consideration of resource allocation in the capital planning and programming process between pressing asset condition-related needs and other improvements.

#### Implementation Path Characteristics

- Requires changes to the capital planning and programming process, so many agency’s functions will be exposed to some degree of business process improvement.
- Requires some dedicated resources, but much less than Implementation Path #1 (Enterprise-Driven).
- Executive-Level champion may be needed to drive consistency of capital needs measurement across asset classes and to encourage agency departments to share data; however, the leadership required is significantly less than Implementation Path #1 (Enterprise-Driven).
- Benefits may be realized within a couple of years depending on the agency’s ability to compile appropriate data.

#### Benefits

This implementation path has the potential to provide an agency with the following benefits:

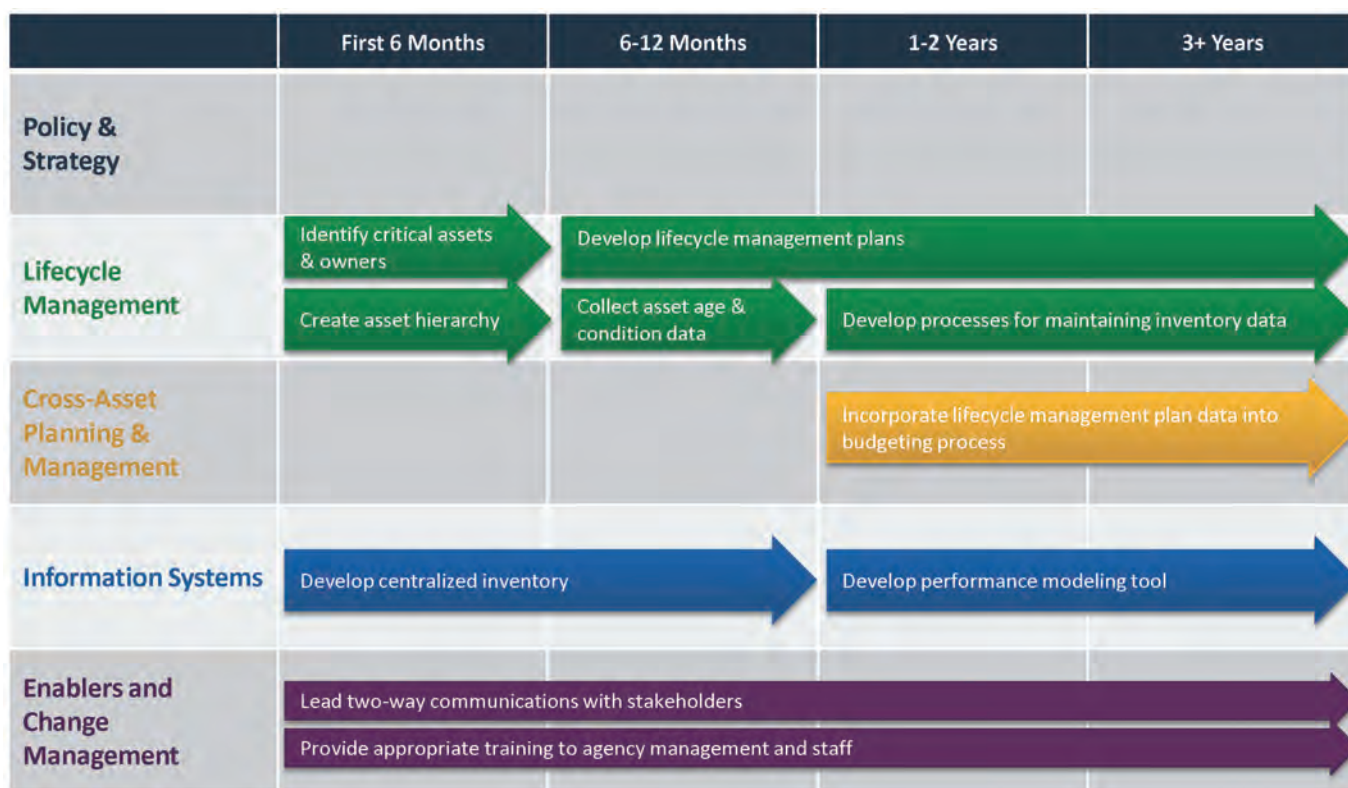
- Provides simplified access to comprehensive, reliable data to support agency decision-making and capital programming.
- Provides transparency in decision-making at all levels.
- Improves communications regarding the agency’s capital needs, funding decisions, and scenarios reflecting the impact of different levels of capital funding within the agency (internally) and with stakeholders (externally).
- Justifies the level of investment needed to improve an agency’s assets’ condition and performance and the performance impacts of not receiving that level of funding.

## Attributes of Agency Interested in this Implementation Path

- Single- or multiple-mode agency with assets of any ages.
- Asset management champion does not necessarily exist at Executive Level.
- Staff are most likely not dedicated to an asset management improvement program; however, staff are required to collect data (likely from many different sources) and incorporate into a scenario evaluation tool.
- Agency management and/or staff recognize the need to prioritize the capital program in a more transparent, systematic way to more effectively use capital funds.
- Depending on staff and information systems availability, some consultant support and software investment may be required.

This involves the development of a single inventory with the application of consistent condition measures across all assets, and the use of information systems that systematically prioritize the capital needs based on different levels of funding. As shown in **Figure 5-7**, the full implementation of this initiative can take more than three years; however, benefits are likely to be realized after a couple of years.

**Figure 5-7.** Implementation Path #3 (Capital-Driven) Summary Activities and Schedule



While Implementation Path #3 (Capital-Driven) includes the development of a single inventory and consistent condition measurement, the inventory is typically used to support the capital planning and programming function and does not provide the detail to support asset management activities at the maintainable unit level. So, the single inventory provides planning-level condition information such as a score (for example, on a scale of 1 to 5) for each of the agency's asset classes. In this way rail vehicles may have a condition score, but it may not provide information about the vehicles' subcomponents, their condition, past maintenance activities, and the replacement value. That detailed information is more likely to support the lifecycle management of the vehicle.

## Relevance of Case Study

This case study illustrates how the Santa Clara Valley Transportation Authority (VTA) implemented a Commercial-Off-the-Shelf (COTS) software package for use in project prioritization. The software provides VTA with an ability to better prioritize its projects considering agency goal and objectives, and do so using a documented, repeatable process.

## Agency Overview

The Santa Clara VTA was created in 1972 to provide public transportation to Santa Clara County. The system serves a total of 326 square miles. VTA currently maintains the following assets:

- ▶ 450 active buses with an average age of 7½ years;
- ▶ 75 routes covering 1,235 miles with 3,814 stops; and
- ▶ 99 light rail vehicles and 4 historic trolleys covering 42.2 route miles.

In 2008, the Santa Clara VTA had an average of 106,673 weekday riders and an annual budget of \$363 million.

## Asset Management Implementation Approach

VTA's asset management efforts were initially triggered by the Metropolitan Transportation Commission (MTC) requirements for each San Francisco Bay Area transit property to submit asset data in support of the MTC Regional Transit Capital Inventory (RTCI). Previously VTA had basic information on its inventory, but found it had to supplement its inventory data with additional detail. Also, VTA was already using an enterprise resource planning (ERP) system for accounting and work order management, but this system was not used for maintaining detailed inventory data. As a result of its efforts to provide data for the RTCI, VTA developed a basic transit asset inventory that has formed the basis for subsequent transit asset management efforts.

An important catalyst for VTA's recent efforts to further improve its asset management data and tools was the Bay Area Rapid Transit (BART)

extension to San Jose. As part of its work applying for FTA New Starts funding for this project, VTA was required to develop a 20-year financial plan detailing the costs of maintaining VTA's assets. Based on its initial analysis, VTA recognized that it required better data and tools for assessing its state-of-good repair needs. The agency then initiated an effort to better define what investments would be required to maintain a state of good repair for VTA assets, and to prioritize state-of-good-repair investments given available funds.

To help develop its financial plan VTA engaged a consultant to identify investments that may be required to achieve a state of good repair over a 20-year period, based on data collected for the RTCI and considering future asset deterioration. The consultant developed a list of 70 candidate capital projects, supplement a list of 26 projects previously identified by VTA. To develop the list of projects, VTA and the consultant grouped needs for individual assets into projects, as the agency found it more manageable to work with a consolidated set of larger projects than a large number of individual asset repairs.

In order to prioritize the set of projects for inclusion in the financial plan, VTA defined a set of basic factors to consider for each project. These include transit system preservation, system improvements, cost impact, enhancement of safety and security, environmental sustainability, and the ability to increase ridership. VTA technical staff evaluated the extent to each of the projects achieved agency goals with respect to these factors.

Once each project and its factors were defined, VTA used decision-making software to set weights on each of the prioritization factors and establish a prioritized list of projects. The system allows multiple users to create personalized prioritization scales and uses these scales to create composite weights that determine project rankings. The system also allows individuals to change the conditions and weights, creating flexible models than can provide new outputs if priorities change or budgets shift.

VTA assembled a set of fifteen senior management personnel, representing all of the major departments. VTA technical staff reviewed each of the proposed projects, and agency managers created their prioritization scales for the projects. The

process was an iterative one, with adjustments made following review of the rankings, until a consensus emerged on the agency's priorities.

The results from the process described above were used to develop the final list of projects in the agency's 20-year financial plan. VTA staff are now using the decision-making software, along with updated information on what work is currently being performed, to develop its capital plan for Fiscal Year 2014-2015. Moving forward, VTA expects to continue to develop its asset management data and tools, supplementing its use of the decision-making software for prioritization with additional functionality for projecting future conditions and investment impacts.

## Benefits and Outcomes

The major outcome of VTA's asset management efforts is that VTA has been successful in developing a financial plan that recognizes future infrastructure renewal and replacement needs, and that demonstrates a path to funding a major expansion of the VTA system while continuing to operate and renew the infrastructure supporting existing services. Further, VTA expects that the projects it performs based on its improved approach to project prioritization will maximize the use of available funds, and provide results consistent with agency goals and objectives.

## Sources

Information provided by senior contact at VTA.

## 5.4.6 Outline Key Asset Management Activities and Roles and Responsibilities

The asset management plan described in Chapter 3, should list the agency’s approach to achieving the target it has set for improving asset management. The plan has two major components:

- Enterprise-wide implementation actions that provide enabling support and direction for asset management across all asset classes and services
- Direction and expectations for asset class owners and department managers regarding lifecycle management planning and processes—with a focus on the lifecycle management plans (see Section 3.2.3).

The plan outlines how people, processes, and tools come together to address the asset management policy and goals. It should clearly identify the outcome to be achieved (the target), and provide detail regarding how each of the projects that comprise the asset management improvement program will be completed – with a focus on the first year. As with all well managed implementation programs, each of the asset management activities should be broken down into small, manageable, and well-communicated tasks, with agree timelines and resources allocated. Ideally, each project, or activity, has a clear scope, work plan, and work breakdown structure so that the project can be managed successfully. When documenting the activities, it will also be important to document any potential risks and outcomes. This will be important for communicating to stakeholders and managing the overall initiative.

“This is both an operating and capital initiative. Neither area within your agency should dominate. Maintenance-driven or capital-driven programs are not as efficient as combined programs.”

—U.S. Transit Agency Manager  
(Source: 2011 Parsons Brinckerhoff Survey)

## 5.5 Implement the Asset Management Improvement Program

With a plan in the place, the agency should be ready to implement the asset management improvement program. While implementation will address the activities outlined in the plan, this section describes the approach to developing the strategy around two key asset management enablers: communications and information systems.

### 5.5.1 Develop a Communications Strategy

Communication is a critical part of change management and is fundamental to any asset management improvement program. No matter the level of asset management maturity or the selected implementation path, no change initiative can be successful without the awareness and buy-in of everyone involved. It is important to identify who your agency’s stakeholders are and how they are connected to asset management. In some cases, these stakeholders may have a direct implementation role (for example, a maintenance staff member); however, in other cases, a stakeholder may participate in the goal-setting process and only feel the impacts of improved asset management (for example, interest member group or a rider).

“Our agency learned that the buy-in of internal and external stakeholders is invaluable. Upper management must see the SGR [state of good repair] database as an important tool for asset management, capital program development, and long-term financial planning. At the same time, department managers must see the benefit of inputting accurate and complete data. The process must also be understood by State policymakers and legislators to receive increased funding.” —U.S. Transit Agency Manager (Source: 2011 Parsons Brinckerhoff Survey)



The Asset Management Program Manager should establish a communication strategy that addresses the interests of each stakeholder group. The communication messages, timing, delivery mechanism, and feedback approach should be specified in a communication strategy. On an ongoing basis, the Asset Management Program Manager and the Asset Management Improvement Team should be communicating the key activities, accomplishments, and challenges associated with the asset management improvement program. It can also include any changes to policies and notifications for any upcoming events. This may occur through email newsletters, updates at department meetings, and flyers posted in visible locations. Additionally, staff should be given the opportunity to participate in the asset management improvement program when possible.

Important considerations when communicating anything related to the asset management improvement program include:

- The message must be created clearly and with sufficient detail, and must convey integrity and commitment.
- The message must be relevant to the recipient's job and it should be clear how asset management could benefit that staff member ("What's in it for me?").
- Staff must be willing to listen, ask questions, and trust the sender.
- The message must be delivered in a format that is accessible and acceptable for staff.

### 5.5.2 Determine Information Systems Strategy

This section provides added detail on considerations and steps for implementing improvements to asset management information systems. This detail is provided because at its core, asset management applies rigorous, fact-based decision-making using information about the performance of an asset across its lifecycle. This requires an information systems infrastructure that specifies what tools, including functional and technical requirements, will best support the selected implementation path. An agency's existing tools may already address aspects of the asset management strategy's needs, but it is likely that improvement is required to data administration and management practices in addition to software upgrades, integration, and/or development. Added detail is provided because implementing information systems changes in many transit agencies involves considerable risk, can take a long time, is costly, and requires technical competencies that are usually not "core" to a transit agency.

As part of the implementation program, it will be necessary to identify the system solution that most cost-effectively addresses the agency's asset management information requirements. The key steps involved in determining the agency's asset management information systems strategy include:

- Define and document high-level enterprise asset management (enterprise asset management) system requirements.
- Conduct an information technology infrastructure needs assessment.
- Conduct fit/gap analysis on system alternatives.
- Identify and conduct alternatives analysis.
- Select system and implement.

These steps are designed to help an agency identify their asset management system requirements, the best available solution, and the benefits they may expect from the software solution.

A sample set of high-level functional requirements is presented below to act as a starting point for agencies:

- ▶ Track asset inventory (rail, rolling stock, bus stops, park and rides, etc.).
- ▶ Retrieve data easily and update the inventory.
- ▶ Record current inventory condition.
- ▶ Track warranties on all assets.
- ▶ Update inventory condition, and maintain historical condition data.
- ▶ Automatically rate assets based on condition and rating thresholds stored in the system.
- ▶ Automatically flag infrastructure assets for preservation, betterment, or maintenance based on condition, usage, and depreciation information.
- ▶ Provide capability to make asset preservation trade-offs based on current conditions, deterioration trends, and available funds.
- ▶ Support capital programming and O&M budgeting processes.
- ▶ Integrate financial (budget) data, track expenditures on assets.
- ▶ Provide the ability to perform online and batch queries (ad hoc reporting) of inventory across the agency.

## Define and Document High-Level Enterprise Asset Management Information System Requirements

As discussed in Chapter 4, an enterprise asset management information system is a tightly integrated system architecture that integrates various systems, including, for example, the maintenance management system, condition monitoring and detection systems, and the financial software, to inventory, exchange and analyze data. It is critical for the agency to define and document high-level requirements to ensure that the key stakeholders are in agreement on the system needs, and the agency has a clear understanding of the functionality expected from the tools. This includes determining the following:

- System functionality (What should the system be able to do?)
- Technical requirements (Where will the data be stored? Should the system be web-based?)
- Level of integration of the systems (Are we tracking the same data in multiple places?)

All of this information should be documented in an information systems requirements document. Typical practice is to prioritize requirements on a 3-point or a 5-point scale. A 3-point scale [High-Business critical; Medium-Important; Low-Desirable] is generally preferred.

## Conduct an Information Technology Infrastructure Needs Assessment

With consideration for the enterprise asset management vision, the agency should document how well its current systems address those requirements. This assessment can be conducted through user interviews and a thorough analysis process to determine how well each system and sub-system addresses the requirements outlined in the first step. By understanding the strengths and weaknesses of the existing systems, the agency will be able to evaluate the costs and benefits of implementing a new system. Additionally, understanding the current level of integration between the different systems will allow the agency to evaluate how a new system, if needed, will fit in the agency's information technology architecture or ecosystem.

This step should include a review of the agency's plans for system upgrades. If any plans exist, the agency should determine how the upgrades/changes will affect current systems as well as any new capabilities that may be added. Agencies have also been moving to data warehouses to allow data from disparate systems to be integrated and analyzed together.

## Conduct Fit/Gap Analysis on System Alternatives

When evaluating software alternatives, an agency should consider learning from the industry's experience by conducting a peer (agency) review, (software) industry review, and/or visiting peer agency's sites.

This step involves comparing the functionality of Commercial-Off-the-Shelf (COTS) software to the agency's requirements. Remember: The key is to first define the asset management business processes (as described in Chapter 3 of this guide) because the software should be evaluated against its ability to enable these processes. This can include discussions with software vendors and peer agencies using the software

alternatives to obtain a perspective on the system capabilities, implementation challenges, as well as lessons learned during prior implementations. The agency may also consider custom-developed software if some or many of the requirements are not able to be met by any COTS.

### Identify and Conduct Alternatives Analysis

Based on the previous step, the agency should have identified a small number of software alternatives. The alternatives may include COTS solution(s), custom software, and "best of breed" system (COTS along with custom software/add-ins). A benefit/cost analysis of these can include the following for each alternative:

- Degree of fit with agency's strategic direction.
- Degree of fit with business requirements.
- Consistency with agency/stakeholder IT direction.
- Speed of implementation.
- Total cost of ownership – The software estimate should include the cost of developing software, cost to implement (both agency staff as well as vendor costs), hardware costs (computers, servers, additional bandwidth, among others) and regular maintenance costs (for COTS). *Note: The cost to implement, including both staff costs and vendor costs, can be more than the software itself. For example, most states realize that the cost of software license for an ERP solution could be just 1/10<sup>th</sup> of the total implementation costs.*
- Degree of risk.
- Incremental expandability and flexibility.
- Breakeven point (in years) – Allows the agency to realize how long it will take to recoup the investment. The analysis should also include key risks associated with each alternative.
- Benefits – Includes quantifiable, as well as those that cannot be quantified. As a general rule, benefits should be quantified to the extent possible. These should include both direct benefits (e.g. staff time savings in entering data, data analysis) as well as indirect benefits (e.g. social benefits).

This analysis allows an agency to determine its budgetary needs, timeline, and whether a Request for Proposal (RFP) should be released for a COTS, custom, or a "best of breed" software.

The benefits and shortcomings of both COTS and custom software are provided below:

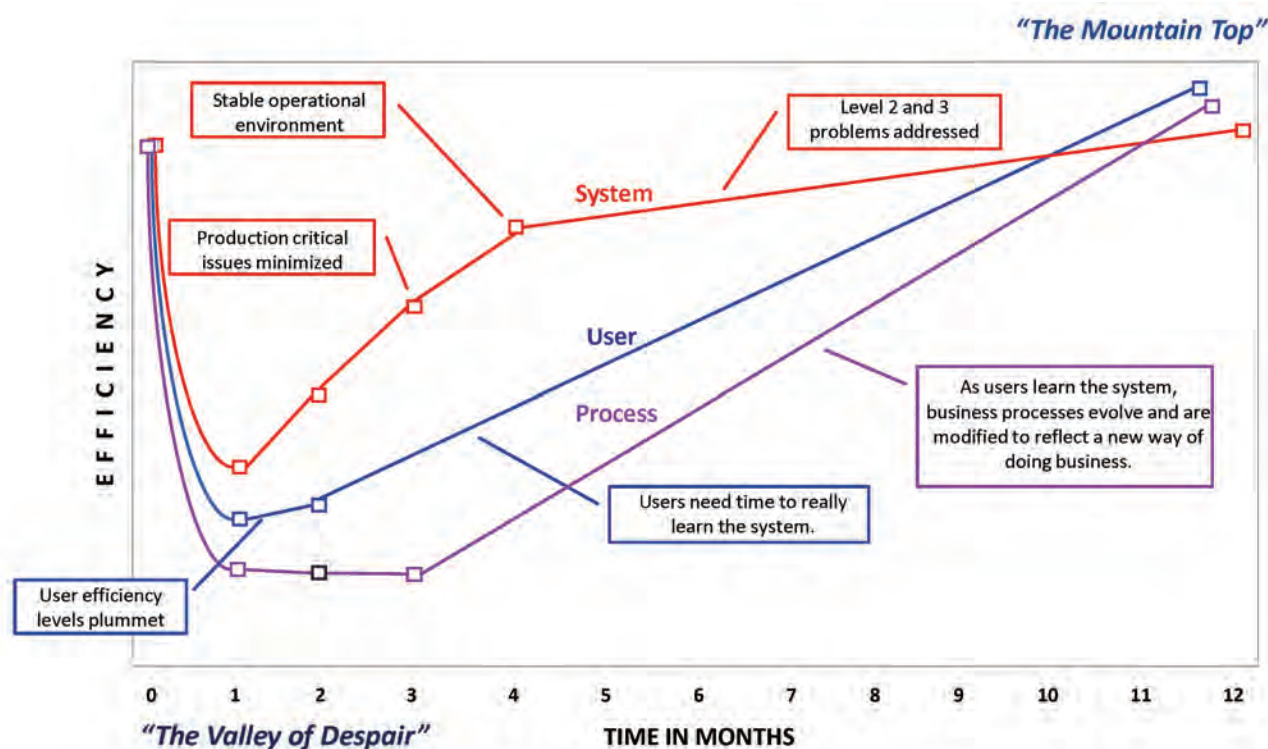
- ▶ COTS software costs are generally lower than custom-developed systems and, if done correctly, can have less risk.
- ▶ COTS software is generally used by a number of clients, allowing the agency to obtain support from other clients that may include agency's peers.
- ▶ Generally, COTS software developers update their software regularly to add new functionalities, providing their users an incentive to upgrade (and pay additional licensing/configuration/support costs in some cases), and also to ensure that their software provides more value to the customers than their competitors. As a result, the user interface and capabilities of current COTS software can be expected to improve over time.
- ▶ COTS systems are usually designed with multiple clients in mind, and therefore may not meet all the needs of an agency. At the same time, the system may attempt to incorporate best practices among various agencies (as best deemed by the software vendor, and may include feedback from current and future clients) to make the software more attractive to agencies.
- ▶ Any customizations made by an agency may not work and need to be updated if the software vendor releases software updates.
- ▶ Developing new software from scratch generally adds additional cost and schedule risk. Implementing a COTS system is generally faster than developing the custom software and implementing it.
- ▶ The custom software typically meets an agency's needs more so than COTS software.
- ▶ Custom software can be maintained in-house, and can be updated to add new functionality more easily than COTS. On the other hand, custom software may require the agency to maintain IT resources in-house (if current staff do not have the capacity or capability) thus increasing maintenance costs.
- ▶ The custom software can be developed following the agency's IT standards, and is more compatible with other agency software.

## Select System and Implement

Once the alternatives analysis is complete and the agency has selected the most feasible alternative, the next step is to release an RFP, review responses, select a vendor, and begin the implementation phase.

Project success is heavily dependent on how the implementation phase is managed. In fact, according to the Standish Group (which collects data on IT project successes and failures), only about 16 percent of projects are truly "successful." The majority of the projects face challenges during the implementation stage. Furthermore, staff efficiency does not increase as soon as a system is implemented. Most systems go through a "stabilization" phase where the staff gets used to the new system interface, usability, and capabilities, during which the efficiency actually decreases before increasing to new levels. **Figure 5-8** shows an example of the stabilization period.

**Figure 5-8.** Example of a System Stabilization



Source: Presentation by Louisiana Department of Transportation & Development at 91<sup>st</sup> Annual Transportation Research Board conference (January 2012)

"Our biggest challenge is the disparity in the level of asset management maturity in each department."  
 —U.S. Transit Agency Manager  
 (Source: 2011 Parsons Brinckerhoff Survey)

## 5.6 Key Implementation Planning Considerations/Lessons Learned

The following list describes implementation considerations and lessons learned based on feedback from transit agency managers and other transportation leaders from around the world:

- As part of an agency's asset management plan update, the Asset Management Improvement Team should capture lessons learned to ensure that the plan is updated to reflect these findings.
- Regularly re-visit asset management goals to ensure that the agency is constantly striving to improve. There is no end to the process; there are always opportunities for further improvement.
- Asset management in the transit industry is constantly evolving as agencies endeavor to improve their existing practices. Seek opportunities for knowledge sharing within the industry. Industry conferences and workgroups may provide good opportunities.
- When possible, involve staff who have worked in different agency departments (e.g., operations and maintenance, engineering, finance). These people likely have relationships and a technical understanding of both departments, which can help to bridge the traditionally siloed areas.



Improvement initiatives fail or do not yield their full potential for many reasons, including the absence of a change champion, loss of commitment and motivation, or inadequate executive support. Transformation can also collapse during the execution phase because of unclear strategy and conflicting priorities or an ineffective management team. Tactics for addressing these potential failures include:

- ▶ Plan, talk, and act as if implementation is key, right from the start.
- ▶ Avoid skirting difficult issues, compliment personal skills, discuss weaknesses, and avoid silence.
- ▶ Track and respond to performance indicators to assess, change course, and adjust, but keep in mind that some changes may take time to produce results.
- ▶ Ask what activities can be curtailed to free up resources for this change.
- ▶ Nurture and empower the right champions and change agents.
- ▶ Shepherd good ideas, insights, and connections.

- An agency-wide risk assessment can help the agency to understand the asset classes that the present the highest business risk; this information can then be used to support decision-making.
- Consider the importance of developing transportation leaders to fill future needs. The Asset Program Manager should consider creating a succession program to train and groom future leaders. This could be as easy as informal shadowing opportunities for junior managers or line staff.
- Areas of lifecycle cost and risk can be challenging to quantify or even capture. Some assets do not decline in functionality, but rather work until failure, at which point it is an extremely lengthy process to rebuild/restore service.
- When planning for an asset management improvement program, acknowledge that the improvements may take a number of years to fully implement. For this reason, it is important to develop long-term strategies while also considering short-term “wins” to maintain momentum. Examples might be centralizing an asset inventory, communicating performance metrics to stakeholders, and developing one asset class’ lifecycle management plan.
- Asset management often involves a significant amount of jargon. Use simple language whenever possible and, when introducing more complex terms, clearly explain their meaning and use them consistently.
- Encourage a hands-on approach from staff. Allowing staff to “get their hands dirty” and actively participate in infrastructure needs assessments and solutions might be the best way to obtain tangible, short-term gains/savings in asset management and set the stage for rolling ideas from lower staff levels to corporate strategic levels.
- Provide direction without being too prescriptive. Staff should be allowed to collaborate, which leads to more innovation.
- Treat asset management as a journey and not a destination. Continuous improvement is fundamental.

“It took us five years to become an overnight success!”  
—U.S. Transit Agency Manager (Source: 2011 Parsons  
Brinckerhoff Survey)





## Glossary of Transit Asset Management Terms

This guide introduces concepts that may be new and terms that are not commonly used in many transit agencies today. These can provide the basis for a common vocabulary and understanding. This section provides an explanation of the key concepts mentioned throughout and a common language for the industry.

### Key Concepts

**Asset Management** – Transit asset management is 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, reliable service to current and future customers.

**Asset Management Business Plan** – Refers to a document that outlines the implementing activities, roles, responsibilities, resources, and timelines needed to address an agency's asset management policy and strategy. More information on developing an asset management business plan can be found in Section 3.1.3 and Section 5.5.

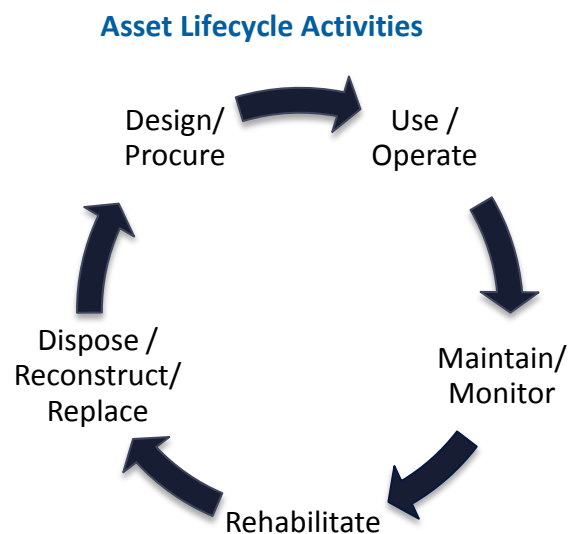
**Asset Management Maturity** – Refers to an agency’s level of asset management practice. An agency’s asset management maturity may be as basic as understanding what assets it owns; however, a more mature asset management agency will be able to use that asset information to model different funding scenarios and optimally allocate funding to its assets. More information regarding asset management maturity levels is found in Chapter 5.

**Level of Service** – Level of service is the defined service quality that the agency and its assets are expected to deliver and be measured against. Levels of service usually relate to the quality, quantity, reliability, responsiveness, sustainability, cost, and cost efficiency of service. It applies at the enterprise level and for asset classes (for example, buses and elevators). Generally, level of service should be driven by what is important to the customer.

**Lifecycle Cost Analysis** – Lifecycle Cost Analysis (often abbreviated LCCA) is an approach for measuring an asset’s total cost of ownership, usually to facilitate a financial comparison of investment options. It includes the estimation of both capital and operating costs of an asset at each lifecycle stage or activity (see Lifecycle Management). Estimated costs are typically in current dollars (versus escalated) terms to allow direct comparison. Costs may also be normalized to a particular time horizon to account for varying design lives.

**Lifecycle Management** – Lifecycle management enables agencies to make better investment decisions across the lifecycle using management processes and data specific to each asset as a basis for predicting remaining useful life (including age, condition, historic performance, and level of usage). Transit asset management involves processes for managing and maximizing the performance of an asset while minimizing its costs throughout the course of its lifecycle. Lifecycle activities include the following (see figure):

- **Design/Procure** – If creating, this includes planning, design, and construction of the asset. If acquiring, this includes the scoping of the development and procurement of the asset. The asset management perspective involves considering level of service requirements and total cost of ownership in this initial step.
- **Use/Operate** – This involves the use (or operation) of the asset. Asset management ensures that the asset is available in the specified condition to be used, or operates reliably to deliver the planned level of service.
- **Maintain/Monitor** – This involves all the predictive, preventive, corrective, and reactive activities required to maintain the asset in the condition required to deliver the planned level of service.
- **Rehabilitate** – Rehabilitation is the planned capital expenditures required to replace, refurbish, or reconstruct an asset partially, in-kind, or with an upgrade to optimize service and minimize lifecycle costs. Examples might include reconstruction work on a bridge structure that replaces critical elements and thereby extends the bridge’s life or a rail vehicle overhaul.
- **Dispose/Reconstruct/Replace** – When an asset can no longer perform at its intended level of service, the agency has the choice to dispose, reconstruct, or replace the asset. Typically at this stage, it is no longer cost



effective to renew the asset or it is functionally obsolete, and the agency must determine whether the asset must be replaced, whether the function of the asset remains necessary, and whether its function can be met more economically or efficiently by being replaced outright.

**Lifecycle Management Plan** – Documents the costs, performance, and risks associated with an asset class throughout its life. Reflecting input from all departments that are involved in that asset’s lifecycle, a lifecycle management plan can be used to ensure that the performance expectations of the asset are understood and fit within the agency’s broader goals and performance objectives, and that all investment decisions are transparent and well-communicated. More information regarding developing a lifecycle management plan can be found in Section 3.2.3.

## Other Terminology

**Asset Category** – Refers to a grouping of asset classes. For example, “Vehicles” is the asset category for two asset classes: “Rail Vehicles and Fixed Guideway Non-Revenue Vehicles” and “Buses, Paratransit and Non-Revenue Vehicles.” More descriptions on asset categories can be found in the *Asset Management Guide Supplement*.

**Asset Class** – Refers to the sub-groups within an asset category. For example, “Vehicles” is the asset category for two asset classes: “Rail Vehicles and Fixed Guideway Non-Revenue Vehicles” and “Buses, Paratransit and Non-Revenue Vehicles.” More descriptions on asset classes can be found in *Asset Management Guide Supplement*.

**Asset Class-Level** – Refers to any management or decision-making activities that occur for individual asset classes. For example, the condition monitoring approach for stations is an asset class-level business process, while establishing an agency-wide policy is an enterprise-level business process.

**Asset Management Business Processes** – Refers to the six key processes that comprise the transit asset management framework. Business processes include, for example, asset management policy, capital planning and programming, and condition assessment and performance monitoring. For each business process, Chapter 3 describes what best practice looks like, key implementation activities and challenges, and peer examples.

**Asset Management Framework** – The asset management framework provides a structure that outlines best practice in asset management practice. It is comprised of six business processes, including, for example, asset management policy, capital planning and programming, and condition assessment and performance monitoring. An introduction to the framework is found in Chapter 2 and overview of each of the framework business processes is found in Chapter 3.

**Asset Management Program Manager** – Refers to the person held accountable for developing, maintenance, and implementation of the asset management business plan. Additionally, this person is responsible for communicating with the Executive Team, leading the Enterprise Asset Management Team, and managing internal and external communications regarding the asset management initiative. More information regarding the role of the asset management program manager is found in Chapter 5.

**Asset Owners** – Refers to the agency staff or department responsible for managing the full lifecycle of an asset class. These are typically the same group responsible for developing and maintaining that asset class’ lifecycle management plan. More information regarding the role of an asset owner is found in Chapter 5.

**Enterprise Asset Management Team** – Comprising representatives from maintenance, operations, engineering, capital planning, information technology, and other related departments, this group provides the asset



management knowledge and practice leadership for the agency. This cross-functional team represents their department's technical expertise and interests. This group's role is to be the owners of improved processes or have the changes incorporated in the work of their units. More information regarding the role of the enterprise asset management team is found in Chapter 5.

**Enterprise-Level** – Enterprise level activities refer to any management or decision-making activities that need to occur at the higher levels of an organization and apply to the entire organization. Transit asset management integrates activities across functions in a transit agency to optimize resource allocation by providing quality information and well-defined business objectives to support decision-making within and between classes of assets.

**Performance and Predictive Modeling** – Transit asset management involves establishing models to predict the performance of an asset and asset condition over time based on its use, natural processes, and maintenance, operating, and rehabilitation practices. Modeling techniques and the nature of assumptions vary by asset class. Performance and predictive modeling can assist in the identification of underperforming assets and provide useful information to improve capital programming and O&M budgeting decisions. More information about performance and predictive modeling can be found in Section 3.3.3.

**Performance Management** – The American Association of State Highway and Transportation Officials (AASHTO) defines performance management as an ongoing process that translates strategic goals into relevant and detailed measures and targets that, along with resources, are continuously monitored to ensure achievement of published institutional goals. Asset management is a management process that directly impacts critical business metrics of cost, reliability and safety. It explicitly links strategies, plans, operations, and budgets to level of service. Advanced transit asset management practices involve scenario evaluation that incorporates service levels, asset lifecycle needs, and performance based on varying funding levels.

**Risk Management** – Risk management is the process through which risks are identified, assessed and managed. Risk management approaches can range from completely ad-hoc to very formal, yet they all share the same fundamentals. Most importantly, the primary objective for any of these risk management approaches is to improve the performance of the agency as a whole and individual business areas. Each approach seeks to anticipate risks and opportunities and then develop management strategies to minimize the occurrence of negative events. More information about risk management can be found in Chapter 2.

**Total Cost of Ownership** – Reflects the total estimated capital and Operations and Maintenance costs associated with an asset throughout the its lifecycle (including the cost to design/procure, use/operate, maintain/monitor, rehabilitate, and dispose/reconstruct/replace. The total cost of ownership should be represented in an asset's lifecycle management plan.



Source: Steve Kay

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