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TRANSIT COOPERATIVE RESEARCH PROGRAM
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Research Results Digest 101

International Transit Studies Program
Report on the Spring 2010 Mission

FUNDING FOR INFRASTRUCTURE MAINTENANCE: ACHIEVING AND SUSTAINING A STATE OF GOOD REPAIR

This TCRP digest summarizes the results of mission performed from June 11 through 25, 2010, under TCRP Project J-03, "International Transit Studies Program." This digest examines how bus and rail agencies and operators in several European cities develop community support for public transportation and how those communities implement sustainable funding strategies for transit assets, operations, and maintenance. It was prepared by Harrington-Hughes & Associates, Inc., and is based on the reports filed by the mission participants.

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INTERNATIONAL TRANSIT STUDIES PROGRAM

The International Transit Studies Program (ITSP) is a part of the Transit Cooperative Research Program (TCRP), authorized by the Intermodal Surface Transportation Efficiency Act of 1991 and reauthorized, in 2005, by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. TCRP is managed by the Transportation Research Board (TRB) of the National Academies and is funded annually by a grant from the Federal Transit Administration (FTA). ITSP is managed by Harrington-Hughes & Associates, Inc., under a contract to the National Academies.

TCRP has sponsored the ITSP since 1994. The primary purpose of the ITSP is to broaden the professional development of U.S. transit managers by providing them with opportunities to visit transit systems abroad; the managers return with insights and knowledge useful to their organizations, the transit industry, and their own transit careers. ITSP carries out its mandate by offering transportation professionals practical insight into global public transportation operations. The program affords the opportunity for them to visit and study exemplary transit operations outside the United States.

Two ITSP study missions are conducted each year, usually in the spring and fall, and are typically composed of 15 participants, including a senior official designated as the group spokesperson, a representative of FTA, and a mission coordinator. Transit organizations across the nation are contacted directly and asked to nominate candidates for participation in the program. Nominees are screened by committee, and the TCRP Project J-03 Oversight Panel endorses all selections. Members are appointed to the study team based on their depth of knowledge and experience in transit operations, as well as for their demonstrated advancement potential to executive levels of the public transportation industry. Participation on a mission team is designed to complement and enhance professional development, helping

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to produce managers and leaders capable of dealing with a variety of problems inherent in managing transit activities in a complex environment. Travel expenses for ITSP participants are underwritten by TCRP Project J-03 funding.

Each mission abroad focuses on a theme that encompasses a topic of concern in public transportation. Cities are selected according to their ability to demonstrate leading-edge strategies and approaches to public transportation issues and challenges as reflected in the study mission's overarching theme.

The members of each study team are fully briefed prior to departure. The intensive, professionally challenging, 2-week mission has three objectives: to afford team members the opportunity to expand their network of domestic and international public transportation peers, to provide a forum for discussion of global initiatives and lessons learned in public transportation, and to facilitate idea-sharing and the possible import of strategies for application to transportation communities in the United States. Mission participants return home with ideas for possible application in their own communities. Participants are encouraged to share their international experience and findings with peers in the public transit community throughout the United States.

For additional information about the International Transit Studies Program, please contact Gwen Chisholm-Smith at TCRP (202-334-3246; gsmith@nas.edu) or Kathryn Harrington-Hughes at 443-385-0300 (khh@tcrpstudymissions.com).

ABOUT THIS DIGEST

The following digest is an overview of a mission that explored how bus and rail agencies and operators implement innovative, sustainable funding strategies for transit assets, operations, and maintenance in London and Nottingham, United Kingdom; Strasbourg, France; Karlsruhe and Berlin, Germany; and Oslo, Norway. It is based on individual reports, provided by the mission team members, and it reflects the observations of the team members, who are responsible for the facts and accuracy of the data presented. The digest does not necessarily reflect the views of TCRP, TRB, the National Academies, the American Public Transportation Association (APTA), FTA, or Harrington-Hughes & Associates.

A list of the study team members is included in Appendix A. A list of the public transport agencies and organizations with which the team met is included in Appendix B.

INTRODUCTION

Achieving a state of good repair is a priority for transit agencies throughout the United States. As ridership grows and those riders demand better public transportation service, agency staff seek ways to implement improvements in an environmentally, economically, and socially responsible manner while struggling with funding restraints. Public transportation is increasingly viewed as a necessary and crucial mode of travel in communities of all sizes; ensuring that transit systems are maintained in a state of good repair is more important than ever. In many larger cities, where public transportation has been in place for more than 100 years, the infrastructure is crumbling and the need for reinvestment is clear. In other cities, the need might not be so obvious, but agencies know that they must be proactive in developing a plan to keep the system in a state of good repair.

FTA is taking the lead in developing a common basis for defining, measuring, and reporting on the condition of the nation's public transport vehicles and infrastructure. More than 1,700 public transit agencies exist throughout the United States. Each is at a different stage of maturity, but all are challenged with maintaining a level of outstanding, reliable, and safe service for the public. The challenge lies in identifying the proper level of maintenance to be provided to ensure their system remains in a state of good repair.

At present, there is no universally accepted definition for "state of good repair" for public transit assets; rather, individual transit agencies typically employ their own internal definitions (if they have even adopted a definition), and these definitions can vary appreciably. Most agencies base their definitions either on direct measures of asset condition, such as the proportion of assets that exceed their useful life, or on indirect performance measures, such as the presence of track slow zones.

The ITSP study mission team consisted of transit professionals from large and small systems in communities throughout the United States. The team met with transit operators and regulators in six cities in four European countries to learn how they are achieving and sustaining a state of good repair.

The meetings, presentations, tours, and experiences provided team members with a broad understanding of the history, political structure, operation,

management framework, and performance measurement systems in place at each agency. The systems have much in common with each other and with U.S. transit agencies: quality of service, safety, and cost control, for example, present the same challenges worldwide. On the other hand, many of the conditions underlying the success of transit systems in Europe do not exist in U.S. cities. The political systems, approaches to planning, population densities, and levels of investment in transit in the European systems are dramatically different from those in the United States.

TRANSIT SYSTEM PROFILES

London

Transport for London (TfL) was created in 2000 to serve as the organization responsible for the integrated transport system in London. The primary roles of TfL are to implement the Mayor of London's Transport Strategy and to manage transport services for the city. TfL is responsible for the oversight of London's buses, London Underground, Docklands Light Railway, London Overground, Tramlink, London River Services, and Victoria Coach Station. Other responsibilities include managing the congestion charge (which is aimed at reducing traffic levels in London, with the proceeds invested in improving public transport); maintaining 580 km of main roads and all of London's traffic lights; regulating the city's taxis and private-hire trade; making London's transport more accessible; and promoting a range of walking and cycling initiatives.

London has more than 7 million residents. TfL estimates that it provides a combined total of more than 24 million trips each day. Total annual expenditures for TfL are £9 billion, half of which are funded by fares and half of which are provided by government grants.

The London Underground, under TfL's oversight, carries more than 1 billion passengers per year on its 11 lines, which consist of more than 800 km of track and more than 270 stations. TfL operates the trains, stations, and control centers, as well as sets fare policies and collects the fares. TfL has more than £40 billion of upgrade work for London planned over a 10-year period.

TfL manages the city's bus services, known as London Buses. It is one of the largest bus networks in the world, with more than 8,000 buses in the fleet. The buses are operated largely by private-sector companies and serve more than 2.2 billion passengers per year (see Figure 1). In accordance with the bus operating contracts, the bus fleet is replaced every 3 years, and the fleet includes a large contingent of diesel-electric vehicles to help meet the agency's targets for reducing greenhouse gas emissions. The 3-year replacement cycle is intended to ensure a clean, safe, and state-of-the-art fleet that will attract riders and, thus, increase the bus mode share.

The Greater London Authority sets TfL powers and duties. The Authority consists of the elected Mayor of London, the 25 elected members of the London Assembly, and a team of support staff. The mayor directs policies for London's transport, as well as for its social, economic, and environmental development. The London Assembly examines the mayor's activities, evaluates decisions and policies, approves the mayor's proposed budget before it is submitted, and investigates issues of importance to Londoners. It uses this information to make proposals and recommendations to the relevant organizations.

Figure 1 London's iconic double-decker buses carry more than 2.2 billion passengers each year.

Nottingham

Nottingham is a city of almost 400,000 located in the county of Nottinghamshire, less than 2 hours by train from London. Responsibility for delivering transit service in the region is divided between the county and the city. The county services cover a larger geographical area, while the city has more transit services operating in a smaller area. The city of Nottingham provides 75 million trips annually (35% by bus), and the county delivers 35 million rides per year. The region recently constructed a tram line that traverses the center of the city, and a commuter rail line connects the city to other parts of the United Kingdom.

The majority of bus services in this region are operated on a commercial basis. In the greater Nottingham area, 80% of the network is privatized, while this figure is closer to 97% in the city. The remaining 20% of services in the county and 3% of services in the city, which include services for persons with disabilities and for the elderly, are supported and subsidized by government grants. If there are any underserved areas in the county or in the city, the city or county will subsidize additional service to ensure accessibility to public transport. These subsidized routes may travel on a portion of a commercial operator's routes or operate independently of the commercial operators.

Augmenting the bus network is the 14.5-km tram line that opened for service in March 2004. Nottingham Express Transit (NET) was built to ease congestion, enhance the environment, and improve access within the greater Nottingham area. NET Line One has 24 tram stops and more than 3,000 car parking spaces at five strategically located park-and-ride sites. The system, which operates 7 days a week, carries approximately 10 million passenger journeys per year and has done so since it opened for service. The system is widely popular, with more than 95% of passengers expressing satisfaction with the service. Five years after the inauguration of Line One, public transport use in the city had increased by 8%—twice the average growth for public transport in the United Kingdom over the same period—and traffic volumes had decreased by 1% (see Figure 2).

Funding for public transport in Nottingham and Nottinghamshire comes from several sources, including the following:

- Council tax (property taxes),
- Ticket sales,
- Parking fees (park-and-ride facilities),
- General revenue funds from the city and county,
- Community infrastructure levy,
- Advertising revenues, and
- Central government.

Figure 2 Five years after Nottingham's tram went into operation, public transport use in the city had increased by 8%, and more than 95% of the riders report being satisfied with the service.

Strasbourg

The Strasbourg metropolitan area is composed of 28 communities with a population of 456,000 in an area of more than 300 sq km. The city of Strasbourg has a population of 264,000, which includes 50,000 students at three universities. The delivery of transport is managed by the Communauté Urbaine de Strasbourg (CUS). CUS controls a broad range of urban affairs, which includes urban infrastructure development, town planning, housing, transport, and economic development. CUS does not deliver transport services; however, it regulates it (e.g., through

parking policies) and oversees the transport service provider.

Transport services within the Strasbourg region are provided by the Compagnie des Transports Strasbourgeois (CTS). CTS operates the tram system and the bus network, under a contract with CUS. In addition, CTS is responsible for the maintenance of vehicles and related transport infrastructure.

CTS is 80% owned by the city; the other 20% of the organization is funded through the private sector, which has a financial interest in the success of the city. CTS's contract for delivering the service and maintaining the system extends to 2020. Negotiations to the contract occur only when extensions are planned or implemented. Control of the organization is largely influenced by the mayor, who is the chairman of the board. CTS owns 256 buses and 94 tram vehicles and has 1,454 employees. The assets must be returned to the city at the end of the contract.

In the early 1960s, city leaders made the decision to remove the old wooden trams from the streets and to build up the bus system instead. Soon after, however, the city experienced an enormous increase in congestion as the privately operated automobile, rather than the bus, became the major form of transportation. In 1989, planning began for a system of modern trams that would regain a role in the region's transportation plan. During that year's mayoral election, the successful candidate won on a platform of bringing trams back to the city and creating a pedestrian-only zone in the city center. Today, the city's tram network is the largest of any city in France.

The first tram line, which opened in November 1994, ran north and south. The second line opened in 2000, running east and west. The tram system is currently 54 km long and connects with more than 12 park-and-ride facilities that offer more than 5,000 parking spaces. The system has 70 tram stops. Currently, 300,000 daily trips are taken on the tram—10 times the number originally expected—and the number is expected to rise to 500,000. City leaders insisted on modern-looking vehicles with wide, unique windows. The vehicles are low floor to ensure easy access for passengers with disabilities (see Figure 3). The vehicles are maintained at one maintenance depot. After 11 years and 600,000 km, the trams undergo a major refurbishing.

Dedicated bus lanes are prevalent through the city, which contributes to the efficiency of bus operations. Local buses share passenger platforms with the tram lines, providing easy and convenient connections for the passengers. Platforms are equipped with real-time information displays and ticket-vending and validation machines.

Figure 3 Strasbourg's trams were designed to have very large windows to provide passengers with a wide view of the city and to have low floors, ensuring easy access for passengers with disabilities and passengers pushing strollers or carts.

CTS has initiated a program to modernize its bus fleet. The average age of the fleet is 7 years. About 95% of the bus fleet is air conditioned, and 95% are low-floor vehicles. Forty-three percent of the fleet (109 buses) run on compressed natural gas (CNG). In 2009, CTS added 28 articulated hybrid buses (electric/diesel) to the fleet.

Karlsruhe

The Karlsruhe Transport Authority, Karlsruher Verkehrsverbund (KVV), operates public transport services in the greater Karlsruhe area in southwestern Germany. Several modes are operated by KVV including light rail, trams, and buses. Overall, the KVV provides more than 160 million trips per year.

KVV is known primarily for its tram-train system, operating since the early 1990s, in which one set of tracks and related infrastructure are used by both tram and train. This model allows for enhanced direct connections between cities and towns, making interchanges unnecessary. To implement this ambitious plan, Albtal-Verkehrs-Gesellschaft (AVG) designed and manufactured a "dual-mode vehicle" that functions on both the tram and the rail network. The direct

Figure 4 Karlsruhe's tram-train is a dual-mode vehicle that can be run on tram and train tracks and on AC and DC power, allowing for direct connections between cities and towns and reducing infrastructure costs.

connection between these two modes allows for lower infrastructure costs (see Figure 4).

The tram-train system covers 530 km of tracks and has more than 260 light-rail vehicles. Of the 260 vehicles, 121 of these are tram-train cars. These "hybrids" operate on dual modes, allowing them to switch between direct current (DC), which is used when they operate as part of the tram network (generally inside the city), and alternating current (AC), which is used when they operate as part of the train network (generally outside of the city). Changeover between the two modes is seamless and relatively undetectable to passengers.

The tram-train has features that allow it to operate with greater flexibility than other types of rail services. The high acceleration and short-distance braking features allow the tram-train to stop frequently without affecting travel times. An example of this can be seen in the town of Bretten, population 28,000, which prior to the introduction of the tram-train had only six railway stops. With the introduction of the tram-train, the number of stops increased to 13, allowing greater accessibility to the town center, schools, and industrial and residential areas. The system has done so well that it is being adopted in other areas of Germany and is even being considered for operation in Strasbourg, France.

AVG is owned by the city of Karlsruhe and the non-state-owned railway company (NE-Bahnen). AVG operates light-rail services in cooperation with the Verkehrsbetriebe Karlsruhe (VBK) as the local tram operator and with the federal railway company Deutsche Bahn AG. Segments of the railway tracks are leased from Deutsche Bahn AG. This arrangement allows AVG to adapt the infrastructure to the needs of the tram-train operation model.

Berlin

The Berliner Verkehrsbetriebe (BVG) is the main public transport company of the city of Berlin. BVG manages the city's U-Bahn underground railway, the tram system, the bus network, and the ferry networks. The BVG service does not include the S-Bahn urban (commuter) rail system, which is a subsidiary of Deutsche Bahn AG. BVG primarily serves the city of Berlin, which has an area of approximately 891 sq km and a population of 3.4 million. Approximately 900 million trips per year, or 2.5 million trips per day, are generated.

The current configuration of the BVG system was very much influenced by World War II. After the war, when the city was divided, East Berlin became the capital of East Germany, while West Berlin became a de facto West German exclave, surrounded by the Berlin Wall. During this period, the BVG networks in West Berlin and East Berlin were operated separately as BVG West and BVG Ost (which in 1969 was renamed the Kombinat Berliner Verkehrsbetriebe, or BVB). Prior to the division of Berlin, tram lines had provided service throughout the city; by 1967, however, BVG West had abandoned the tram lines in its part of the city, replacing them with buses. BVG Ost kept its tram lines in East Berlin.

With reunification of the city, the two agencies faced major obstacles in linking Berlin transport. Bus lines were added to fill service gaps in the train and tram networks. Despite the challenges, the public transportation systems worked for a resolution, and, at the start of 1992, the two transportation agencies became Berliner Verkehrsbetriebe (BVG).

The focus of BVG became the introduction of uniform standards. The company underwent an unprecedented modernization program in which technical innovation took center stage as massive investment was directed toward improving aging infrastructure. Part of the modernization process included reductions in BVG's workforce. Between 1994 and 2009, the number of employees was cut by 40% from 21,811 to 13,017. These reductions took place while BVG was optimizing the transportation

network and reducing service by 8%. BVG has now completed a period of comprehensive restructuring and reforms. These reductions in personnel allow BVG to cover labor costs (exclusive of benefits) with fare revenues.

At the start of 2008, BVG and the state of Berlin signed a 12-year agreement, which secures the company's existence until 2020. With this stability, BVG can undertake long-term planning and development. Metro, tram, bus, and ferry services are commissioned by the state of Berlin. BVG is the only provider of these services. BVG's quality of service is continuously checked against the benchmark set in 2007, before the signing of the long-term contract. BVG is subject to the terms of the contract with the city and federal regulations. For instance, BVG has established preventive and corrective maintenance schedules for all its vehicles; in addition, there are strict rules that establish the need for overhaul or heavy maintenance after a number of miles or for special purposes (e.g., improved accessibility).

Oslo

The organizational structure for implementing and delivering public transport in Oslo is complex. Ruter AS is the administrative agency that manages public transport for the city of Oslo and the surrounding Akershus County. It is organized as a limited company that oversees bus, metro, trams, and ferries. The agency also holds special agreements with Norges Statsbaner for fare regulation on commuter trains operating in the area. In addition, Ruter AS is responsible for administrating, funding, and marketing public transport. Ruter AS, with 130 employees, is owned by the City of Oslo (60%) and Akershus County (40%).

Kollektivtransportproduksjon AS (KTP) is a public transport operator that is wholly owned by the city of Oslo. KTP was established in 2006 and since 2008 has operated under contract with the public transport authority Ruter AS. KTP operates and maintains the Oslo Metro and Oslo Tramway. In addition, KTP is responsible for rail infrastructure in Oslo. The Oslo Metro is operated by the subsidiary Oslo T-banedrift, while the Oslo Tramway is operated by the subsidiary Oslo Oslotrikken AS. KTP also owns UniBuss, which was awarded several of the public service obligation bids for bus service in Oslo and Akershus. At the end of 2009, KTP had approximately 3,300 employees.

Overall, transit accounts for more than 50% of the modal choice in the region. More than 252 million trips occurred in 2009, split as follows:

- Bus network: 42%,
- Metro system: 30%,
- Tram lines: 17%,
- National Railway: 10%, and
- Ferry: 1%.

Funds for both operating and capital expenditures come from various sources, including ticket sales, congestion pricing, national government, and local government. Farebox revenues cover 55% of the funds required to operate and maintain the system; the difference is made up by grants.

DEFINING AND MEASURING A STATE OF GOOD REPAIR

Investments in infrastructure maintenance have lagged in a large number of transit systems in the United States. Many American public transit systems have difficulty obtaining sufficient funding to maintain their assets in a state of good repair. A major focus of this study mission was to look at how the various European transport systems maintain their transit assets, how they manage funding for such investments, and what best practices can be gleaned for potential application in the United States.

A number of the host agencies shared how maintenance standards are established for their transport systems. In general, thresholds for these standards are established by law, by the operating agencies, or a combination of both. Depending on the asset class (e.g., rolling stock, track, etc.), standards can be established by national and sometimes European standards. These standards can also result from input and benchmarks provided by the manufacturers and suppliers.

The definition of "state of good repair" is fairly consistent among the authorities visited: an asset is considered in a state of good repair if it is safe, reliable, and keeps the customer satisfied. Maintaining a state of good repair, however, involves a constant process of assessing an asset's residual life and balancing that against costs. An assessment can be based on a variety of factors: government regulations, laws, manufacturer's recommended maintenance plan, age, performance, distance traveled, inspections, and experience. Experience is gained in collaboration with the manufacturer, other asset owners, and daily prac-

tices and observations. Implementation of needed repairs versus replacement is dependent on cost and availability of funding or, as in the case of third-party operators, profit.

In the United Kingdom, governmental and statutory bodies establish and set requirements that need to be met for certain asset areas (e.g., escalators). In other areas (e.g., fleet maintenance), no benchmarks are established by law.

Transport for London has a structured methodology for determining the state of good repair for all assets. Although different criteria may apply to the various categories of assets, the methodology remains the same. Three steps occur in the review: condition assessment, life costing, and risk analysis.

A *condition assessment* is performed to determine the residual life of the asset. Condition assessment standards are developed by TfL's engineers and are based on discussions, surveys, experience, and benchmark information obtained from consultants, original equipment manufacturers, and engineering universities. At a minimum, TfL must comply with the requirements established by the British Standards Institution (BSI). The specific category of asset will also be broken down into a hierarchy of components. Each subcomponent has its own expected and residual useful life, which impacts the whole. Additional factors that impact the condition assessment are availability of parts (obsolescence); risk code (crucial to the asset's performance); and ambience. (Ambience became a factor as a result of customer feedback and expectations.) The results are rolled up into a final residual life expectancy.

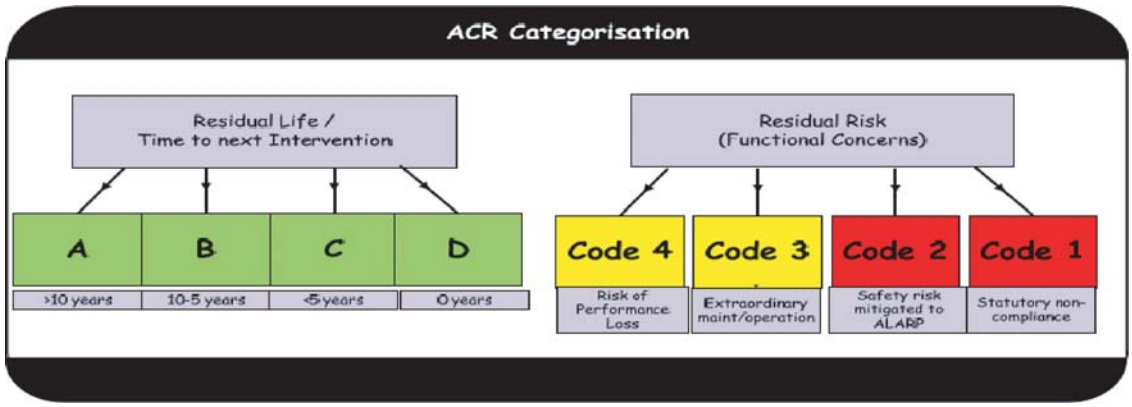
The next step is *life costing*. TfL determines the cost for the remaining life of the component and the entire asset. This includes labor and material costs for maintaining the component over the expected useful life of the entire asset (e.g., 40 years for a passenger rail car).

The final step is a *risk analysis,* which determines whether the component will be maintained, replaced in kind, or upgraded. The results of residual life and life costing are compared with performance risks—measures such as customer journey time, lost customer hours, compliance, extraordinary maintenance, and safety factors. Figure 5 illustrates this final step.

TfL's risk analysis for buses showed that it was less expensive to retire buses at 3 years of age than to maintain them for the general useful life of 9 to 12 years. The current policy is thus to sell 3-year-old buses, which usually are purchased by systems in other European countries or in South American countries. The average cost of a new bus is €100,000 (about $160,000). This replacement program is supported by funding generated from congestion pricing.

TfL estimates it has a €1.5 billion backlog of repair and replacement work necessary to regain a state of good repair. It anticipates the work will be completed in approximately 22.5 years. Currently, 89% of the assets have at least 1 year of life remaining. A satisfactory state of good repair is achieved when a percentage of assets have greater than 5 years of residual useful life.

Nottinghamshire provides tram and bus service for a total of approximately 1.8 million trips per year. The tram system opened in 2004, so the infrastructure assets are fairly new and in a state of good repair. The buses are operated and maintained by a third party. In general, authorities that have entered into operating and/or maintenance agreements with third parties are



Source: Richard Moore, presentation on "Asset Management Development," June 14, 2010.

Figure 5 Comparing residual life of an asset to performance risks.

cautious in sharing performance and cost data due to the competitive nature of the contracts. Such operating agreements are prevalent throughout Europe, especially with bus services.

Transit authorities segregate social, branding (marketing), and profit responsibilities. Financial responsibilities for operating and maintaining the assets are passed to the third-party operators, while the authority focuses on social needs and requirements and monitoring the operator. Performance standards and requirements are stated in the contract. These are usually tied to reward and penalty fees. In general, standards are developed based on regulatory requirements, such as those set by the BSI, and the European Union's expected useful life and safety standards.

Independent traffic controllers, as well as the authority's engineers, perform periodic inspections. The purpose of these inspections is to monitor actual performance against standards, compliance with contractual performance requirements, and condition assessment of the asset. The authority's engineers perform random inspections every 4 weeks, as well as oil analysis, inspection of spot failures, and annual vehicle tests that include a review of the maintenance records. Independent traffic controllers also define, manage, and investigate performance measurements in accordance with European standards.

In general, buses have an expected life span of 12 years or about 600,000 km. Once they reach this threshold, the buses are passed down to the school system, where they are operated for short periods in the morning and the afternoon, allowing for daytime maintenance work. The buses are used in this capacity for another 12 to 13 years. Although these are the general asset life parameters, the age of the fleet is determined solely by the commercial operator. Also, the operator may determine that a route or service is no longer profitable and request release from the contract. The main indicator for determining whether service is viable is cost per head.

In France, the trams and related track in Strasbourg are maintained by a third party. The decision whether to repair or replace an asset is profit driven and must first be presented to CUS for approval. CUS makes the decision as to whether the operator should continue maintaining the asset or whether the owner should replace the asset. Because the operator is working in a competitive market, not all data are shared with the owner; much of the data are protected and confidential.

All assets are tracked and monitored and are to be turned over to the authority at the end of the contract. At that time, the equipment will be inspected, as it must meet certain useful life and reliability conditions prior to the turnover. Currently, the operator spends approximately €4 to €5 million per year to maintain a 17-year-old fleet of 26 trams (94 cars), 54 km of track, and 59 stations. The initial expectation was that the track was "built to last forever"; however, that soon changed to a realization that the track required maintenance, particularly in the areas where four or five rails cross.

The operator began developing a formal maintenance plan in 2010. Work is under way to develop maintenance cycles with other companies. The intent is to compile information on their experiences and to share which processes work and which do not work. Due to the competitive nature of the market, however, the shared information tends to gravitate toward the latter (i.e., what does not work). Repair cycles fluctuate among the group. The information is updated annually, accelerated and deferred scenarios are analyzed, and each scenario is compared with the original cost. There is no final answer yet.

In some cases, responsibility for maintaining a state of good repair is passed to the supplier via warranties or insurance—for example, the supplier of the propulsion system inspects the component(s) at the end of its useful life and determines whether maintenance was performed as required.

The bus facility handles all levels of work including repair, rehabilitation, cleaning, and painting. Subcontractors are available when needed, but only the seats are subcontracted out on a regular basis. Buses are considered beyond their useful life at 12 years or 600,000 km. At 480,000 km, the buses undergo major repair: all crucial control components are changed out, upgraded and modernized parts are installed, and the bus's interior is painted. The bus shop facility maintains a 1-year supply of parts, with the exception of parts for the newer buses manufactured in Poland; parts for those buses are ordered as needed directly from the manufacturer and are received within 3 days. Buses are cycled into the shop weekly, and on average 12 buses are repaired each day. Maintenance practices are scheduled at 1,000 km, 5,000 km, and 10,000 km. An automated system monitors maintenance-level requirements and distance traveled. Buses are rotated among the routes as needed to maintain an even level of use (mileage).

Germany also establishes standards and benchmarks for certain asset classes similar to those used in the United Kingdom. For example, for rolling stock, the standards for reconstruction are governed by German law, which requires a renewal every 8 years. Other standards are set by suppliers and by industry standards.

In Karlsruhe, equipment replacement cycles are generally 30 years for trams and 15 years for buses. All requests for replacement must be accompanied by cost-benefit analyses. Three basic criteria must be met: an increase in ridership, a reduction in building and maintenance costs, and an increase in production.

Asset conditions are monitored using SAP software. Condition assessment criteria are lengthy and are prioritized. In general, the many maintenance items are grouped into intervals of 5 and 10 years. Major repairs are performed at a separate facility. Drivers perform tram and track condition assessments while in service and provide immediate feedback to the control center. Track and mobile teams perform repairs for failures in the field. Minor repairs are performed at the shop: trams are repaired, cleaned, and sent back out in 40 minutes. Maintenance costs are also supported via vendor warranty, time and material contracts, and insurance.

BVG in Berlin faces a major challenge to bring its assets up to a state of good repair. On the tram side, deferred maintenance needs total almost €26 million; on the metro side, the amount ranges from €60 million to €90 million. All stations also require improvements to meet standards; upgrades will require more than €500 million over a 10-year period.

BVG has a formalized maintenance plan with various categories and level of repair. There are three basic categories and five levels of work. The categories are as follows:

- Preventive maintenance (periods depend on mileage);
- Corrective maintenance (repairs, accident reconditioning, cleaning/repairing acts of vandalism); and
- Reconstruction (as established by legislative body and to meet passenger needs).

The levels of repair are as follows:

- Level A: Visual inspection (under the vehicle and laterally) for damage by external factors (ground contact or foreign matter), as well as on fixed bearings, safety devices, and tightness of all elements and pipes and wires under the car body.
- Levels B and C: Execution of maintenance works (clearing, lubrication, adjustments) and work on particular components and measurements on the cars.
- Level D: Maintenance and inspection work, work on the bogies, and a check of the gearboxes on a test stand.
- Level E: Major modernization and renewal based on German law (BOStrab) after 8 years of operation or 500,000 km. Renewal of elements of bogies, drive propulsion, controllers, parts of the car body, and the interior.

In Oslo, KTP has a comprehensive maintenance plan for regular maintenance and long-term replacement strategies. It is managed through a software program (IFS) that tracks all assets by components. Work orders are created for the planned maintenance and inspections that include condition assessment. Every time a new project is implemented, the last phase of the project requires that the team create and key in a plan for maintenance, including rehabilitation and replacement.

KTP manages an infrastructure planning group to review the different priorities of work generated. The group looks at all requests for projects and considers safety, functionality, and politics. This group is influenced by operations, maintenance, and, of course, the owner—the city. It can recommend penalties if the service is unsatisfactory.

Assets owned and operated by KTP are inspected daily. More detailed inspections are performed every third year. Rail is inspected twice each year. Similar to other European transit authorities, KTP has noted that the transit industry lacks standards such as those found in the aviation industry. KTP is dependent on its multidisciplinary teams to review operating maintenance issues and to recommend corrective action plans. A technical rules division develops guidelines for condition assessment. These rules guide daily maintenance requirements and short-term projects. Larger infrastructure needs are scoped, planned, and presented to the county for review, approval, and funding support.

KTP is currently focused on a 20-year, €9 billion expansion project and a €500 million backlog of maintenance and state-of-good-repair work. This includes transitioning the fleet to comprise heavier equipment and converting catenary-provided power

Figure 6 KTP list of maintenance upgrades includes converting catenaries to third-rail power for its extensive tram system.

to third-rail-provided power for operational flexibility and consistency with existing operations (see Figure 6).

PRIORITIZING CAPITAL INVESTMENTS

One would think that priority setting for capital investment would be intuitive, with priority for renewal and maintenance assigned to assets that are in the worst condition and that have the greatest risk of operating failure. This is not necessarily the case, however, at the transport systems visited by the ITSP team.

In London, the priorities set by TfL are, on a broad level, defined in the Mayor's Transport Strategy. The Transport Strategy establishes six key goals for improving the city's transport services over the next 2 decades, as follows:

1. Support economic development and population growth,
2. Enhance the quality of life for all Londoners,
3. Improve the safety and security of all Londoners,
4. Improve transport opportunities for all Londoners,
5. Reduce transport's contribution to climate change and improve its resilience, and
6. Deliver services for the London 2012 Olympics and secure a lasting legacy.

These priorities have forced TfL to come to terms with its funding issue with the government. In order to expand the capacity of its surface transport system, TfL must aim to achieve and sustain a state of good repair—for example, the London Underground's Annual Asset Management Plan, as agreed to by TfL and contractors operating under public-private partnerships, sets forth how investments are to be made. The prioritization process, to a large extent, is transferred to the public-private partnership contractor. TfL sets the benchmarks for performance, and the contractors make investments in renewals and maintenance that will allow them to meet those benchmarks.

The Nottingham story is one of need bringing dreams to reality. In 1988 the Nottingham City Council, along with the Nottingham County Council, realized that drastic transportation changes were necessary if the area's economy were to grow and expand. Faced with an aging transport system, road congestion, and ever increasing pollution, it was evident that something new and of major proportion had to be done—and that a huge sum of funds would be required.

In 1994, the two councils presented their plans to the British Parliament. After extensive and lengthy deliberations in both the House of Commons and the House of Lords, the Greater Nottingham Light Rapid Transit Act was passed in 1994. There was still much, however, that the two councils had to accomplish before the tram system could be built.

Needing a tremendous amount of money to design and build a system that would solve the major issues facing the area, the two councils turned to private industry to design, build, and operate a new tram system. They selected Arrow Light Rail to receive the concession to operate the tram and Arrow Funding as the company to finance the building of the tram. This was done by Arrow Funding securing a private finance initiative (PFI), which was backed by the national government.

At BVG in Berlin, investment priorities are set mostly through negotiations. At a high level, the transportation system has a list of programs and projects it wants to advance. The public transport system receives a fixed amount of funding from the city. BVG submits justifications for the projects that it wants to invest in. Through negotiations, the prioritized list of projects is established. Although the system is funded through an annual budgeting process, a 4-year plan for capital improvements is established with the city (see Figure 7).

In Oslo, KTP undertakes a reinvestment assessment. Prioritization of projects is based primarily on inspections and, to some extent, politics. On the methodical and technical end, a technical team develops standards for asset classes. At the political end, KTP, working with its tram and metro operating contractors, determines priorities for projects.

KTP is responsible for the strategic planning and, thus, the prioritization for transportation services for the city. Its counterpart, Ruter, is responsible for the administration and funding of the system.

Figure 7 BVG evaluates and maintains its assets based on both technical and operational reliability. All assets are inspected annually.

FUNDING FOR PUBLIC TRANSPORT SYSTEMS IN EUROPE

Funding for public transportation has always been a major challenge, whether here in the United States or abroad. In the United States, funding for capital and operating needs derives from various sources, with capital funding available at the state and federal levels. Funds for operations derive from fare revenues, but must be supplemented by other sources, which include local sales taxes, property taxes, state subsidies, parking fees, and other concession charges.

For the European systems visited by the ITSP study team, funding options are similar, but fare receipts do play a larger role and pay for a larger proportion of these systems' operating costs than do fare receipts in the United States. For example, fares support 50% of TfL's annual expenditures. In Nottingham, more than 90% of the trips within the city are run privately, requiring no grant subsidies or public dollars. Only school trips and trips for persons with disabilities or above a certain age are subsidized and paid with government grants. Fare policies are generally established by the oversight or managing agencies, even if the service is privately run. For BVG in Berlin, fare receipts generated are enough to cover more than €500 million of personnel costs, and in Oslo, fare revenues cover 55% of its operations.

Due to the current worldwide economic downturn, spending is being reduced at the national levels. In the United Kingdom, transit systems enter into multiyear "funding settlement" schedules with the central government, similar to full-funding grant agreements or the multiyear transportation authorization legislations in the United States. In light of austerity programs that are being considered across the European continent, reduction in spending has already begun for many programs and projects.

The findings regarding funding and finance for state of good repair in the European transit systems can be summarized in four broad themes:

1. **Funding for a state of good repair is a universal challenge.** Countering team members' preconceived notion that because European transit systems are more well developed and heavily used than their American counterparts, they must be well funded and in a state of good repair. Staff at the

agencies that the mission team met with described backlogs of deferred maintenance and/or funding shortfalls for their capital programs.

2. **A wide variety of funding sources and structures support transit capital programs.** These include national, regional, and local taxes; fares; tolls; and private capital investments in public-private partnerships. Gas taxes are not a major funding source for public transportation in the countries visited by the study mission.

3. **National governments play varying roles in funding maintenance for a state of good repair.** Despite the common perception that governments in Europe play a more active role in national life compared with the United States, the national governments in three of the four countries visited by the mission (the United Kingdom being the exception) play very limited roles in funding transit services, particularly capital programs to achieve and maintain a state of good repair. Most of the funding sources mentioned above resulted from local or regional, rather than national, initiatives.

4. **The results from privatization of transit capital programs are decidedly mixed.** Public-private partnerships have been employed to finance, design, build, operate, and maintain transit systems in Europe, especially in the United Kingdom, but the results have ranged from exemplary success to calamitous failure.

In the United States, federal and state gas and diesel fuel taxes provide much of the funding for transit state-of-good-repair needs. In Europe, in contrast, gas taxes are typically treated as a general revenue source for national governments and are not a major funding source for transit, even though gas taxes in Europe are far higher than in the United States. Instead, European transit agencies maintain their systems with a wide variety of funding sources and structures including national, regional, and local taxes; fares; tolls; and private capital investments in public-private partnerships.

London is well known for its congestion charge—a toll assessed on drivers who cross into a defined district in the central city. Introduced in 2003, the congestion charge was extended into West London in 2007. The toll now generates approximately £140 million annually in net revenues. Certain vehicles are excluded from paying the fee including London licensed taxis, motorcycles, and bicycles. Residents who live within the zone receive a 90% discount. Eighty percent of the profits are allocated to bus operations and maintenance. The city's 9,000 buses are operated and maintained by about 20 private companies that contract with TfL. The remaining 20% of the congestion toll revenues are dedicated to "green initiatives" such as replacing diesel buses with hybrid models.

In addition to providing a major source of funds for the transit system, the charge has reduced congestion in the center city by 30% and traffic by 22%. Nonetheless, the current city administration is moving to reverse the 2007 expansion and to halve the size of the district where the charge is imposed. The revenue impact would be partially offset by increasing the charge from £8 per day to £10.

In Nottinghamshire, capital projects are largely funded by central government grants. In order to increase mobility for low-income and transit-dependent populations, Nottingham and the county contract with private operators to provide services that would not be provided by the free market. Under the contracts, government subsidies pay for reduced fares for the target populations. The subsidies may take the form of providing government-owned buses for use by the operator (who still maintains the buses).

Maintenance of buses is funded almost entirely by fares collected by the private bus operators that provide all bus services in the region. Under the United Kingdom's deregulation law, any licensed operator can offer transit services. The high cost of driving in the country leads to a different calculus of mode choice than that of U.S. commuters, allowing operators to charge fares that cover all of their costs for commuter services, including maintenance of privately owned buses.

In France, the *versement transport,* a payroll tax paid by public- and private-sector employers with more than 10 employees, provides roughly half of the funding for construction, operations, and maintenance of transit systems. Started as a pilot in Paris in 1971, the tax was expanded to districts, called Public Transport Agencies, that encompass most large- and medium-sized cities in the country. The tax rates vary by region, ranging from 1% to 2.6% of payroll. Tax revenues totaled about €5.5 billion nationwide in 2007, but more recently, revenues have declined due to the economic downturn while state-of-good-repair needs for transit systems have continued to increase. Expanding the *versement transport* to additional regions would yield diminishing returns as 80% of the wages in the country

are already subject to the tax. Proposals to increase rates and/or extend the tax to smaller employers are under consideration.

In Oslo, transit capital needs are funded by a combination of fares (the fare recovery rate is an impressive 55%); local government subsidies; and toll revenues from a series of toll packages. Since the 1980s, Oslo has implemented three toll packages. Package 1 introduced tolls on the ring road around the city to generate NOK 11 billion ($1.7 billion) for road and tunnel projects. Package 2 increased tolls and added a NOK 0.75 ($0.12) surcharge to transit fares, which raised NOK 15.6 billion ($2.5 billion) for transit expansion projects. Package 3 will provide NOK 58 billion ($9.2 billion) for a combination of road and transit expansion projects (including the costs for unfinished projects from Package 2) over 20 years (2008–2027). Tolls will generate NOK 45 billion, with the remainder coming from central and local governments. About half of the funding in Package 3 will be dedicated to transit projects.

The toll packages, in addition to raising funds for infrastructure improvements, have several other objectives, as follows:

- Reduce congestion;
- Increase use of transit, bicycling, and walking;
- Reduce greenhouse gas emissions, air pollution, and noise pollution;
- Reduce fatalities and injuries from traffic accidents; and
- Increase access and mobility.

The goal of reducing congestion presents a paradox—the more successful the tolls are at reducing automobile use, the less revenue they generate. The current economic downturn has further reduced traffic and toll revenues, leading to a need for increased support from the city government.

Finally, it is worth noting that while the tram-train model in Karlsruhe is not a financing scheme per se, this German innovation does allow for lower infrastructure costs since one set of tracks and related infrastructure are shared by two modes, the tram and the train. Not only does this lower infrastructure costs, but it also reduces the cost of acquiring rolling stock, since these specially designed vehicles can operate in dual modes. This model also has encouraged development in smaller cities and towns and has provided direct connections to these jurisdictions.

PUBLIC-PRIVATE PARTNERSHIPS

With interest growing in the United States for public-private partnerships (PPPs) and other privatization options for transit services, the study mission had a particular interest in learning how these tools have been implemented in Europe. Private-sector service contracts and PPPs are used extensively in the United Kingdom and, to a lesser extent, in Oslo to finance, design, build, operate and maintain, and rehabilitate transit systems, with a varying range of results. U.S. transit managers considering PPPs for their state-of-good-repair programs would benefit from studying the European experiences.

Most private-sector involvement in transit is through operating contracts similar to those widely used in the United States, particularly by smaller operators. In London, Nottingham, and Oslo, buses are operated and maintained by private operators who generally receive fare revenues and a subsidy from the responsible government agency based on the performance of measures spelled out in the contract such as ridership, on-time performance, and cleanliness of buses. The buses may be owned by either the government agency or the private operator, but the operator is typically responsible for maintaining the vehicles to standards set in the contracts. None of the transit agency staff with whom the study team met with reported any serious issues with this type of contract.

Nottingham undertook a unique approach to secure a PFI to finance the design, construction, and maintenance of NET Line One. The Nottingham City Council and Nottinghamshire County Council jointly awarded a concession to a consortium of companies operating as Arrow Light Rail, Ltd., for a period of 30.5 years—3.5 years to construct the line and 27 years to operate the service. Unlike most PPP projects that are solicited after preliminary engineering, the final design right-of-way acquisition and permits were completed and approved before seeking the contract. This method eliminated risk of the project stalling due to community discontent.

Arrow issued private debt and contributed investor equity that covered 90% of the £200 million capital cost of constructing the 14.5 km Line One route. The debt received credit support from the central government through the PFI—the largest PFI ever employed for a local project in the United Kingdom.

Arrow also let a contract to the Nottingham Tram Consortium (NTC) to operate and maintain the system for 27 years. NTC is a partnership of Transdev, a private company, and Nottingham City Transport, a city governmental agency. NTC receives all fare revenues as well as performance payments from the city to repay Arrow's debt and investors. NTC also sets the fares. The performance payments are based on the amount of service provided.

The contract with NTC also specifies maintenance standards for the system. While it is too early to assess the effectiveness of the contract in keeping the tram in a state of good repair—Line One opened for service in 2004—the city staff who met with the study team expressed satisfaction with the results to date. Two additional lines for the system are in the planning stages.

The attempt by London Underground to manage its state-of-good-repair program through PPPs provides a more cautionary tale. The city agency issued three PPP contracts in 2002 and 2003 to two private infrastructure companies (infracos) for maintenance and renewal of the entire underground system. Each contract covered a bundle of routes in a geographic sector of the city. London Underground staff continued to operate the system.

The contracts were issued for 30-year terms, with renewal options for both the city and the contractor every 7.5 years. At each renewal point, costs and performance measures for the next 7.5 years could be renegotiated. The infracos received fixed payments from the city with bonuses or penalties for performance on several measures including improving the reliability, capacity, travel time, cleanliness, and quality of underground services. The contract specified targets for each measure. If an infraco exceeded the target, it would receive a bonus on top of the fixed payment; if it failed to meet the target, it would be penalized with a deduction from the base payment.

The means of meeting the performance targets was left up to the infracos. The contract did not specify what work needed to be done. For example, to meet a target to reduce travel time on a particular line, the infraco could elect to replace the rolling stock, upgrade the power or signaling systems, or perform rehabilitation work on the tracks.

The completely performance-based nature and sheer scale of the contracts was unprecedented in the transit industry. For London Underground, the PPPs offered the promise of improved system performance while limiting the city's liability and eliminating most of the uncertainty inherent in capital planning by shifting most of the risk of unanticipated costs to the private sector. However, results were not positive.

Metronet, the infraco for two of the PPP contracts, went bankrupt in 2007. When attempts to sell the company failed, it was bought by Transport for London, and the work that was to have been performed under the contracts was brought back in house, with responsibility given to London Underground.

The remaining contract, with Tube Lines, was terminated at the first renewal point. London Underground and Tube Lines were €2 billion apart in the negotiations over costs for the second 7.5 years. The dispute went to arbitration, where the arbitrator split the difference and ruled that €1 billion of the cost increase sought by Tube Lines was justified. However, the total was still €1 billion more than the city was willing to pay and €1 billion less than the infraco was willing to accept. The decision to terminate the contract was a mutual one.

London Underground is currently working to absorb the work that had been assigned to Tube Lines, as it did with the Metronet work, which is resulting in major costs for the city. The agency had completely reorganized itself to manage the PPP contracts instead of performing the maintenance and renewal work, and it is now having to reverse itself. Engineering and maintenance staff that had left the city to work for the infracos are being rehired. The Tube Lines contract also included a £310 million termination charge.

London Underground staff attributed the failure of the PPPs in part to the inability of the infracos to accurately project the costs of meeting the performance measures and to manage their costs to keep them within budget. Metronet waited until it was €1 billion over budget before seeking additional funding through a change-order process known as "extraordinary review," at which point it was too late for the company to recover.

From the city's perspective, the extraordinary review process was intended for truly unforeseen and unforeseeable costs. By agreeing to retain some of the risk for unknown costs, the city hoped to limit the amount of risk premium that was included in the performance payments, but it became apparent in the negotiations that the infracos' business plans relied on extraordinary review to recover costs that they could

not cover through the negotiated performance payments. This approach, which virtually guaranteed that the city would incur costs above and beyond the performance payments and bonuses, ultimately proved unacceptable to the city.

POLITICAL AND COMMUNITY INVOLVEMENT

In general, national policies authorize funding sources for transportation, but the impetus for the laws comes from local or regional initiatives, and the work to develop political support for the measures and to implement them is performed by local stakeholders. The national governments in three of the four countries visited by the study mission play very limited roles in funding transit services, particularly capital programs to achieve and maintain a state of good repair. In France, Germany, and Norway, the central government focuses on intercity and high-speed rail and provides only a small percentage of the funds for operating and maintaining local and regional transit services.

In Germany, cities and states provide most of the funding for state-of-good-repair needs. In France, the *versement transport* payroll tax is established and administered regionally by the public transport agencies. The tax rate is limited by national law, but is set within the national limits by the public transport agencies, which function somewhat like metropolitan planning organizations in the United States (except in Paris, where the rate is set by the national government).

Similarly, the toll packages in Oslo were authorized by national law, but regional officials and other stakeholders in Oslo initiated the proposals, lobbied for their enactment, negotiated the combination of projects needed to win sufficient support, and implemented the measures.

In contrast, the central government in the United Kingdom plays a major role in funding transit services. A central government grant of €40 billion ($61.6 billion) over 10 years will cover about half of Transport for London's operating and capital costs. In Nottinghamshire, central government grants fund nearly all major capital projects and many minor ones.

However, unlike the United States where federal fuel taxes support FTA programs that provide much of the funding for building and maintaining transit systems, the United Kingdom has no dedicated revenue sources or ongoing funding programs for transit capital projects. Transit needs compete with other government-funded programs for general fund support on a year-by-year basis.

Small (under €5 million) projects compete at the local level to be included in the Local Transportation Plan, and the Local Transportation Plan competes with other local needs, such as human services, for a share of an allocation from the central government's general fund. The size of the allocation depends on the region's performance against targets for a set of national indicators such as ridership and rider satisfaction. The indicators are standardized across the country, but local agencies set the targets and regional officials review them.

Larger projects compete at the national level based on performance measures, such as increasing ridership or reducing travel times, for the percentage of project costs that will be covered by local funds. The process for the largest projects—such as London's £40 billion operating and capital grant or a major station project with associated real-estate development—is more politicized, with each grant essentially a one-time deal negotiated between project proponents and lawmakers.

TRAINING AND PERSONNEL

As a standard definition of state of good repair is up for debate and the field of state of good repair in the transit industry is still an emerging one, the industry needs training programs developed to bring more precision, rigor, and consistency to the task.

Many U.S. transit agencies, large to small, have developed robust training programs for their maintenance providers, but there are agencies that haven't yet developed adequate training programs with an emphasis on maintaining a proper level of state of good repair. Most agencies train maintenance staff to adequately perform preventive and corrective maintenance on rolling stock and safety-critical assets, but the training of staff to maintain facilities to extend the service life and reduce costs is frequently overlooked.

Contrary to practice at most transit agencies in the United States, many European agencies contract services out to third parties. The agreements set forth performance and maintenance standards, and the contractors decide that their finances are best served by maintaining their assets in a state of good repair.

In London, training on how to maintain the system relies on the contractors who are financially liable for the assets under their purview. It is the same in Nottinghamshire: the contractors that have entered into operating and/or maintenance agreements are responsible for maintaining their assets in a state of good repair and are therefore responsible for training their staff, with the corporate headquarters of each contractor determining the proper level of training.

KVV in Karlsruhe has an apprenticeship program that provides training in the job skills required to maintain the tram system. Manufacturers are responsible for training staff in any new technologies installed on their trams and also for providing continuing education for the maintenance staff. Berlin's BVG, on the other hand, has no formal training program, and maintenance workers perform job duties as assigned. Manufacturers are, however, responsible for training BVG staff in the operation and maintenance of all new rolling stock introduced to the system.

In Oslo, most bus service is provided by third parties. Contract agreements specify performance measures and penalties for failure to meet the targets, leaving the training in the hands of the contractor.

TRACKING AND PRIORITIZING INVENTORY AND MAINTENANCE

Transport for London uses software from J.D. Edwards for its financial system and Mincom Ellipse software for its maintenance and inventory system. Mincom is a comprehensive asset management system that has a full application to manage the equipment, inventory, preventative maintenance, and condition monitoring. The application includes a planning module that can be used to allocate resources (e.g., labor, materials, etc.) and equipment strategies. London Underground uses all of these modules, but found it easier to download the assets into a spreadsheet for tracking and evaluating the regular planning of major rehabs and replacement of assets.

The concept of asset management was not new when the PPPs were created in the United Kingdom. A strong movement for responsible asset strategies was evident throughout the country. The Institute of Asset Management of the United Kingdom had been working on a standard for years. The resulting outcome was a national standard for the optimized management of physical assets—Publicly Available Specification (PAS) 55—published in 2004. This specification provides guidance on, and a 28-point requirements checklist for, good practices in physical asset management. Asset intensive industries are considered to include gas, electrical and water utilities, road, air and rail transport systems, public facilities, and the processing/manufacturing of natural resources.

PAS 55 is getting a lot of interest and shows promise to become a worldwide specification for any organization that wants to create a whole life-cycle management of its physical assets. This standard is based on a concept that the optimal management of assets and related costs requires regular evaluation of risks and performance. The standard has recently undergone a substantial revision, with the participation of 50 organizations from 15 industry sectors in 10 countries, and has been adopted as a European standard.

CTS in Strasbourg operates and maintains the transit system through a PPP, a very common arrangement in France. The ownership of CTS is shared by the national government, the department of transportation, the city, and a private entity. System maintenance is comprehensive and starts with a full inventory of all assets (facilities, stations, tracks, and rolling stock) by component. The rolling stock has a comprehensive maintenance plan that is primarily designed by the equipment manufacturers and has always included a heavy maintenance plan for midlife rehabilitation work. With the adoption of the international standard PAS 55, CTS is now developing a more comprehensive plan for its infrastructure. There has always been an understanding of the need to do a condition assessment and to maintain a life-cycle costing plan of all assets, but the difficulty of doing this has meant it has been put on the back burner. The agency is once again trying to raise the priority.

In Germany, national standards are set for new infrastructure and for maintaining assets. The federal and state governments usually finance the new infrastructure, while it is up to governments at the state and local level to operate and maintain the system. Federal grants are restricted to projects that exceed £50 million, and federal funding is capped at 60% with the other 40% normally being split by the state and local governments. Anything below this level is usually funded 75% by the state. These grants are very competitive, and the application requires a cost-benefit analysis showing a return on investment, as well as an increase in ridership.

Karlsruhe does have life-cycle standards, including estimated time for major rehab of its assets. Buildings are considered to have a 100-year life, tracks have a 50-year life, rail cars a 30-year life, and buses have a 15-year life (stations and facilities were not mentioned). In all instances, the assets are usually kept longer due to a lack of funding for replacement. The vehicles (trams and buses) go through a rehabilitation/major maintenance process after 8 years. The bridges are required to be rehabilitated after 10 years. These life-cycle standards and major rehabilitation of assets are the basis for long-term planning. The agency does maintain a 10-year capital plan. Although the agency has a plan outlining what needs to be done, agency staff pointed out that they were facing a major maintenance backlog.

As far as regular maintenance of track and rolling stock, priority is usually based on inspection and driver feedback. The manufacturer is required to provide a full maintenance plan for all rolling stock, equipment, and infrastructure, which is then incorporated into the inspections. The agencies perform regular inspections to assess asset condition.

KVV uses SAP software for all of its business applications, including their maintenance and inventory systems and their short-term and long-term maintenance plans. The maintenance program includes special software for condition monitoring, ensuring there was a regular review of the life of assets.

BVG in Berlin also uses SAP as its software for maintaining all of its business applications, including the maintenance and inventory systems. The maintenance of vehicles and infrastructure are maintained by different groups and are separated in the system. The company has a lot of experience in monitoring the condition of its assets on a regular basis and has a few internally developed software applications that assist with this. The evaluation and maintenance of assets is based on both technical and operational reliability. Every year, all assets are inspected, and plans are developed for scheduled replacement. BVG maintains a list of projects more than 10 years out, but the company faces a €500 million backlog in projects to bring the assets to a state of good repair. The biggest issue is funding. The current contract with the city guarantees a fixed budget for operations and maintenance until 2020, but major rehabilitations and replacements are considered special projects and that funding is only granted in 2-year cycles. BVG cannot appropriately plan and create a capital plan that would keep its assets in a state of good repair.

CONCLUSION

As different as each country's agencies are, there were certain aspects that were consistent: efforts to balance priorities, maintain the infrastructure they have, deliver efficient and effective programs with their financial resources, and provide excellent service that is safe and reliable. They each have programs and strategies in place aimed at maintaining a state of good repair, even though they may frame it differently. Their efforts are similar to those of transportation agencies in the United States.

All of the host agencies had good programs for maintaining their assets. The governing structures and the political will in each city affect what they are able to successfully implement. They must grapple with some of the same challenges that we do. The agencies were creative and open to new ideas; none was satisfied with the status quo—they were focused on making changes to improve their systems and maximize their services.

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(Affiliations listed were current at the time of the study mission.)

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