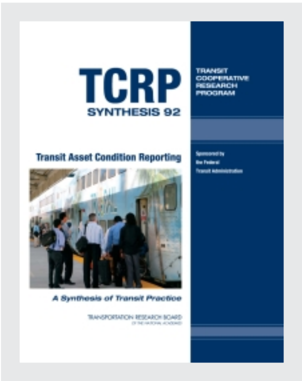

Transit Asset Condition Reporting

DETAILS

45 pages | | PAPERBACK
ISBN 978-0-309-14349-3 | DOI 10.17226/14595

AUTHORS

Brian McCollom; Stephen A Berrang; Transportation Research Board

TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP SYNTHESIS 92

Transit Asset Condition Reporting

A Synthesis of Transit Practice

CONSULTANTS

BRIAN McCOLLOM

and

STEPHEN A. BERRANG

McCollom Management Consulting, Inc.

Darnestown, Maryland

SUBSCRIBER CATEGORIES

Economics, Finance, Public Transportation

Research Sponsored by the Federal Transit Administration in Cooperation with the Transit Development Corporation

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.

2011

www.TRB.org

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academy of Sciences, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by TRB. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

TCRP SYNTHESIS 92

Project J-7, Topic SG-11
ISSN 1073-4880
ISBN 978-0-309-14349-3
Library of Congress Control Number 2011931177

NOTICE

The project that is the subject of this report was a part of the Transit Cooperative Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

The Transportation Research Board of the National Academies, the National Research Council, and the sponsors of the Transit Cooperative Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.

Published reports of the

TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at
http://www.national-academies.org/trb/bookstore

Printed in the United States of America

Cover figure*:* TriRail (Courtesy: McCollom Management Consulting, Inc., Photo Archives).

FOREWORD

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, "Synthesis of Information Related to Transit Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice.*

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Donna L. Vlasak
Senior Program Officer
Transportation Research Board

The purpose of this synthesis was to examine and document the current state of the practice in transit asset condition management. Transit asset management is defined here as a strategic planning process that supports informed capital investment planning and programming. It is said that "good" transit asset management can provide critical support in two key areas—establishing the level of need for infrastructure investment and programming the cost of effective investment. The report's objective is to provide transit agencies and their federal, state, and local funding partners with a review of current practices in hopes of encouraging industry-wide discussion on standards and the data needed to measure conditions and use the information in making effective investment decisions.

The report contains information derived from a literature review and the results of an industrial survey of the 50 largest multi-modal transit agencies in terms of operations size, which yielded an 82% response rate. Further, detailed case studies of innovative practices at the Massachusetts Bay Transportation Authority and the New York City Transit Authority describe the origin of each agency's asset management system, how it is used, and how it evolved over time. Then two agencies were chosen to represent two distinct State of Good Repair systems that represent different approaches and that would likely have the most advanced asset management systems because of the complexity of their operations. These examples might help others identify opportunities and challenges for upgrading and increasing the consistency of their own transit asset condition reporting.

Brian McCollom and Stephen A. Berrang, McCollom Management Consulting, Inc., Darnestown, Maryland, collected and synthesized the information and wrote the paper, under the guidance of a panel of experts in the subject area. The members of the Topic Panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

TRANSIT ASSET CONDITION REPORTING

SUMMARY

This synthesis examines and documents the current state of the practice in transit asset management at large transit agencies. The objective of a good transit asset management system is to achieve and maintain a "State of Good Repair" (SGR), where all transit assets (e.g., vehicles, stations, and power systems) are replaced when needed.

Achieving and maintaining SGR is a matter of urgent national concern. A 2008 FTA report, *Transit State of Good Repair—Beginning the Dialogue,* estimates that 25% of public transit assets are in marginal or poor condition. In addition, overall conditions have been declining because current infrastructure funding is inadequate and addresses only 60% to 80% of what is required for ongoing replacement needs and for the elimination of the backlog of past unfunded replacement needs (often termed backlog needs).

The underinvestment in public transit infrastructure has significant consequences. Operating costs are higher because of the increased costs of maintaining assets that are performing beyond their useful lives. Service reliability suffers as more buses and rail cars breakdown in service. The quality and appearance of passenger amenities declines as stations and shelters age and escalators experience frequent failures. Safety becomes a greater public concern when aging assets fail at critical times, as recent accidents in Boston and Chicago have demonstrated. Ultimately, these consequences make transit service less attractive and result in lower use of transit services.

This synthesis found that the large transit agencies are concerned about the consequences of underinvestment, but use asset management systems that are elementary and limited. Most agencies have systems that track all assets and are frequently updated; however, these systems have limited ability to estimate the consequences of not making asset replacements when needed. The systems also lack the ability to test the impacts and consequences of different funding scenarios.

These limitations hamper the transit agencies in their efforts to develop compelling arguments for increased funding. They also do not provide the needed information that would help prioritize the programming of investment projects when available funding is not sufficient to provide implementation of all needed projects.

This synthesis presents an overview of published literature on transit asset management systems, a survey of the 50 largest transit agencies, and in-depth case studies of two transit agencies that have focused attention on transit asset management.

An initial challenge in this work was the definition of a good transit asset management system. For this synthesis, attention was focused on the use of technical modeling approaches for:

- Estimating funding needed to address ongoing and backlog replacement and rehabilitation needs, and
- Setting priorities for the funding of SGR projects when funding is not sufficient to provide implementation of all needed projects.

The literature review identified a small number of publications that described approaches for estimating funding needs or setting funding priorities in constrained funding environments. Most of the literature focused on the need for SGR analysis, funding, general processes, and frameworks for conducting the analyses.

The small number of relevant publications documented efforts to estimate transit capital needs at three different aggregation levels: nationally, statewide, and locally. The technical approaches described in these reports varied in several respects.

- **Types of Capital Asset Costs Included.** Some applications only considered replacement costs as capital costs. Others included significant mid-life renewals as capital costs. One approach examined life-cycle costs that included operating and maintenance costs.
- **Measure of SGR.** Some applications defined assets as being in a state of good repair if they were replaced before the end of their defined useful life (e.g., 12 years for buses, 25 years for rail cars, and 50 years for stations). Others used asset condition ratings (decay curves) that were adopted from an approach developed by the Chicago Transit Authority in the 1990s. Therefore, two identical assets may be scheduled for replacement at different ages based on the intensities of their use and their respective levels of maintenance.
- **Scenario Testing.** All applications provided estimates of the capital funding needed to bring the assets to, and maintain the assets at, a state of good repair. Several applications estimated the capital costs of reaching SGR, but also maintaining (or improving) service performance in terms of passenger crowding and travel speeds as population and travel congestion increases. One application also included the ability to prioritize the funding of specific asset renewal or replacement projects in constrained funding environments where the available funding is less than what is needed to bring all assets to SGR.

General findings from the survey highlighted differences and commonalities in SGR approaches and results among the nation's 50 largest transit agencies. The transit agencies surveyed are primarily multi-modal transit agencies that typically operate heavy, light, or commuter rail services, and conventional bus service. The survey focused on these agencies because it was expected that they would likely have the most advanced asset management systems owing to the complexity of their operations.

The survey was sent to all 50 large transit agencies, and it generated a response rate of 82%, or 41 respondents. Virtually all respondents indicated that they maintain comprehensive inventories of assets that are updated regularly. A high proportion of respondents also indicated that these data are used for capital planning or development of investment strategies.

Detailed survey responses received from transit agencies revealed the following about the collection and analysis of the data at these agencies:

- The primary sources of the data vary among the transit agencies. Common sources include financial records (fixed asset ledgers), asset inspections, maintenance management systems, or some combination of these sources.
- Although all data are maintained electronically, there are variations in how the data are stored. The most common storage packages are off-the-shelf, financial information or asset management databases, and special databases developed internally or by outside consultants.
- Two of every three respondents indicated that their agencies use rolling programming cycles (e.g., 2009–2013, 2010–2014). This means that most of the large transit agencies need to make capital needs forecasts every year.
- Most responding agencies determine asset condition through a combination of age and inspection results. This may mean that agencies assess the condition of selected asset categories based on inspections (e.g., bridges) while relying on age for other asset categories (e.g., buses).

The responding transit agencies indicated that they made good use of the asset tracking and condition data. Most agencies stated that they use the age and condition data to make an assessment of their infrastructure needs and to support appeals for more funding. The majority of the responding agencies reported that these efforts produce good results and that their asset condition systems were used to change capital funding priorities to improve their SGR.

The responses suggest that the transit agencies use the transit assent condition data as another qualitative factor to be considered in the determination of investment priorities and development of capital programs. None of the responding agencies provided examples of how the data were used quantitatively to set investment priorities.

Two case studies of the Massachusetts Bay Transportation Authority (MBTA) and the New York City Transit (NYCT) demonstrate that focused attention to transit asset management can improve the funding of SGR projects. At the MBTA, the funding of SGR investments increased from about 50% to almost 80% within 5 years.

In 1982, NYCT's system was in a state of disrepair. In response, the MTA undertook a series of 5-year capital plans to bring the system back into a state of good repair. The MTA is now in its fifth 5-year capital plan and has made significant strides in restoring the agency's assets. The use of an extensive asset inventory with condition ratings was critical to this success.

The two case studies highlight two desirable features of an ideal transit asset management database system. The MBTA database is a good case study of an effective strategic planning and programming tool. The MBTA database can assess the impacts of different funding scenarios on the state of repair of a transit system. These scenarios can be run "automatically" because the database contains:

- Pre-determined condition settings and measures of SGR,
- Costs of asset renewal and replacement, and
- A programming logic that makes "funding decisions" based on the weighting of several project factors.

NYCT's database is a good example of a detailed database. Assets such as stations are broken down into very detailed components that each have a service life and can be renewed. This level of detail provides the opportunity to consider the programming of specific renewals (e.g., replace escalators and roofs) rather than the programming of simpler actions at a higher level of asset aggregation (e.g., rehabilitation of a station).

Based on the literature review, surveys, and case studies a number of suggestions are made to improve the design and use of the asset databases. The suggestions address the structure of the databases, improved analysis techniques, and use of SGR-based tools for funding prioritization, and are outlined in chapter six, Conclusions.

CHAPTER ONE

INTRODUCTION

The purpose of this synthesis is to examine and document the current state of the practice in transit asset management for transit agencies and other stakeholders. Transit asset management is defined as a strategic planning process that supports informed capital investment planning and programming. It is said that "good" transit asset management can provide critical support in two key areas:

Establishing the level of need for infrastructure investments. A comprehensive analysis of infrastructure needs can produce an estimate of the funding needed to address: (1) ongoing asset replacement and rehabilitation needs, and (2) past unfunded infrastructure needs (often termed backlog needs). This funding estimate and supporting documentation can provide a compelling argument and support for increased funding.

Programming of cost-effective investments. A systematic approach that is based on good quality data and clear organizational objectives can help prioritize the programming of investment projects when available funding is constrained and not sufficient to support the implementation of all needed projects. The use of this approach will help maximize the effectiveness of local, state, and federal funding investments.

The condition of public transit infrastructure is a current and important national topic. Much has been written about the importance of maintaining the nation's bus and rail systems in a "State of Good Repair" (SGR). A 2008 FTA report, *Transit State of Good Repair—Beginning the Dialogue,* estimated that approximately 25% of public transit infrastructure is in marginal or poor condition. This report suggests that this decline is because nationally current infrastructure funding is inadequate and is estimated to address 60% to 80% of what is required to provide for ongoing replacement needs and to eliminate the backlog of past unfunded infrastructure needs.

The underinvestment in public transit infrastructure has significant consequences. Operating costs are higher because of the increased costs of maintaining assets that are required to perform beyond their useful lives. Service reliability suffers as more buses and rail cars break down in service. The quality and appearance of passenger amenities declines as stations and shelters age and escalators have more frequent failures. In addition, public safety becomes a greater concern when aging assets fail at critical times, such as the recent accidents in Boston and Chicago demonstrate. Ultimately, these consequences make transit service less attractive and result in the lower use of transit services by potential passengers.

PROJECT OBJECTIVE

The focus of this TCRP synthesis project is to document the state of current asset management system practices. The project addresses transit asset condition inventorying and condition tracking and the use of the resulting data to guide short-term (5-year) priority-setting and budgeting, and long-term (10- to 20-year) investment strategies.

The project objective is to provide transit agencies and their federal, state, and local funding partners a review of the state of the practice of current asset management system practices. It is hoped that this review will encourage an industry-wide discussion on the standards and data needed to measure asset conditions and the use of this information for making effective investment decisions. Improving the understanding of infrastructure conditions can support the articulation of a compelling argument for increased funding and systematic management of investments.

PROJECT SCOPE

The scope of this synthesis project was designed to obtain information on current transit asset management system practices using three different information collection approaches:

1. A literature review,
2. An industry survey, and
3. Case studies of innovative practices at local transit authorities.

The objective of the literature review was to identify key publications that described current transit management practices in the transit industry. The transit industry not only includes transit agencies, but also their local, state, and federal funding partners. These partners also have the need to employ good transit asset management systems to monitor the impacts of their funding investments in local transit agencies and to report these findings to their senior managers and political leaders. It was hoped that the literature review would identify innovative practices that had potential or were beginning to be adopted by transit agencies.

The objective of the industry survey was to develop a picture of the state of the practice in the transit industry—what is the range of techniques being used and how many transit agencies are using them. The topics covered in the survey were:

- How transit agencies are measuring asset conditions and determining asset funding needs.
- How the condition of transit assets is communicated to transit agency decision makers (management and governing boards); state, local, and federal funding partners (agency staff and elected officials); and the general public.
- How the asset condition data are used to make investment and capital programming decisions.

The nation's 50 largest transit agencies in terms of operations size were surveyed. These transit agencies are primarily multi-modal transit agencies that typically operate heavy, light, or commuter rail services and bus services. The survey focused on these agencies because it was expected that they would likely have the most advanced asset management systems because of the complexity of their operations.

The conduct of case studies was the third element of the project scope. It provided the opportunity to review in depth the experiences at innovative transit agencies in terms of innovations, lessons learned, and gaps in methods and information. The results of the case studies could help identify opportunities and challenges for upgrading and increasing the consistency of transit asset condition reporting.

TECHNICAL APPROACH TO PROJECT

The project involved three parallel streams of activity as outlined in the project scope:

1. A literature review,
2. An industry survey, and
3. Case studies of innovative practices at local transit agencies.

Literature Review

The literature review examined eight articles, papers, or reports that were judged important to this synthesis project. The limited availability of literature may suggest that the active use of asset management systems for more than data collection and manipulation of asset inventory data is not common.

The results of the literature review are discussed in chapter two, Literature Review, and selected titles are provided in the References and in the form of an annotated bibliography in Appendix D.

Survey

A survey was carried out in early 2010. The nation's 50 largest transit agencies in terms of operations size were polled. The survey focused on these agencies because it was expected that they would have the most advanced asset management systems because of the complexity of their operations.

The survey included a set of 37 questions regarding current asset management systems practices. The questions addressed the scope of the agency asset inventory, the agency human resources used, the determination of asset condition and its use, and details of the agency's capital programming.

Of the 50 agencies from which responses were solicited, 41 or 82% responded to the survey. A total of 37 agencies provided responses to the more detailed questions in the survey, and complete responses to the questions on state of good repair were provided by 11 agencies.

Case Studies

Detailed case studies of two of the 50 largest transit agencies—the Massachusetts Bay Transportation Authority (MBTA) and the New York City Transit Authority (NYCT) were undertaken as part of this synthesis. The case studies describe the origin of each agency's asset management system, how it is used, and how it has evolved over time.

The two agencies chosen represent two distinct SGR systems that represent different approaches. They are both, however, considered state of the art and examples of best practices.

REPORT ORGANIZATION

This report contains the following chapters and related findings. A summary of the findings from the survey are provided in chapter three, Survey Results: Transit Capital Programming and Asset Tracking Systems, and chapter four, Agency Use of Asset Tracking and Condition Assessment Data. A copy of the survey questions is provided in Appendix A, a detailed summary of survey responses is presented in Appendix B, and Appendix C lists the agencies who participated in the survey.

CHAPTER TWO

LITERATURE REVIEW

The literature review involved a search of major sources including transit agency websites, TRB proceedings and publications, and APTA publications. The literature search was conducted using web and Transportation Research Information Services (TRIS) search engines.

The literature search focused on identifying technical methods used for effective transit asset management. As mentioned in chapter one, these methods can be used to produce an estimate of the funding required to address asset replacement and rehabilitation needs. The methods can also help set and prioritize the programming of replacement and rehabilitation projects when available funding is constrained.

The literature review found a large number of publications that discussed the importance of maintaining transit assets in SGR. Generally, the major focus of these articles was that the condition of transit assets has been declining through underinvestment and that increased funding is needed to reverse this decline. These publications, however, did not discuss or describe the technical methods that might be used for more effective transit asset management.

The literature on *technical* methods used for transit asset management is limited. Eight articles, papers, or reports were identified and judged important to this synthesis project. The publications are cited in the References and summarized in the Annotated Bibliography found in Appendix D.

Although the literature is limited, the review of the relevant sources suggests how the technical methods may advance in the coming years and become more comprehensive and sophisticated. The key advances may come in several areas including the definition used for SGR, the asset costs considered in the analyses, and the use of scenario testing.

MEASURE OF THE STATE OF GOOD REPAIR

The conventional approach for defining assets being in SGR is that the assets are replaced before the end of their useful life. Examples of these definitions are 12 years for buses, 25 years for rail cars, and 50 years for stations. Often, these definitions are based on federal grant requirements that only permit federal funding to be used for asset replacements when the assets have reached minimum ages.

Recent and more detailed approaches recognize that, in practice, the need to replace an asset is related not only to age, but to other factors as well, such as intensity of use (e.g., miles), level of preventive maintenance, and climate. Therefore, two identical assets may be scheduled for replacement at different ages based on the intensities of their use and their respective levels of maintenance.

The approach used by the FTA in its Transit Economic Requirement Model (TERM) is an excellent example of this approach (Laver 2009). It simulates the full life and decay of all transit assets based on factors such as asset use (e.g., miles), annual maintenance, and age. Empirically derived decay curves are used to determine when assets should be replaced. These curves are based on detailed asset condition inventories that used a five-point scale (1 = poor condition, 5 = excellent condition). An asset is replaced when its condition falls below 2.5.

Another advance is suggested by the approach developed in Illinois for determining when buses should be replaced (Booz Allen Hamilton 2003). A minimum cost replacement strategy was used to minimize total life-cycle costs. These costs were allocated over the life of a vehicle on a per mile basis. The purchase and rehabilitation costs per mile decline over the life of the vehicle. In contrast, operating and maintenance costs per mile tend to increase as a vehicle ages. When these divergent unit cost trends are combined to produce a total life-cycle cost curve, a minimum unit cost and its corresponding lifetime mileage can be determined and used as the replacement point.

ASSET COSTS CONSIDERED

A common public view is that good transit asset management will be achieved when there is sufficient funding to replace or rehabilitate assets at the end of their useful lives. Therefore, the task is to determine the needed replacement and renewal funding.

This approach ignores the issue that mid-life renewals often are needed to ensure that assets reach their useful life. Examples of these mid-life renewals include the replacement of engines and transmissions for buses, heating and roofs for stations, and traction motors and assemblies for rail cars.

More comprehensive approaches recognize the need to include these mid-life renewals (Yoder and Delaurentis 2003;

McCollom 2006; D'Alessandro et al. 2009; Laver 2009) as part of good asset management analysis. However, there is limited information in the literature about how these mid-life actions should be defined for all asset types.

SCENARIO TESTING

Most of the applications documented in the literature provided estimates of the capital funding needed to bring the assets to, and maintain the assets at, SGR. This might be termed "ideal SGR funding."

However, in many communities, funding is limited. Decision makers would like to know the consequences of providing less than ideal funding.

The Boston methodology (McCollom 2006; D'Alessandro et al. 2009) was the only one identified that included the ability to prioritize the funding of specific asset renewal or replacement projects in constrained funding environments. It uses a weighting scheme that relies on several factors, such as ridership impact, replacement costs, and impact on operations, to determine funding priorities. The consequences include a summary of asset actions (replacement or mid-life maintenance) funded on-time, later than scheduled, or not at all, and changes in the backlog of actions throughout an analysis period.

The limitation of the Boston approach (McCollom 2006; D'Alessandro et al. 2009) is that the consequences are related to the successful completion of desired programming actions. It does not estimate impacts of underinvestment on operating costs, service reliability, safety, and passenger usage.

SUMMARY

The limited availability of literature on this topic suggests that the active use of asset management systems for more than data collection and manipulation of asset inventory data is not common. As the state of the industry matures, it is reasonable to expect more reports on this subject.

Although the literature is limited, it provides a strong indication of where methodical improvements will be made. Significant advances were found in the definition used for SGR and the asset costs considered in the analyses. More work is needed in forecasting the consequences of underinvestment.

CHAPTER THREE

SURVEY RESULTS: TRANSIT CAPITAL PROGRAMMING AND ASSET TRACKING SYSTEMS

The major effort in this project was the survey of industry practice in transit asset management. The nation's 50 largest transit agencies in terms of operations size were polled using an Internet survey. The transit agencies surveyed are primarily multi-modal transit agencies that typically operate heavy, light, or commuter rail services and bus services. The survey focused on these agencies because it was expected that they would likely have the most advanced asset management systems because of the complexity of their operations.

The survey collected basic agency information and asked if the agency had and used a comprehensive asset database. The survey also covered a detailed set of 37 questions regarding current asset management systems practices. The questions addressed the scope of the agency asset inventory, the agency human resources used, the determination of asset condition and its use, and details of the agency's capital planning and programming.

SURVEY RESPONSE

The response rate for the initial survey was 82% or 41 agencies (Figure 1). Collectively, the respondents operate a variety of modes. More than two-thirds of the respondents (28 agencies) operate some form of rail service, heavy rail, light rail, or automated guideway (Table 1). The remaining agencies typically operate bus and demand response services. Nearly all of the respondents (93%) provide bus service and most (86%) also provide demand response service. This illustrates the complexity of the multi-modal operations of the 50 largest U.S. transit agencies.

The final question of the initial survey asked if the respondent was willing to participate in a much more detailed survey regarding the agency's asset inventory database, its structure, and its use. A total of 37 respondents or 90% indicated their willingness to proceed with the second survey.

SCOPE OF ASSET INVENTORY

Virtually all respondents to the initial survey (98%) reported that they had a comprehensive asset inventory database. The same number of respondents noted that they maintained (updated) the database on a periodic basis.

These responses are consistent with the grant requirements for agencies receiving federal funding regarding adequate control. Transit agencies must demonstrate knowledge of and control of transportation assets that are federally funded.

The primary source of asset inventory data varies among the responding agencies (Figure 2). The most popular source was fixed asset ledger/counting data, which was cited by 40% of respondents. Often, these databases were created for financial control purposes.

Data collected for operational purposes, either as part of asset inspection or maintenance management systems, were cited by approximately one-third of the respondents. These databases were created to support the maintenance of good asset condition.

The types of data systems used for asset inventory and condition monitoring varied across responding agencies. All respondents indicated that an electronic database was used to store the data (Figure 3). However, only one-half of the respondents reported using networked applications. Networked applications generally are considered to be the best way to enter and maintain data that must be entered by many departments in an agency because they reduce or eliminate the double-entry of data.

The types of data storage also varied. More than one-half of the respondents reported that their agencies stored data in off-the-shelf, financial information, or asset management databases (Figure 4). Another 30% of the respondents indicated that their agencies use specially developed databases (internally or consultant).

It is important that planning, as well as both near-term and long-term capital programming, be informed and guided by analysis based on asset inventory data. To make the most use of the asset inventory there needs to be a connection between (1) the update of the asset database (number of items) and (2) the planning and budgeting process.

Approximately two-thirds of the responding agencies update the asset data in their databases every 1 to 2 years (Figure 5). A 5-year update schedule is used for another 14% of the responding agencies.

The remaining agencies do not have a fixed update schedule. For some responding agencies (8%), the frequency of updates occurs when changes are made to the asset inventory. For others (6%), the update frequency varies by asset type.

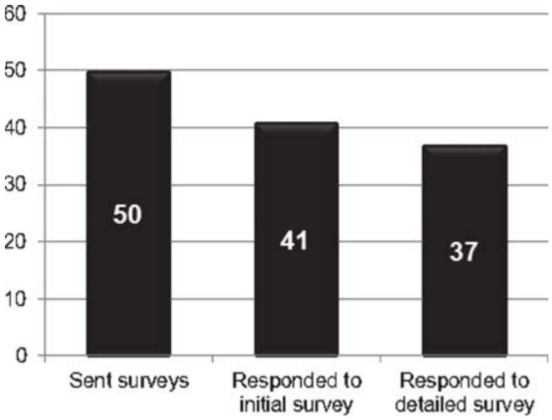

FIGURE 1 Agency response to survey.

Designated in-house staff support and update the databases for most responding agencies. More than 80% of the respondents reported that their agencies use only in-house staff and do not use contractors to maintain and update their asset inventories (Figure 6). Almost 60% of the responding agencies use designated, but not dedicated, staff to maintain and update their asset inventories. These inventory responsibilities are one of several job responsibilities for the designated staff.

USE OF INVENTORY DATA

The use of the inventory data is reported to be high (greater than 75%) for most common applications (Figure 7). There is near unanimity reported in the use of the inventory data for capital planning purposes. For many agencies, the inventory also serves as the basis for condition assessment as well as regulatory and financial reporting purposes.

The capital program cycles vary by length and by whether the time interval is fixed (e.g., 2010 to 2014, then 2015 to 2019) or rolling (e.g., 2010 to 2014, then 2011 to 2015). About two-thirds of the responding agencies use programming cycles that are 5 years or less (Figure 8). Two of every three respondents indicated that their agencies used rolling programming cycles.

Taken together, these two responses indicate that at least two-thirds of the transit agencies revise their capital programs every year; therefore, most of the large transit agencies need to make capital needs forecasts every year.

The programming cycles are related to the planning cycles at most of the responding agencies. Twenty-five agencies (71%) reported that the renewal cycles of their capital programs are linked to the duration of their planning cycles.

The types of capital spending are often the subject of criticism from transit observers. Capital spending can be divided into three general categories: (1) SGR, (2) service expansion, and (3) enhancements to existing assets. It is often claimed that SGR spending is low because it does not generate the public interest that is created by spending in the other two categories. However, the respondents reported that an average of 62% of 2009 capital funding was spent on SGR projects (Figure 9). This may reflect the national norm for a large transit agency seeking to balance growth and re-investment. The responses ranged from a low of 6% to a high of 100%.

CONDITION ASSESSMENT

Nearly 90% of responding agencies indicated that they assess the condition of some or all assets. This assessment may be tied to the reported high use of the data for capital programming and agency funding (see Figure 8). More than 80% of responding agencies determine asset condition through a combination of age and inspection results (Figure 10). This may imply that agencies assess the condition of selected asset categories such as bridges based on inspections while relying on age for other asset categories.

Almost two-thirds of the responding agencies update the condition data in their databases every 1 to 2 years (Figure 11). This is consistent with the responses to the question regarding the frequency of updates to the inventory data (see Figure 5).

Another 17% of the responding agencies reported that the frequency of their updates varies by asset type. The collection of condition data on some asset types (e.g., vehicles) typically are part of routine maintenance activities. For other asset types (e.g., bridges), special efforts must be made to update the condition data.

SUMMARY

The survey revealed some key findings about the state of practice of asset tracking systems and capital programming at large transit agencies:

- Virtually all large agencies have asset tracking databases that are frequently updated and include all assets.
- The primary sources of the data vary among the transit agencies. Common sources include financial records (fixed asset ledgers), asset inspections, maintenance management systems, or some combination thereof.
- Although all data are maintained electronically, there are variations in how the data are stored. The most common storage packages are off-the-shelf, financial information or asset management databases, and special databases developed internally or by outside consultants.
- Designated in-house staff support and update the databases for most responding agencies. Most responding agencies do not use outside contractors for this support.

TABLE 1
RESPONDING TRANSIT AGENCIES AND MODES OPERATED

		Modes Operated										
Transit Agency	**Location**	AG	MB	CC	CR	DR	FB	HR	IP	LR	TB	VP
Alameda Contra Costa Transit District (AC Transit)	Oakland, CA		X			X						
Bay Area Rapid Transit District (BART)	Oakland, CA							X				
Bi-State Development Agency (METRO)	St. Louis, MO		X			X				X		
Broward County Transit (BCT)	Pompano Beach, FL		X			X						
Capital Metropolitan Transportation Authority (CMTA)	Austin, TX		X			X						X
Central Florida Regional Transportation Authority (LYNX)	Orlando, FL		X			X						X
Chicago Transit Authority (CTA)	Chicago, IL		X					X				
City of Detroit Department of Transportation (DDOT)	Detroit, MI		X			X						
City of Los Angeles Department of Transportation (LADOT)	Los Angeles, CA		X			X						
City of Phoenix Public Transit Department (Valley Metro)	Phoenix. AZ		X			X						
Dallas Area Rapid Transit (DART)	Dallas, TX		X		X	X				X		X
Greater Cleveland Regional Transit Authority (GCRTA)	Cleveland, OH		X			X		X		X		
King County DOT — Metro Transit Division (King County Metro)	Seattle, WA		X			X				X	X	X
Los Angeles County Metropolitan Transportation Authority (LACMTA)	Los Angele, CA		X					X		X		X
Maryland Transit Administration (MTA)	Baltimore, MD		X		X	X		X		X		
Massachusetts Bay Transportation Authority (MBTA)	Boston, MA		X		X	X	X	X		X	X	
Metro Transit	Minneapolis, MN		X							X		
Metropolitan Transit Authority of Harris County, Texas (Houston METRO)	Houston, TX		X			X				X		X
Metropolitan Transit System of San Diego (MTS)	San Diego, CA		X			X				X		
Miami Dade Transit (MDT)	Miami, FL	X	X			X		X				
Ride-On Montgomery County Transit	Rockville, MD	X	X									
MTA Bus Company (MBT BUS)	Brooklyn, NY		X									
MTA Long Island Bus	Garden City, NY		X			X						
MTA Long Island Rail Road (MTA LIRR)	Jamaica, NY				X							
MTA New York City Transit (NYCT)	New York, NY		X			X		X				
Niagara Frontier Transportation Authority (NFT METRO)	Buffalo, NY		X			X				X		
New Jersey Transit Corporation (NJ Transit)	Newark, NJ		X		X	X				X		X
Orange County Transportation Authority (OCTA)	Orange, CA		X			X						X
Pace Suburban Bus Corporation (PACE)	Arlington Heights, IL		X			X						X
Port Authority of Allegheny County (Port Authority)	Pittsburgh, PA		X			X			X	X		
Port Authority Trans-Hudson Corporation (PATH)	Jersey City, NJ						X	X				
Regional Transportation District (RTD)	Denver, CO		X			X				X		X
Sacramento Regional Transit District (Sacramento RT)	Sacramento, CA		X			X				X		
San Francisco Municipal Transportation Agency (SFMTA)	San Francisco, CA		X	X		X				X	X	
Santa Clara Valley Transportation Authority (VTA)	San Jose, CA		X			X				X		
Southeastern Pennsylvania Transportation Authority (SEPTA)	Philadelphia, PA		X			X		X		X		
Tri-County Metropolitan Transportation District of Oregon (TriMet)	Portland, OR		X			X				X		
Utah Transit Authority (UTA)	Salt Lake City, UT		X		X	X				X		X
VIA Metropolitan Transit (VIA)	San Antonio, TX		X			X						X
Washington Metropolitan Area Transit Authority (WMATA)	Washington, DC		X			X		X				
Westchester County Department of Transportation (The Bee-Line System)	Mt Vernon, NY		X			X						

Mode Code Legend:

AG: Automated Guideway	MB: Bus	CC: Cable Car	CR: Commuter Rail
DR: Demand Response	FB: Ferryboat	HR: Heavy Rail	IP: Inclined Plane
LR: Light Rail	TB: Trolleybus	VP: Vanpool	

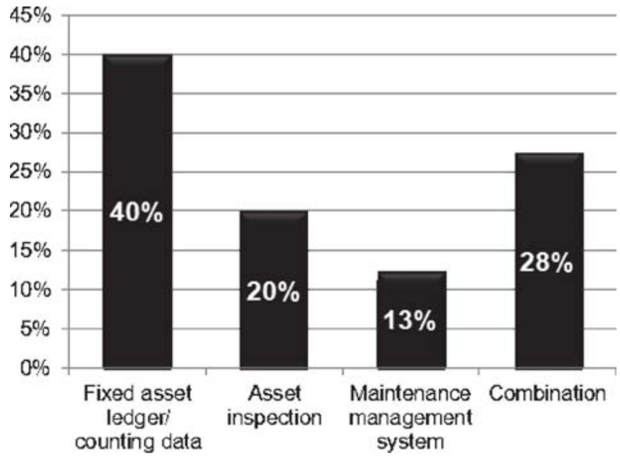

FIGURE 2 Primary source of inventory data ($n = 40$).

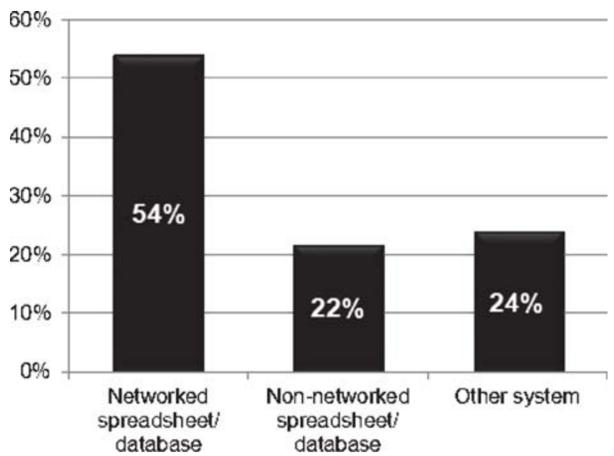

FIGURE 3 Data record and update system ($n = 37$).

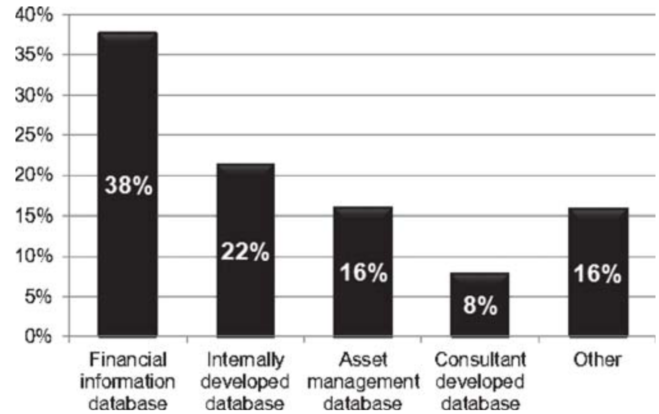

FIGURE 4 Data storage ($n = 37$).

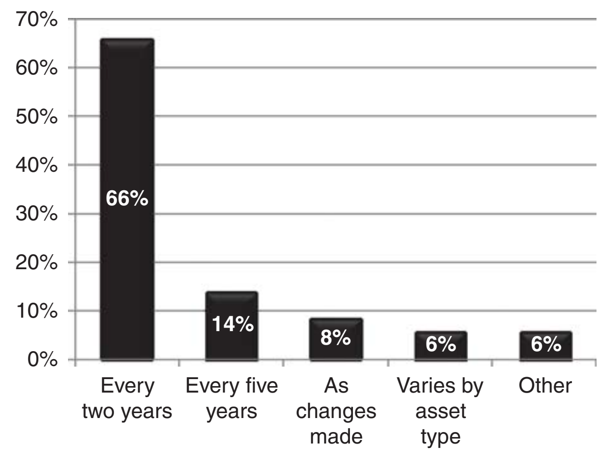

FIGURE 5 Frequency of inventory data updates ($n = 36$).

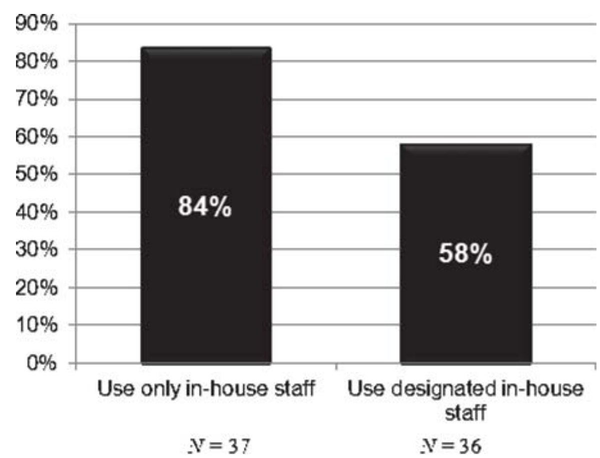

FIGURE 6 In-house support.

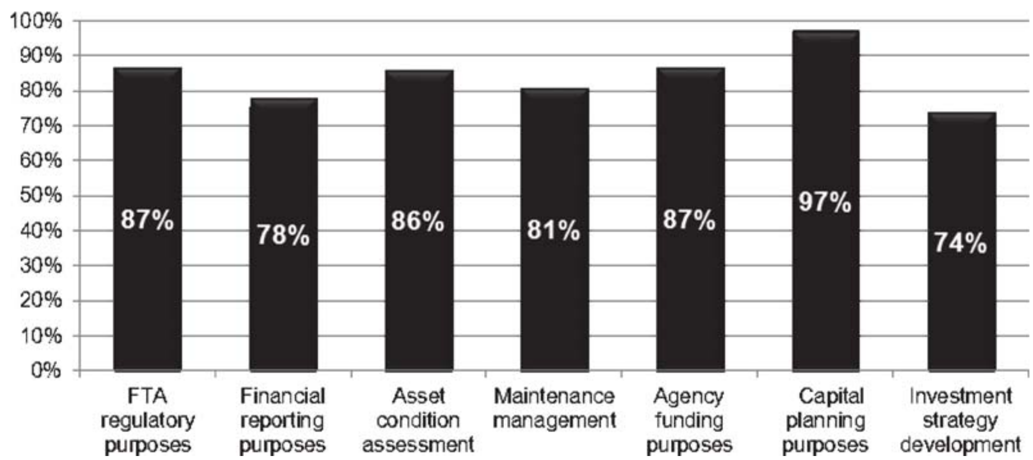

FIGURE 7 Use of asset inventory data ($n = 40$).

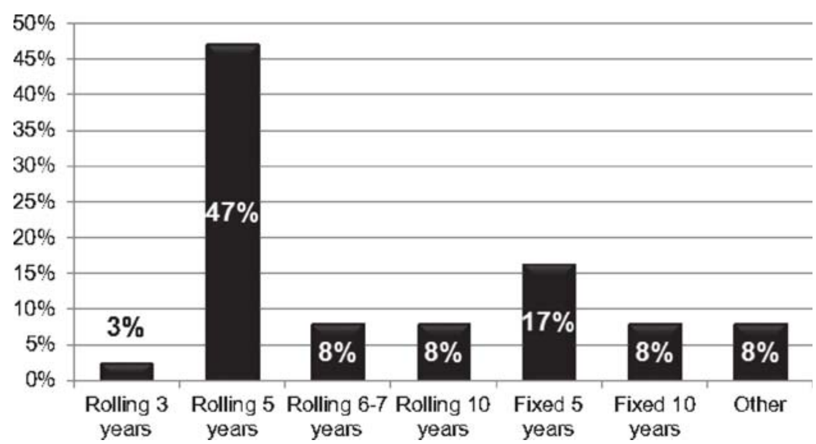

FIGURE 8 Capital program type ($n = 36$).

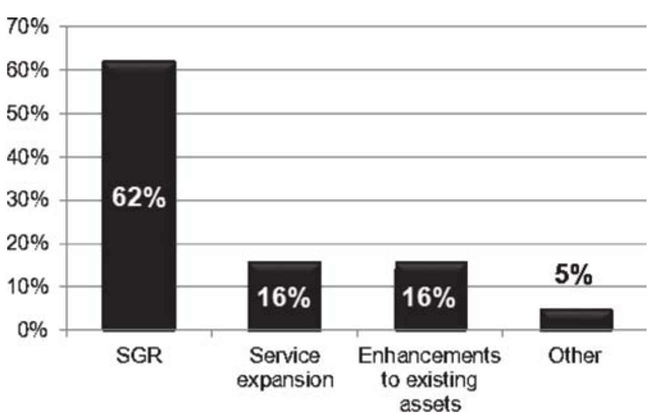

FIGURE 9 Capital spending by investment type ($n = 27$).

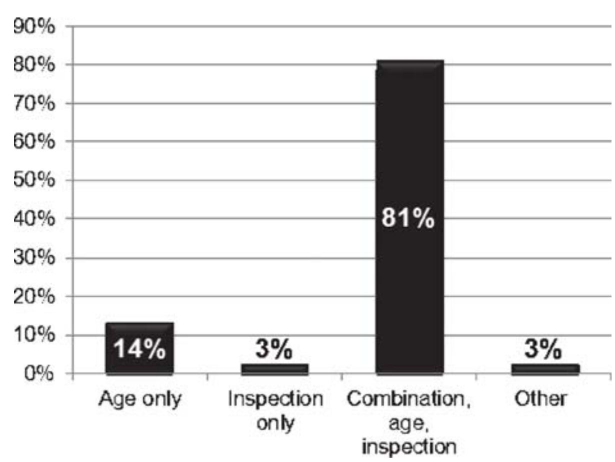

FIGURE 10 Condition assessment approach ($n = 31$).

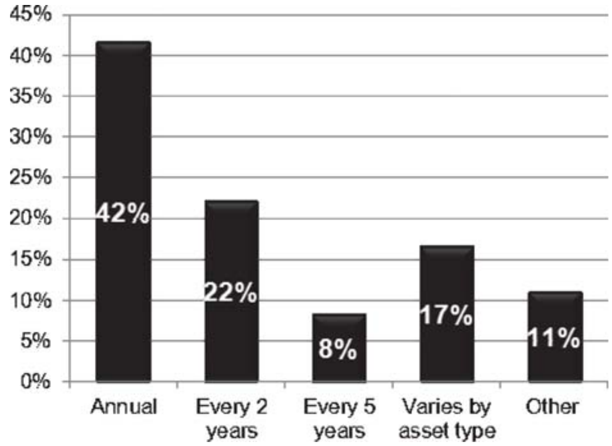

FIGURE 11 Frequency of condition updates ($n = 36$).

- Two of every three respondents indicated that their agencies use rolling programming cycles. This means that most of the large transit agencies need to make capital needs forecasts every year.
- The responding transit agencies spent an average of 62% of their 2009 capital funding on SGR projects. This may reflect the national norm for a large transit agency seeking to balance growth and re-investment.
- Most responding agencies determine asset condition through a combination of age and inspection results. This may mean that agencies assess the condition of selected asset categories such as bridges based on inspections while relying on age for other asset categories.
- Almost two-thirds of the responding agencies update the condition data in their databases every 1 to 2 years.

CHAPTER FOUR

AGENCY USE OF ASSET TRACKING AND CONDITION ASSESSMENT DATA

Age and condition data can provide help for transit agencies in several ways. It can help establish the level of need for infrastructure investments in terms of ongoing asset replacement and rehabilitation needs. This estimate and supporting documentation can provide a compelling argument and support for increased funding. It can also support the programming of cost-effective investment when available funding is constrained and not sufficient to support the implementation of all needed projects.

AGE AND CONDITION DATA USE

Questions were asked in the survey about how the responding agencies use the age and condition data. Specific choices were provided in a yes/no format. The respondents were also given the opportunity to provide information on other uses.

An ongoing need for most transit agencies is more capital funding. More than 83% of the respondents reported that their agencies use the age and condition data to support appeals for more funding (Figure 12).

The analysis of infrastructure needs can provide support for funding appeals and can also help transit agencies manage their assets and capital programming more effectively. More than 85% of the respondents reported that their agencies assess their infrastructure needs. The survey did not include follow-up questions about the types of assessments that were performed.

Many transit analysts believe that the the analysis of unfunded replacement and renewal needs (often termed SGR backlog) is an important part of infrastructure needs assessment. The analysis helps agencies identify assets that are not in SGR and determine how much funding is needed to address this problem. This analysis can also project future backlogs and needs for increased funding.

More than two-thirds of respondents reported that their agencies use inventory and condition assessment data to estimate SGR backlogs. Similar percentages of agencies reported making estimates of current backlogs and projected future backlogs (see Figure 12). These responses may suggest that assessing the SGR backlog is important to many transit agencies.

Conversely, approximately one-third of the responding agencies do not use condition data for any type of current or future SGR analysis. The survey did not include follow-up questions for these agencies. It may be that assessing SGR backlogs is not a priority for these agencies. It may also be that these agencies do not have personnel with the technical skills or knowledge to perform this analysis. There may also be other reasons as well.

The survey revealed that the analyses of SGR backlog were beneficial to the transit agencies. Nineteen agencies (nearly 60%) reported that their asset condition system was used to change capital funding priorities to improve their SGR. The examples of the use of the data ranged from a detailed use for a pin replacement in rolling stock to addressing larger strategic issues such as changing a station capital investment strategy from station rehabilitation to station component replacement.

Although the majority of the respondents reported that their agencies estimate replacement and renewal (SGR) backlogs, the responses to two specific questions raised concerns about the quality and detail of these estimates. More than two-thirds of the respondents reported that their agencies use inventory and condition assessment data to estimate replacement and renewal (SGR) backlogs (Figure 13). Based on these responses, it might be expected that these agencies could provide estimates of the current replacement value of the agencies' assets and of the values of SGR backlogs. However, only 31% of the respondents (11 agencies) provided values for these estimates.

There may be several explanations for the low response. Some respondents may not have provided the estimates for reasons of confidentiality. Other respondents may have not had access to the values that resided in other departments in their agencies.

A less favorable explanation is that the respondents inadvertently overstated the level and detail of the SGR analysis being performed by their agencies. For example, the respondents may have believed that having a count of assets that are operating beyond their useful lives is a good estimate of SGR backlog.

Regardless of the possible explanations, the responses to these two questions were disappointing and may suggest that very few large transit agencies are performing rigorous analyses of current SGR backlogs.

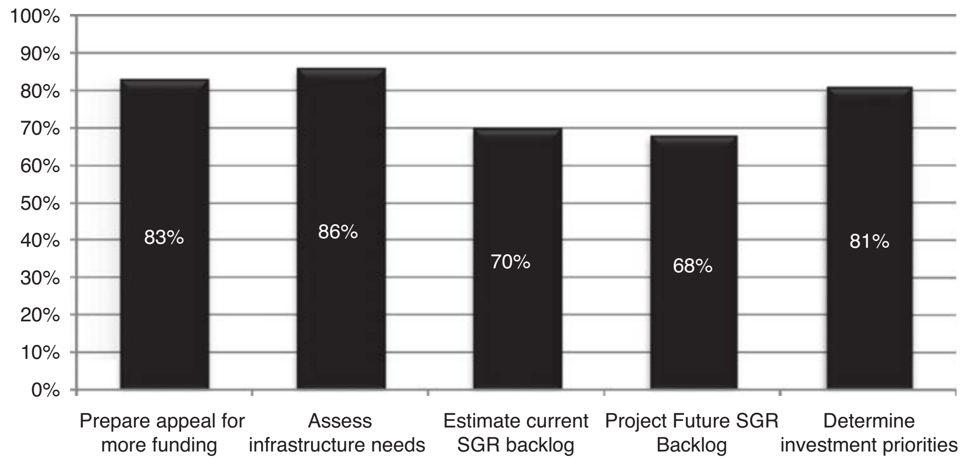

FIGURE 12 Use of age/condition data ($n = 37$).

Furthermore, no responding agency provided information in the survey that suggests that agencies are making projections of impacts of underinvestment besides the measure of SGR backlog. These projections might address impacts such as increased operating costs or reduced reliability.

Age and condition data can be used to support the programming of cost-effective investments when available funding is constrained and not sufficient to support the implementation of all needed projects. More than 80% of the respondents stated that their agencies use these data to determine investment priorities.

The survey asked respondents to describe how the transit asset condition system has been used to change capital investment priorities to improve the SGR of the agency. The following are selected responses:

- "Calculating the SGR backlog (about $2.7 billion in 2006) more clearly showed policy-makers that the agency needed to invest its limited dollars in SGR projects, and the future impact if maintenance was not funded at sufficient levels. The state also agreed to fund expansion and other commitments, so as not to take away funding from SGR."
- "Condition Assessment Studies conducted to assess the condition of the revenue fleet and signal system led to a determination to replace revenue fleet and signal systems in tandem rather than alternatives such as service life extensions or deferred action."
- "The level of need for maintenance facilities is very large; the total picture of our asset condition has been used to justify investment in non-customer facing assets."
- "First the agency identifies what assets are no longer in a state of good repair using condition information, age, whether or not the assets meet certain performance standards, and other measures. We then direct our capital dollars to eliminate the backlog of conditions relating to that asset type. Example: 25+ years of a station rehabilitation program had only addressed about half of the stations. A detailed survey of components was undertaken (part of a condition survey), and now a targeted component investment program is proposed to address deficient conditions on a component level."

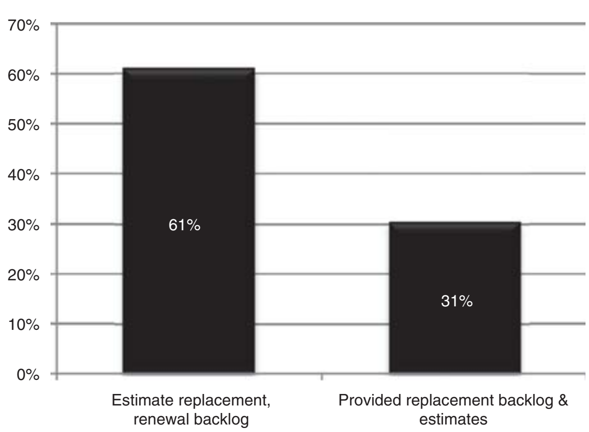

FIGURE 13 Comparison of stated SGR planning versus provision of SGR estimates ($n = 36$).

The responses suggest that the transit agencies used the transit asset condition data as another qualitative factor to be considered in the determination of investment priorities and development of capital programs. None of the responding agencies provided examples of how the data were used quantitatively to set investment priorities.

SUMMARY

The survey revealed some key findings about the state of practice of the use of asset tracking and condition assessment data at large transit agencies.

- Most of the responding agencies use the age and condition data to make an assessment of their infrastructure needs and to support appeals for more funding.

- Most of the respondents stated that their agencies use inventory and condition assessment data to estimate both current and future SGR backlogs. The majority of the responding agencies stated that their asset condition system was used to change capital funding priorities to improve their SGR.
- The responses suggest that the transit agencies used the transit asset condition data as another qualitative factor to be considered in the determination of investment priorities and the development of capital programs. None of the responding agencies provided examples of how the data were used quantitatively to set investment priorities.

CHAPTER FIVE

CASE STUDIES

Detailed case studies of two of the largest 50 transit agencies, the Massachusetts Bay Transportation Authority (MBTA) and the New York City Transit Authority (NYCT), were undertaken as part of this synthesis. The MBTA SGR project is an analytical approach for identifying capital reinvestment needs and setting investment priorities. The FTA cited the MBTA SGR project as the most comprehensive approach being used in the U.S. transit industry.

NYCT is the largest transit authority in the country. In the last 25 years it has undergone a remarkable change from being in a state of disrepair to a much higher state of repair. The tool used to track and monitor this transformation is its Asset Condition Databases, which is covered in the second case study.

CASE STUDY: ASSET CONDITION DATA COLLECTION AND TRACKING AT THE MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Background

The MBTA is the country's fifth largest transit authority and carries approximately 1.3 million passengers daily. It is fully multi-modal, providing heavy rail, light rail, bus, trolley bus, bus rapid transit, commuter rail, demand response ADA (Americans with Disabilities Act), and ferry services. It provides transit services to eastern Massachusetts and commuter rail service that extends to Rhode Island. It has a 5-year capital plan of approximately $3.8 billion and an annual operating budget of $1.6 billion.

In 1995, the MBTA devoted a substantial portion of its capital program to expansion or enhancement to the current system. Several large projects were undertaken simultaneously including:

- A new bus rapid transit line with a one-mile tunnel,
- Three new commuter rail lines including stations and rolling stock, and
- The rebuilding of a number of existing stations as part of an ADA program.

Owing to the level of expansion activity, the funding available for investments in the existing infrastructure had shrunk to about half of the overall capital program. The other half was devoted to expansion.

This approach did not appear to provide adequate funding for maintaining the existing system. It was deemed likely that a backlog of SGR investments was being created.

Purpose

In 1997, aware of the likely imbalance caused by expansion activity, the MBTA commissioned a study to determine the condition of its asset base and to develop an interactive SGR database. The goal was to:

- Assess and monitor the true condition of the Authority's assets.
- Define in monetary terms the SGR backlog for the agency overall, by asset class, and on an asset by asset-specific basis.
- Estimate the funding necessary to return the system to a state of good repair over a defined period and to maintain it thereafter.
- Articulate the case for additional funding.
- Advocate for a permanent switch in the priorities of the capital program from expansion to investment in the existing infrastructure.
- Select projects to be included in the Capital Investment Program based on the priority ranking provided by the system.

SGR System/Database

The asset tracking/condition assessment system that was developed is an interactive database that tracks assets, their useful life and condition, and calculates replacement values over time. The SGR database helps the MBTA assess the implications of various planning scenarios (i.e., for specific dollar amounts or an unlimited amount) and time periods (5-year or 20-year).

The design of the database uses an age-based definition of SGR that involves funding renewal and replacement actions at specific years during an asset's life. Assets are:

- Renewed at critical midlife ages (e.g., engine replacements 6 years, roof replacements 15 years).
- Replaced at the end of their useful life (e.g., buses 15 years, bridges 50 years).

The SGR database uses age as the major measure of condition. The default values can be changed if a specific asset (or class) needs to be retired earlier (or later) than expected. These exceptions are based on a management evaluation of the asset's condition.

The MBTA does not have any specific rules for making these exceptions. The exceptions do require a detailed analysis of why a different service life should be used. This analysis, which typically would be prepared by operations management, is discussed and reviewed by senior management.

The individual asset data in the database includes the following information:

- Count of each asset.
- "Condition" measures (age, service life).
- Project "action" costs
  - Replacement/renewal costs
  - Cash flow in years in which expenditures are made.
- Data for ranking measures
  - Ages as percent of service life
  - Operational impact—yes/no for whether asset is essential to operations
  - Cost-effectiveness—cost of action per rider impacted.
- Mode (e.g., subway, light rail, bus, and commuter rail).
- Service area (e.g., Red Line or Green Line).
- Asset type (e.g., rolling stock, station).

The SGR scenario analysis is a sequential programming process that looks at SGR required actions by year. The programming steps for each year are:

- Identify candidate projects, either replacement/renewal actions that come due in the analysis year or delayed projects from prior years.
- Score and rank projects using the ranking measures.
- Fund safety-critical projects regardless of their ranking measures.
- Fund the remaining projects in priority rank order until the cost of the next project is greater than funds remaining.
- Mark unfunded projects as candidates for next year.

In discussions with the MBTA, senior management emphasized its strong position that "safety is priority one." Safety projects should be and are funded when needed, regardless of the output from the SGR database or any criteria ranked therein.

The definition of safety-critical projects includes two general types of projects. The first are projects that the MBTA must implement by legal mandate such as federal, state, or local laws or court decisions. The second concerns projects that involve assets for which failure would produce catastrophic results. These involve a small number of projects related to signaling and communications. Such projects and asset types were selected based on a consensus of MBTA senior management and have not been changed significantly over the use of the database.

The results are provided in graphic and table format, and can be provided at the system level, by asset type (e.g., track, rolling stock), service mode (e.g., commuter rail), and service mode area (e.g., Blue Line). These output features were included to make it easy to prepare focused and consistent presentations of the results. It was expected that there would be ongoing communication with decision makers about the MBTA's progress toward meeting SGR for the entire system as well as for specific asset types, service modes, and service mode areas.

The funding scenarios can be set in two dimensions:

1. Funding Levels. The scenario can assess the implications of unconstrained funding or specific funding by year (e.g., \$4 million in 2010, \$4.1 million in 2011).
2. Asset Categories. The scenario can assess the implications for all assets or for an asset category (e.g., power, rolling stock).

Management at the MBTA reported that it would useful if the scenarios generated by the SGR database identified the cost benefits of funding or not funding specific projects to help inform agency managers and stakeholders. The original software is now being modified to include a component that will identify the reduction of corrective maintenance costs resulting from the funding of one new investment over another.

Impact/Use

The study and database took 2 years to complete. In 2000, the SGR database and its output were first used by the MBTA in its capital planning and programming activities.

The output from the SGR database has been used effectively by the MBTA. After the database was completed, the MBTA made a concerted effort to persuade elected and appointed officials of the need to emphasize the funding of investments in the system's current infrastructure over the funding of expansion services.

This effort was successful. The funding of SGR investments increased from about 50% to almost 80% within 5 years. In a subsequent development, the state has agreed to help fund mandated expansion projects.

Recently (2009), a study of the system was undertaken at the request of Governor Deval Patrick. In this study, the use of the SGR database output was used to illustrate the impact of investment in the system's infrastructure.

CASE STUDY: UPDATING THE DEFINITION OF BEING IN A "STATE OF GOOD REPAIR AT NYC TRANSIT"

Background

NYCT is the country's largest transit authority. It is multimodal and operates heavy rail (subway), bus, express bus, bus rapid transit service, and demand response ADA services. NYCT provides transit services to the five boroughs that comprise New York City as well as bus service on Long Island.

NYCT carries 5.1 million daily subway passengers and 2.3 million daily bus passengers. It has a 5-year capital program of $12.8 billion and approximate annual operating expenses of $6.2 billion.

In 1982, NYCT's system was in a state of disrepair. In response, the MTA undertook a series of 5-year capital plans to bring the system back into SGR. The MTA is now in its fifth 5-year capital plan and has made significant strides in restoring the agency's assets to SGR.

SGR Database

As part of the SGR initiative, NYCT developed a database to help quantify and track its asset base. The information system contains details about each of the agency's operating equipment and support assets. The database was also designed to help NYCT prioritize its capital investment needs.

At the base of the asset management system are individual spreadsheets for each asset type. The amount of detail provided varies by asset type, but generally includes for each asset:

- Age
- Manufacturer and model
- Asset type
- Mode (e.g., subway, bus)
- Service area (e.g., the 1, 2, or 3 Lines, higher level "A-Division")
- Past SGR capital investment information.

This detailed level of information enables NYCT to identify specific assets that are in need of capital investment. This contributes significantly to both 5-year capital plan development and 20-year needs planning. For most asset types, this information is presented on a single summary sheet that shows the numbers of the asset in question, the average age of the asset, age distribution, and condition information. In addition, the basis for any backlog in SGR investments is provided such as condition assessment, age, or performance.

More detailed information about assets is tracked within the database than is done at the MBTA. For example, stations are broken down into 11 separate components: platforms, platform edges, mezzanines, stairs, ventilators, wind screens, canopies, elevators, escalators, ADA access, and automatic fare collection system/equipment. In comparison, the MBTA's database tracks three station components.

The NYCT information can be combined and displayed by asset class type (e.g., rolling stock), mode (e.g., subway, bus), and service area (e.g., the 1, 2, or 3 Lines or at a higher level such as the "A-Division"). Although maintenance is continually done on these assets, the condition information in the base asset spreadsheets is updated on a rolling, 5-year basis. This is based on field assessments that are undertaken with a higher degree of credibility than are undertaken by the MBTA.

However, the NYCT database does not have some features that make the MBTA database an effective strategic planning and programming tool, including:

- The cost of asset replacement is integrated in the MBTA database. At NYCT, the costs are contained in a distinct and separate database.
- Estimates of current SGR backlog can be made automatically in the MBTA database based on pre-determined condition settings and measures of SGR. This cannot be done automatically in the NYCT database. Instead, special manual querying and processing is required to produce these estimates. This involves a much higher level of human interaction.
- Scenarios can be run automatically in the MBTA database using different funding levels. The MBTA database has a programming logic that makes "funding decisions" based on the weighting of several project factors. This cannot be done in the NYCT database.

In summary, the asset management system is a functional and detailed accounting of NYCT's asset base and an assessment of its condition. NYCT senior managers report that it is fully integrated into the planning and funding efforts of the agency. They believe that the rolling, 5-year updating of the database helps provide substantive input into the 5-year Capital Plan.

SGR Definition: The Old and the New

At the beginning of the NYCT's SGR initiative, the agency developed and applied investment "state" definitions to the assets tracked in the database. These definitions initially prescribed investment priorities, but also defined how outputs and asset conditions would be tracked and measured.

For the first 20 years of the SGR initiative, when an asset reached SGR (through capital investment or was in SGR prior to the capital program), it was defined to remain in SGR because it was assumed that the asset would receive proper maintenance. This assumption was made regardless of an actual condition or age. As these SGR-defined assets reached the end of their service life and were replaced, the costs of replacement were considered as "normal replacement" investments, not as SGR investments.

This approach of counting an asset as SGR asset regardless of its actual condition led to an inaccurate measurement of the percentage of SGR achieved. It also unintentionally led to an investment process that supported investments based on definitions applied to the assets (normal replacement or not-at-SGR) rather than a more complete assessment of what was in a state of good repair and what was not.

To address this issue, NYCT initiated a new condition-based approach. In this approach, an asset's condition is determined using one of the following three metrics most appropriate to its asset class:

1. Asset condition (ranked 1 to 4).
2. Asset age versus the presumed useful life of the asset.
3. Actual asset performance as compared with standards identified by the agency.

This approach is sensitive to the actual condition of NYCT's assets. It permits an asset that reaches SGR to lose its SGR status as it ages and its condition declines.

Station Component Program

In conjunction with this more refined approach to asset classification, a NYCT also adopted a more focused approach for its station investment program. Initially, the agency rehabilitated stations from top to bottom and replaced all station components without regard to their actual condition. After the station was rebuilt, it was then declared to be in SGR. NYCT believed that this approach misallocated resources and was unsustainable over the long run. It limited the number of stations that could be rehabilitated within a given funding level and precluded other stations with repair needs from benefiting from SGR investment.

NYCT developed a new approach to provide more benefits to more stations and customers. Station components would be repaired individually or in cost-effective groupings depending on their individual condition across a large number of stations. No longer would improvements be focused on a small number of stations. This component based and targeted approach was made possible by a survey of more than 11,000 station components systemwide.

The new approach also included renewal projects. Where appropriate, components are bundled together with other capital improvements into station "renewal" projects instead of station "rehabilitation" projects.

The revised NYCT brings more improvements to the system and the public in more places at a quicker pace. It also makes better use of funding because it avoids unnecessary investment in components not in need of repair.

Results

As a consequence of the new approaches adopted by NYCT, the reported condition of various asset classes changed. Although several key assets (cars, track, and switches) remained stable at 100% in SGR, the reported condition of other asset classes changed, reflecting a more detailed and realistic measure of SGR. Three examples of the impact of this are:

1. Stations. Overall this category went from 53% in SGR to 67% because of the new definition and the new station component assessment regime. Funds allocated to stations were better focused on components in poor condition.
2. Power. The reduction in SGR status from 95% to 62% for this asset class reflected a more detailed assessment of the condition of the power system components. Previously, only substations were counted; now the components of a substation and the power distribution network are included in the assessment.
3. Buses. The SGR for both buses and their support facilities dropped because assets formerly considered replacement actions now are considered SGR actions. The SGR for buses dropped from 100% to 87%, whereas support facilities dropped to 66% from 90%.

SUMMARY OF CASE STUDIES

The two case studies demonstrate that focused attention to transit asset management can improve the funding of SGR projects. At the MBTA in Boston, the funding of SGR investments increased from about 50% to almost 80% within 5 years. The Commonwealth of Massachusetts has agreed to help fund mandated expansion projects. In 1982, NYCT's system was in a state of disrepair. In response, the MTA undertook a series of 5-year capital plans to bring the system back into SGR. The MTA is now in its fifth 5-year capital plan and has made significant strides in restoring the agency's assets to SGR.

The two case studies highlight two desirable features of an "ideal" transit asset management database system. The MBTA database is a good case study of an effective strategic planning and programming tool. The MBTA database can assess the impacts of different funding scenarios on the state of repair of a transit system. These scenarios can be run "automatically" because the database contains:

- Pre-determined condition settings and measures of SGR;
- Costs of asset renewal and replacement; and
- A programming logic that makes "funding decisions" based on the weighting of several project factors.

NYCT's database is a good example of a detailed database. Assets such as stations are broken down into very detailed components that each have a service life and can be renewed. This level of detail provides the opportunity to consider the programming of specific renewals (e.g., replace escalators and roofs) rather than consideration of simpler actions at a higher level of asset aggregation (e.g., rehabilitation of a station).

CHAPTER SIX

CONCLUSIONS

The literature review; a survey of the largest transit agencies, with an 82% response rate; and case studies yielded some key findings regarding the state of the practice in transit asset management and the limitations in current methods. The results of the synthesis also suggested additional research to improve transit asset management practices.

Good transit asset management can provide critical support in two key areas:

1. **Establishing the level of need for infrastructure investments.** A comprehensive analysis of infrastructure needs can produce an estimate of the funding needed to address (1) ongoing asset replacement and rehabilitation needs, and (2) past unfunded infrastructure needs (often termed backlog needs). This funding estimate and supporting documentation can provide a compelling argument and support for increased funding.
2. **Programming of cost-effective investments.** A systematic approach that is based on good quality data and clear organizational objectives can help prioritize the programming of investment projects when available funding is constrained and not sufficient to support the implementation of all needed projects. The use of this approach will help maximize the effectiveness of local, state, and federal funding investments.

The synthesis revealed the following key findings about the state of the practice at the largest transit agencies:

- *Most large agencies have asset tracking databases that are frequently updated and include all assets.* The primary data sources vary but include financial records (fixed asset ledgers), asset inspections, maintenance management systems, or some combination of these sources. There are variations in how the data are stored including the use of off-the-shelf, financial information or asset management databases, and special databases developed internally or by outside consultants. Most agencies use designated in-house staff to support and update the databases for most responding agencies.
- *Many transit agencies maintain separate equipment rosters that are independent from the mainstream planning, programming, and budgeting processes.* This is done for internal maintenance management and to meet federal requirements for adequate control of grant-funded assets. Often, there is limited consideration given as to how the inventory and condition data might be integrated to support short-term and strategic planning and investment policy. As a result, human interaction is needed to adapt or process the data for these activities.
- *Most large transit agencies determine asset condition through a combination of age and inspection results.* Many agencies assess the condition of selected asset categories such as bridges based on inspections while relying on age for other asset categories. Most transit agencies are not using decay curves for assessing current State of Good Repair (SGR) or projecting future investment needs. Decay curves depict the relationship among asset condition, useful life, and maintenance practices and were initially developed by the Chicago Transit Authority. They are key elements of FTA's Transit Economic Requirements Model (TERM).
- *The assessment of SGR needs has benefited many transit agencies.* Most large transit agencies use inventory and condition assessment data to estimate both current and future SGR backlogs and investment needs. The agencies stated that their asset condition systems were used to change capital funding priorities to improve their SGR. The two case studies demonstrated that focused attention to transit asset management can improve the funding of SGR projects.
- *The large transit agencies do not use asset condition data to set investment priorities for capital programming.* Most large transit agencies use the transit asset condition data as another qualitative factor to be considered in the determination of investment priorities and development of capital programs. This was even true for the Massachusetts Bay Transportation Authority (MBTA) application, which has the ability to prioritize the funding of specific asset renewal or replacement projects in constrained funding environments.

The current methods used by the large transit agencies surveyed are at an elementary level. The key issues with the methods are:

- The appropriate measurement of SGR using age and/or condition.
- The limited estimation of benefits or consequences of alternative investments.
- The absence of scenario testing for different funding levels.

The synthesis revealed that there has been significant discussion of the appropriate measurement of SGR using age and/or condition among large transit agencies. In concept, most managers at large transit agencies believe that condition is the best measure of SGR because it recognizes that the need to replace an asset in practice is related not only to age, but to other factors such as intensity of use (e.g., miles), level of preventive maintenance, and climate. However, condition measurement often incorporates on-site inspections and evaluations by expert engineers—a costly ongoing expense for many transit agencies faced with tight funding.

Condition measurements are most helpful for making detailed, short-term investment decisions that involve investment actions for specific assets in an asset class with common characteristics (e.g., how many 14-year old buses should be programmed this year in view of other investment needs?).

Age is viewed as a simple and less desirable (compared with condition) measure of SGR because it does not recognize the other factors that contribute to the physical declines of different assets. The use of age implies it is reasonable to apply one service life for an asset type (e.g., conventional buses) in all situations. Age data have the advantages over condition data of being easier to collect and maintain and to explain to decision makers.

Age data may be a reasonable way to make appeals for more SGR funding because of these advantages. These advantages may also apply to long-term planning activities that, by nature, are willing to use more simple models of condition.

Fundamentally, the tradeoffs of using age data versus condition data involve the degree of variation (variance) in replacement ages based on analysis of condition data. For example, if the analysis of condition data suggests that most buses should be replaced between 12 and 14 years, then using an age-based service life of 13 years is reasonable and saves the added costs of condition inspections. However, if this variance is wider, for example 12 to 18 years, then using condition data is preferable and warrants the added costs of condition inspections.

Unfortunately, the synthesis did not identify significant efforts to address the age versus condition issue. The continued development of decay curves for FTA's TERM model and other agency applications may add more insight to this issue.

The estimation of the benefits (or consequences) of investment decisions is seldom performed in current practice. Generally, the benefits are estimated as the degree to which the SGR has been achieved (e.g., 70% of assets are in SGR, the average rating is 3.2). However, these SGR measures are really surrogates for the potential impacts of SGR investments that have real meaning to decision makers and the general public—impacts such as reduced operating costs, improved reliability, and increased safety.

Unfortunately, these impacts have been difficult to estimate and are not explicitly considered by most large transit agencies. Most agencies rely on the expert judgments of transit managers and engineers and assume that these experts weigh these factors as they define the times when assets should be replaced.

The Illinois Department of Transportation effort is an example of how the impact on operating costs could be determined. The Illinois model estimated the life-cycle costs of different types of buses, including operating, maintenance, and capital costs. The resulting total cost curves were used to determine the service lives that minimized total costs. The data from these curves could also be used to estimate the added cost impacts of deferring bus replacements beyond these service lives.

Finally, the ability to perform scenario testing is limited at most transit agencies. Most large transit agencies use inventory and condition assessment data to estimate the funding needed to eliminate current SGR backlogs. They also estimate future funding needed to maintain SGR. Both of these approaches are useful for arguing for additional funding to reach "ideal" operating environments.

However, decision makers and the general public are skeptical of these "ideal-based" funding estimates. Often, it is believed that it is not possible to provide this ideal level of funding. Instead, there is an interest in determining the impacts of lower levels of funding. Often, the discussion begins with determining the level of funding needed to halt the decline in the SGR for a transit agency. It then advances to questions about the benefits of increasing funding beyond this "SGR steady-state" funding.

A methodology is needed to prioritize the funding of specific asset renewal or replacement projects when these scenarios involve funding that is less than what is needed to bring all assets to SGR and maintain them at SGR. Only the application at the MBTA in Boston has this ability to test different funding environments because it has a programming logic that can prioritize the funding of specific asset renewal or replacement projects in constrained funding environments. Although this work is widely known, managers from the large transit agencies expressed interest in learning more about the development, use, benefits, and limitations of this prioritizing tool.

Additional research on the effective design and use of asset databases is suggested. The research might focus on the following issues:

- *The structure and level of detail in effective databases.* Research to define the elements of a good asset condition inventory database addressing issues such as database structure, function, data requirements, assets covered, frequency and method of updates, analytical capabilities, and helpful output reports. The potential of sharing good asset inventory database software or specific database analysis modules might also be investigated.

- *The effective use of age and condition-based assessments of SGR for different asset types.* Research to examine the degree of variation (variance) in replacement ages based on analysis of condition data. For some asset types, it may be determined that age is an appropriate measure. For other asset types, it may be determined that the added cost of condition measurements and inspections is warranted.
- *The estimation of the benefits* (*or consequences*) *of investment decisions.* Research to examine analytical methods for estimating the potential impacts of SGR investments that have real meaning to decision makers and the general public—impacts such as reduced operating costs, improved reliability, and increased safety.
- *The use of prioritization decision tools for examining the impacts of different SGR funding levels.* Research to examine the effective design and use of such tools and their benefits and limitations.

ACRONYMS

DOT	Department of Transportation
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
MBTA	Massachusetts Bay Transportation Authority
NYCT	New York City Transit
RTA	Regional Transportation Authority
RTAMS	Regional transit asset management system
SGR	State of Good Repair
TERM	Transit Economic Requirements Model
TRIS	Transportation Research Information Services

REFERENCES

Anderson, M.D. and N.S. Davenport, *A Rural Transit Asset Management System,* University Transportation Center for Alabama, Tuscaloosa, June 2005.

Booz Allen Hamilton, Downstate Illinois Capital Needs Assessment, PowerPoint, prepared for Illinois Public Transportation Association, funded by the Illinois Department of Transportation, Springfield, Oct. 2003.

Cambridge Systematics, Inc., A.E. Pisarski, and A.T. Reno, *Bottom Line Technical Report: Highway and Public Transportation National and State Investment Needs,* prepared for American Association of State Highway and Transportation Officials, Washington, D.C., Mar. 2009.

D'Alessandro, D.F., P.D. Romary, L.J. Scannell, and B. Woliner, "MBTA Review," Boston, Mass., Nov. 1, 2009.

Laver, R., First FTA SGR Roundtable, Transit Economic Requirements Model (TERM), PowerPoint Presentation to the FTA First State of Good Repair Roundtable, Washington, D.C., July 10, 2009.

McCollom, B., Systemwide Condition Assessment and Capital Investment Plan, presentation to the World Bank, Washington, D.C., Mar. 28, 2006.

"Transit State of Good Repair: Beginning the Dialogue," Federal Transit Administration, U.S. Department of Transportation, Washington, D.C., Oct. 2008.

Yoder, S.L. and J. Delaurentis, "The Framework for a Regional Transit Asset Management System," *ITE Journal,* Institute of Transportation Engineers, Washington, D.C., Sep. 2003, pp. 2–3.

APPENDIX A
Survey Questionnaire

Cover Memorandum from TRB

February 2, 2010

MEMORANDUM

TO: Selected Transit Agencies
FROM: Donna L. Vlasak—Senior Program Officer, Synthesis Studies
SUBJECT: TCRP Synthesis Topic SG-11, Transit Asset Management

The American Public Transit Association (APTA), through its nonprofit educational and research organization, the Transit Development Corporation, Inc. (TDC), is cooperating in a research project to prepare a Synthesis of Current Practice on the topic noted above. This is part of the Transit Cooperative Research Program (TCRP), which was authorized in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) to be managed by the Transportation Research Board (TRB) in cooperation with the Federal Transit Administration (FTA) and the TDC. The synthesis will provide practical information and guidance for transit agencies of all sizes in profiling innovative and successful practices, lessons learned, and gaps in information.

McCollom Management Consulting is preparing this synthesis report under contract to TRB. In order for the Synthesis to reflect the best current information, it is important that responses be obtained from selected transit agencies of various sizes and geographic locations.

http://s-nw3j2-231172.sgizmo.com/i/47505e00000p59083

Your assistance in expediting the completion of the questionnaire as accurately as possible will be greatly appreciated. Descriptions of any practices and techniques used to overcome problems are welcomed, as are reports or other documentation. Individual responses will remain anonymous; an aggregated summary of the responses may be published to reflect the range of practice.

While this survey format may be the most user-friendly version, a hard-copy version of the survey is also available. If you would prefer hardcopy, or if you have any questions about the survey, please contact Cathi Nussbaum at cathi@mccollomconsulting.com or by phone at xxx.xxx.xxxx to obtain a copy. **Please complete the survey in either form by March 1, 2010.**

Thank you for your assistance. We believe the final product will be of considerable interest. Copies of the published Synthesis will be available upon request from APTA and electronically on the TRB Homepage.

Welcome

Dear Survey Recipient,

McCollom Management Consulting has been asked by TRB to undertake an industry and literature review on the subject of transit asset condition reporting. To that end, we are requesting key managers at transit agencies to respond to an on-line survey on the means and methods that are practiced at their transit agencies to track assets and monitor their condition as well as how this information is used.

For purposes of this survey, an asset is defined to be in a state of good repair (SGR) when it is operating at its ideal capacity within the span of its design life. An asset management system is defined to be any management process and associated database that contains an inventory of revenue and non-revenue transit assets and information about those assets, including condition and performance characteristics.

This survey and literature review will provide a synthesis of SGR management practices of large public transit authorities, descriptions of asset management systems used, as well as identifying best practices where appropriate. The end results will help local transit authorities, state DOTs, and the FTA to understand how assets are inventoried, conditions assessed and tracked, and how asset management systems are used to help identify priorities to ensure that our scarce public transit funding will have the most impact in providing safe, reliable, and comfortable transit for riders and employees alike.

Your individual responses will be kept confidential and you will not be cited in the general findings section of the TRB report. However, your responses will be incorporated into the industry-wide survey responses. Best practices by individual transit agencies will be cited only with the permission of the respondents. If we believe that your transit agency is a candidate for a best practices case study, we will contact you for permission and a follow-up interview.

Please click on the link below to take you to the survey tool. Where possible, questions are yes/no, multiple choice, or other close-ended answers. There are several questions that request samples of agency documents in which case an e-mail and U.S. mailing address (your choice) is provided.

Please feel free to contact either of the two authors below for additional information.

Regards,
Steve Berrang
steve@mccollomconsulting.com
Brian McCollom
brian@mccollomconsulting.com

Tickler Survey

Please complete the following information about yourself:

Transit Agency Name ____________________

First Name ____________________

Last Name ____________________

Title ____________________

Street Address ____________________

City ____________________

State ____________________

Zip Code ____________________

Phone Number ____________________

E-mail Address ____________________

1. Does your agency possess a comprehensive inventory of your operating infrastructure assets?

   NOTE: For purposes of this review, **comprehensive** is defined to include both revenue- and non-revenue-related transit assets.

   ☐ Yes

   ☐ No

2. Does your agency maintain this inventory on a periodic basis?

   ☐ Yes

   ☐ No

3. What is the primary source of data for this asset inventory data?

- ☐ Asset inspections
- ☐ Fixed asset ledger/counting data
- ☐ Maintenance management system
- ☐ Combination of one or more of the above

4. How do you use this inventory?

5. Are you willing to answer more detailed questions on how your transit agency tracks its assets, assesses their condition, and uses the information to develop investment strategies and undertake capital planning?

   It should take about 20–30 minutes to answer these questions.

   If you are unable to continue with this survey and there is someone else within the transit agency that would be able to take this survey for us, please click the **Save and Continue** link located in the top right hand corner of this page and enter that individuals e-mail address. Thank you.

- ☐ Yes
- ☐ No

Main Survey

TOPIC 1: Asset Inventory

Thank you for taking a few minutes to share additional details on how your transit agency tracks its assets, assesses their condition, and uses the information to develop investment strategies and undertake capital planning.

The survey is organized into several topic areas. Please respond to all topic areas and answer the questions using the most current information.

Please do not use the **Enter** key to move from one data entry field to another. To move from one data entry field to another use your **Tab** key.

Please do not use your browsers **Back** arrow to return to a previous page. Use the buttons at the bottom of each screen to go back to a previous page or move forward to the next page.

If at any time during this survey you need to leave the survey and continue at a later time, please click on the **Save and Continue** link located in the top right hand corner of the survey, enter your e-mail address and close the survey.

Or, if you are unable to answer the questions in the survey and there is someone else within the transit agency that would be better suited to complete the survey, please click the **Save and Continue** link located in the top right hand corner of this survey and enter that individuals e-mail address.

If you have any questions on how to finish the survey, please contact: Cathi Nussbaum at cathi@mccollomconsulting.com or xxx.xxx.xxxx.

6. Does the inventory include?

- ☐ Revenue vehicles
- ☐ Support vehicles
- ☐ Passenger stations
- ☐ Fixed guideway infrastructure
- ☐ Maintenance buildings

7. Does your asset inventory cover, to some degree, all modes of service provided?

- ☐ Yes
- ☐ No

   If NO, please describe below why certain services are not included in the inventory.

8. What type of management process and database do you use to record and update asset data?
   - ☐ Non-networked electronic spreadsheet/database
   - ☐ Networked electronic spreadsheet/database
   - ☐ Other system

9. How do you store the asset data?
   - ☐ Financial information database
   - ☐ Internally developed database
   - ☐ Off-the-shelf, asset management database
   - ☐ Contractor-developed database
   - ☐ Other database

10. Where do you store the primary (not backup) asset data?
    - ☐ In-house
    - ☐ Off-site at contractor
    - ☐ Combination of in-house and off-site at contractor
    - ☐ Other (please specify):

11. What is the frequency of update for complete asset inventory?
    - ☐ Periodically (i.e., annually, bi-annually, etc.)
    - ☐ As changes occur (i.e., irregularly)

12. Can you provide us with samples of the forms or sheets used to collect the asset information in an electronic format or samples of the asset inventory?

    If YES, please e-mail them to trbsurvey@mccollomconsulting.com.

    If you have difficulty e-mailing files or prefer to mail hardcopy, please contact Cathi Nussbaum at cathi@mccollom consulting.com or xxx.xxx.xxxx.
    - ☐ Yes
    - ☐ No

TOPIC 2: Asset Inventory Resources

13. Do you have a dedicated agency staff to maintain and update the asset inventory?
    - ☐ Yes
    - ☐ No

    If YES, please indicate the number of people and departments in which they work.

14. Do you use designated, but not dedicated, agency staff to maintain and update the asset inventory?
    - ☐ Yes
    - ☐ No

    If YES, please indicate the number of people and departments in which they work.

15. Do contractors support your agency's efforts to maintain and update the inventory?
    - ☐ Yes
    - ☐ No

16. Please estimate the number of contractor person hours used per update cycle.

TOPIC 3: Asset Condition

17. Do you assess the condition of some or all of your assets agency-wide?

- ☐ Yes
- ☐ No

18. How do you determine asset condition?

- ☐ Age (only)
- ☐ Continuous condition inspection (only)
- ☐ Periodic condition inspection (only)
- ☐ Combination of age and condition inspection
- ☐ Other (please specify):

19. What is the frequency of condition of update to the asset condition database?

- ☐ Periodically (i.e., regular intervals such as annually)
- ☐ Varying based on asset type or as changes occur

20. At what level of asset aggregation does your agency record and assess asset condition?

- ☐ Individual assets (e.g., bus by bus, bridge by bridge, or station by station)
- ☐ Individual asset purchase class (e.g., all 2001 diesel 40′ buses, all #1 cars for heavy rail line)
- ☐ Asset type (e.g., stations, revenue vehicles, service vehicles, garages)
- ☐ Various breakdown schemes depending on asset type

21. At what level of service aggregation does your agency record and assess asset condition?

- ☐ Mode (e.g., bus, light rail, heavy rail, commuter rail)
- ☐ Line or region (e.g., Red line, North division)
- ☐ Combination of mode and line/region
- ☐ Do not use service aggregation coding

22. Can you provide us with samples of the forms or sheets used to collect the asset information in an electronic format or samples of the asset inventory?

If YES, please e-mail them to trbsurvey@mccollomconsulting.com.

If you have difficulty e-mailing files or prefer to mail hardcopy, please contact Cathi Nussbaum at cathi@mccollomconsulting.com or xxx.xxx.xxxx.

- ☐ Yes
- ☐ No

23. Does your agency use the age/condition assessment to:

- ☐ Perform infrastructure needs assessment
- ☐ Estimate current magnitude of state-of-good-repair backlog
- ☐ Project future magnitude of state-of-good-repair backlog
- ☐ Prepare an agency funding appeal for additional funding
- ☐ Determine agency investment priorities
- ☐ Estimate magnitude of state-of-good-repair backlog
- ☐ Other applications (please explain below):

24. Other applications explanation:

25. Does your agency use the inventory and condition assessment to estimate a backlog of needed replacement and renewal investments?
    - ☐ Yes
    - ☐ No

26. What is the replacement value ($) of your non-real estate assets?

27. In what Year dollars?

28. What is the current estimate ($) of the value of the backlog?

29. Please provide the backlog ($) by investment type:
    - ☐ Revenue vehicles (heavy rail)
    - ☐ Revenue vehicles (light rail)
    - ☐ Revenue vehicles (buses)
    - ☐ Revenue vehicles (commuter rail)
    - ☐ Revenue vehicles (ferries)
    - ☐ Revenue vehicles (vans)
    - ☐ Support vehicles (e.g., tow trucks)
    - ☐ Passenger stations
    - ☐ Track
    - ☐ Power
    - ☐ Signals
    - ☐ Tunnels
    - ☐ Bridges
    - ☐ Maintenance buildings
    - ☐ Administrative buildings
    - ☐ All other assets

TOPIC 5: Agency Capital Program

30. What is the time frame for your agency's capital program?
    - ☐ Fixed five years (e.g., 2005–2009, then 2010–2014)?
    - ☐ Rolling five years (e.g., 2005–2009, then 2006–2010)?
    - ☐ Fixed ten years (e.g., 2005–2014, then 2014–2023)?
    - ☐ Rolling ten years (e.g., 2005–2014, then 2006–2015)?
    - ☐ Other (please specify):

31. Is the renewal cycle of your agency's capital program (i.e., 5-year fixed, 5-year rolling, 10-year, etc.) linked to the duration of its planning cycle?
    - ☐ Yes
    - ☐ No

32. Is the renewal cycle of your agency's capital program linked to the frequency asset inventory update?
    - ☐ Yes
    - ☐ No

33. What is the size of current plan ($)?

34. Please indicate the percentage breakdown of your agency's current capital program by the following categories. Please ensure that the sums equal 100%.
    - ☐ State of good repair (SGR) investments
    - ☐ Service expansion
    - ☐ Enhancements to existing assets
    - ☐ Other (please specify):

    Please explain Other above:

35. Has the transit asset condition system been used to change capital funding priorities to improve the SGR of the agency?
    - ☐ Yes
    - ☐ No

36. Please describe how the transit asset condition system has been used to change capital funding priorities to improve the SGR of the agency?

37. Would you be willing to participate in a best practices case study as part of this project?
    - ☐ Yes
    - ☐ No

Disqualification (No Response: Does your agency possess a comprehensive inventory of your operating infrastructure assets?)

Thank you for responding.

Because you do not possess a comprehensive inventory of your operating infrastructure assets you will not be able to answer the remaining survey questions.

Should you have question, feel free to contact Cathi Nussbaum, Brian McCollom, or myself with any questions.

Regards,

Steve Berrang

Thank You! (No response: Are you willing to answer more detailed questions on how your transit agency tracks its assets, assesses their condition, and uses the information to develop investment strategies and undertake capital planning?)

Thank you for taking part in this survey on TRB survey on Transit Asset Reporting.

If you are unable to continue with this survey and there is someone else within the transit agency that would be able to take this survey for us, please click the **Save and Continue** link located in the top right hand corner of this page and enter that individuals e-mail address.

Should you have any questions, feel free to contact Cathi Nussbaum, Brian McCollom, or myself with any questions.

Regards,

Steve Berrang

Thank You (Complete Survey Submission)

Dear Survey Respondent,

Thank you for taking part in this survey on Transit Asset Reporting.

As mentioned earlier, your individual responses will be kept confidential and you will not be cited in the general findings section of the TRB report. However, your responses will be incorporated into the industry-wide survey responses.

We may be back in touch with some follow-up questions. And, if we believe that your transit agency is a candidate for a best practices case study and you answered **Yes** to our last question, we will contact you for permission and a follow-up interview.

Feel free to contact Cathi Nussbaum, Brian McCollom, or myself with any questions.

Regards,

Steve Berrang

APPENDIX B

Detail Summary of Survey Responses

TABLE B1
DOES YOUR AGENCY POSSESS A COMPREHENSIVE INVENTORY OF YOUR OPERATING INFRASTRUCTURE ASSETS?

Respondents	Percentage
Yes	98
No	2
	100

n = 42.

TABLE B2
DOES YOUR AGENCY MAINTAIN THIS INVENTORY ON A PERIODIC BASIS?

Respondents	Percentage
Yes	98
No	2
	100

n = 40.

TABLE B3
WHAT IS THE PRIMARY SOURCE OF DATA FOR THIS ASSET INVENTORY DATA?

Respondents	Percentage
Asset Inspection	20
Fixed Asset Ledger/Counting Data	40
Maintenance Management System	13
Combination of One or More of the Above	28
	100

n = 40.

TABLE B4
HOW DO YOU USE THIS INVENTORY?

Respondents	Yes	No
Financial Reporting Purposes (i.e., fixed asset ledger)	78%	22%
FTA Regulatory Purposes	87%	13%
Maintenance Management	81%	19%
Asset Condition Assessment	86%	14%
Investment Strategy Development	74%	26%
Capital Planning Purposes	97%	3%
Agency Funding Purposes	87%	13%
Average	84%	16%

n = 38.

TABLE B5
ARE YOU WILLING TO ANSWER MORE DETAILED QUESTIONS ON HOW YOUR TRANSIT AGENCY TRACKS ITS ASSETS, ASSESSES THEIR CONDITION AND USES THE INFORMATION TO DEVELOP INVESTMENT STRATEGIES AND UNDERTAKE CAPITAL PLANNING?

Respondents	Yes	No
Are you willing to do the detailed survey?	90%	10%

n = 41.

TABLE B6
DOES THE INVENTORY INCLUDE?

Respondents	Yes	No
Revenue Vehicles	95%	5%
Support Vehicles	89%	11%
Passenger Stations	97%	3%
Fixed Guideway Infrastructure	88%	12%
Maintenance Buildings	94%	6%
Administrative Buildings	97%	3%
Average	93%	7%

n = 37.

TABLE B7
DOES YOUR ASSET INVENTORY COVER, TO SOME DEGREE, ALL MODES OF SERVICE PROVIDED?

Respondents	Percentage
Yes	59
No	41

n = 37.

TABLE B8
IF NO, PLEASE DESCRIBE BELOW WHY CERTAIN SERVICES ARE NOT INCLUDED IN THE INVENTORY

Responses:
Our agency contracts out for all paratransit service. The vehicles used for the paratransit service are owned by the vendors, and therefore are not included in our inventory process.
Metro does not own assets on the vanpool program.

TABLE B9
WHAT TYPE OF MANAGEMENT PROCESS AND DATABASE DO YOU USE TO RECORD AND UPDATE ASSET DATA?

Respondents	Percentage
Non-networked Electronic Spreadsheet/Database	22
Networked Electronic Spreadsheet/Database	54
Other system	24
	100

n = 37.

TABLE B10
HOW DO YOU STORE THE ASSET DATA?

Respondents	Percentage
Financial Information Database	38
Internally Developed Database	22
Off-the-Shelf, Asset Management Database	16
Consultant Developed Database	5
Contractor Developed Database	3
Other Database	16
	100

n = 33.

TABLE B11
WHERE DO YOU STORE THE PRIMARY (not backup) ASSET DATA?

Respondents	Percentage
In-house	81
Combination of In-house and Off-site at Contractor	19
	100

n = 36.

TABLE B12
WHAT IS THE FREQUENCY OF UPDATE FOR COMPLETE ASSET INVENTORY?

Respondents	Percentage
Periodically (i.e., annually, bi-annually, etc.)	78
As Changes Occur (i.e., irregularly)	22
	100

n = 36.

TABLE B13
CAN YOU PROVIDE US WITH SAMPLES OF THE FORMS OR SHEETS USED TO COLLECT THE ASSET INFORMATION IN AN ELECTRONIC FORMAT OR SAMPLES OF THE ASSET INVENTORY?

Respondents	Percentage
Yes	63
No	37
	100

n = 30.

TABLE B14
DO YOU HAVE A DEDICATED AGENCY STAFF TO MAINTAIN AND UPDATE THE ASSET INVENTORY?

Respondents	Percentage
Yes	42
No	58
	100

n = 36.

TABLE B15
IF YES, PLEASE INDICATE THE NUMBER OF PEOPLE AND DEPARTMENTS IN WHICH THEY WORK

Department	No. of People	FTE
Finance	1	1
Finance	1	0.5
Finance	3	3
Chief Operating Officer	1	1
General Accounting	1	1
Accounting	2	2
Accounting	1	1
Accounting	2	0.25
Accounting	4	4
Transit Operations	1	
Maintenance	1	
Asset Accounting	2	1.5
Transportation	1	
Materials Management		
Public Transit	1	1
Budget	1	1
	23	17.25

TABLE B16
DO YOU USE DESIGNATED, BUT NOT DEDICATED, AGENCY STAFF TO MAINTAIN AND UPDATE THE ASSET INVENTORY?

Respondents	Percentage
Yes	59
No	41
	100

n = 37.

TABLE B17
IF YES, PLEASE INDICATE THE NUMBER OF PEOPLE AND DEPARTMENTS IN WHICH THEY WORK

Department	No. of People	FTE
Cap Program Management	1	1
Finance	1	1
Knowledge Management Planning	2	0.5
Property Service	1	1
	5	3.5

TABLE B18
DO CONTRACTORS SUPPORT YOUR AGENCY'S EFFORTS TO MAINTAIN AND UPDATE THE INVENTORY?

Respondents	Percentage
Yes	16
No	84
	100

n = 37.

TABLE B19
PLEASE ESTIMATE THE NUMBER OF CONTRACTOR PERSON HOURS USED PER UPDATE CYCLE

Department	No. of People	FTE
Information Technology	3	3
	3	3

TABLE B20
DO YOU ASSESS THE CONDITION OF SOME OR ALL OF YOUR ASSETS AGENCY-WIDE?

Respondents	Percentage
Yes	89
No	11
	100

n = 37.

TABLE B21
DO YOU ASSESS THE CONDITION OF SOME OR ALL OF YOUR ASSETS AGENCY-WIDE?

Respondents	Percentage
Age (only)	13
Periodic Condition Inspection (only)	3
Combination of Age and Condition Inspections	81
Other	3
	100

n = 38.

TABLE B22
WHAT IS THE FREQUENCY OF CONDITION OF UPDATE TO THE ASSET CONDITION DATABASE?

Respondents	Percentage
Periodically (i.e., regular intervals such as annually)	61
Varying Based on Asset Type or as Changes Occur	39
	100

n = 36.

TABLE B23
AT WHAT LEVEL OF ASSET AGGREGATION DOES YOUR AGENCY RECORD AND ASSESS ASSET CONDITION?

Respondents	Percentage
Individual assets (e.g., bus by bus, bridge by bridge, or station by station)	24
Individual asset purchase class (e.g., all 2001 diesel 40 ft buses, all #1 cars for heavy rail line)	5
Asset type (e.g., stations, revenue vehicles, service vehicles, garages)	14
Various breakdown schemes depending on asset type	57

n = 37.

TABLE B24
AT WHAT LEVEL OF SERVICE AGGREGATION DOES YOUR AGENCY RECORD AND ASSESS ASSET CONDITION?

Respondents	Percentage
Mode (e.g., bus, light rail, heavy rail, commuter rail)	24
Line or Region (e.g., Red line, North division)	2
Combination of Mode and Line/Region	22
Do Not Use Service Aggregation Coding	46

n = 37.

TABLE B25
CAN YOU PROVIDE US WITH SAMPLES OF THE FORMS OR SHEETS USED TO COLLECT THE ASSET INFORMATION IN AN ELECTRONIC FORMAT OR SAMPLES OF THE ASSET INVENTORY?

Respondents	Percentage
Yes	47
No	53
	100

n = 30.

TABLE B26
DOES YOUR AGENCY USE THE AGE/CONDITION ASSESSMENT TO:

Respondents	Yes	No
Perform infrastructure needs assessment	86%	14%
Estimate current magnitude of state-of-good-repair backlog	70%	30%
Project future magnitude of state-of-good-repair backlog	68%	32%
Prepare an agency funding appeal for additional funding	83%	17%
Determine agency investment priorities	81%	19%
Estimate magnitude of state-of-good-repair backlog	67%	33%
Other applications (please explain below)	51%	47%
Average %	74%	26%

n = 36.

TABLE B27
OTHER APPLICATIONS EXPLANATION:

Responses
“What-if” analyses—e.g., what will future backlog be at various annual investment levels?
Annual budget preparation (capital replacement element thereof)
Asset databases inform the development of the agency-wide Twenty Years Needs and Five Year Capital Program
Determining depreciation schedule based on age or condition
Insurance risk, financial planning, service planning, budgeting
Only priority and safety repairs are reported in backlog. Routine repairs addressed as maintenance, but backlog not tracked routinely across divisions owing to maintenance management differences
Plan and program our capital projects
Reporting requirements (federal, etc.)
Validation of adequacy of existing asset maintenance programs

TABLE B28
DOES YOUR AGENCY USE THE INVENTORY AND CONDITION ASSESSMENT TO ESTIMATE A BACKLOG OF NEEDED REPLACEMENT AND RENEWAL INVESTMENTS?

Respondents	Percentage
Yes	61
No	39
	100

n = 36.

TABLE B29
IN WHAT YEAR DOLLARS?

Respondents	Percentage
2008	22
2009	30
2010	30
Other	17

n = 23.

TABLE B30
PLEASE PROVIDE THE BACKLOG ($) BY INVESTMENT TYPE:

Item	Responses
Revenue Vehicles (heavy rail)	7
Revenue Vehicles (light rail)	4
Revenue Vehicles (buses)	12
Revenue Vehicles (commuter rail)	5
Revenue Vehicles (ferries)	4
Revenue Vehicles (vans)	8
Support Vehicles (e.g., tow trucks)	13
Passenger Stations	16
Track	10
Power	11
Signals	11
Tunnels	9
Bridges	8
Maintenance Buildings	15
Administrative Buildings	7
All Other Assets	15

TABLE B31
WHAT IS THE TIME FRAME FOR YOUR AGENCY'S CAPITAL PROGRAM?

Item	Responses
Fixed five years (e.g., 2005–2009, then 2010–2014)	1
Rolling five years (e.g., 2005–2009, then 2006–2010)	1
Fixed ten years (e.g., 2005–2014, then 2014–2023)	3
Rolling ten years (e.g., 2005–2014, then 2006–2015)	2
Other	10

TABLE B32
IS THE RENEWAL CYCLE OF YOUR AGENCY'S CAPITAL PROGRAM (i.e., 5-year fixed, 5-year rolling, 10-year, etc.) LINKED TO THE DURATION OF ITS PLANNING CYCLE?

Respondents	Percentage
Yes	71
No	29
	100

n = 35.

TABLE B33
IS THE RENEWAL CYCLE OF YOUR AGENCY'S CAPITAL PROGRAM LINKED TO THE FREQUENCY ASSET INVENTORY UPDATE?

Respondents	Percentage
Yes	40
No	60
	100

n = 36.

TABLE B34
PLEASE INDICATE THE PERCENTAGE BREAKDOWN OF YOUR AGENCY'S CURRENT CAPITAL PROGRAM BY THE FOLLOWING CATEGORIES. PLEASE ENSURE THAT THE SUMS EQUAL 100%

Item	Responses
State of Good Repair (SGR) Investments	27
Service Expansion	21
Enhancements to Existing Assets	21
Other	11

TABLE B35
PLEASE EXPLAIN OTHER ABOVE:

Response
4.6% accessibility and 23.4% state transit commitments included in the MBTAs 5-year capital program
Capital funds will primarily be directed toward replacement buses
Incorporates service and capacity expansion, and customer enhancements
Information derived from FY09 Budget Book
Lines 32 and 33 above include revenue vehicle procurement and are for the period 2009–2015
Maintaining current service
Normal replacement projects
Other is replacement of temporary World Trade Center (WTC) station. Original WTC station destroyed by terrorism on 9/11
Program administration, environmental remediation, and insurance
Safety and administration
Security and smart fare card projects

TABLE B36
HAS THE TRANSIT ASSET CONDITION SYSTEM BEEN USED TO CHANGE CAPITAL FUNDING PRIORITIES TO IMPROVE THE SGR OF THE AGENCY?

Respondents	Percentage
Yes	58
No	42
	100

n = 33.

TABLE B37
PLEASE DESCRIBE HOW THE TRANSIT ASSET CONDITION SYSTEM HAS BEEN USED TO CHANGE CAPITAL FUNDING PRIORITIES TO IMPROVE THE SGR OF THE AGENCY?

Responses:
Vehicles were determined to have an expensive flaw in the rail vehicle pivot pin. A capital project was created and funding moved to cover these repairs. This is typical of our methodology.
The asset condition system is used as basis for identifying 20-year needs. Based on this assessment, priorities are reviewed and ranked. From this, a 5-year capital program is developed and adjusted as necessary based on overall needs.
Intermediate asset condition assessments are used to adjust capital program priorities as needed.
The asset condition system is used to determine remaining life for some assets.
Agency recently went through a strategic prioritization of capital needs. Asset condition informed the prioritization process.
The asset database provides a uniform point of comparison between different categories of capital assets. The database also provides a quantifiable justification to demonstrate the need for capital investment.
Calculating the SGR backlog (about $2.7 billion in 2006) more clearly showed policy makers that the MBTA needed to invest its limited dollars in SGR projects, and the future impact if maintenance not funded at sufficient levels. The state also agreed to fund expansion and other commitments, so as not to take away funding from SGR.
Determination of existing (or future) condition of assets helps us prioritize. For instance, when the age and/or mileage of our fleet indicate a need for an “unanticipated” bus purchase, we might put off making some other capital purchase. Or if a regulatory need arises which requires immediate action, i.e. contamination at a maintenance facility, other capital purchases might be delayed.
Condition Assessment Studies conducted to assess the condition of the revenue fleet and signal system led to determination to replace revenue fleet and signal systems in tandem rather than alternatives such as service life extensions or deferred action. Note: On previous page no backlog is shown for revenue fleet or signal system because they are in process of being replaced and old equipment is being scrapped as new equipment is accepted.
As the system has been restored and improved over the past 25 years, the need for ongoing work for state of good repair and normal replacement has been highlighted by the asset condition surveys.
Although we have yet to go through a CIP cycle since the adoption of MTC’s Regional Transit Capital Inventory, we previously utilized our own in-house effort (BART’s 30 Year Plan) to refocus our capital priorities on railcar rehabilitation/replacement and developing a funding strategy for maintaining state of good repair for our 43 rail stations.
Has provided visibility to our current assets out in the field and determines replacement needs and costs.
It has provided a means for correction and/or validation of SGR assumptions incorporated into the 20-year financial plan.
The level of need for maintenance facilities is very large; the total picture of our asset condition has been used to justify investment of non-customer facing assets.
First the agency identifies what assets are no longer in a state of good repair using condition information, age, whether or not the assets meet certain performance standards, and other measures. We then direct our capital dollars to eliminate the backlog of conditions relating to that asset type.
Example: 25+ years of a station rehabilitation program had only addressed about half of stations. A detailed survey of components was undertaken (part of condition inventory), and now a targeted component investment program is proposed to address deficient conditions on a component level.
Under the current economic conditions, a portion of 5307 funding was used for maintenance activities rather than purchasing vehicles.
The systems assets are reviewed each year by members of the capital programs department. Over the past several years due to age and condition a greater emphasis has been placed on maintaining our current assets. Additionally, as capital funding is harder to obtain it is much more difficult if not impossible to consider expansion.
Bus acquisition plan involves replacement of 100 buses per year out of a total fleet of 1,320. Result is an improved state of good repair.
The asset condition system is used to identify current and future needs. The priority projects in the yearly capital program are developed based on the condition assessments.

TABLE B38
WOULD YOU BE WILLING TO PARTICIPATE IN A BEST PRACTICES CASE STUDY AS PART OF THIS PROJECT?

Respondents	Percentage
Yes	58
No	42
	100

n = 33.

APPENDIX C

Listing of Responding Agencies

TABLE C1
RESPONDING AGENCIES, TITLES, AND LOCATIONS

Transit Agency (Respondent Title)	Location
Alameda Contra Costa Transit District (AC Transit) (Manager, Capital Development, Legislation, and Grants)	Oakland, CA
Bay Area Rapid Transit District (BART) (Manager, Capital Development)	Oakland, CA
Bi-State Development Agency (METRO) (Director, Accounting and Budgeting)	St. Louis, MO
Broward County Transit (BCT) (Associate Director)	Pompano Beach. FL
Capital Metropolitan Transportation Authority (CMTA) (Director of Maintenance)	Austin, TX
Central Florida Regional Transportation Authority (LYNX) (Manager of Finance)	Orlando, FL
Chicago Transit Authority (CTA) (Manager, Capital Program Development)	Chicago, IL
City of Detroit Department of Transportation (DDOT) (Director)	Detroit, MI
City of Los Angeles Department of Transportation (LADOT) (Chief of Transit)	Los Angeles. CA
City of Phoenix Public Transit Department (Valley Metro) (Management Assistant III)	Phoenix. AZ
Dallas Area Rapid Transit (DART) (Vice President, Maintenance)	Dallas, TX
Greater Cleveland Regional Transit Authority (GCRTA) (Director of Rail Operations)	Cleveland, OH
King County DOT—Metro Transit Division (King County Metro) (Manager—Power Distribution/Facilities Maintenance)	Seattle, WA
Los Angeles County Metropolitan Transportation Authority (LACMTA) (Deputy Executive Officer, Rail Operations)	Los Angele, CA
Maryland Transit Administration (MTA) (Administrator)	Baltimore, MD
Massachusetts Bay Transportation Authority (MBTA) (Deputy Director of Financial Planning)	Boston, MA
Metro Transit (Manager of Accounting)	Minneapolis, MN
Metropolitan Transit Authority of Harris County, Texas (Houston METRO) (Director/ Grant Programs)	Houston, TX
Metropolitan Transit System of San Diego (MTS) (Property Accountant)	San Diego, CA
Miami Dade Transit (MDT) (Chief, Knowledge Management)	Miami, FL
Ride-On Montgomery County Transit (Grant Manager)	Rockville, MD
MTA Bus Company (MBTABUS) (Director Budget)	Brooklyn, NY
MTA Long Island Bus (Manager, Capital & Strategic Planning)	Garden City, NY
MTA Long Island Rail Road (MTA LIRR) (Director—Strategic Investments)	Jamaica, NY
MTA New York City Transit (NYCT) (Senior Director, Capital Program Development)	New York, NY
Niagara Frontier Transportation Authority (NFT METRO) (Manager Equipment & Bus Maintenance)	Buffalo, NY
New Jersey Transit Corporation (NJ Transit) (Chief, Capital Program Administration)	Newark, NJ
Orange County Transportation Authority (OCTA) (Analysis Project Manager)	Orange, CA
Pace Suburban Bus Corporation (PACE) (Chief Financial Officer)	Arlington Heights, IL
Port Authority of Allegheny County (Port Authority) (Director of Technical Support and Capital Programs)	Pittsburgh, PA
Port Authority Trans-Hudson Corporation (PATH) (Facility Maintenance Specialist)	Jersey City, NJ
Regional Transportation District (RTD) (Supervisor of Property & Grants)	Denver, CO
Sacramento Regional Transit District (Sacramento RT) (Chief of FBSS Division)	Sacramento, CA
San Francisco Municipal Transportation Agency (SFMTA) (Manager, Capital Planning)	San Francisco, CA
Santa Clara Valley Transportation Authority (VTA) (Fiscal Resources Manager)	San Jose, CA
Southeastern Pennsylvania Transportation Authority (SEPTA) (Director, Administration and Finance)	Philadelphia, PA
Tri-County Metropolitan Transportation District of Oregon (TriMet) (Director, Operations Planning & Development)	Portland, OR
Utah Transit Authority (UTA) (Assistant General Manager)	Salt Lake City, UT
VIA Metropolitan Transit (VIA) (Vice President Maintenance)	San Antonio, TX
Washington Metropolitan Area Transit Authority (WMATA) (Not Submitted)	Washington, DC
Westchester County Department of Transportation (The Bee-Line System) (Commissioner)	Mt Vernon, NY

APPENDIX D

Annotated Bibliography

Eight articles, papers, or reports were identified and judged important to this synthesis project. Seven publications document efforts to estimate transit capital needs at three different aggregation levels:

1. **National.** Two publications summarize efforts to estimate national transit needs. The AASHTO report (Cambridge Systematics, Inc. 2009) estimated national investment needs for both highways and public transportation. FTA's Transit Economic Requirements Model (TERM) is described in the second paper (Laver 2009). FTA uses TERM estimates in its biennial report to Congress on the conditions and performance of transit.
2. **State.** Two publications describe the approaches used in Alabama (Anderson and Davenport 2005), and in Illinois (Booz Allen Hamilton 2003) to estimate statewide needs. The Illinois (Booz Allen Hamilton 2003) approach is also interesting in that needs assessments are also prepared for the individual transit systems.
3. **Local systems.** Three publications describe how the transit systems in Boston (Massachusetts Bay Transportation Authority) (D'Allessandro et al. 2009; McCollom 2006) and Chicago (Regional Transportation Authority; RTA) (Yoder and Delaurentis 2003) have developed transit asset management systems in efforts to bring their systems to a State of Good Repair (SGR). The two publications about the Boston experience cover the model development and initial application in 2001 (McCollom 2006) and the recent use of the approach in 2009 (D'Allessandro et al. 2009).

The approaches described in these reports also varied in several respects including assets costs, SGR measure, and scenario testing (see Table D1).

The last publication in the literature review, *Transit State of Good Repair: Beginning the Dialogue,* is a summary of a workshop that FTA recently held with 14 transit managers to discuss current practice in transit asset management. The report identified a number of technical issues that need further research including: (1) the definition of state of good repair, (2) the effective use of condition ratings instead of just age, (3) the determination of optimal preventive maintenance, and (4) the estimation of the benefits (or consequences) of investment decisions on operating costs, reliability, and safety.

The participants in the workshop stated that few transit systems used ordinal ranking or other methods for prioritizing their expansion, rehabilitation, and replacement investment needs. Instead, the needs typically are prioritized in meetings of agency department managers. They also expressed strong interest in learning more about the use of decision support tools as a means of assessing and prioritizing SGR needs.

Anderson, M.D. and N.S. Davenport, *A Rural Transit Asset Management System*, University Transportation Center for Alabama, Tuscaloosa, June 2005.

This describes an Alabama Department of Transportation (DOT) asset management system used for transit vehicles purchased under the FTA Section 5310 and 5311 funding programs. According to the report, Alabama DOT uses the system to estimate the overall fleet quality, identify annual vehicle replacement needs, and to predict future funding and budgetary needs.

The model employs regression analysis to predict the level of vehicle procurement necessary. It uses vehicle fleet characteristics including make, model, and year of manufacture; mileage; and capacity. The model assigns a vehicle condition rating based on:

- Engine starting trouble
- Engine running condition
- Interior condition (upholstery damage, seats missing)
- A/C condition
- Wheelchair lift operation
- Exterior condition
- Mileage.

The condition rating is a five-point scale:

1. Bad: Vehicle needs immediate replacement.
2. Poor: Vehicle should be replaced.
3. Fair: Vehicle is acceptable.
4. Good: Vehicle has no outstanding problems.
5. Excellent: Vehicle is in new condition.

A series of regression models are tested using variables that included vehicle age, annual vehicle mileage, wheelchair accessibility, and population over 65 years of age. The results show that vehicle age is the best predictor of vehicle condition.

Booz Allen Hamilton, Downstate Illinois Capital Needs Assessment, PowerPoint prepared for Illinois Public Transportation Association, funded by Illinois Department of Transportation, Springfield, Oct. 2003.

Illinois DOT developed a capital asset needs model to estimate 10-year capital needs for "downstate" transit agencies—Illinois systems located outside of the Chicago metropolitan area. The transit agencies completed a detailed survey of existing asset inventory (vehicle fleet and major facility components) and known investment needs. The data included asset ages, acquisition costs, and lifetime mileages.

In addition, on-site capital cost data collection and inspections of asset physical conditions were conducted at five agencies—three urban and two rural systems. Historical cost data were collected for:

- Facility construction and capital repairs
- Annual capital expenditures on other needs such as security-related equipment, shelters, and radios
- Annual operating and maintenance costs
- Engine/transmission rebuilds.

These onsite visits provided the data required to establish life-cycle cost curves for four types of buses and seven types of para-transit vehicles. The life-cycle costs included (Figure D1):

- Original purchase (investment) cost
- Lifetime rehabilitation costs (engine and transmission rebuilds, mid-life overhauls)
- Annual operating and maintenance costs.

A minimum cost replacement strategy was used to minimize total life-cycle costs. These costs were allocated over the life of a vehicle

TABLE D1
SUMMARY OF ASSESSMENT APPROACHES IDENTIFIED IN LITERATURE REVIEW

	Geographic	Asset Costs			SGR Measure		Scenario Testing		
Authors	Area	Replacement	Mid-Life	O&M	Age	Condition Ratings	SGR Condition	Service Performance	Prioritized Funding
Pisarski/Reno	U.S.	X	X	X	X		X	X	
Laver	U.S.	X	X	X		X	X	X	
Illinois DOT	Illinois	X			X	X	X		
Anderson/Davenport	Alabama	X				X	X		
Yoder/Delaurentis	Chicago	X	X	X		X	X		
McCollom	Boston	X	X	X	X		X		X

on a per mile basis. The purchase and rehabilitation costs per mile decline over the life of the vehicle. In contrast, operating and maintenance costs per mile tend to increase as a vehicle ages. When these divergent unit costs are combined to produce a total life-cycle cost curve, a minimum unit cost and its corresponding lifetime mileage can be determined (Figure D2).

This lifetime mileage was used to establish when the vehicles should be replaced in the Illinois DOT capital needs model. In contrast to vehicles, replacement needs for all facilities components were determined based on standard useful lives.

The on-site data collection also provided the data required to evaluate the physical condition of downstate transit assets. The FTA vehicle decay curves (see Laver above) were recalibrated to reflect the Illinois experience.

Illinois DOT has used the capital assets needs model annually since 2003 to estimate statewide capital needs. It also prepares needs assessments for the individual transit systems that they can use in their capital planning.

Cambridge Systematics, Inc., A.E. Pisarski, and A.T. Reno, *Bottom Line Technical Report: Highway and Public Transportation National and State Investment Needs*, prepared for American Association of State Highway and Transportation Officials, Washington, D.C., Mar. 2009.

The report addresses the types of public transportation capital needs including the:

- Elimination of the backlog of vehicle needs and replacement; and
- Rehabilitation of other existing transit assets, including track, signals, maintenance facilities, passenger stations, and passenger fare systems to bring transit systems to a SGR.

Urban and rural systems are looked at separately.

The analysis identified four different investment scenarios by applying combinations of physical conditions and service performance:

1. Maintain physical condition (insufficient funds to replace asset based on recommended service life).
2. Improve physical condition (sufficient funds to replace asset based on recommended service life).
3. Maintain service performance.
4. Improve service performance.

The estimation models use an age-based approach to estimate SGR needs using data from the National Transit Database and other FTA sources. The analyses parallel prior biennial reporting from the U.S.DOT Condition and Performance Report to Congress.

D'Alessandro, D.F., P.D. Romary, L.J. Scannell, and B. Woliner, "MBTA Review," Boston, Mass., Nov. 1, 2009.

This summary is an update of the capital program using the SGR planning process implemented by MBTA in 2001. It comments on the current backlog of projects and annual funding requirements as follows:

> For FY2010, over $3 billion worth of projects were identified by the MBTA as needed to address SGR issues. Only 15 of those 201 projects totaling $203M were funded. In other words, all but 6 percent of what was requested to address SGR issues went unfunded.

Because it can fund only a small portion of the SGR backlog, MBTA prioritizes annual capital projects against predetermined criteria. Each project is scored with low to high priority to a maximum of 100, based on:

- Safety
- Health
- Environment
- SGR
- Operations impact
- Cost/benefit
- Legal commitments.

This paper suggests that the SGR planning process implemented by the MBTA in 2001 has and continues to be useful for estimating capital funding needs. However, the paper indicates that the MBTA has not used its methodology to prioritize annual capital projects.

Laver, R., First FTA SGR Roundtable, Transit Economic Requirements Model (TERM), PowerPoint presentation to the FTA First State of Good Repair Roundtable, Washington, D.C., July 10, 2009.

This presentation gives an overview of the Transit Economic Requirements Model (TERM). TERM is used to analyze current asset conditions with the objective of either maintaining condition or to improve condition and performance. TERM focuses on needs assessment—the replacement of assets and the expansion of the existing system.

The presentation also describes how TERM is used to determine investment needs for reaching a SGR over specified time periods, based on funding level scenarios. FTA uses TERM in its biennial report to Congress on the conditions and performance of transit.

TERM COMPONENTS

The TERM model consists of:

- Model database
  - Inventory of U.S. transit assets
  - Agency-mode operating characteristics

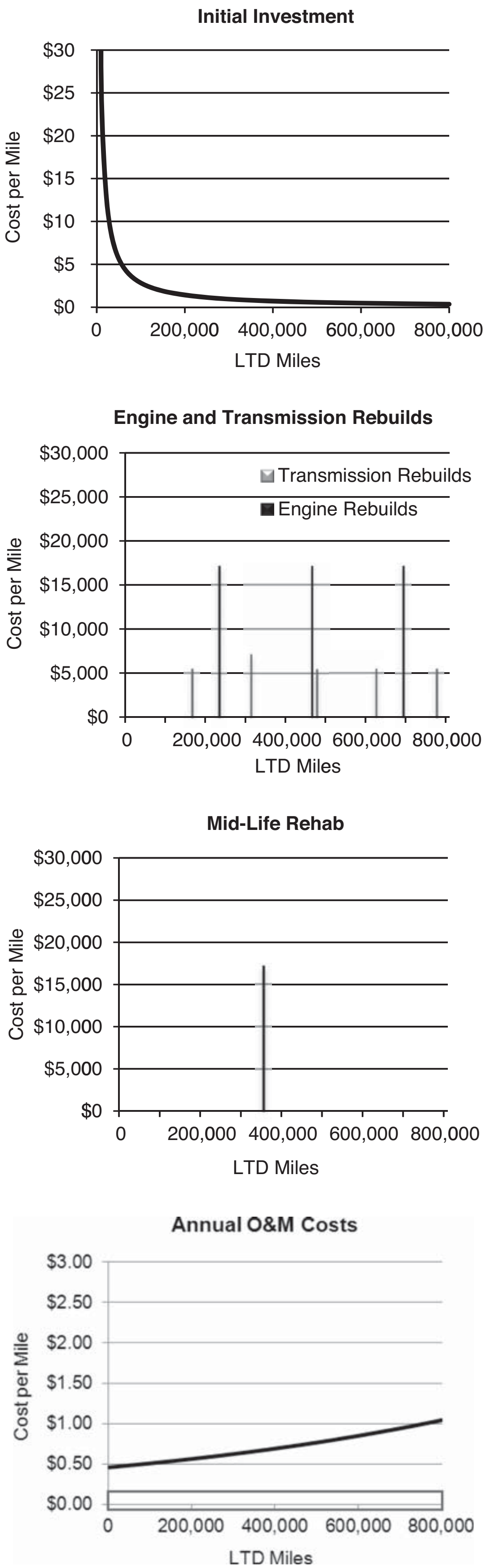

FIGURE D1 Minimum cost replacement.

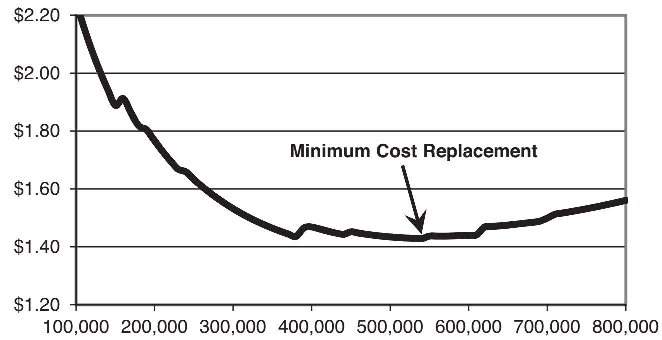

FIGURE D2 Total life-cycle cost.

  - Urbanized areas demographics
  - Cost and investment benefits data by mode
  - User-defined investment scenarios
  - Asset rehabilitation and replacement polices
  - Budget constraints
  - Financial assumptions (inflation, discount rate).
- Estimation of investment needs by type, mode, and urban area size.
- Asset conditions forecasts.

NEEDS INVESTMENT MODULE OVERVIEW

The TERM model estimates national transit investment needs for six scenarios:

1. **Rehab–Replacement (Maintain or Improve Condition):** Total investment required for rehabilitation and replacement of the nation's existing transit assets.
2. **Asset Expansion (Maintain Performance):** Total investment in new, expansion assets as required maintaining existing transit performance given projected growth in transit travel demand.
3. **Reduce Crowding (Improve Performance I):** Expansion investments to reduce crowding in local agency modes with high vehicle occupancies.
4. **Increase Average Speed (Improve Performance II):** Expansion investments in higher speed modes (heavy rail transit, light rail transit, or bus rapid transit) to improve performance in urbanized areas with low operating speeds.
5. **Benefit-Cost I (Maintain/Improve Condition, Maintain Performance):** Evaluates cost-effectiveness of rehab replacement and asset expansion investments.
6. **Benefit-Cost II (Improve Performance):** Evaluates cost-effectiveness of performance improvement investments.

An Asset Decay Simulation methodology is used for the Rehab-Replacement scenario to make an SGR forecast and Assets Condition forecast. The methodology simulates the full asset life cycle and decay of all transit asset types based on the following factors:

- Asset use (e.g., vehicle mileage, annual boardings, hours of service)
- Annual maintenance
- Aging (years of service)
- Life-cycle events (capital maintenance, rehabs/rebuilds, and replacement).

The analysis relies on:

- A detailed transit asset inventory based on a five-point condition scale where 1 = poor condition and 5 = excellent condition. An asset reaches its mid-life when its condition rating = 3.5. An asset reaches the end of its useful life when its condition rating = 2.5 to 2.75.
- Asset investment policy (timing of life-cycle events).
- Empirically derived decay curves (predict asset condition based on asset type, age, maintenance and utilization).

The analysis predicts current assets physical condition and timing/cost of life-cycle events over the next 20 years. The aggregate physical condition rating uses the five-point rating scale.

McCollom, B., MBTA Systemwide Condition Assessment and Capital Investment Plan, presentation to the World Bank, Washington, D.C., Mar. 28, 2006.

This presentation discusses the Massachusetts Bay Transportation Authority's SGR project. The objectives of the project were to demonstrate ongoing funding needs through an engineering assessment of current needs and to develop a long range capital planning model for project programming under limited funding availability.

The model development focused on high-cost MBTA assets and did not try to establish a maintenance database of all assets. It also focused on the ability to run "what if" scenarios in a reasonable time frame—less than 5 minutes.

The SGR scenario model inputs use annual budgets, asset table of key assets (vehicles, facilities, and systems), and condition measures (age and life), and prioritization weighting scheme. The asset table lists three attribute areas:

1. "Condition" measures
   - Age
   - Life
2. Project "action" costs
   - Replacement/renewal
   - Contingency factors
   - Cash flow years
3. Ranking measures
   - Condition measures
   - Operational importance
   - Affected ridership.

Candidate projects are then scored using a weighting scheme and based on the following:

- Age (default weight 60%)
  – Age as a percent of service life.
- Operational impact (default weight 20%)
  – Yes/no
  – Selected assets are essential to system operations
  – Critical projects include buses, track, signals, and power
  – Noncritical projects include stations, parking facilities.
- Cost-effectiveness (default weight 20%)
  - Cost of action/ridership
  - Reflects customer service impacts.

The methodology can be used to address the cost and timing of bringing and maintaining the system (existing assets) to a state of good repair. A baseline scenario is run that involves unconstrained funding availability. This establishes the minimum time and funds to reduce the backlog of projects and to maintain the transit system at SGR.

Additional scenarios can be run that examine the consequences of constrained funding over a 20-year planning period. These consequences include a summary of asset actions (replacement or mid-life maintenance) funded on-time, later than scheduled, or not at all, and changes in the backlog of actions throughout the period.

The presentation also suggests potential enhancements to the model. These include the use of decay curves based on a preventive maintenance program, treatment of multi-year funding of projects, and deferral of a portion of a project cost if insufficient funds are available.

Transit State of Good Repair: Beginning the Dialogue, Federal Transit Administration, U.S. Department of Transportation, Washington, D.C., Oct. 2008.

FTA convened 14 representatives of transit systems and state DOTs in 2008 to discuss transit asset management and SGR at their agencies and what is needed to resolve critical capital needs. The intent was both to measure the extent of the problem and to look at creative financing for maintaining and upgrading aging assets. Topics discussed included capital needs and financing for aging transit infrastructure, defining SGR, inventory and tracking of transit assets, maintenance/preventive maintenance practices and standards, and tools and research needed to address SGR.

Seven papers are presented in the report covering:

- Current conditions of the nation's transit infrastructure
- Defining and measuring state of good repair
- Transit asset management
- Standards for preventive maintenance
- Core capacity of a transit system
- Alternative approaches to financing
- Research needs.

The report documents that one-quarter of the nation's bus and rail assets are in marginal or poor condition and the proportion increases to one-third in the nation's largest rail systems. FTA estimates ". . . the total level of investment required to bring the nation's bus and rail assets to a state of good repair is currently estimated at $25 billion ($ 2004) . . . [and that] . . . after eliminating the backlog, an additional $9 to $11 billion from all sources is required annually to maintain this state of good repair into the future."

The report identified a number of technical issues that need further research including: (1) the definition of state of good repair, (2) the effective use of condition ratings instead of just age, (3) the determination of optimal preventive maintenance, and (4) the estimation of the benefits (or consequences) of investment decisions on operating costs, reliability, and safety.

The participants in the workshop stated that few transit systems used ordinal ranking or other methods for prioritizing their expansion, rehabilitation, and replacement investment needs. Instead, the needs typically are prioritized in meetings of agency department managers. They also expressed strong interest in learning more about the use of decision support tools as a means of assessing and prioritizing SGR needs.

Yoder, S.L. and J. Delaurentis, "The Framework for a Regional Transit Asset Management System," *ITE Journal,* Institute of Transportation Engineers, Washington, D.C., Sep. 2003, pp. 2–3.

This paper describes the efforts by the Regional Transportation Authority (RTA) to develop a framework for overseeing public transit funding in the six-county Chicago area. The RTA is not a transit operator, but is legislatively responsible for fiscal planning and policy oversight. To improve its oversight ability, in 2000 it laid out the framework for a regional transit asset management system (RTAMS).

The RTAMS goals were to give RTA management the data and tools to support decision making on transit asset management strategies and investment tradeoffs. Five goals in particular emphasized the information base and analytical tools:

1. Provide multimedia retrieval on asset locations, conditions, usage, performance, capital projects, and maintenance practices of the RTA system regardless of ownership.
2. Enable RTA to comprehensively analyze, maintain, and manage transit information.
3. Enable RTA to prioritize capital investments and capital replacement needs.
4. Develop applications and simulation tools linking to the RTA budgetary process and financial reporting requirements.
5. Develop data mining tools capable of simulating "what if" scenarios.

In the planning process five transit asset management system functions were identified. The first function is a Multimedia Integrated Data Warehouse, including a condition rating of each asset containing:

- Asset locations (e.g., for a rail station would have physical description of layout, escalators, entrances, and fare collection equipment);
- Conditions (e.g., station age, capital project descriptions, routine and preventive maintenance practices, and asset condition ratings);
- Usage (e.g., rail station boardings and alightings, connecting transit lines, park-n-ride, fares, and schedules); and
- Capital improvement information (e.g., asset performance information—station ridership ranking, on time-performance, and asset demand information for prioritizing capital investment including user profiles, adjacent land uses, station area development patterns, vicinity maps, tourist attractions, and demographics surrounding the station areas).

Another function was scenario simulations. This built on earlier work during the 1990s that developed decay curves based on the compilation and analysis of the CTA engineering assessment data and asset purchasing information and maintenance records. The curves depict the relationship among asset condition, useful life, and maintenance practices.

Using the decay curves, future asset conditions can be predicted given the asset age and maintenance practices. Therefore, the decay curves were the principal input for developing a life-cycle capital replacement/renewal tool. This tool permits RTA to simulate "what if" scenarios, answering questions such as:

- What is the trade-off between maintenance cost and capital renewal cost?
- Is it better to replace or repair a certain asset category?
- How much capital funding is required for the next 10 years to bring all assets from poor condition to good condition?
- To what condition will an asset deteriorate if no additional funding is provided?

Abbreviations used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation