The Bus Renaissance

Intercity Travel, Bus Rapid Transit, Technology Advances, Rural Services
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TRANSPORTATION RESEARCH BOARD

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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PHOTO: CHRISTY GERENCHER

Main terminal interior, Washington Dulles International Airport, at dawn.
INTRODUCTION

The Bus Renaissance

Innovations Drive a Boom

VICTORIA A. PERK AND DENNIS P. HINEBAUGH

Buses form the backbone of public transit operations in the United States and are a major means of intercity transportation. According to the American Public Transportation Association, Americans took approximately 5.1 billion trips by transit bus in 2015, accounting for nearly half of all transit trips. In addition, intercity buses, which have experienced a renaissance in the past decade, carry many more passengers than trains, even in the modally diverse Northeast Corridor.

This special issue of TR News is dedicated to the ubiquitous, but often overlooked, bus. The articles showcase recent developments and innovations in bus planning, operations, and services, highlighting the uses of data and technology by operators and their customers, the challenges that rural bus operators are addressing, the revitalization of intercity bus travel, and bus rapid transit or BRT—perhaps the most significant innovation in bus transit in recent times.

Notable Successes

BRT integrates several service features to mimic light rail, while providing the flexibility and cost of buses. Jennifer Flynn explains the BRT concept and describes the history of the mode, from its origins more than 40 years ago in Curitiba, Brazil, to its present-day incarnations in cities throughout the United States. Randall Davis of the Connecticut Department of Transportation offers a glimpse into one of the newest BRT systems in the nation, CTfastrak in Hartford. Launched in March 2016, CTfastrak already has served more than two million passengers.

Despite the growing use of BRT systems in the United States and around the world, critics maintain that BRT does not compare favorably with rail transit. In a Point of View article, Samuel Zimmerman and Herbert Levinson examine some common myths about BRT service, including limited capacity, rider preferences for rail, and the inability of BRT to promote economic development. Zimmerman and Levinson argue that BRT has proved successful when properly planned and implemented.

Intercity bus travel was once considered a “mode of last resort” in the United States. Joseph Schwieterman describes the industry’s resurgence and explains how innovations have contributed—such as curb-side operation and ticketless boarding. Although amenities in buses and express downtown service have attracted riders, the industry also has benefited from the commercialization of the Internet and the advent of smartphones, which have reduced ticketing costs and have enabled easy access to schedule information. David Hall, General Manager of BoltBus, gives a firsthand account of the intercity bus renaissance by detailing the challenges that Greyhound—the parent company—faced at the close of the 20th century and the company’s response in expanding its brands and services.

Applying Technologies

The traditional transit bus has been the subject of innovation in recent years, benefiting from information technology and telecommunications advances. Catherine Lawson describes how data routinely collected by transit agencies are being used to improve bus service and operations planning. In a Research Pays Off article, Kari Edison Watkins and Candace Brakewood discuss the open-source mobile application OneBusAway, which provides transit riders with real-time information about bus schedules and arrivals. A sidebar traces the Kansas City Area Transportation Authority’s introduction of on-demand “microtransit” bus service in partnership with the private service Bridj. Riders can hail small transit buses via a mobile application similar in concept to the taxi-like services of Uber and Lyft. In this way, the bus stop “comes to the riders, on the rider’s schedule.”

Jill Hough and Jeremy Mattson discuss how rural bus operators are innovating to serve the needs of rural communities. The authors point to the many challenges on the horizon for rural bus operators as the demographics of their service areas undergo changes. For these bus operators, innovation is not an option—it is essential for meeting the challenges.

Research, technology, and innovative service strategies have contributed to maintaining the role of the bus as the workhorse of public transit. These same forces are increasing the importance of buses for local and longer-distance transportation.

Special thanks to Jennifer Flynn for assisting us in the coordination of the articles for this issue; to Frank Spielberg, emeritus member and past Chair of the TRB Bus Transit Systems Committee, for his help in the review of the articles; and to Thomas R. Menzies, Jr., who originated the idea for this issue, assisted in shaping the contents, and served as liaison to the TR News editorial board.
A resurgence in intercity bus service is changing commercial competition for travelers between many cities in the United States. A bevy of new curbside operators—including BoltBus, Go Buses, and Megabus—are rejuvenating a sector regarded as “a mode of last resort” only a decade ago. The new services are making significant changes to downtown-to-downtown routes of 125 to 350 miles—distances considered too short for airline trips but uncomfortably long for driving.

Several factors are spurring the intercity bus phenomenon. Airport hassles, aggressive pricing strategies, and an infusion of overseas capital are important contributors. A revival of downtown districts in many cities—and a growing interest in an urban lifestyle—appear to be part of the mix, as are the expanding capabilities of personal electronic technology, such as travel apps that make ticket purchases easier. Energy-efficient bus travel also gained appeal with the dramatic escalation of fuel prices, which made single-occupant driving less affordable—although this factor has subsided recently as oil prices have plummeted.

The increase in bus travel has raised issues for transportation planners and researchers—notably, curbside congestion during arrivals and departures, the safety of the so-called Chinatown carriers, and the diversion of traffic from state-supported rail services. Some planners continue to be caught off guard, having watched the intercity bus sector decline in the

The Decline and Revival of Intercity Bus Service

JOSEPH P. SCHWIETERMAN

For potential riders, free Wi-Fi access has raised the profile of commuter, regional, and intercity bus travel.
30-year period before 2006, when Megabus aggressively entered the U.S. market and helped orchestrate the turnaround.

During the industry’s decades-long period of retrenchment, Greyhound Lines, various Trailways operators, and small “mom and pop” carriers gradually eliminated less-traveled routes and pared back frequencies. Many large downtown terminals built in the early post–World War II period—a time of optimism about intercity bus travel—were shuttered in favor of smaller facilities, often located in less central areas. To many, the bus was a viable choice only when all other options had failed.

Delayed Reaction to Deregulation

The industry’s recent turnaround has followed a pattern that differs from that of other transportation modes after deregulation. In 1982, regulatory reform allowed bus lines to enter and exit routes freely and to compete on prices, but the changes did not spark the innovations and the efficiency improvements that occurred in airlines and rail freight.

Redefining Routes

No major new carriers entered the scene during the next 20 years. Greyhound—by far the largest carrier—suffered from strained labor–management relations and had to downsize before bankruptcy proceedings led to a reorganization. Increases in car ownership and heightened competition from airlines delivered fatal blows to many longer-haul bus routes. By 1995, some large cities, such as Cleveland, Ohio, had fewer than two dozen daily bus departures.

Major bus lines complained about unfair competition from Amtrak. In some cities, bus lines sought to strengthen the connecting opportunities available to passengers by moving into consolidated transportation centers with Amtrak and local transit providers. Amtrak, in turn, elevated the role of its Thruway bus system, creating a synergy with feeder bus operations that continues today.

The once-lucrative routes of the Northeast Corridor (NEC) underwent smaller reductions in service than routes in other regions, but the warning signs were abundant. In response, Greyhound entered a “pooling arrangement” with Peter Pan Bus Lines and Trailways of New York to serve the NEC and other Eastern routes jointly, to improve the competition with airline shuttles and Amtrak. The three bus carriers coordinated schedules and offered consumers an array of departure times.

The Curbside Model

By 2000, indications of a turnaround appeared. Among the most notable signs was the introduction and expansion of Chinatown bus services on the East Coast. A large number of daily bus trips involved travel to and from the Chinatown district in lower Manhattan. Generally owned and operated by Asian businesses, the carriers loaded and unloaded at the curb—a practice permitted by federal law—at bargain prices.

A few Chinatown owners achieved sufficient ridership gains to upgrade their waiting rooms in restaurants and stores adjacent to the curbside stops to dedicated storefronts. Some became notorious for their cat-and-mouse games with regulatory agencies concerned about safety.

Although Greyhound and Peter Pan suffered from the competition, the Chinatown services greatly expanded the number of passengers traveling by bus. The initial focus had been to serve immigrant groups...
and passengers on tight budgets, but these cut-rate services soon began to attract young urban professionals and travelers with larger budgets. The corporate carriers eventually copied the successful curbside model.

Nonetheless, the expansion of the Chinatown carriers in the Northeast Corridor proved to be an outlier in an industry with weak passenger demand. Even rising gasoline costs and the additional fees and inconveniences associated with air travel after the terrorist attacks of September 11, 2001, did not stem the tide. As David Hall notes in his feature article (page 11), another round of cuts in the next several years left many small cities without any bus service.

**Heightened Competition**

With the national economy recovering and the Chinatown carriers demonstrating the potential of curbside buses, the industry began to attract large-scale corporate investment. The Scotland-based Stagecoach Group, owner of Coach USA—a set of established bus lines, mostly in the Eastern United States—and of Megabus, a bus service in the United Kingdom, moved first to test the potential of the U.S. market.

In spring 2006, Stagecoach opened a Megabus hub in Chicago, Illinois, operating mostly to points within 250 miles—although longer-haul routes, such as Chicago to Minneapolis–Saint Paul, Minnesota, proved popular. Operating from curbside at Chicago Union Station, Megabus emerged as a serious competitor with Amtrak.


FirstGroup invested heavily in Greyhound, purchasing many new buses and upgrading stations. In 2009, the company launched Greyhound Express service, featuring limited-stop service with guaranteed seating, power outlets, and later, Wi-Fi.

The stage was set for heightened competition across the country. In a sustained push to gain a foothold in new markets, Megabus established a hub in Philadelphia, Pennsylvania, in 2009, and in Wash-
ington, D.C., the following year, while smaller carriers, such as Go Buses and Vamoose, operated side by side in the NEC.

**New Frontiers**

Observers wondered if the curbside bus model would be viable in car-dominated regions with thinly provided rail and bus services. In 2011, Megabus added hubs in Atlanta, Georgia, and Pittsburgh, Pennsylvania (see Figure 1, right), areas without much corridor development by Amtrak or by the Chinatown bus lines.

Greyhound affiliate BoltBus added the Pacific Northwest to its network in 2011 and California in 2013. By 2014, Megabus double-deckers were traveling new bus routes in California, Florida, and Texas. Greyhound grew more aggressive in defending its turf against Megabus, often launching a Greyhound Express service whenever Megabus initiated service in a region. Chinatown carriers experienced a decline in response to the new competition and to federal safety crackdowns.

The aggressive expansion gave value-conscious travelers the widest variety of ground-transportation options in many years. In the Seattle–Portland market of the Pacific Northwest, for example, BoltBus offered nine daily trips in each direction, compared with Amtrak’s five and Greyhound Express’ four (Figure 2, lower right). The discount bus line, however, did not make intermediate stops—a change from its NEC routes—but focused on endpoint-to-endpoint travel.

**Answering Demands**

The rapid expansion of city-to-city express carriers contributed to public pressure to address safety and aesthetics. The large numbers of buses at curbside locations raised concerns, and public agencies in some cities either encouraged or demanded the carriers to move to off-street locations. BoltBus and Megabus relocated in response to a Boston ordinance and in New York, Washington, D.C., and several other cities voluntarily moved to an off-street location.

Much of the explosive growth of curbside service was attributable to discount prices. Just as fares on conventional Amtrak trains generally undercut air fares, bus fares generally are less than those for trains—often approximately 30 percent less. The difference tends to be greater in the NEC and somewhat less in other parts of the country. In the past year, the differences appear to have shrunk somewhat, but demand has been sufficient for both the intercity bus lines and Amtrak to experience simultaneous growth in traffic.

Surveys suggest that most passengers prefer to travel by rail than by bus when price and other factors are equal. Trains offer a more spacious environment and more room to maneuver than buses can provide. The popularity of bus travel, however, appears to be fueled by the opportunity for travelers to use their time on the bus productively. Onboard bus observations show a dramatic growth in the use of personal electronic devices between 2011 and 2014, suggesting that passengers are increasingly using the onboard time to multitask.
Industry Size
No centralized data set allows for accurate measurements of the intercity bus renaissance. Aggregate-level and route-level data are available for rail passenger and air travel, but intercity bus carriers are not required to report traffic statistics. Although carriers must report the number of buses and bus miles they operate to the federal government, the release of the data is on a delay and does not include passenger counts. “Deadhead” or out-of-service miles and—in some cases—nonscheduled or charter operations are included in the statistical reports, confounding analysis.

As a result, consultancies such as AECOM and Resource Systems Group (RSG) have evaluated bus schedules to estimate the size of the sector. DePaul University has a small team that annually measures the number of daily schedules operated by approximately 115 intercity bus companies. A schedule is a specific origin–destination pair, which is assigned a unique number in a timetable, like an airline flight—but unlike airline flights, a bus schedule can entail several dozen stops, making analysis of bus networks difficult.

Estimates suggest that approximately 5,000 intercity bus trips are scheduled each weekday in the United States—an increase of about 35 percent since 2006. The agglomerated data from a variety of sources, including company annual reports and onboard passenger counts, indicate that these buses handle an estimated 62 million passengers annually, according to DePaul research findings; this total excludes travel by airport shuttle buses or by intercampus, public transit, and casino services. Estimates by AECOM and RSG differ but are of the same approximate magnitude. In comparison, Amtrak handles about 31 million passengers annually, and scheduled airlines handle around 650 million.

Types of Service
Most intercity bus lines fall into four groupings:

- **Conventional bus lines** operate primarily from terminals in the downtowns of major cities and usually participate in agreements to “interline” passengers—that is, allow connections between buses operated by different carriers with a single ticket. Greyhound Lines, various Trailways units, and Jefferson Lines are notable players in this sector, which accounts for approximately 40 to 42 million riders.

- **Express city-to-city, or curbside, operators** emphasize downtown-to-downtown service between major cities and rely primarily on Internet ticketing.
These carriers handle 12 to 13 million riders annually and generally do not make interline arrangements. Examples are Boltbus, Megabus, and Go Buses.

* Chinatown operators, generally Asian or Asian-American businesses, run between Chinatown districts in major cities, typically in buses without a company logo. A higher degree of uncertainty surrounds this sector—for example, carriers often do not publish traditional timetables. Many Chinatown carriers recently have been shut down, but a modest comeback appears to be under way. This sector handles perhaps 2 to 3 million passengers annually.

* Latino operators offer services oriented to Spanish-speaking populations. Tornado Bus, Turimex, and Tufisia are among the largest in this group, which emphasizes long-haul service from cities near the U.S.–Mexico border. Because of the issues surrounding immigration policy, many of these carriers keep a low profile. This sector handles perhaps 4 to 5 million passengers each year.

The data suggest that since 2006, bus service has expanded much faster than air and rail service. Bus ridership also appears to have grown at a faster rate than for air and rail, although substantiating this claim is difficult. The past 15 months, however, have raised difficulties—with gasoline prices falling, the sector's growth has slowed dramatically.

**New Amenities and Apps**

City-to-city express or curbside lines, once dominated by young people traveling between major transit-oriented cities or college campuses, have attracted an ever-widening range of passengers. Personal business and commuter trips appear to be growing, as does travel by senior citizens. The number of business travelers, however—such as those on expense-reimbursed trips—appears to remain low, and families traveling with children are also uncommon.

**Luxury Services**

New luxury services are entering the fray and are expanding the base of business travel. In Florida, Red Coach, concentrating on the Miami to Jacksonville and Tampa routes, offers dedicated first- and business-class buses, with flat screens at every seat.

Vonlane launched a first-class service between Austin and Dallas, Texas, in 2014 and recently added Houston to its network. The buses have only 16 seats, but feature Wi-Fi and an on-board attendant who serves snacks and drinks. Fares cost approximately $100 each way, slightly higher than advance-purchase airfares but much lower than walk-up fares. Vonlane targets travelers who previously had flown via Southwest Airlines.

The luxury-oriented Royal Sprinter recently began four daily roundtrips in the crowded New York–Washington, D.C., market. The concept of a higher level of bus service is not new to the NEC, with such providers as Limoliner in Boston, Vamoose Gold in the Washington, D.C. area, and Dartmouth Coach in New England. Royal Sprinter, however, offers a first-class service with only eight seats on board and uses coaches that are somewhat smaller than the norm.

**Wi-Fi and Websites**

Larger, more established bus lines are also investing in amenities. Last autumn, Greyhound began publicizing the availability of power outlets and Wi-Fi on every bus, and Megabus expanded its reserved seat program to a choice of 20 seats, including some at tables. Both lines are offering bus tracker apps that project accurate arrival times.

Sophisticated travel booking websites—notably Wanderu.com and Busbud.com—are offering higher-income travelers a convenient means of comparison shopping for bus travel. By aggregating booking information for buses, the websites allow for searches similar to those of Orbitz and Travelocity for air travel.

Wanderu now covers more than 80 percent of the United States and partners with Boltbus, Megabus, Greyhound, and other major carriers. Its search tools provide point-to-point directions, so that travelers can walk, bike, or drive to and from the bus stops.

In 2014, Busbud entered a formal partnership with Greyhound. Busbud operates on a worldwide scale and lists more than 1 million departures each week across 89 countries, in 11 languages, for nearly 1,500 operators worldwide.
Booking data from Wanderu suggest that bus travelers crave flexibility. More than half of the ticket purchases through the system occur less than two days before the departures. This suggests that rigid airline ticketing rules may be pushing some travelers to buses.

BestBus, Megabus, and Vamoose have added website features that allow customers to change reservations for $10 or less, plus any difference in fare—far less than the $200 fee that some major airlines impose for changes in flights. BoltBus charges a fee of $4.50 for changes made via phone.

**Building on Synergies**
The vitality of the intercity bus sector, particularly of city-to-city express carriers, suggests that this mode will continue to command the attention of planners and researchers. State governments are expanding programs to build synergy between bus travel, intercity rail, and public transit networks. Programs in Colorado, Massachusetts, and Oregon are under way to build networks for convenient connections between points throughout the state.

The sharp decline in fuel prices in the past 2 years has slowed the rate of growth in bus travel dramatically. Cheap gas has offset the advantages of the high level of fuel efficiency of bus travel, which can exceed 175 passenger miles per gallon when buses are fully loaded. Whether the full extent of the intercity bus network is viable at the current price of crude oil remains to be seen. Some routes already have curtailed frequency.

Another concern is traffic congestion. Research by the Texas A&M Transportation Institute shows that traffic levels are rising sharply in some major cities; this makes bus operators susceptible to delays, particularly in densely populated regions, such as the NEC. Bus travelers are accustomed to delays on routes to and from New York and other traffic-clogged cities. Crowding at curbside locations is another constraint that limits growth during peak periods.

Yet the growing synergy between bus travel and carsharing and ridesharing services—such as those offered by UberPool and Lyft Line—offers an occasion for optimism. With technological innovations, planners and app developers are shaping a world in which travelers can access an integrated network of intercity coaches, minibuses, vans, and small vehicles, providing neighborhood pickup and drop-off with a single click. The possibilities bode well for a sector dismissed as a mode of last resort only 20 years ago.
Most people readily associate intercity bus service with the name Greyhound and the iconic symbol of the greyhound running swiftly and efficiently. Greyhound Lines originated in Minnesota more than 100 years ago as a curbside operator, transporting miners from Hibbing to Alice for 15 cents a ride.

The founding entrepreneur, Carl Wickman, laid off from the mines, had decided to become a Hupmobile car salesman. He had a single seven-seat car in inventory but lacked a buyer. Knowing that many of his former colleagues at the mine needed transportation from home to the mines, he launched the intercity bus service that evolved into Greyhound Lines.

The Greyhound network today serves thousands of communities. Operations span nearly the entire North American continent, from as far north as Yellow Knife in Canada’s Northern Territories, across most of the continental United States, to as far south as Monterrey, Mexico. The transcontinental network serves 3,800 locations and more than 180,000 unique city pairs.
The Greyhound enterprise includes many brands and services, as the company has diversified to meet customer needs. Among the new brands and services are BoltBus, Greyhound Express, QuickLink, and Rural Connector Service. Greyhound’s experience in introducing these new brands and services, particularly BoltBus, exemplifies a broad renaissance of the intercity bus industry that few transportation experts had foreseen.

Historical Context
In 1987 Greyhound acquired Continental Trailways, combined the two route networks, made some refinements, and left the resulting network largely unchanged for 15 years. The network emphasized rural and long-haul travel, the basic service strengths of the two companies.

Trailways had operated an extensive network in the Southeast, and the substantial overlap made many routes redundant. The Greyhound network also had an imbalance of low-volume routes subsidized with revenues from the higher-volume routes. Some cross-subsidization is not unusual in large networks—the stronger routes internally subsidize the weaker ones, and all of the routes benefit as part of a larger network that offers passengers many choices of origins and destinations. Internal subsidizing of some routes is acceptable because the operator receives incremental revenue across the network. Cross-subsidization becomes a problem, however, if the number of weaker routes becomes too large for the stronger routes to support. This had become Greyhound’s problem by 2002.

Greyhound traditionally had routed longer-haul passengers via a more rural schedule, often on roadways off the Interstate Highway System. Schedules were devised to achieve the maximum connectivity and to facilitate passenger flow. Some schedules, however, required connections at both ends of the link to the longer-haul traffic.

This practice typically added several hours and many more stops to a long-haul trip. Although intended to increase the profitability of rural routes, the rural routing became a deterrent to passenger satisfaction and repeat ridership. Customers criticized the company for making too many stops and taking too long to reach the destination.

A Changing Market
As these problems were becoming evident, other factors had begun to influence the demographics and demand of Greyhound’s traditional customer base. In the 15 years since the Greyhound–Trailways merger, the country’s rural population had declined and the urban population was increasing; discount airlines had increased service; and car ownership per household was continuing to grow.
These developments combined to redefine the type of customers who sought intercity bus service. Recognizing that the customer base was changing, Greyhound began in the late 1990s to invest in improvements to route data and reporting.

By 2002, however, the company's profitability had dropped dramatically, and the declining financial performance led Greyhound to assess its route network critically and to make fundamental revisions. To survive, the network would not only need to undergo contraction but to align with a changing customer base.

Although customers taking longer trips with connections were still important for profitability, the company had to shift the emphasis from rural and long-haul trips to urban center–to–urban center trips. Greyhound also sought to make travel easier and faster for all passengers, whether on long or short trips.

In 2003, Greyhound assembled a team from within to work with consultants to plan changes in the company's business approach and structure. Data mining was crucial to a highly analytical and quantitative examination of each route's contribution to network traffic and profitability.

Informed by these steps, Greyhound methodically reduced its schedule network in five phases over 2 years. This contraction reduced the company's route miles by 32 percent, eliminating service to entire states and to 900 locations overall. These actions were necessary to stabilize the company's profitability and to inform actions to modernize and revitalize the company.

**Diversifying Services**

With financial performance no longer a pressing issue, Greyhound was able to focus on growth and reinvigoration. In response to the increasingly popular curbside intercity bus carriers (see the article by Schwieterman, page 4), Greyhound launched BoltBus in 2008 in the Northeast Corridor.

The new brand started as a clean-sheet concept. BoltBus offered passengers more legroom than other network services, 110-volt power outlets, free onboard Wi-Fi, convenient curbside boarding, a ticketless process, a loyalty program, and dynamic pricing. The intercity bus industry already had implemented some of these elements, but BoltBus packaged them all together.

At least 70 percent of BoltBus service connects with local transit providers.
The goal was to create an enticing value proposition for the customer, offering many amenities at affordable prices. The service was tag-lined “Bolt for a Buck,” as every schedule offered at least one $1 fare.

The new line’s performance on three city-pair routes in the Northeast exceeded Greyhound’s expectations for the first year of operation. Surprisingly, the brand attracted customers who were younger and more educated than those using traditional intercity buses, indicating newfound appeal to the millennial generation. Today, 70 percent of BoltBus customers are between 18 and 34 years old; of these, 82 percent have completed some college education.

These statistics represented distinct changes from the typical profile of a Greyhound passenger, and the result was significant growth in market share for Greyhound overall. BoltBus therefore expanded from its original three routes to operate in three regions, on both coasts, and in more than 40 city-pair markets.

Adapting Curbside Features

BoltBus operates in an innovative and efficient segment of the intercity bus industry. Buses providing curbside service do not require much direct infrastructure. Because tickets are purchased online, a ticket counter is not needed. The operator only needs a safe area to load and unload passengers quickly.

The light infrastructure enables low-risk launches of service—the startup costs are limited. BoltBus and other bus industry entrepreneurs can explore routes and locations that provide additional travel options to the public without incurring large and irrevocable losses if the service fails to attract riders.

Three general types of service locations host BoltBus operations:

1. Curbside environments, 44 percent;
2. Outdoor transit stations, 42 percent; and
3. Terminal infrastructures, 14 percent.

The space needed to accommodate the curbside service can be fairly small, because the mostly point-to-point service typically does not require a place for passengers to wait for connections. In the United States, 70 percent or more of BoltBus traffic connects with local transit. Transit connections are therefore vital to curbside bus operations, creating a seamless multimodal experience.

Dynamic Strategies

Curbside bus service has grown rapidly in the past 10 years, in terms of passengers carried and the number of carriers. The original Chinatown bus line, Lucky Star, operates between South Station in Boston, Massachusetts, and New York City’s Chinatown district. Megabus began curbside service in Chicago in 2006 and has added operations in several regions of the United States and Canada. Initially a no-frills service, Megabus now offers amenities such as 110-volt power outlets and free onboard Wi-Fi.

Some carriers focus on a single travel corridor and grow by offering additional pickup locations within a metropolitan area. For example, Washington Deluxe, operating exclusively between Washington, D.C., and New York City, maintains several pickup locations in the Washington metropolitan area.
area: traditional terminal berths at Union Station and several curbside locations.

Greyhound also uses BoltBus to test concepts and ideas that may be applicable to the company’s larger system and its other new brands. Greyhound applied the lessons learned from the BoltBus niche operation to large sections of its traditional network to create Greyhound Express.

The new brand took many of the service amenities and features that had proved popular on BoltBus and adopted them for standard nationwide service on hundreds of routes. Greyhound Express operates from the traditional terminal network and offers free Wi-Fi, extra legroom, and a loyalty program. Greyhound Express currently serves 1,000 city pairs in 130 markets.

Reopening Rural Routes
Greyhound created BoltBus and Greyhound Express as new brands to attract new riders. But the company traditionally had provided rural transportation and wanted to revitalize and reopen those markets. The company therefore launched Greyhound Connect to provide rural communities with access to regional transportation and with connections to the larger Greyhound network.

Greyhound Connect deploys smaller buses to keep costs down and works closely with local transit providers to increase travel options for customers. Currently in 10 states, the service usually operates collaboratively, with federal, state, and local community support. The brand has reintroduced intercity bus service to rural communities that had none after the route contraction of 2003.

New Intercity Services
The shift of population from rural to urban areas has contributed to traffic congestion in metropolitan areas. Greyhound has responded with QuickLink, a brand targeting people who travel frequently between major metropolitan areas for work, family visits, doctor appointments, and the like. The cost and hassle of parking, gas, highway tolls, and traffic delays for these trips can make riding a convenient, easy-to-use commuter bus service attractive.

For instance, QuickLink recently launched service between Baton Rouge and New Orleans, Louisiana. The service is largely nonreservation, operating on a first-come, first-served basis but also gives customers the option of a reservation or a boarding pass.

Technology Advances
Reworking the passenger network and adding brands has reinvigorated Greyhound, but technological advancements have been critical to the company’s future and to that of the intercity bus industry. Greyhound is working to advance several technology platforms to enhance customer experience at all phases of trip planning, from the consideration of whether and when to travel to making reservations and purchasing tickets.

The company has modernized its website, added a mobile site, and developed iPhone and Android apps. These platforms make it easier to purchase a ticket and to store and retrieve booking information. The design allows the web page to load on any device, including a tablet, phone, or personal computer. New features enable customers to comparison-shop for less expensive fares. On some Greyhound brands, customers can travel paperless by using an image on their smartphones instead of a printed ticket.

Greyhound’s Bus Tracker tool demonstrates the benefits of technology for intercity bus travelers. Bus tracking previously involved a simple time-point capture manually entered en route by the bus driver. Today’s systems can track a GPS-enabled bus every 2 minutes and employ algorithms that draw on current traffic data to forecast arrival times. Greyhound customers can access the tracking system on the website and the mobile apps.

Industry Comeback
As Greyhound’s experience illustrates, the intercity bus industry is undergoing a renaissance. After years of declining ridership and departures, the industry’s innovations have gained steady growth in passengers and service levels.

In the 2014 Year-in-Review of Intercity Bus Service in the United States, the Chaddick Institute for Metropolitan Development at DePaul University concluded that “intercity bus service providers added more than 100 new daily services across the United States in 2014, resulting in a 2.1 percent increase in daily scheduled operations. While bus service grew, Amtrak train-miles held constant, and the number of airline flights diminished by 3.5 percent.”

Greyhound is proud to have contributed to this renaissance, which has demonstrated the efficiency and versatility of the bus in providing intercity travelers with more transportation options.
In less than two decades, bus rapid transit (BRT) has progressed from a little-known innovation to one of the fastest-growing transit modes in the country. Industry awareness of the mode spread rapidly after its adoption in the United States in the late 1990s. Swift and inexpensive implementation makes BRT an attractive option for cities contending with traffic congestion and constrained budgets for public transportation. Today, BRT is operating or in development in most major cities and is a modal alternative in nearly every transit planning study. In comparison with advances on the international scene, however, BRT is a relatively recent development in the United States, and the full scope of its cost, performance, and impacts remains to be seen.

Key BRT Features

BRT is an umbrella term encompassing an array of features that can be applied in a single corridor or across an entire bus system. The BRT mode is often viewed as bridging the quality gap between the local bus system and light rail transit (LRT), but this gap is significant and covers a range of applications.

At one end of the spectrum are the systems that run in mixed traffic, often referred to as BRT-lite. To improve speed, reliability, and convenience, these systems typically use relatively low-cost techniques, such as giving transit buses priority at traffic signals and positioning bus stops at the far side of intersections.

To maximize speed and reliability, BRT systems usually feature some form of dedicated runningway.
The most basic form is a shoulder bus lane, which often can be provided at minimal expense by restriping a lane or by repurposing a lane previously designated for parking or deliveries. The bus lane approach can be applied to a specific route segment or can be limited to certain times, such as the morning and evening travel peaks.

Median bus lanes and median busways represent the next level in performance and investment. Locating the bus lane in a median reduces the number of conflicts with side-street access, parked cars, and other obstacles, allowing for faster travel speeds. Median busways usually are more costly than median bus lanes but provide the benefit of physical separation from traffic.

At the high end of the investment spectrum are exclusive busways, also known as full-service or high-level BRT. These implementations require obtaining the right-of-way, sometimes by making use of older transit alignments such as abandoned rail lines.

Although complete grade separation is seldom possible, full-service busways minimize the number of at-grade intersections. These systems usually feature other amenities more commonly associated with rail systems, such as stylized vehicles, permanent stations, level boarding, and off-board fare collection (1).

BRT systems come in many shapes and sizes, but all aim to combine the quality of rail-based transit with the flexibility and affordability of a bus system. Different BRT features can be bundled into a range of flexible, scalable configurations, and can be implemented all at once or added incrementally. This versatility allows agencies to tailor projects to local operating environments, travel markets, and resources, and to adapt as conditions change. Furthermore, BRT's ability to travel on pavement enables a higher level of operational flexibility than rail-based systems.

Origins of BRT

Many of the concepts of BRT have been in use for decades. The earliest attempt to give buses priority in urban traffic dates to 1939, when the world’s first bus lane was built in Chicago, Illinois (2). Nevertheless, busway and bus lane experiments did not begin to proliferate in North America until the early 1970s, with a renewed federal focus on improving public transport.

Examples of early busways include the Shirley Highway in Northern Virginia; the Lincoln Tunnel between New Jersey and New York City; the El Monte Freeway in Los Angeles, California; and Highway 101 in the San Francisco, California, area. During this period, Pittsburgh, Pennsylvania, introduced...
The world's first BRT system began in Curitiba, Brazil, featuring tube-shaped stations, and has served as a model for other systems worldwide.

Curitiba inspired adoption throughout Latin America, which now hosts more than one-quarter of the world's BRT systems. Perhaps the most notable of the Latin American systems inspired by Curitiba is Transmilenio in Bogotá, Colombia, which has experienced ridership volumes comparable to those of subways (3).

Federal BRT Initiative

In 1998, Federal Transit Administration (FTA) chief Gordon Linton led a delegation of local and state officials on a scanning tour of Curitiba’s system. Impressed by the findings, FTA sponsored a BRT Demonstration Program, partnering with several competitively selected transit properties for the implementation, operation, and evaluation of BRT projects. In 2001, FTA sponsored the National Bus Rapid Transit Institute, a national program of research, innovation, training, and technical assistance.

FTA’s early BRT initiatives fostered working relationships with the American Public Transportation Association, domestic bus manufacturers, and the Transportation Research Board, leading to the design of BRT vehicle prototypes and to the development of consensus-based BRT standards. These efforts also assembled a foundational body of knowledge through research studies, evaluations, and decision tools produced by the National BRT Institute and other FTA research partners.

By the early 2000s, projects were under way in Los Angeles; Boston, Massachusetts; Oakland, California; Las Vegas, Nevada; Kansas City, Missouri; Cleveland, Ohio; and Eugene, Oregon—BRT was beginning to take off in the United States.

Examples of Successes

Metro Rapid: BRT-Lite Service in Los Angeles

After finding that its buses had been spending nearly half of their service hours stopped at red lights or loading passengers, the Los Angeles County Metropolitan Transportation Authority (Metro) partnered with the City of Los Angeles to improve bus speed and reliability by minimizing the delay at traffic signals and bus stops. This effort gained momentum when Metro staff and City officials joined FTA for the 1998 scanning tour of the Curitiba system. Impressed by Curitiba’s success, Metro launched two pilot lines in June 2000, under the Metro Rapid Demonstration Program.

The BRT demonstration projects on the 26-mile Wilshire–Whittier Boulevard and the 16-mile Ventura Boulevard corridors added other features to improve bus speeds, reliability, and convenience. Bus frequencies were increased, stops were spaced farther...
apart and placed at the far side of intersections, traffic signals were adjusted to give priority to buses, and low-floor buses were introduced to speed passenger loading. Amenities included lighting, canopies, and real-time arrival information.

The innovations reduced passenger travel times along the two corridors by as much as 29 percent, and ridership increased by 40 percent; one-third of the increase was from new patrons who had not previously used public transit (4). The total capital cost for the 42.4 miles of BRT service was $8.3 million, or approximately $196,000 per mile (5).

Branded as Metro Rapid, the system has grown into a network of more than 20 arterial routes providing nearly 400 miles of service in some of the highest-demand transit corridors of Los Angeles County. The San Pablo Rapid in Oakland is one of several transit systems that have applied the Metro Rapid model.

**Metro Orange Line: Full-Service BRT in Los Angeles**
The Metro Orange Line debuted in Los Angeles in 2005 as one of the first full-service BRT lines in the United States. At the time of its opening, the line spanned 14.5 miles through the San Fernando Valley, almost entirely along an at-grade, dedicated busway within an abandoned railroad right-of-way.

The Orange Line features high-capacity articulated vehicles, permanent stations, near-level boarding, off-board fare payment, headway-based schedules, and traffic signal priority. Stations are spaced at approximately 1-mile intervals and outfitted with canopied platforms, real-time arrival information, bicycle parking, and automated fare collection machines.

The project also included extensive native landscaping, a multiuse recreational path, and public art. The capital costs were $305 million, approximately $21.0 million per mile (6). A four-mile extension was added in 2012 at a cost of approximately $134 million (7).

A 2011 evaluation found reduced travel times and improved levels of service reliability in the Orange Line corridor. The BRT reduced the average peak-hour travel time in the corridor by 22 percent, with little difference between peak and nonpeak running times (6).

Los Angeles County Metro developed its Metro Rapid service after a scanning tour to Curitiba, Brazil.

Ridership on Los Angeles County Metro’s full-service BRT, the Orange Line, greatly exceeded expectations almost immediately after opening in 2005.
Ridership dramatically exceeded the forecasts. Metro had estimated an average of 5,000 to 7,000 weekday boardings in the first year of service and projected an average of 22,000 weekday boardings by 2020. By May 2006, the line already had attracted nearly 22,000 average weekday boardings, achieving the 15-year ridership target in seven months. Since the 2012 extension, ridership has increased (6), with roughly 27,000 weekday boardings in 2015 (8) and a projected average of 45,000 weekday boardings by 2030 (9).

**EmX: Small-Scale BRT in Eugene, Oregon**

The Emerald Express, or EmX, operated by Lane Transit District (LTD) in Eugene, Oregon, is the first application of BRT in a small city. Opened in 2007, the 4-mile Franklin Corridor forms the backbone of the EmX, linking LTD’s two major hubs, the neighboring downtowns of Eugene and Springfield.

Service is provided with 60-foot articulated buses that have multiple doors on both sides. Most of the station platforms are located in the median and provide level boarding, enhanced lighting, information displays, bike racks, and real-time arrival information. Buses operate on a combination of single and dual exclusive lanes with special paving, as well as in general-purpose travel lanes. EmX vehicles receive traffic signal priority.

Public opinion about travel time savings has been favorable—more than 60 percent of respondents to a 2007 on-board survey indicated that their travel time had decreased. Among those who drove before changing to the EmX, nearly 60 percent stated that the EmX was faster (10).

Like the Orange Line, the EmX has surpassed ridership expectations. LTD estimated that ridership over the 20-year design period would increase by approximately 40 percent compared with conventional bus service; this would approximate 3,780 average weekday boardings. The Franklin EmX exceeded that projection in its first month of service, with approximately 4,000 average weekday boardings. By the end of the first year of service, ridership grew to nearly 6,000 average weekly boardings, a more than twofold increase over the previous bus service (10).

After the opening of the 5.5-mile Gateway Extension in January 2011, average weekday ridership on the two corridors grew to approximately 9,500 boardings; by October 2013, the figure had reached 11,017 (11). The Franklin EmX required $25 million in capital costs, or $6.25 million per mile (10). The Gateway Extension cost about $41.3 million, or $5.3 million per mile (12).

LTD is developing a third EmX project to extend the service to West Eugene, with completion expected in late 2017. LTD plans to provide EmX service along a 61-mile network that includes most of the main transportation corridors in the area.
Addressing Challenges
Despite BRT’s successes, some challenges have arisen and some implementations have fallen short of expectations. The EmX, for example, experienced several bus–automobile collisions in its early months of operation. The accident rate declined once local drivers became accustomed to the busway (12).

Metro responded to a series of collisions in its early Orange Line operations by requiring buses to slow to 10 mph through intersections, but this concession reduced the travel time benefit expected from the segregated busway (6). To increase speeds, Metro recently withdrew the order for intersection slowdowns, and to add capacity, the agency is considering replacement of its 60-foot buses with 80-foot buses that carry 40 percent more passengers. Metro also is studying the option of adding overpasses at the busway’s busiest intersections.

Another challenge for BRT is sustaining service quality. BRT’s key competitive advantage of flexibility can lead to erosions in service features. In some cases, features that were used to build public support for ambitious projects have been gradually eliminated to save money on capital costs, until all that is left are some basic upgrades to bus service. Of course, this is not a problem with the BRT concept itself, but an issue of planning and implementation.

Next Advances
Decision makers must recognize that BRT works best as an integrated system of operational, vehicle, and infrastructure features. The BRT boom shows no signs of letting up. It has made inroads in cities large and small, from Seattle to Austin, Texas, to Jacksonville, Florida. Aspen, Colorado, has built the nation’s first rural BRT system, covering nearly 40 miles and connecting the ski resort city to several small communities. Many of the systems in planning or under construction are smaller, corridor-based projects.

BRT clearly has become a permanent fixture in the urban landscape of the United States—a revolution has occurred. The next decade will witness an evolution, as BRT fine-tunes into a fully mature mode.

Features of BRT increasingly are spreading to non-BRT corridors—BRT-lite may become the regular bus system of the future. Because buses account for almost half of the nation’s transit trips, improvements in services could have a significant impact on transit’s mode share.

To realize the improvements in mobility, congestion, and economic growth that BRT can produce, the transition from individual BRT lines to integrated BRT route networks would constitute a major advance. As research on U.S. BRT progresses beyond case studies to focus on the life-cycle costs of maturing systems and on the experiences of newer systems, more advances will emerge.

References
CTfastrak in Hartford County, Connecticut, is one of the newest bus rapid transit (BRT) systems in the United States. The system celebrated its first anniversary in March 2016. During its first year in operation, passengers took more than 3 million trips on the bright green buses.

System Profile
The heart of the system is a 9.4-mile dedicated busway with 10 rider-friendly transit stations that incorporate off-bus ticket vending machines, level platform boarding, on-board Wi-Fi service, and stainless steel and glass shelters with teak seating. Customers receive real-time bus arrival information on electronic message boards at the stations, through automatic vehicle location systems combined with routing, scheduling, and other data. These data also are made available to app developers free of charge; Google Transit and Transit App use the data to provide real-time travel information to customers. A 5-mile multiuse recreational trail extends along the western half of the busway, enabling residents to bike, run, or walk to local destinations in New Britain and Newington.

The CTfastrak system operates 21 hours a day, Monday through Saturday, and 14 hours on Sunday. The system’s Route 101 uses 60-ft articulated buses to provide frequent, high-capacity service. The buses arrive at designated transit stops every 7.5 minutes during the weekday peak periods, every 12 minutes on middays and weekends, and every 20 minutes at night.

The system also has 40-ft buses, which can travel on and off the bus-only roadway. These buses link the Route 101 services to education, health care, entertainment, and popular shopping destinations, as well as to business districts and neighborhoods. CTfastrak’s 30-ft buses connect smaller communities and the region’s secondary schools and colleges to the system. The CTfastrak express services use 45-ft coach buses to provide access to Waterbury and the Metro-North Railroad station, as well as to Southington, Bristol, and Cheshire. The CTfastrak Express routes travel on the dedicated busway to avoid traffic into and out of Hartford, the state capital.

Making Connections
The CTfastrak transit stop at Hartford’s Union Station, a major transportation hub for Central Connecticut, allows BRT passengers to connect to Amtrak trains, intercity bus lines, and the Bradley International Airport shuttle bus, the Bradley Flyer. In 2018, this transportation center will add a new commuter rail service, the Hartford Line, with frequent trips between New Haven, Hartford, and Springfield, Massachusetts. The increased connectivity of rail, bus, and airline services greatly expands the intermodal reach and effectiveness of Connecticut’s transportation system.

During the 20-month period before the opening of the CTfastrak transit system, the Connecticut Department of Transportation held more than a dozen community open house events to gain public input about the planned bus services, including the scheduling and routing. The final operations plan for CTfastrak incorporated the valuable information collected at these meetings. A strategic and integrated marketing, public relations, and social media campaign followed the outreach, to educate the various audiences throughout the region about the benefits of the BRT service. In addition, CTfastrak offers passengers a consumer-friendly rewards program, featuring discounts on dining, entertainment, shopping, and professional services from more than 60 businesses and other organizations accessible from the system and from other local transit stations and routes.

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Years ago, a reporter asked Yogi Berra, a former New York Yankees baseball player, what he thought of a then-trendy and popular Manhattan restaurant. His answer: “Nobody goes there anymore. It’s too crowded.” (1)

Yogi Berra’s observation drew many laughs and became famous as yet another of the colorful baseball player’s malapropisms. His statement sounds funny, but many people say essentially the same thing about bus rapid transit (BRT). They believe BRT has little appeal for people with transportation choices and that the capacity limits make BRT too crowded with passengers—who, ironically, had chosen to ride it.

Those who describe the capacity of BRT as significantly lower than other rapid transit options, such as light rail, may believe BRT is little more than a local bus route employing 40-foot buses operating in mixed traffic and stopping on every block. BRT is not that; nor is it a modest-length busway or a limited-stop, mixed-traffic bus route with essentially the same buses as operate elsewhere but painted a different color or given an evocative name.

Features and Myths

Full-featured BRT uses specially configured buses operating for the most part on dedicated transitways. They have stations—not stops—and also may use off-board fare collection, no-step boarding and alighting, and passing lanes at stations to allow for express or skip-stop services. These features are intended to increase schedule speed and frequency and to avoid the delays that often slow conventional buses, such as waiting in traffic or while passengers pay on board.

BRT’s limited capacity is one of several myths often repeated by politicians, citizens, journalists, and even transit professionals and advocates. The persistence of
these claims can be frustrating some 40 years after the first BRT lines went into successful operation in Curitiba, Brazil.

Worldwide, more than 150 BRT-type applications are in service, including a growing number in the United States. Most of these systems are working well, with significant gains in performance, passenger satisfaction, and ridership compared with the previous local bus services in the same corridors. Moreover, evidence indicates that BRT has positive, sustainable effects on urban development.

The persistent myths about BRT err in citing the following flaws:

- Limited passenger capacity,
- Lack of appeal to travelers who have other transportation choices,
- High operating and maintenance costs,
- Significant air and noise pollution, and
- Weakness as an urban development tool.

The intent of debunking these myths is not to argue that BRT is preferable in all urban settings or to dismiss other transit approaches. Decisions about the specific transit solutions best suited to an urban area or corridor should be objective and transparent.

In most urban corridors, no specific transit mode clearly dominates across the spectrum of criteria. Nonetheless, more than four decades after the inauguration of BRT in Brazil, the evidence is sufficient to suggest that BRT deserves serious consideration as an attractive, high-capacity, and cost-effective rapid transit investment.

Limited Capacity Myth

Full-featured BRT applications in the United States include the Silver Line in Boston, Massachusetts; the Orange Line in Los Angeles, California; the Cleveland, Ohio, Health Line; EmX in Eugene, Oregon; SbX in San Bernardino, California; and CTfastrak in Hartford, Connecticut (see article on page 22).

All operate 60-foot articulated buses. Some international BRT applications employ biarticulated buses as long as 80 feet, such as those in Curitiba; Mexico City, Mexico; and Bogota, Columbia. In other cases, such as in Istanbul, Turkey; 64-foot buses operate in two-vehicle platoons running every 60 to 90 seconds. With transitways in the medians of roadways, off-board fare collection, and no-step boarding, these platoon systems can achieve capacities in excess of 15,000 passengers per hour.

A capacity of more than 15,000 per hour is higher than that of any U.S. heavy rail system outside of New York City. Some BRT corridors have even higher ridership levels. For instance, the Metropolitano BRT in Lima, Peru, moves more than 30,000 passengers per hour by using passing lanes and articulated 60-foot buses. The Las Caracas Corridor of the Transmilenio in Bogota, which has passing lanes and some biarticulated vehicles, serves more than 40,000 passengers per hour at peak times.

Admittedly, capacity constraints are an issue on these BRT systems—Bogota riders consistently give their BRT system low grades because of crowding and crowding-related crime. Nevertheless, the appli-
cation of BRT in dense urban corridors like those of Bogota and Lima illustrate that capacity limitations should not be an issue in the less dense urban corridors of the United States. According to the *Transit Capacity and Quality of Service Manual*, the busiest U.S. light rail corridors serve approximately 10,000 passengers per hour (2, Exhibit 2-25).

**Unattractiveness Myth**
Some argue that BRT will not lure people out of their cars the way that rail-based alternatives would, because “people with a choice will never ride a bus.” A reluctance to ride the bus is understandable when a system is poorly planned, operated, and maintained; however, in developed and developing cities with BRT, the patronage includes significant percentages of people who once traveled by private vehicle. Some BRT systems, such as in Boston, Cleveland, and Mexico City, have attracted significant numbers of travelers away from the urban rail systems.

In surveys conducted on all transit modes in Los Angeles and Rouen, France, passengers evaluated the available options according to attributes associated with mode choice, such as comfort, convenience, travel time, and reliability (2). In both cities, riders were familiar with all of the transit options, in contrast to surveys undertaken when BRT is brand new or a hypothetical option. The composite ratings for the BRT service in both cities were equal to or exceeded ratings for the rail equivalents. In the case of Los Angeles, the BRT ratings were far higher than those for the local bus service.

These survey results do not imply that travelers always prefer BRT to light rail or rapid rail but are examples of empirical evidence refuting the notion that people with a choice would not choose BRT.

**High Costs Myth**
A popular view holds that because each BRT bus requires an operator, the operating cost is more than that for a multcar rail-based system that can transport more passengers per operator. One of the biggest pluses of BRT, however, is its speed advantage, which derives from operating on dedicated lanes and with longer stop spacing, off-board fare collection, and no-step boarding and alighting. The gains in travel speed increase the passenger-carrying capacity per given amount of labor.

For example, the BRT-like M-15 Select Bus operating on Manhattan’s East Side, from 126th Street in Harlem to South Ferry, has an end-to-end travel time approximately 25 percent faster than the parallel M-15 local bus route—73 minutes versus 101 minutes in the morning peak. The lower travel time derives from a combination of off-board fare collection, multidoor boarding, fewer stops, and a portion of running time on bus-only lanes. The 25 percent time savings is consistent with that observed for the BRT systems in Los Angeles and Boston.

Users rated Los Angeles BRT service far higher than local bus service.
In addition, most BRT applications use buses that are significantly larger than the standard 40-foot bus; as noted, some BRT systems abroad use buses as long as 80 feet. These longer buses can carry approximately 200 passengers at normal U.S. standee densities.

BRT has maintenance advantages over rail-based systems. The running way, signal systems, and vehicles are less expensive to maintain—the costs are essentially the same as those for the adjacent roadway system and the local bus fleet. Moreover, the technicians for the local bus fleet can maintain the BRT system; a separate unit of specialized technicians, as for rail-based systems, is not necessary.

Table 1 (above) illustrates the potential operating and maintenance cost advantages of BRT; the U.S. Department of Transportation’s National Transit Database for 2013 is the source of the data. The table includes data for Cleveland, Los Angeles, Pittsburgh, and Las Vegas, Nevada. Cleveland and Los Angeles have both BRT and light rail systems. In both cities, the operating and maintenance costs per unit of supply—per revenue mile and revenue hour—and per unit of demand—per trip and passenger mile—are lower for BRT than for light rail. Moreover, by some of the measures of operating and maintenance expenditures, BRT is less costly than the local bus service.

Pittsburgh has a light rail system, and a significant share of the city’s regular bus operations is on dedicated busways. Although the Pittsburgh bus system does not have the speed and efficiency advantages of full-featured BRT systems with off-board fare collection and no-step boarding, it has high reliability and high operating speeds because of the extensive busway and high-occupancy vehicle systems. Compared with the local bus system and its many BRT features, Pittsburgh’s light rail has higher unit operating and maintenance costs for every measure.

The Las Vegas light rail operating and maintenance costs are for an automated monorail system. Without operators, the system should have low operating labor costs, yet the operations and maintenance costs are higher than those of the city’s BRT and local bus systems.

The table does not present a comprehensive comparison and cannot be used to conclude that BRT is less costly to operate and maintain than similar light rail alternatives. Nonetheless, the data refute the notion that BRT necessarily will have higher operating and maintenance costs.

**Pollution Myth**

Most BRT applications in North America use vehicles with advanced propulsion systems. The Cleveland and Hartford BRTs, for example, use hybrid systems with low sulfur–diesel, electric battery engines; Los Angeles BRT uses natural gas–fueled spark ignition engines. According to an FTA-sponsored study, these vehicles produce extremely low levels of all kinds of air emissions, especially in the BRT duty cycles that require much less starting and stopping than regular bus services (4). The same study also showed that, per unit of service distance, BRT systems emit carbon dioxide and other greenhouse gases at levels lower than or comparable to rail systems powered by electricity from power plants fueled by coal or natural gas.

Moreover, the natural gas and hybrid electric BRT buses are much quieter than the all-diesel vehicles. In addition, some bus manufacturers offer battery-powered, electric-only buses with a distance range that exceeds typical BRT route lengths. The first battery-powered articulated buses with acceptable ranges are entering the market. The Chinese manufacturer BYD is testing a battery-powered articulated bus in Bogota for BRT applications.

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**Table 1: Comparative Operating and Maintenance Costs (3)**

<table>
<thead>
<tr>
<th>City</th>
<th>$/revenue hour</th>
<th>$/revenue mile</th>
<th>$/passenger</th>
<th>$/passenger mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleveland, Ohio</td>
<td>222.51</td>
<td>89.55</td>
<td>135.74</td>
<td>4.04</td>
</tr>
<tr>
<td>Los Angeles, California</td>
<td>359.02</td>
<td>210.42</td>
<td>139.22</td>
<td>17.74</td>
</tr>
<tr>
<td>Pittsburgh, Pennsylvania</td>
<td>324.07</td>
<td>25.52</td>
<td>14.32</td>
<td>6.42</td>
</tr>
<tr>
<td>Las Vegas, Nevada</td>
<td>136.74*</td>
<td>92.45</td>
<td>104.06</td>
<td>10.43*</td>
</tr>
</tbody>
</table>

*Monorail.

Note: NA = not applicable.
Urban Development Myth

Some critics claim that BRT will have little if any impact on urban development because the mode lacks the permanence that makes rail-based systems attractive to developers: to them, BRT’s inherent flexibility means that the service can be withdrawn. These assertions, however, overlook the permanence of BRT’s various infrastructure elements, such as busways and stations.

Empirical evidence also refutes this myth. Like rail transit, BRT does not create the basic demand for housing or commercial space. Isolating the development impacts of a transit line or determining whether the observed development is a net addition to the economic activity of a region is always difficult. Evidence suggests that BRT can serve as a development tool when combined with other strategies to direct sustainable development to preferred locations supported by transit.

Curitiba’s success in using BRT as a tool for sustainable development is well documented, but in other cities throughout Latin America, from Guadalajara, Mexico, to Lima, Peru, new clusters of walkable, transit-oriented development have grown up around BRT stations. Anecdotal evidence points to positive development effects near BRT stations in the United States.

The Cleveland Plain Dealer, for instance, reports that the city’s Health BRT Line has brought more than $4 billion of investments into the city (5). Likewise, the Los Angeles Daily News reports that the Orange Line BRT service influenced a $3 billion high-rise development in the West San Fernando Valley (6).

A 2012 report by the U.S. Government Accountability Office concluded that “the results of our land value analysis of BRT corridors also is consistent with the perception that the permanence of BRT features may play a role in spurring development and increasing land values” (7). In a 2013 study, Perk et al. concluded that increases in land price correlated with the distance to stations on Boston’s Silver Line BRT (8).

Synthesizing case studies of BRT systems in Bogota and Ahmedabad, India, as well as survey results from 27 other cities, Cervero and Dai observed:

Notably, BRT should be conceived as more than mobility investments. They also present unprecedented opportunities for restructuring urban and regional growth in more sustainable formats. BRT can serve as a backbone for guiding growth in a more compact, mixed-use urban form—one that not only promotes transit riding and less driving, but also curbs sprawl and the significant costs associated with it. (9, p. 135, Section 7)

Debunking the Myths

Like all transit approaches, BRT should be viewed objectively. Experience has shown that properly planned, designed, and operated BRT can be cost-effective, enhance mobility, and improve the quality of urban living. As additional BRT systems develop, more empirical evidence will become available to assess the benefits and costs across a range of conditions. That evidence should inform decisions about BRT’s applicability and should not echo a litany of claims that have no basis.

References

Data and information technology are not only transforming the way that people use buses but also the way that bus systems are being planned to serve riders more effectively. Operational data and other information routinely collected by bus systems are being put to work in new ways to assist bus riders and system planners.

Bus operators have a long history of collecting data to answer questions from customers and staff. For example, riders want to know when a bus is scheduled to arrive at a stop and what stops the bus will make.

In some urban areas, a bus rider can open a mobile device, enter a desired destination, and immediately receive information about what bus to take, when it will arrive, and where. The data and information systems providing this service rely on open data resources—and on bus operators who are willing to provide and maintain reliable, machine-readable data.

Although these data applications can provide considerable benefits to riders, the effective use of data also can aid bus system planning. When planning their systems, bus operators want to know the following:

- How many riders typically are on a particular bus, what is the ridership on a particular route, or what is the ridership on the overall system?
- Where do the majority of riders get on and off a bus?
- How much revenue do the bus services generate, overall and by specific routes and route segments?
- What set of stop locations and routes would maximize service levels for customers and boost revenues?
- Where are the buses during service hours in real time?
Types of Data
To answer these questions, operators traditionally have relied on “paper and pencil” data collection programs. For example, traffic checkers can collect three types of data:

- Ride checks: the number of passengers getting on and getting off and the time for each stop;
- Point checks: a record of the time, the number of passengers getting on and off, and of passing buses at a particular point; and
- Fare checks: an onboard record of each passenger's fare category when boarding at a bus stop.

Onboard surveys also are used to query passengers about their trip origins and destinations, trip purposes, fare types, and sociodemographics. In addition, supervisors may monitor adherence to schedules by observing bus traffic and may consult the fare payment records for ridership information.

When computers were introduced into the bus agency work environment, the staff converted the manually collected data into machine-readable formats, making it possible to store and retrieve digital records with ease and efficiency. Manually entering the data, however, was time-consuming. The solution was to “harvest” and archive machine-readable data automatically from the equipment installed on buses for operational purposes.

Harvesting Valuable Data
A variety of equipment installed on modern buses provides a range of data for analyzing bus operations and planning.

Dispatching and Tracking Data
Computer-assisted dispatch and automatic vehicle location equipment track buses in real time. The tools improve operational efficiency and support incident management, security response, and restoration of service.

The captured and archived data contain a rich set of information that is geocoded—for example, recording the exact position of the bus—and time-stamped. These data serve many purposes, such as comparisons of actual stops with scheduled stop locations to monitor on-time performance, calculations of estimated arrival times, and the dissemination of the estimated times to bus shelter monitors, web displays, and mobile phone services.

Other onboard systems generate data from the openings and closings of the doors and from electronic event logs. These data can be useful in analyzing bus services—for instance, by examining data on the deployment of lifts, bus operators can gain a better understanding of how the disabled community uses buses. Similarly, the locational data on door activity can inform the placement of stops on a bus route.

Automated Passenger Count Data
Automatic passenger counting equipment generates data that can be archived and linked to the vehicle's location and time-stamp data. Having actual data on how many passengers enter a bus at a particular stop and at a particular time of day can guide the deployment of on-board surveys so that the results can be generalized to a larger population of riders. Additionally, market researchers can use these data to understand passenger behavior at the stop, route, and system levels.

The data can serve other planning and administrative purposes as well. For example, the Federal Transit Administration requires transit agencies to submit operations data to the National Transit Database. Buses equipped with automatic passenger counters can capture many of the required data elements in much larger quantities than the traditional manual counting methods, improving the quality of the data.

Automated Fare Collection Data
Automated fare collection techniques, such as smartcards, not only provide convenience for bus customers, but also create an opportunity to harvest valuable operations data. Transit agencies often “roll up” the fare collection data to produce monthly or annual revenue figures for financial reporting, but the original transactions data can assist in system planning.

Generated at the stop level, fare data can yield passenger flow information, including origin and destination, trip purpose, and fare type.
destination matrices. These data also can inform fare policy strategies and facilitate revenue modeling. For example, bus systems with fare zones can examine patterns in the archived data to inform decisions about fare adjustments.

Data Challenges

Using these data encounters many challenges—some technical and others related to policy.

Ensuring that the data are in a useful geocoded format is an example of a technical challenge. Real-time bus routing and operations require a dynamic spatial approach, not a static map. Geographic information systems (GIS), traditionally used for making maps and for scoping service-level planning, are not well suited for projecting day-to-day bus operations. The GIS data, however, can be useful in creating and maintaining bus asset inventories, including the location of bus stops, routes, and time points.

Analyzing the rich source of data from smartcards raises concerns about privacy, a policy-related challenge. Bus agencies must balance the need to gather detailed trip information against the need to protect rider privacy. This may require adopting privacy principles to communicate to customers how the data will be used and protected.

Ownership of the archived data can also raise issues. In most cases, the equipment and software in buses are purchased from commercial vendors. Bus agencies therefore need an agreement with each vendor to spell out the ownership and uses of the archived data.

Data Sciences Approach

Many bus operators are unable to take advantage of these data sources because of a lack of skills in the workforce and a lack of the software to handle large quantities of data, or “big data.” To deal with these resource challenges, data scientists increasingly are using open-source software, and whenever possible, open data.

Open-source software has source code that is available for modification or enhancement by anyone. This openness provides opportunities for additional progress by teams with new ideas, as well as feedback on these features and improvements to the original software creators. Similar to open-source software, open data can be used and distributed freely.

Data science notably came to the assistance of bus planning in 2005, when the Tri-County Metropolitan Transportation District of Oregon, or TriMet, partnered with Google to develop an open data scheduling strategy. The efforts led to the creation of the General Transit Feed Specifications (GTFS), which enable the generation of static schedule information—such as stop location, route geometries, and stop times—in a standard format.1 GTFS, combined with automatic vehicle location data, produces

Open-Source Resources for Bus Systems

A Sampling


**TransitWand:** a mobile application for collecting GTFS data in the field https://github.com/conveyal/transit-wand.

**GTFS Editor:** a web-based, visually based application for creating and editing a GTFS feed; https://github.com/conveyal/gtfs-editor.

**Open Trip Planner:** a web-based multimodal trip planning tool; https://github.com/openplans/OpenTripPlanner.

**Open-Trip Planner Analyst:** a web-based platform for using GTFS to analyze transit service data; https://github.com/openplans/opentripplanner-analyser.

**GTFS-RT Admin Tool:** a web-based platform for tracking transit service delays; https://github.com/conveyal/gtfs-rt-admin.

**Sakay:** a web and SMS—or short message service—platform for trip planning that supports informal transit routes; https://github.com/thatsmydoing/sakay-gateway and https://github.com/ahelpingchip/sakayph.

**SimpleGTFSCreator:** a Python programming script that generates GTFS feeds from GIS files; https://github.com/PatSunter/SimpleGTFSCreator.

**TransitFeeds:** a worldwide directory of GTFS and GTFS-R feeds; http://transitfeeds.com.


Data science notably came to the assistance of bus planning in 2005, when the Tri-County Metropolitan Transportation District of Oregon, or TriMet, partnered with Google to develop an open data scheduling strategy. The efforts led to the creation of the General Transit Feed Specifications (GTFS), which enable the generation of static schedule information—such as stop location, route geometries, and stop times—in a standard format.1 GTFS, combined with automatic vehicle location data, produces

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1 See https://developers.google.com/transit/gtfs/.
Microtransit is not an on-demand car and not a scheduled bus but fills a gray area in between. The Kansas City Area Transportation Authority (KCATA) is the first major transit agency to partner with a technology company to employ microtransit as a public transportation option.

KCATA is piloting on-demand bus service through a partnership with Bridj, a company based in Boston, Massachusetts. For a traditional bus service, riders go to a bus stop located on a prescheduled route, but with the RideKC Bridj microtransit service, the stop comes to the rider, on the rider’s schedule.

Like the ride-hailing apps, the Bridj software sorts through billions of data points to determine where riders want to go and how to get them there at the times they want to depart and arrive. The Bridj routes are formed with algorithms that sift through transit data, social media, and requests for service on the mobile Bridj app. Riders requesting the service head to convenient “pop-up” stations indicated on the app; these pop-up stops usually are within a 5-minute walk from where the rider lives or works.

Getting Started
KCATA and Bridj selected Ford Transit vehicles for the project (see photo, below). Ten leased vehicles, built at the automaker’s Kansas City assembly plant, were specially outfitted for the service. The vehicles have a 14-passenger seating layout and a custom-installed large running board for passenger convenience and safe boarding. Bright logos posted on the vehicles’ sides make for easy visibility.

The service operates during weekday rush hours, offering an introductory fare of $1.50, the same as the local bus fare. Bridj riders enjoy fewer stops and do not need to make transfers. The shuttle-like bus is equipped with free Wi-Fi and mobile device chargers. KCATA expects that the smaller vehicles with amenities and flexible scheduling will give riders a feeling of choice and comfort, more like traveling by car than by transit bus.

During planning, KCATA and Bridj identified several metropolitan areas with large clusters of jobs, as well as other areas that could benefit from transit service. The planners focused on areas in downtown Kansas City, the neighborhoods east and south of downtown, three regional hospitals, and a slice of the Kansas suburbs that had infrequent or inconvenient bus service. The so-called Hospital Hill area, for example, has more than 10,000 jobs.

Making Adjustments
By studying the travel request data and ascertaining where the demand for Bridj service is the highest, planners identified potential new markets and routes. After an influx of travel requests from Kansas City’s River Market area, for example, the service area was adjusted to include that part of the city.

As a result, Bridj is providing reverse commutes from downtown Kansas City back to the Kansas side of the state line and to the University of Kansas Medical Center, which has many employees but few parking spots. The dynamic nature of the service has allowed the agency to test and match demand to hours of operations and to areas of the city in ways that were not possible with the more traditional fixed-route bus service.

KCATA has used a mix of grassroots marketing and geotargeted, mobile advertising to reach potential customers. The agency has fielded myriad questions from customers who are unfamiliar with microtransit service.

Making Connections
Because the microtransit operators must interact more closely with the riders, Bridj has recruited staff from customer service industries. The operator training covers the traditional areas of driving, safety, and customer service but also includes instruction on using mobile devices to connect with passengers booking rides.

After the successful launch, KCATA President and CEO Robbie Makinen said that “Bridj is an empowering tool that gives people one more alternative to driving their personal vehicle. There is no one-size-fits-all transit solution. That’s why KCATA is committed to enhancing its portfolio of services to help people connect with all sorts of opportunities.”

Information for this article was supplied by Kansas City Transportation Authority, Kansas City, Missouri; for more information, visit www.kcata.org.
GTFS-Realtime, or GTFS-R, for an on-screen display of buses traveling in real time.

Universal access to GTFS, including the instructions, is available via the Internet. A community of GTFS producers and consumers has demonstrated the value of this approach in developing mobile apps that deliver schedule information to bus riders on their smartphones, tablets, and computers. Figure 1 (page 30) shows the screen display; entering a current location—which can be detected automatically in some instances—and the desired destination can produce instant instructions for the nearest bus service.

The World Bank provides developing countries with open-source tools and instructions for creating GTFS. Tests show that editing and using this program does not require training or experience (for additional resources, see sidebar, page 30).

**Pulling It All Together**

More advanced bus system analysis and planning tools are under development, including tools for internal bus system planning that leverage the interoperability of the open-source approach. The new generation of web-based, open-source tools for bus planning and forecasting can combine archived bus operations data with new open data resources, particularly GTFS and the U.S. census.

For example, Bus Transit Market Analyst seamlessly predicts bus ridership by following a sequence of steps using open-source tools; GTFS routes are used to define the market areas. The Census Bureau's American Community Survey and the Census Transportation Planning Products can extract the demographic information to predict bus ridership from census tracts adjacent to bus routes.

A mobile app, Open Trip Planner, serves as a

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**Automation Advancing into Transit Bus Operations**

*Lane Assist, Crash Avoidance—and More*

**MATTHEW LESH**

As the testing of driverless cars gains headlines and sparks the public’s imagination, automation is making inroads into transit bus operations. For example, bus rapid transit (BRT) is a good candidate for applications of lane assist technology. Already widely deployed in passenger cars, lane assist systems can help prevent crashes caused by a driver drifting out of the lane—the device alerts the driver and provides a countersteering force.

When the right-of-way for building new lanes for BRT is limited, lane assist technology can allow buses to operate safely in narrow lanes, such as a freeway shoulder. These systems also can help buses pull to within centimeters of the curb, allowing faster loading and unloading of passengers, including riders with special needs. The Minnesota Valley Transit Authority and

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The author is Director of Mobility Systems, Local Motors, Inc., National Harbor, Maryland, and Vice Chair of the TRB Automated Transit Systems Committee.
microsimulation routing engine. Bus riders take microsimulated trips in Open Trip Planner based on the GTFS schedule, as if they were using their smart phones to navigate their way to work via the bus. Open-source tools that tap automated farebox data validate the outcome of the microsimulation.

These demand modeling tools can include customizable inputs for forecasting future conditions at the regional level, such as increases or decreases in population and employment; at the route level, such as increases or decreases at the census tract level; and at the stop level, such as land use changes within walking distance of the stop.

**Next Steps**
Many bus operators are making their services more appealing by providing GTFS for customer-focused apps, but the real leap forward will occur when the bus operators themselves can take full advantage of all the emerging open-source data and programming capabilities available for bus system planning. Several efforts would assist that leap:

- Encouraging cooperation by vendors to adopt data format standards—for example, for farebox data—to facilitate data integration; bus operators could specify standardized data and data ownership policies in their procurements;
- Training bus agency staff to use the available open-source tools with their own archived data;
- Developing new courses and webinars in transportation planning to allow staff to gain acquaintance and expertise with web-based deployments, including the ability to customize code; and
- Encouraging the use of data resources by small and medium-sized bus agencies, so that bus operators everywhere can take advantage of the open-source resources to improve their systems, as the World Bank effort to assist bus services in developing countries has demonstrated.

**Leveraging the Tools**
The upward trajectory for the adoption of open source and open data is promising, given the success of GTFS. Even if onboard equipment remains primarily an environment of retrofitted advancements, and vendors cannot participate in the production of standardized data elements, data science can help to address these issues.

As more bus systems join the initiative to provide GTFS for mobile apps that assist bus riders, they will contribute to a rich data resource for their own planning needs. The ability to leverage tools for bus system planning and forecasting, using GTFS as a foundational data resource, promises a bright future.

**Additional Reading**


Hough is Program Director and Associate Professor of Transportation, and Mattson is Associate Research Fellow, Small Urban and Rural Transit Center, Upper Great Plains Transportation Institute, North Dakota State University, Fargo.

The Changing State of Rural Transit

Challenges, Trends, Benefits, and Innovations

JILL HOUGH AND JEREMY MATTSON

Transit agencies serving the needs of people in rural areas throughout the United States are challenged by low population densities and long travel distances. Rural transit agencies face other challenges as well, such as finding and training the staff to operate and maintain vehicles and securing local funding from a limited tax base. Many rural agencies have been resourceful in meeting these challenges.

Rural Travel Behavior

The gap between urban and rural areas in the availability and use of public transit is significant. According to the 2013 American Housing Survey (AHS), 73 percent of urban and 47 percent of suburban households have access to a grocery store by public transit, compared with only 27 percent of households in nonmetropolitan areas. Access to other services and amenities by transit reveals similar disparities.

AHS data, along with data from the American Community Survey and the National Household Travel Survey, show that rural residents rely on the automobile much more than their urban counterparts do. Only 4 percent of rural households lack access to an automobile, but 70 percent have access to two or more vehicles.

Only 0.5 percent of rural residents use public transportation to commute to and from work, compared with 6 percent of urban residents. Rural residents may take fewer trips per day than urban residents but drive significantly more miles because of the long travel distances. Differences in commute distances account for a large share of the disparity in miles driven—daily commute miles for rural residents are nearly double those of urban commuters (1).

The general population’s reliance on the automobile in rural areas creates difficulties for subpopulations such as older adults, people with disabilities,
and people in low-income households, who lack access to an automobile and require transportation alternatives. Members of the relatively few rural households that lack access to an automobile make almost one-third fewer trips per day than members of households that own a single vehicle. The disparity is greater when compared with households that have two or more vehicles (2). The difference—known as the mobility gap—suggests a need for rural mobility services for those who cannot drive or do not have access to a vehicle.

**Demographic Trends**

Older people and people with disabilities, veterans who need health care services, and Native Americans living on reservations face a variety of transportation challenges in rural areas. Older adults tend to rely on others, especially family members, for transportation, but this can be problematic, because family members are often far away or not available—they may have moved to other communities or have jobs and other commitments.

Approximately 16 percent of residents in rural areas are 65 years of age or older, compared with 13 percent in urban areas. As age increases, so does the likelihood that an individual will have a disability that creates mobility needs and limitations. According to American Community Survey data, 15 percent of residents in rural areas have a disability, compared with 12 percent in urban areas.

The percentage of population age 65 or older has increased in both urban and rural areas in the past decade, but the increase has been greatest among the rural population. The share of the rural population that is elderly is likely to continue to grow in the next several decades as the baby boom generation ages.

Veterans also are more likely to have disabilities. In general, the need for veteran transportation is growing because of the many injured men and women returning from overseas military service. Veterans in rural areas are more likely than their urban counterparts to be older, in poorer health, and disabled (3). Many rural veterans must travel long distances to reach a Veterans Administration health care facility.

Many Native Americans, especially in the Upper Great Plains and Southwest, live on remote, rural reservations. They have limited access to medical services, shopping, employment, and educational opportunities (4). One-way trips of 50 or 100 miles are not unusual.

Rural reservations also tend to have a high percentage of low-income households. According to the 2013 AHS, approximately one-third of American Indian and Alaska Native households live below the poverty line—roughly twice the national average.

**Rural Transit Benefits**

Providing transit is less efficient in low-density rural and small urban areas than in urban settings, measured by cost per trip or by trips served per mile. Nevertheless, research has shown that rural transit agencies provide a net benefit to their communities in three main ways:

- Transportation cost savings to the user, who would have taken more costly forms of transportation in the absence of transit;
- Trips that would have been foregone if transit service were not available; and
- Local economic activity resulting from transit operations—including not only the jobs created by the transit agency, but the jobs created in industries that supply inputs to public transit and the economic activity induced from the income generated by these new jobs (5).

Although all three categories of benefits are potentially valid reasons for investing in rural transit, research indicates the importance of providing trips to those who otherwise would not be able to travel. A study by the National Center for Transit Research found that a $1 investment in rural transit returned $1.20 in transportation cost savings and mobility benefits (5). This estimate, however, did not include the local economic activity and therefore may be conservative. Other studies of rural transit have estimated similar cost–benefit advantages (6).

A missed medical trip can affect a person’s quality of life and can result in a need for more costly care. Compared with the cost of health care, the cost of providing transportation for access to health care can be small.

Providing work trips via transit also can have a positive net benefit for society if the service is less
expensive than providing government assistance to people who lack access to jobs. Providing other types of trips also has benefits, although these are often qualitative and difficult to measure—for example, the quality-of-life benefits from social trips.

In addition, rural transit services can offer a safer form of travel, especially for older riders whose ability to drive has deteriorated. Driving abilities can decrease because of age-related vision loss, hearing impairment, poor reflexes, and medical conditions. A higher percentage of seniors in rural areas continues to drive, often because of a lack of alternatives.

Data from the 2009 National Household Travel Survey show higher driving rates in rural areas for all age groups, including senior citizens. The survey also shows that people living in rural areas who have a medical condition or disability that makes travel difficult are less likely to give up driving (7). Providing alternative forms of transportation makes the decision easier for seniors and those with disabilities to give up driving as their skills and safety levels decline.

Size and Scope

According to data from the rural National Transit Database, 1,317 rural transit agencies provided 495 million vehicle miles, 28 million vehicle hours, and 131 million rides in 2013. The geographic coverage of rural transit has slowly expanded in recent years. Nationwide, 79 percent of all counties had some level of rural transit service. These data include rural public transit agencies receiving Section 5311 Non-Urbanized Area Formula Program funding but do not include the specialized transportation providers funded by other programs.

The median number of trips provided by a rural transit agency in 2013 was 33,520, and the median vehicle miles operated was 184,506. The sizes and types of operations, however, vary. For example, the smallest 10 percent of agencies provided less than 25,000 miles of service, but the largest 10 percent provided more than 800,000 miles. Among the larger agencies, 100 provided more than 1 million miles of service and 16 provided more than 1 million rides.

These statistics exclude urban systems that provide transit in rural areas; these systems report their data to the urban National Transit Database. The number of urban systems receiving Section 5311 funding for service in rural areas has doubled within the past few years to 231 in 2013, when these agencies provided 36 million rural trips. When these urban providers are added to the rural systems, a total of 1,548 transit agencies provided 167 million rural transit trips in 2013.

Rural transit systems almost exclusively provide bus transit. A few ferryboat operators serve rural areas, as do van pools, demand-response taxi services, and resort-area tramways—a special case with greater similarities to urban transit than to the typical rural system. Most rural transit operators provide fixed-route or demand-response bus service. Many rural transit agencies offer only demand-response service; approximately one-third operate some type of fixed-route service.

Some regional differences apply. The Southeast and Midwest have the greatest number of rural transit agencies. The operators in these regions are mostly demand-response providers. The Northeast and far Western regions favor fixed-route service.

Workforce Development

Maintaining and increasing staffing is critical, as rural transit agencies attempt to meet the growing demand for service. In a 2014 survey of North Dakota transit agencies, most of which serve rural areas (8), half responded that they have too few staff to meet current needs, and most of the remainder said that they will need additional staff within the next five years to meet expected higher future demand.

Many North Dakota agencies reported difficulties in finding qualified staff. Transit operators from cities in western North Dakota, such as Minot and Dickinson, reported that they had to compete with the oil industry for drivers. The superintendent for
Minot City Transit noted the difficulty “for a municipality to compete with oil field and private companies’ wages...to hire and retain drivers.” The Dickinson Public Transit director commented that the agency needs more office and transit staff, but “to hire and maintain qualified staff, we need more money for salary and benefits.”

Staffing issues are not limited to areas with an active oil industry. Rural transit agencies also must compete with trucking firms that offer higher wages. Moreover, respondents from eastern North Dakota observed that low unemployment rates throughout the state have made qualified workers difficult to find.

Transit agencies may need to continue increasing wages to attract and maintain a qualified staff. This could result in higher operating costs, because labor is the largest cost in supplying transit service.

**Innovation and Resourcefulness**

Many bus operators have answered the challenges of rural transit demand in innovative and resourceful ways. For example, South Central Adult Services, which provides transit services in a large six-county area of North Dakota, partners with a private company, Lafarge, to use transit vehicles during the off-peak season to provide cancer patients with rides to treatment facilities; Lafarge covers the operating and fixed costs for the rides. The partnership allows South Central Adult Services to use other vehicles to provide more mobility for more people in the region.

Transit Cooperative Research Program (TCRP) Synthesis 94, *Innovative Rural Transit Services*, offers other examples of innovations (9). The specialized CountyRide transportation program in Baltimore County, Maryland, for example, uses a sophisticated, computerized scheduling and dispatch system to take trip requests in advance. The system digitally dispatches trips to drivers and optimizes scheduling in real time.

Rural agencies across the country are adopting intelligent transportation systems products that optimize scheduling and routing, facilitate coordination, reduce fuel costs and wasted miles, and improve on-time performance and rider satisfaction. The adoption rate for these technologies is difficult to estimate because of a lack of national-level data.

In North Dakota, more than 15 agencies have adopted dispatching software in the past two years. As reported in TCRP Synthesis 94, one agency estimates that ridership has nearly doubled in some rural areas, because drivers can focus on driving and quality of service instead of the completion of paperwork. With the higher utilization of vehicles, some agencies have added services for such markets as preschool and daycare passengers.

**Meeting the Demand**

The challenges in providing mobility services to rural residents will persist. The number of elderly in rural areas is growing, as the baby boom generation reaches retirement. In a North Dakota survey, a majority of AARP members reported that improved access to public transportation and more ride alternatives were needed to allow them to stay in their homes and remote neighborhoods (10). Access to rural transit is especially important to people with disabilities, veterans who need medical treatment, Native Americans living on reservations, and people in low-income households.

Meeting this demand requires an innovative and resourceful approach that makes the best use of available vehicles and technologies. The type of transit provided in rural areas may differ from that in urban areas, but rural operators are showing that the service is equally important to users.

**References**


7. Mattson, J. *Travel Behavior and Mobility of Transportation-Disadvantaged Populations: Evidence from the National Household Travel Survey*. DP-258, Upper Great Plains Transportation Institute, North Dakota State University, Fargo, 2012.


Most long-distance trips begin in one metropolitan region and end in another less than 500 miles away. These interregional trips account for approximately three-quarters of all long-distance travel.

Although local travel has been the subject of considerable study and is relatively well understood by planners and public officials concerned with urban transportation, several recent developments have directed attention to the interregional segment of travel. Among them are California’s plan to invest more than $60 billion in a new high-speed rail line connecting the state’s southern and northern cities and the emergence of express curbside buses in the heavily trafficked Northeast Corridor (NEC), which spans Boston, Massachusetts, to Washington, D.C. These and other cases in which new transportation services and systems are being considered—sometimes involving large public investments in long-lived infrastructure—require a thorough understanding of interregional travel demand, service options, and corridor traffic and trip-making patterns.

TRB Special Report 320, Interregional Travel: A New Perspective for Policy Making, reviews the demand for interregional travel in the United States and the uncertainties that arise in supplying transportation services and infrastructure to accommodate the demand. The study committee (see box, page 42) considered relevant experience in other countries in serving interregional travel demand, especially by providing passenger train service.
The findings of the committee suggest that appropriate analytical tools and up-to-date data on long-distance travel patterns are lacking in the United States, complicating decisions about investments in the nation’s interregional corridors. In addition, the study identifies significant gaps in decision-making capacity, largely because transportation funding sources and institutions do not align well with the country’s interregional corridors, which connect and cross multiple metropolitan areas and states. The committee recommends several initiatives to fill these gaps.

**Changing Travel Patterns and Technologies**

The American Travel Survey (ATS), conducted in 1995, is the primary source of information on long-distance travel in the United States. Like its predecessor in 1977, the survey revealed the dominance of the private automobile in long-distance trip making, especially for distances under 500 miles.

A long-distance travel survey, if conducted today, likely would reveal many travel patterns not observed in the ATS, as would be expected after two decades of demographic, economic, and technological change. Since 1995, the U.S. population has increased by more than 20 percent; grown older, as indicated by the median age—34.3 years in 1995 and 37.6 years in 2013; become more concentrated in metropolitan areas; and continued to shift further to the South and West. Average household size has declined, as the number of households with children has grown at a slower rate than that of households of couples and of individuals living alone.

Transportation technologies also have changed—dramatically in some cases. Advances in in-vehicle electronics have made travel by automobile more reliable and comfortable for longer-distance trips, not only by assisting with driving functions—for example, adaptive cruise control and lane-keeping systems—but also by providing onboard entertainment and navigation assistance.

The commercialization of the Internet and the introduction of the smartphone and other electronic and telecommunications devices have created new means of marketing and shopping for airline, train, and bus fares—for example, through travel agency websites and online ticketing. Mobile computer and communications technologies also have allowed a more productive use of time while traveling. These technologies may be influencing travelers’ choice of modes—and even their overall demand for travel—with a growing number of options for working remotely and staying connected to friends and family.

**Intercity Bus Renaissance**

The recent proliferation of intercity express bus services illustrates the changes that have been taking place in interregional travel—and by extension, the uncertainties that decision makers face when considering investments in long-lived transportation infrastructure, such as high-speed railways.

During the 1990s, the nation’s intercity bus industry was in the midst of a long-term decline in ridership. Today, the industry has been rejuvenated by bus companies providing nonstop service between the downtowns of major cities.

The express bus appears to have filled a void in the low-fare and shorter-haul interregional market. The services accommodate mostly solo travelers who lack access to automobiles, find driving too expensive or a car unnecessary at the destination, or want to make enjoyable or productive use of travel time through the onboard amenities and the uninterrupted use of portable electronic devices.

Public officials noticing this renaissance may question the need for capital-intensive transportation investments to compete with the low-cost private buses. Or they may view this development as indicative of more people seeking transportation alternatives to the automobile, and thus as a signal for investing in other options, such as intercity train service and priority access lanes and terminals for intercity buses.

**Limited Passenger Rail Options**

In most of the country’s interregional corridors, intercity trains operate on freight lines. Corridor investments to increase passenger train speeds and frequencies are generally not attractive to the private freight railroads that own these lines and may be undesirable if they hinder the efficient movement of freight.
With skeletal passenger train service and limited prospects for introducing passenger rail service with competitive speeds and frequencies on heavily trafficked freight lines, few corridors other than the passenger-oriented NEC have developed a large ridership base. The absence of a well-established ridership increases the uncertainty of investing in competitive service levels, particularly when a large commitment of public funds is needed for infrastructure development.

The NEC is the only interregional corridor with train frequencies and schedule times that can compete successfully for market share with airlines, buses, and automobiles. The NEC accounts for most interregional train ridership in the United States. The 400-mile corridor, with New York City at the center, contains many large metropolitan areas that are closely spaced and positioned linearly, so that multiple city-pair markets can be served with frequent trains on a single line. Also fundamental to the success of train service in the NEC is that Amtrak controls the electrified right-of-way, which carries little freight and is used mainly by local commuter and intercity passenger trains.

**Learning from Experience Abroad**

The scarcity of passenger train service in the United States outside of the NEC contrasts sharply with the widespread availability of service in Europe and Japan. Because Japan and most European countries are geographically compact, passenger rail networks can connect each country’s major cities in ways that are not practical in the continental-size United States.

In the past 50 years, the national governments of Europe and Japan have made sustained investments to create modern and increasingly integrated rail networks to accommodate fast, frequent, and reliable passenger trains. Consequently, most European and Japanese investments in new or substantially upgraded passenger rail services, such as high-speed rail, are made in markets already demonstrating high rail ridership.

In this regard, the European and Japanese experience bears directly on the NEC, which has a well-established intercity train service and known ridership demand. But the European and Japanese experience in providing passenger rail in established markets is less relevant to investing in passenger rail where train service is sparse and ridership is low or nonexistent, as characteristic of most U.S. corridors.

Transportation planners in California, for example, have recognized that improving passenger rail service by increasing train speeds and frequencies on the main lines of freight railroads is not a practical option for building a strong ridership base. Therefore the state is planning to build a new high-speed trunk line devoted to passenger service. The investment is being informed by evaluations of airline traffic and stated preference surveys rather than the traditional approach of examining the demand revealed by existing train ridership.
The NEC’s Uniqueness
The geographic, demographic, and travel demand circumstances of the NEC set it apart from other U.S. interregional corridors. The NEC is characterized by the following:

- Numerous large metropolitan areas in the region that are
  - Well connected economically and socially—this creates densely trafficked interregional rail, air, and highway routes;
  - Located within 100 to 300 miles of each other and positioned in a linear fashion that suits service by a single rail line;
  - Served by extensive public transit systems capable of providing fast, convenient access to downtown train and bus stations; and
  - Centered on cities with downtowns that are major origins and destinations for interregional travelers;
- An electrified rail right-of-way devoted to passenger rail and able to accommodate frequent, fast trains without being encumbered by freight trains;
- Rail and bus ridership levels comparable with those of corridors in countries that have made sustained investments to develop competitive rail service—in some cases, by investing in high-speed trains;
- Several major airports in the area, with regulatory limits on daily flights and a general difficulty in expanding airport and airway capacity; and
- A transportation infrastructure that spans numerous states—too many to generate a highly coordinated program contributing to the development of infrastructure but too few to have strong national-level support.

Because of these distinct circumstances, as well as a location in one of the country’s most populous and heavily trafficked regions, the NEC presents far less uncertainty about the benefits from potential investments in passenger rail, including high-speed rail. Clearly the NEC should be treated differently from other corridors in terms of the scale and timing of the resources made available for assessing and meeting its transportation investment needs.

Corridors and Institutions
As evident in the multistate NEC, the planning and development of interregional corridors are complicated by the many public and private entities responsible for supplying transportation services and infrastructure. Yet even when a corridor lies within a single state, much of the transportation infrastruc-

Economically and geographically, the metropolitan regions in the Northeast Corridor are well suited for intercity passenger rail.
Committee for a Study of Intercity Passenger Travel Issues and Opportunities in Short-Haul Markets

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In contrast to the MPO process, the provision of interregional transportation appears to lack the most basic information on travel activity and the well-honed analytical tools for transportation planning and priority setting. The absence of interregional planning and decision-making bodies that would need these data and tools on a continuing basis explains this deficiency in part.

Nevertheless, proposals for transportation investments often address interregional corridors, and some involve large, long-term commitments, like California’s plan to develop a high-speed rail line. These proposals require careful analysis and planning. In addition, most large transportation investments require institutional coordination, absent in many interregional corridors.

In the committee’s view, more federal attention and leadership can address the deficiency. The committee recommends that the U.S. Department of Transportation (DOT) bring about a more rational and coordinated process for developing the nation’s interregional transportation systems by taking the following actions:

- Supporting the establishment of a national data program focused on observing and understanding the behavior of long-distance travelers and the transportation services available to them;
- Supporting the development and application of state-of-the-art analytical tools for planning and prioritizing interregional transportation investments; and
- Creating the incentives for states to collaborate in developing multimodal, interregional transportation planning and decision-making organizations. The incentives should allow states to choose whether to form such organizations and should provide the flexibility to structure the organizations and define their responsibilities in ways best suited to meeting corridor-specific interests and needs.

A New Perspective

The desirability of planning and prioritizing urban transportation systems from a metropolitanwide perspective was recognized 50 years ago. That was the genesis of what became the multimodal and multijurisdictional MPO process.

At times, the federal government has helped in creating and supporting interregional bodies such as the NEC Commission and the I-95 Corridor Coalition. These efforts not only offer conceptual models for coordinated transportation planning and programming but also indicate the importance of leadership by the federal government and U.S. DOT in motivating and supporting implementation. The actions recommended in Special Report 320 are intended to provide similar support and motivation.
To attract more riders, transit must offer high levels of service in frequency, travel time, and reliability. Transit agencies constantly work to improve reliability, but the cost is often substantial. Real-time transit information can improve perceived and actual wait time and rider satisfaction inexpensively—and even may increase ridership.

**Problem**

Transit agencies can improve service reliability by providing dedicated right-of-way and signal priority on routes, adding slack to schedules, applying other service planning approaches, and implementing vehicle holds and other control strategies. Although effective, these measures either yield only minor improvements or prove costly. An inexpensive solution is needed to combat transit users’ perception that service is unreliable.

**Solution**

Unknown wait times present a difficulty for many transit riders—riders want to know when the transit vehicle actually will be arriving. By empowering riders with some degree of confidence about their trips, transit agencies can increase ridership and retain riders who have a choice of modes.

Several technology enhancements have made the provision of real-time transit information easier, less costly, and more effective for transit agencies:

- In 2000, the federal government deactivated the selective availability restrictions on GPS for civilian applications. This increased the usefulness and availability and decreased the cost of GPS devices. More transit agencies were able to equip their vehicles with automatic vehicle location systems.
- In 2005, Google and TriMet in Portland, Oregon, collaborated to standardize transit schedule data. The General Transit Feed Specification (GTFS) that emerged has enabled transit agencies to share their data, which can be used to populate Google’s transit trip planner. This application has raised awareness and has sped adoption of the transit data standards. New standards, such as GTFS-Realtime and the Service Interface for Real-time Information, or SIRI, allow agencies to share real-time data feeds with developers.
- The ubiquity of smartphones throughout the United States has facilitated mobile access to information by the majority of transit riders, and third-party software developers are interested in creating applications. As more transit agencies release their data feeds in response to the push for open data, developers can gain access to transit data feeds from across the nation.

These technological advances catalyzed the development of OneBusAway, a mobile real-time transit information platform.¹

**Application**

OneBusAway was developed in 2008 at the University of Washington. By 2011, more than 100,000 unique users in the greater Seattle region consulted OneBusAway each week on a range of platforms, including native applications on iPhone, Android, and Windows phones, as well as through a website, text messaging, a voice recognition system, and public displays in store windows.

OneBusAway is an open-source system that allows developers, researchers, and transit agencies to adapt

¹ http://onebusaway.org
the code to their own systems and to build on the initial implementation. In 2013, improvements to the OneBusAway mobile apps allowed data from several regions to feed the apps, enabling deployment in several cities, including New York City; Tampa, Florida; Atlanta, Georgia; Washington, D.C.; and York, Ontario, Canada. Additional technology demonstrations have been implemented in Detroit, Michigan; Washington, D.C.; Boston, Massachusetts; and Lappeenranta, Finland.

Transit agencies have initiated some of the development; in other cases, local developers have sought to fill a gap in available rider information with the intention of supporting the application in the long term or attracting the interest of the local transit agency for adoption.

Benefits
The OneBusAway research project evaluated the effect of this informational tool on ridership levels and on rider perceptions. Surveys of OneBusAway users in Seattle in 2009 and 2012 found that 92 percent of riders reported increased or greatly increased satisfaction with public transportation, as well as an increased sense of safety, among other benefits.

Wait Times
Another study conducted in Seattle focused on users’ perceived and actual wait times. The results showed that for riders without real-time information, the perceived wait time was much greater than the actual, measured wait time; but when real-time information was available, the respondents’ perceptions were in line with reality. Moreover, the study observed that mobile real-time information users actually waited almost 2 minutes less than those who used traditional schedule information.

An evaluation of OneBusAway in Tampa in 2013 included an experiment—some bus riders received access to OneBusAway for three months. Changes in behavior were assessed with before and after web-based surveys. Analysis of “usual” wait times revealed a significantly larger decrease—nearly 2 minutes—for real-time transit information users compared with the wait times of the control group. In addition, real-time users reported significant decreases in levels of frustration when waiting.

Ridership
In some cases, real-time information may have contributed to an increase in transit ridership. The studies conducted in Seattle showed that riders reported an increase in trips, particularly in the off-peak periods when the transit system has additional capacity. Studies conducted in Tampa and Atlanta, in contrast, did not find a substantial change in transit travel associated with use of real-time information; the study methodologies in Tampa and Atlanta, however, did not consider completely new transit riders.

A recently published study evaluated bus ridership in New York City for three years during which real-time information gradually was made available on bus routes throughout the city. Econometric methods controlled for other factors that affect bus ridership, and the models suggested that real-time bus information was associated with a median increase of 1.7 percent in weekday route-level bus ridership.

Positive Outcomes
In summary, the OneBusAway project has enabled testing of the impacts of real-time transit information, and the findings have revealed positive outcomes: increased satisfaction, decreased wait times, and even increased ridership. As more transit agencies adopt open data policies and more transit riders use mobile devices, these benefits are likely to continue to accrue.

Resources


EDITOR’S NOTE: Appreciation is expressed to Joseph Morris, Transportation Research Board, for his efforts in developing this article.
C A L E N D A R

TRB Meetings

July

6–7 3rd International Conference on Access Management*
    Pretoria, South Africa

6–13 Chan Wui and Yunyin Rising
    Star Workshop for Early Career Professionals
    (invitation only)

10–12 11th National Conference on Transportation Asset Management
    Minneapolis, Minnesota

11 Geological Modeling:
    Methods and Methodologies
    Colorado Springs, Colorado

16–18 International Conference on Transportation Infrastructure and Materials
    Xi’an, China

17–20 55th Annual Workshop on Transportation Law
    Washington, D.C.

17–20 Transportation-Related Environmental Analysis, Ecology and Historic and Archeological Preservation Summer Conference
    Salt Lake City, Utah

19–21 Automated Vehicles Symposium 2016*
    San Francisco, California

24–27 Transportation-Related Noise and Vibration Committee Summer Conference
    Missoula, Montana

25–27 GeoChina 2016 International Conference*
    Shandong, China

26–29 Resource Conservation and Recovery Summer Conference
    Asheville, North Carolina

August

4–5 Transportation Planning and Air Quality Conference
    Minneapolis, Minnesota

8–10 Istanbul Bridge Conference*
    Istanbul, Turkey

9–11 2016 Summerail Conference*
    Council Bluffs, Iowa; Omaha, Nebraska

14–17 Use of Scenario Planning in Transportation Planning
    Portland, Oregon

16 2016 Innovations in Transportation Conference: Are You Ready for the Future?*
    Ames, Iowa

September

4–7 3rd International Conference on Transportation Geotechnics*
    Guimarães, Portugal

12–14 15th National Tools of the Trade
    Charleston, South Carolina

    Portland, Oregon

19–21 5th International Conference on Accelerated Pavement Testing*
    San Jose, Costa Rica

25–29 8th World Congress on Joints, Bearings, and Seismic Systems for Concrete Structures*
    Atlanta, Georgia

26–28 International Conference on Demand-Responsive Transportation
    Breckenridge, Colorado

October

2–5 22nd National Conference on Rural Public and Intercity Bus Transportation
    Asheville, North Carolina

5–7 European Transport Conference*
    Barcelona, Spain

31– Partners in Research Nov. 1 Symposium
    Detroit, Michigan

December

1–2 10th University Transportation Center Spotlight Conference: Bicycles and Pedestrians
    Washington, D.C.

January 2017

8–12 TRB 96th Annual Meeting
    Washington, D.C.
    For information, visit www.trb.org/AnnualMeeting

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.trb.org/calendar. Telephone 202-334-2934, fax 202-334-2003, or e-mail TRBMeetings@nas.edu.

*TRB is cosponsor of the meeting.
Growing up in Paris, Brendon Hemily embraced independent travel on the city’s comprehensive subway and bus system and valued the broader purpose of transit: helping people fulfill their lives. “Public transportation was something worth doing,” Hemily recalls; from a young age, he knew it was a career path he wanted to pursue.

In college and graduate school, Hemily studied and worked with leading researchers such as Nigel Wilson and transportation economics expert William Vickrey. He received a bachelor of arts degree in economics from Columbia University in New York; he then pursued a master’s degree and a Ph.D. from the Massachusetts Institute of Technology. In 1978, Hemily attended his first TRB Annual Meeting, discovering a forum that brought together academic researchers, innovative transit agency staff, government agency policymakers, and consultants. “This was an exciting place where knowledge was gained and ideas were discussed,” Hemily comments. He has attended every Annual Meeting since 1978.

At one Annual Meeting, Hemily met George Smerk, who hired him to manage Indiana University’s slate of transit training courses and to conduct research on the use of strategic planning in the transit industry.

Hemily then found himself at a professional crossroads: to continue an academic career, fulfilling research objectives and mentoring young people, or to work with transit agencies to forge innovation and effect change. Hemily found an opportunity to fulfill both career tracks by joining the Canadian Urban Transit Association (CUTA) as research and development (R&D) coordinator. He surveyed innovation activities pertinent to transit systems, identified gaps and related R&D needs, and developed problem statements to encourage applied research. Dissemination also was a significant part of his responsibilities; starting in 1988, Hemily organized theme-specific conferences—an industry first for both North America and Europe. “The success of these conferences inspired other organizations to structure more focused events where colleagues could learn about innovations and share best practices,” Hemily notes.

In 1989, Hemily’s success with R&D at CUTA led to the creation of a national research program at the agency, funded by governments and transit agencies. He became the manager of research and technical services and was responsible for all technical activities. “This was the best of jobs,” Hemily notes. “I worked closely with highly motivated transit system colleagues to identify practical research needs, to define and conduct studies, and to ensure that those who needed the information received it firsthand from the researchers in the form of milestone reports or through workshops—rather than through large final reports that few have the time to read.”

The program facilitated research on many diverse topics, including the implications of demographic and socioeconomic trends on transit, the ergonomic design of the bus driver’s workstation, the use of automatic vehicle location data for planning and management, low-floor buses, rear-facing positioning for wheelchairs on transit vehicles, and more.

In 2000, Hemily left CUTA to pursue applied research as an independent consultant, working in the United States and Canada. He focused primarily on intelligent transportation systems—not from the perspective of a technology enthusiast, but to use technology to enhance effectiveness and efficiency for transit customers.

“Technology is changing our world significantly and offering diverse opportunities,” he muses. “Most of the obstacles to innovation, however, are not technical in nature but are organizational, human, and institutional, compounded by a lack of awareness of best practices.”

Hemily has stayed involved in the academic and research world as well; he taught a graduate course on public transportation at the University of Toronto for 10 years. “Public transportation is a worthwhile pursuit, but it is also challenging, because transit agencies are asked to pursue multiple, and sometimes conflicting, objectives,” he comments. “True innovation requires individuals to have both a multidisciplinary perspective on benefits and challenges—and an eternal curiosity to ask questions and seek better solutions—underlining the importance of research.”

Hemily is chair of the TRB Public Transportation Planning and Development Committee, which he joined in 1986. He is a longtime member and friend of the Bus Transit Systems Committee and also serves on the Transformative Trends in Transit Data Subcommittee and several Transit Cooperative Research Program project panels. In 1993, he served on the steering committee for the Workshop on Transit Fare Policy and Management; in 2007 he worked with Edward Beimborn to organize the Conference on Transit Planning and Land-Use Coordination in Denver, Colorado.
C heryl Allen Richter was an agricultural engineering major at Cornell University when she found a part-time job analyzing rural road data with the Cornell Local Roads Program. Director Lynne Irwin became Richter’s mentor and helped her develop her career focus in pavement engineering; Richter then returned to Cornell for a master’s degree in highway engineering.

“To say that I am indebted to Lynne for much of the success that I have enjoyed in my career would be an understatement,” Richter observes.

After receiving her master’s degree and working for several years as research associate and staff engineer with the first Strategic Highway Research Program, Richter joined the Federal Highway Administration (FHWA) Office of Infrastructure Research and Development. Her work focused on the Long-Term Pavement Performance (LTPP) program, establishing many of the LTPP performance monitoring protocols as well as the falling weight deflectometer calibration. Later, her focus shifted to analysis of the LTPP data. She worked with the TRB Expert Task Group on LTPP Data Analysis to establish a strategic plan for long-term pavement performance data analysis. “Information derived from the LTPP program provides an understanding of pavement performance that can be applied to help agencies make well-founded pavement management decisions,” Richter comments.

In 2002, she received a Ph.D. in pavement and geotechnical engineering from the University of Maryland, College Park.

Richter also served as Technical Director for Pavement Research and Development and as Infrastructure Research Program Manager at FHWA. In 2010, she became assistant director for pavement R&D at FHWA’s Turner–Fairbank Highway Research Center in Virginia.

Now, as senior adviser and program coordinator at the FHWA Office of Infrastructure, Richter provides advice and coordination encompassing all aspects of the agency’s infrastructure activities: administration of the Federal-Aid Highway Program, transportation performance management, bridges and structures, asset management, pavements, and construction. A recent area of focus has included analysis and timely implementation of the Fixing America’s Surface Transportation (FAST) Act of 2015.

“The ongoing transition to transportation performance management, first provided for in the Moving Ahead for Progress in the 21st Century Act and continued under the FAST Act, holds great promise as a way of improving the overall effectiveness of transportation investments. Research is key to developing an understanding of transportation performance,” Richter comments, adding that research allows practitioners and policy makers to keep pace with the evolving challenge of delivering safe and reliable transportation.

“As raw materials have become scarcer and costlier, and as concern for the environmental impacts of highways has grown, research enables the expanded use of reclaimed and recycled materials in the production of asphalt and concrete, without sacrificing durability,” she notes. Other innovations spurred by research include improved test methods and specifications, computer and automation technology applications to expedite and improve construction processes, and the use of ultrahigh-performance concrete to address a key challenge in prefabricated bridge construction.

Richter served on the TRB Design and Rehabilitation of Asphalt Pavements Committee from 1991 to 2003. In 1994, she joined the Pavement Structural Modeling and Evaluation Committee, then called the Strength and Deformation Characteristics of Pavement Sections Committee, which she served as chair from 2006 to 2011; Richter then was appointed chair of the Pavements Section. She spearheaded an organizational review of the section, which she cites as her most significant TRB accomplishment to date.

“Our purpose in undertaking the review was to ensure that the section was organized in a way that would allow it to effectively lead advances in the profession,” she notes. Richter adds that important topics in pavement research did not have an “organizational home” within the TRB committee structure; the two pavement design committees were focused on rigid (concrete) and flexible (asphalt) pavements, and a logical place was needed for cross-cutting pavement design issues such as life-cycle analysis, design approaches applicable to pavements of all types, composite or nontraditional pavements, and more. A consensus on addressing these needs was a challenge, but ultimately, Richter and her colleagues recommended the creation of a new committee and the sunsetting of another, adjusting committee scopes.

Richter received the Federal Highway Administrator’s Award for Superior Achievement in 2003 and 2011; also in 2011, she received the Federal Highway Administrator’s Excellence in Teamwork Award.

“Research is key to developing an understanding of transportation performance.”
Nine TRB volunteer leaders have been designated as National Associates for their contributions to TRB and to the National Academies of Sciences, Engineering, and Medicine. The National Associates, a lifetime honor, recognizes extraordinary service contributions to the organization.

- Vice Admiral James Card, Maritime Consultant
- James Crites, Executive Vice President of Operations, Dallas–Fort Worth International Airport
- Thomas Kazmierowski, Senior Consultant, Golder Associates, Inc.
- Hani Mahmassani, William A. Patterson Distinguished Chair in Transportation and Director, Northwestern University Transportation Center
- Sue McNeil, Professor, University of Delaware
- Lance Neumann, Chairman, Cambridge Systematics, Inc.
- Brian Taylor, Professor and Chair of Urban Planning, University of California, Los Angeles
- Thomas Wakeman, Research Professor, Stevens Institute of Technology
- Johanna Zmud, Director, Texas A&M Transportation Institute

100 Years of Commercial Aviation

In January 2015, the TRB Aviation Group asked several of its emeritus members to review key events in the industry’s history and to look toward the future of aviation, as the commercial aviation industry celebrates its 100th anniversary. Their insights and observations are now part of a podcast that can be accessed at www.trb.org/main/blurbs/172112.aspx. The podcast highlights what these experts think about key industry issues as aviation moves into the next century of flight. The July–August 2016 issue of TR News will explore commercial aviation.

Emeritus members of TRB Aviation Group committees gathered at the 2015 TRB Annual Meeting to reflect on industry milestones and challenges.

Performance-Based Regulations—Peter Bjerager of the international certification group DNV GL participates in a panel discussion at a meeting of the Committee on Performance-Based Safety Regulation, April 14–15 at the National Academy of Sciences Building in Washington, D.C. Managed by the Division of Behavioral and Social Sciences and Education and TRB, the study compares prescriptive- and performance-based forms of safety regulation and identifies opportunities and challenges to facilitate a performance-based regulatory approach in such high-hazard industries as offshore oil and gas, pipelines, and other modes of transportation.
Work Zone Speed Cameras and Distraction

To help enforce speed limits in highway work zones, the Minnesota Department of Transportation (DOT) sought out human factors research on whether automated speed enforcement (ASE) cameras contributed to driver distraction. Researchers from CTC & Associates conducted a literature review on work zone safety and on the effectiveness of work zone crash countermeasures, including ASE. The researchers also used the University of Minnesota’s HumanFIRST Portable Driving Environment Simulator to replicate work zones on US-169 between Jordan and Belle Plaine.

The simulator study included 20 participants from each of three age groups—18 to 30, 41 to 53, and 63 to 77 years—who drove the simulated route four times each. Each time, the work zone featured a different form of speed enforcement: police enforcement, ASE cameras, and ASE cameras with dynamic speed display signs, as well as a control with no enforcement. Participants were instructed to follow a lead vehicle, with simulated real-world travel speed disruptions. Participants also were given a secondary, voluntary task that involved searching for and pressing specific buttons on an in-vehicle screen.

Glasses that tracked eye movements helped researchers determine how much attention participants paid to various areas of interest, such as the speedometer, workers, or signs. These tests indicated that drivers did not pay too much attention to the distractions. The main differences in driver behavior occurred by age group—younger and older drivers exceeded the speed limit most often and varied their speed slightly, depending on the type of enforcement, but drivers in the middle group exhibited the greatest speed control and kept more closely to the speed limit.

To access the full report, visit mndot.gov/research/TS/2016/201606.pdf.

INTERNATIONAL NEWS

Regulatory Reform of Ridesharing Apps

Commercial transportation apps are popular because of their consistency, availability, and ease of use; apps also provide transparency and accountability and improve allocation of capacity, according to a report from the International Transport Forum (ITF). Regulation of for-hire transportation should become more flexible to allow for innovation, the report notes; in general, oversight favors established providers, both because of market capture and because of the particular characteristics of street hailing.

The ITF report presents four principles that should guide regulatory reform of for-hire transportation:

- Set policies to enable innovations that contribute to such objectives as equitable access, safety, consumer welfare, and sustainability.
- Keep the regulatory framework simple and uniform, and avoid creating categories of providers.
- Choose innovative and flexible approaches to regulation, making use of new technology—automated fare data collection, onboard monitoring, and more—as well as better data for targeted oversight.
- Use data-led regulation to improve benefits for all, offering operators a choice between a light and a more burdensome regulatory regime, in return for sharing data that can be used to create benefits for society at large.

To access the full report, visit http://2016.itf-oecd.org/free-publications.
The Long-Term Pavement Performance Program


This comprehensive volume documents the history and future of the Long-Term Pavement Performance (LTTP) Program, the largest pavement performance research program ever conducted. Over a period of more than 20 years, the studies have collected data from 2,000 in-service highway pavement test sections in the United States and Canada and have compiled the data. This database, the LTTP National Information Management System, includes information on environment, traffic, inventory, monitoring, maintenance, materials, and rehabilitation for each test section. FHWA operates the studies and maintains a resource website at www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltpp.

YUL–MTL: Moving Landscapes


This volume describes the innovative approach to landscape infrastructure planning showcased in the YUL–MTL: Moving Landscapes initiative, held in Montreal, Canada, in 2011. The design competition and workshop promoted collaborative efforts among 20 public agencies to rethink a 17-km stretch of gateway corridor between the downtown area and Montreal–Pierre Elliott Trudeau International Airport. Authors describe the process of developing a strategic vision for the area, examine the winning entries, and outline the next steps toward an “atlas of possibilities” for Montreal’s future.

Delivering on Digital: The Innovators and Technologies That Are Transforming Government


The author explores governments worldwide that are harnessing digital tools to expand capabilities and become more efficient, from the adoption of RFID-based cards by San Francisco’s public transit system to Finnish lampposts equipped with fiber-optic and Wi-Fi capabilities.

The titles in this section are not TRB publications. To order, contact the publisher listed.

TRB PUBLICATIONS

Transportation Systems Performance Measurement and Data: Summary of the 5th International Conference

Conference Proceedings on the Web 18

This volume highlights a June 2015 conference and live webcast that convened representatives from public agencies, universities, and the private sector to address ways to develop, apply, and deliver performance measures to support transportation decisions.

For more information, visit www.trb.org/Publications/Blurbs/174018.aspx.

Automated and Connected Vehicles: Summary of the 9th University Transportation Centers Spotlight Conference

Conference Proceedings on the Web 19

Part of a series of spotlight conferences funded by the U.S. Department of Transportation’s (DOT’s) Office of the Assistant Secretary for Research and Technology, this November 2015 event showcased connected and automated vehicles research, testing, and deployment activities at the national, state, and local levels.

For more information, visit www.trb.org/Publications/Blurbs/174288.aspx.
Guidebook on Alternative Quality Management Systems for Highway Construction
NCHRP Report 808
This volume guides readers through the process of developing a quality management system that is both responsive to specific project needs and broad enough to be replicated with adaptations as needed for future projects of similar scope, complexity, and delivery schedules.
2015; 96 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber categories: administration and management, construction.

Environmental Performance Measures for State Departments of Transportation
NCHRP Report 809
Identified in this volume are environmental performance measures that may be integrated into a transportation agency’s performance management program. A spreadsheet-based tool assists agencies in implementing the measures.
2015; 148 pp.; TRB affiliates, $53.25; nonaffiliates, $71. Subscriber categories: administration and management, environment.

Consideration of Preservation in Pavement Design and Analysis Procedures
NCHRP Report 810
This report explores the effects of preservation on pavement performance and service life and describes three approaches for considering these effects in pavement design and analysis.
2015; 68 pp.; TRB affiliates, $41.25; nonaffiliates, $55. Subscriber categories: maintenance and preservation, pavements.

Current Practices to Set and Monitor DBE Goals on Design-Build Projects and Other Alternative Project Delivery Methods
NCHRP Synthesis 481
This overview synthesizes current practices and challenges that state DOTs face as they apply and monitor the Federal Disadvantaged Business Enterprises (DBE) program goals to design–build and other alternative delivery projects.

Guidebook on Best Practices for Airport Cybersecurity
ACRP Report 140
This report offers information about reducing or mitigating inherent risks of cyberattacks on technology-based systems. Also included with the print version is a CD-ROM with multimedia material.
2015; 162 pp.; TRB affiliates, $60.75; nonaffiliates, $81. Subscriber categories: aviation, data and information technology.

Renewable Energy as an Airport Revenue Source
ACRP Report 141
Authors present research on challenges for airports that are considering renewable energy as a source of revenue: geography and terrain, infrastructure, real estate, energy costs, public policy, regulatory and compliance requirements, tax credits, sponsor assurances, and more.

Airside Snow Removal Practices for Small Airports with Limited Budgets
ACRP Synthesis 67
This synthesis explores challenges and successful strategies used by operators at small airports to coordinate and conduct snow removal operations under budget constraints.
2015; 100 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber categories: aviation, maintenance and preservation.

Strategies for Maintaining Air Service
ACRP Synthesis 68
Practices that smaller airports use to maintain air service are presented in this volume.
2015; 52 pp.; TRB affiliates, $36; nonaffiliates, $48. Subscriber categories: aviation, administration and management.

To order TRB titles described in Bookshelf, visit the TRB online Bookstore at www.TRB.org/bookstore/ or contact the Business Office at 202-334-3213.
TCRP Report 181
This two-volume report provides resources for public transportation managers and labor union leaders to establish, manage, and improve labor–management partnerships.
2015; 32 pp; TRB affiliates, $32.25; nonaffiliates, $43. Vol. 2, 92 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber categories: public transportation, administration and management.

A Guide to Building and Retaining Workforce Capacity for the Railroad Industry
NCRRP Report 2
This report presents competency models, describes workforce requirements for the passenger and freight railroad industry, and presents a strategy for improving employee retention and enhancing educational programs to attract new employees to the industry.
2015; 244 pp.; TRB affiliates, $60.75; nonaffiliates, $81. Subscriber categories: education and training, policy, railroads.

Network Modeling 2015, Volumes 1–2
Transportation Research Record 2497 and 2498
Authors present research on data mining and pattern matching for dynamic origin–destination demand estimation, urban travel time reliability analysis with consumer GPS data, Lagrangian relaxation solutions to ready-mixed concrete dispatching problems, and other topics.

Planning 2015, Volumes 1–2
Transportation Research Record 2499 and 2500
Among the topics explored in these volumes are high-performance public involvement, enhancing the visitor experience at Zion National Park in Utah through improved transportation, traffic generated by mixed-use developments, and the prediction of congestion states from basic safety messages by using big-data graph analytics.

Aviation 2015
Transportation Research Record 2501
Workload-based capacity for air traffic management, the interrelationship between airport enplanements and accessibility, and the economic impact of a lightning strike–induced air traffic control tower outage are among the topics presented in this volume.
2015; 92 pp.; TRB affiliates, $45.75; nonaffiliates, $61. Subscriber category: aviation.

Environment and Energy 2015
Transportation Research Record 2502
Examined in this volume is research on driver response to hydrogen fuel cell buses, the effect of improved fuel efficiency on fuel tax revenue and greenhouse gas emissions, predictors of electric vehicle charging behavior, and more.
2015; 153 pp.; TRB affiliates, $53.25; nonaffiliates, $71. Subscriber categories: environment, energy.

Air Quality
Transportation Research Record 2503
Papers in this volume address real-time emissions modeling with U.S. Environmental Protection Agency MOVES, an analysis of vehicles’ daily fuel consumption frontiers with long-term controller area network data, and more.
2015; 172 pp.; TRB affiliates, $57.75; nonaffiliates, $77. Subscriber categories: environment, energy.

Construction
Transportation Research Record 2504
Authors present research on such topics as performance-based warranty contracts for pavement markings, trends in quality management approaches to design–build transportation projects, and concepts to enhance specification and inspection of curing effectiveness in concrete pavement design and construction.
2015; 176 pp.; TRB affiliates, $57.75; nonaffiliates, $77. Subscriber categories: construction, pavements, bridges and other structures.

The TRR Journal Online website provides electronic access to the full text of approximately 15,000 peer-reviewed papers that have been published as part of the Transportation Research Record: Journal of the Transportation Research Board (TRR Journal) series since 1996. The site includes the latest in search technologies and is updated as new TRR journal papers become available. To explore the TRR Online service, visit www.TRB.org/TRROnline.
INFORMATION FOR CONTRIBUTORS TO

TR NEWS

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FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, marine, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, security, logistics, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 words (12 double-spaced, typed pages). Authors also should provide charts or tables and high-quality photographic images with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, and ISBN. Publishers are invited to submit copies of new publications for announcement.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

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- All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word, on a CD or as an e-mail attachment.
- Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi. A caption should be supplied for each graphic element.
- Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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