Bicycles on Transit: A Review of International Experience

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A growing number of transit agencies across North America and Europe permit bicycles to be carried on board buses, subways, and railway vehicles. This marriage of bicycles and transit, which is part of the growing use of bicycles to get to and from suburban express transit services, combines many of the best features of both bicycles and public transportation. Recent research concerning bikes-on-transit from American cities and from foreign sources not readily accessible to North American transportation professionals is reviewed. Recommendations for the further development of bicycle-transit integration are offered as a potentially important strategy for reducing suburban traffic congestion and boosting the performance and productivity of suburban transit services.

Bike-on-rail service can provide high-quality metropolitan and intercity mobility largely independent of petroleum-fueled transportation. Bike-on-bus service can dramatically extend the service areas of rural and express suburban and urban bus routes and help overcome key barriers to bicycle transportation networks, for example, where bridge and tunnel access is a problem. Although express transit offers fast, efficient transportation between limited origins and destinations, the bicycle provides extensive access and egress opportunities that are not subject to the vagaries of local transit service.

As part of a comprehensive dual-mode system involving bicycles and public transportation, bike-on-rail and bike-on bus programs can play an important part. Secure bicycle parking at transit boarding points enables more convenient access to local transit routes at the home end. In typical European and Japanese suburbs, the bicycle is the predominant mode of access to express transit services, accounting for as many as 40 to 60 percent of passenger trips to rail stations and up to 20 percent of bus access.

When users are able to park bikes overnight in secure parking at stations near their workplace, bicycle egress from the station to work sites otherwise poorly served by transit becomes possible. Indeed, bicycle egress can open up entirely new markets for public transportation, making transit competitive with the automobile in terms of total travel time for intrasuburban commute trips ignored by most U.S. transit agencies. In many European suburbs, 10 to 20 percent of those leaving rail stations on the journey to work in the morning peak hours complete their journey by bicycle.

However, unless bicycles can be carried aboard rail cars or buses or rented at stations, only regularly made egress trips can be accommodated by bicycle. As was noted in an Australian report on bicycle–rail linkage (*1*, pp. 56–57):

> Dual mode travel is a field where the impact of 'the whole' is likely to be significantly greater than 'the sum of the parts.' Facilities for bike-bus and bike-tram travel . . . would complement bike-rail dual-mode to provide a comprehensive bike-public transport dual-mode option. . . . It could become the norm to regard the bike as a significant component of the household's stable, both for local *and metropolitan* trips [emphasis in the original].

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HISTORIC PRECEDENT FOR BIKES ON TRANSIT

The original impetus for carrying bicycles on railways came from rail companies in the late 19th century. Hoping to attract additional passengers, railway or streetcar operators welcomed bicyclists and allowed them to transport their bicycles on board at no cost.

As the *Street Railway Journal* noted in 1897 *(2)*,

> One of the strongest competitors the street railways of the country have had to contend with in the last few years has been the bicycle. For this reason, street railway managers have for a long time been studying the problem of recovering a part of this lost traffic, by furnishing accommodations so that the bicyclist will find it more convenient to use the street cars, when looking for good roads, when caught in a storm, or when his wheel has become damaged by an accident. To provide this accommodation the "Doublehook" bicycle holder . . . has been introduced on a number of (rail) lines and is giving entire satisfaction.

As the bicycle became more popular, transit operators began to charge cyclists an extra fare for their vehicle. These fare surcharges provoked substantial political opposition from bicyclists (*3*, p. 222). In February 1896, a bill was introduced into the New York State Legislature requiring railroads to carry all bicycles free as personal baggage. Heavy political pressure, backed by 30,000 signatures on a supporting petition, led to nearly unanimous approval of this bill. In several other states, similar initiatives were introduced.

By early 1897, the Passenger Committee of the Trunk Line Association, a railroad management group, announced that its member railroads would henceforth carry bicycles at no charge. This action led to free bike-on-rail policies in New York, Pennsylvania, New Jersey, Ohio, Michigan, Indiana, and parts of Illinois, California, and Colorado *(3)*.

Throughout the rest of the nation, railroads and many streetcar lines offered bike-on-rail service, but imposed a surcharge. In 1897 the Market Street Railway Company of San Francisco carried an average of 1,800 bicycles a month on one route alone, with up to 6 bicycles suspended from hooks at the front and rear of the trams, generating added revenues of $180 a month, "unattended by any increase in the operating expenses

whatever" *(4)*. The cyclist paid twice the standard nickel fare when transporting his or her bicycle.

Streetcars in a number of American cities, including Brooklyn, New York, offered similar services. In Pittsburgh, Pennsylvania, seats were removed from one side of a number of trolleys to accommodate bicycles *(5)*. Bicycle hangers were installed in the baggage cars of many commuter rail services in the 1890s. As motorbuses were introduced, bicycles were not uncommon elements of baggage, particularly for rural or longer-distance travel. In Europe in the early part of this century, a similar experience prevailed, with bicycles commonly carried on rail and bus services as baggage, sometimes for an additional fare, sometimes without surcharge.

BIKES-ON-RAIL IN CONTEMPORARY EUROPE AND AMERICA

Intercity Railroads

The national railways and most private railroads of Europe have long carried bicycles, usually relying on baggage areas for vehicle storage. As in America, demand for bike-on-rail service declined in Europe along with bicycle use during the post-World War II economic recovery. In recent years, however, there has been a sharp resurgence in bike-on-rail travel, as Table 1 shows. For example, the number of bicycles carried by the West German national railway doubled between 1977 and 1981, to more than half a million per year, despite increases in the surcharge for transporting bicycles.

TABLE 1 BICYCLES CARRIED ABOARD INTERCITY RAILWAYS

Country and Date	No. of Passengers with Bicycles
United States: Amtrak, 1982	10,000–15,000
Denmark: Danske Statsbaner	
Mid-1950s	1,000,000
Mid-1960s	40,000
1981	700,000
West Germany: Deutsche Bundesbahn	
1977	240,870
1979	310,577
1981	570,000
Holland: Nederlandse Spoorwegen, 1978	107,975

SOURCE: Compiled from published statistics of the respective railways and from discussions with railway officials.

In both Europe and America, the purchase of rail coaches lacking baggage areas suitable for bicycle storage over the past 30 years has made it more difficult for some railways to accommodate the recently increased demand for bicycle carriage. Some railroads, such as Nederlandse Spoorwegen (NS)—the Dutch National Railway—and Danske Statsbaner (DSB)—the Danish National Railway—are now purchasing new cars designed to accommodate bicycle storage.

In the meantime, on routes where coaches lack proper bicycle storage areas, some railways provide baggage cars to haul bicycles as freight. Deutsche Bundesbahn (DB)—German Federal Railways—as well as several Swiss light-rail systems operating in and near Zurich have installed rubber-coated bicycle hooks inside rail coaches to permit secure and space-efficient bicycle storage. The Austrian State Railway system has recently introduced some of the best-designed passenger coaches suitable for the carriage of bicycles, according to recent visitors.

Distance-based fares for bike-as-baggage use are common throughout Europe. For short journeys of up to 50 km (30 mi), typical bicycle charges are U.S.$2.50; on longer trips exceeding 150 km (90 mi), the maximum fee for transporting a bicycle is usually U.S.$5.00 to $7.00 *(6)*.

Cyclists do not fare as well in America. The principal intercity rail carrier, National Rail Passenger Corporation (Amtrak), appears to be the only major national rail system that requires bicycles to be partially dismantled and boxed before shipping, charging $10 for a shipping box. Demand for dual-mode intercity travel on Amtrak remains relatively low, at least in part because of the inconvenience and mechanical skills required to dismantle a bicycle for travel.

U.S. Commuter Railroads

The first American commuter rail system permitting bicycles in passenger coaches in recent years was the Southern Pacific (SP), serving San Francisco and San Jose, California. In a 4-month demonstration project sponsored by the California Department of Transportation (Caltrans) in 1982, cyclists were allowed to secure their bicycles in the aisles of the rail cars at no charge during nonpeak hours. No permit was required.

SP management, however, showed little enthusiasm for the project and accepted it only on payment of $73,000 by Caltrans to indemnify SP for potential accidents. In the 4 months of operation, there were no schedule delays, injuries, or inconveniences to other passengers attributed to the program. With a lack of publicity and a short duration, the service attracted only about 100 users a week *(7)*. Although no safety or operational problems were evident and the local railway workers' union voiced support for the program, SP management refused to continue the demonstration unless Caltrans paid $10,000 a month for insurance of clearly questionable necessity, given extensive incident-free experience with bike-on-rail carriage. For obvious reasons, the program was halted *(8)*.

To help overcome this resistance on the part of SP management, one-third of the 48 new SP passenger rail coaches recently ordered by Caltrans were to have provisions for bicycles and wheelchairs. Jump seats, which can be folded up to accommodate bicycles in nonpeak hours, were to be installed at one end of these cars. One bicycle-accessible rail coach was to be added to each SP commuter train *(9)*. Surveys on SP commuter trains have revealed a strong interest in permitting a bike-on-rail program during peak hours and little opposition to the idea from current passengers *(9)*.

Since late 1983, the Long Island Railroad has adopted a liberal bike-on-rail policy, barring bicycles only during peak hours. A permit is required that costs $5. Metro North, which runs trains into Grand Central Station in New York City, has also recently adopted a bike-on-rail program.

Subway and Metrorail Coaches

Until 1980 only a few subway systems in the world allowed bicycles inside rail cars. The Port Authority Trans-Hudson

(PATH), serving New York City and Newark, New Jersey, opened its doors to bicyclists during nonpeak hours in 1962. Since it opened in 1966, Oslo Sporveier, in Norway, has accommodated cyclists at all hours without problems. In San Francisco the Bay Area Rapid Transit (BART) System in 1975 began to accept bicycles on a permit basis during nonpeak hours.

BART has had the most popular American bike-on-rail program. By 1980 more than 9,000 bike-on-rail permits had been issued. Strong community support and the excellent safety record of the program prompted BART to relax restrictions on dual-mode travel in 1980. Permits were made available through the mail at $3 each and bike-on-rail service was extended to peak-period travel in the nonpeak direction between most stations. By 1985 more than 30,000 permits had been issued and only one minor accident claim had been recorded, according to BART staff.

With the success of the BART program, cyclists in other American cities began to press for bike-on-rail service. In 1981 the Washington Metropolitan Area Transit Authority (WMATA) began a bike-on-rail demonstration program after 5 years of intense and patient lobbying by local bicycle activists. "The demonstration program received almost universal acclaim from cyclists and non-cyclists alike," reported *Mass Transit* in 1982 *(10)*. A local magazine, *Washingtonian*, gave the program its "Best New Idea of 1981" award.

Favorable public and media reaction led WMATA to extend the initial weekend-only program to weekday evenings after 7:00 p.m. To obtain a bike-on-rail permit, WMATA requires cyclists to pass an hour-long safety training program offered only during scheduled times at the transit agency headquarters and charges a $15 fee. Despite these restrictions, more than 3,500 permits had been issued as of 1986.

The Metropolitan Atlanta Regional Transit Authority (MARTA) in Atlanta, Georgia, initiated Sunday-only bike-on-rail service in 1981, soon after subway operations had commenced. Signs inside stations inform cyclists of the safety rules and no permit is required. No significant problems have arisen from this policy, according to MARTA staff.

The success of early bike-on-rail programs combined with pressure from bicycle activists similarly led several European subway systems to initiate their own programs in the early 1980s. By 1982 at least 12 European and 6 North American metrorail operations allowed bicycles inside passenger railcars. Each year since then, several other systems have adopted similar policies. Several others have followed informal policies neither promoting nor discouraging dual-mode travel. The policies observed in a number of cities are summarized in Table 2, which does not include all known bike-on-rail systems.

North American bike-on-rail programs have tended to be somewhat more restrictive than their foreign counterparts. Several European systems permit bicycles in peak periods, sometimes but not always relying on small baggage areas inside passenger coaches for bicycle storage. Only three European systems restrict dual-mode travel to weekends. All others offer either unlimited or evening nonpeak period use.

Permits for bike-on-rail travel are not required by any transit system outside North America. Except for Montreal and Atlanta, all North American commuter or subway systems have imposed permit requirements on cyclists who would bring their bikes along as baggage. The open access provided by European systems makes bike-on-rail travel accessible to tourists, occasional users, and those trying dual-mode travel for the first time. The restrictive practices of North American systems, in requiring permits, make dual-mode travel far less useful to potential users and intentionally restricts demand to dedicated bicyclists, even though this reduces non-peak-period, low-marginal-cost, revenue-generating transit ridership.

The number of bicycles allowed per train or per car varies widely, from two bicycles per car in Berlin and New York to eight in the luggage compartment of Paris rail coaches and an indefinite number constrained only by the space available in Rotterdam, Amsterdam, and London.

Few counts of bicycles on trains have been conducted. However, average use has varied widely where estimated, from a few bicycles a day up to some 800 a day during the week in Hamburg and Berlin *(11)* and 3,000 a day on weekends in Berlin *(12)*. An average of several dozen commuters per station use the BART non-peak-direction, peak-period bike-on-rail service in San Francisco. Compared with the average daily ridership, the number of bicycles has varied from 10 per million passengers in Munich to 2,000 per million riders in Amsterdam (*12*, p. 4).

RESEARCH ON BIKE-ON-RAIL POLICIES

Because of political pressure on many transit managers to permit bike-on-rail programs, the Union International des Transports Publiques (UITP), an international association of transit agencies, was asked to survey its members and report on the status and issues surrounding this matter. Of 31 transit organizations responding to the 1981 UITP survey, only 8 permitted bicycles on trains. The reasons cited by railways for refusing to carry bicycles included potential safety hazards to passengers, potential nuisance to passengers due to dirt on bicycles, insufficient space in cars, potential hazards of moving bicycles on escalators, overcrowded station conditions, and a lack of local pressure for such programs from cyclists.

The UITP survey found that in no case has a bike-on-rail program required additional personnel or entailed new costs. Except for two minor incidents attributed to passenger behavior in Berlin, none of the eight operators reported any accidents or operating incidents related to the bike-on-rail program.

The UITP report concludes that, contrary to the fears of most transit agencies, "the excellent experience of undertakings which have granted temporary or definitive permission to carry bicycles should be noted. The apprehensions expressed before introduction of the facility (bikes-on-rail) have not so far been justified in practice" *(12)*.

Support for bike-on-rail programs among European transit officials appears to be growing. The Verband Öffentlicher Verkehrsbetriebe (VOV), the West German Association of Public Transport, in 1982 researched and issued recommendations on dual-mode travel for its members. VOV encouraged member agencies to permit bicycles on all rail lines, excluding bicycles from peak-period, peak-direction travel. VOV advised agencies to set restrictions on the number of bicycles per car and to ban bicycles from escalators, confining them to stairs for station access and egress. Agencies were encouraged to charge extra for carrying bicycles, with the fee adjusted to the demand for dual-mode travel *(13)*.

TABLE 2 BIKE-ON-RAIL PROGRAMS

Country	Bike-on-Rail Subway System	Date Policy Began	Fare for Bicycle	Maximum No. of Bicycles Allowed	Bicycles Permitted			Actual Hours and Comments
					Peak Hours	Weekday Non-Peak	Weekend	
United States	Port Authority Trans-Hudson (PATH), New York–New Jersey	1962	0	2/car		X	X	M–F 930–1500, 1830–600, except Saturday 1300–1900 from NYC
	Bay Area Rapid Transit (BART), San Francisco, Calif.	1975	0	7/train	X	X	X	Not allowed peak period in peak direction; $3 mail-in permit
	Washington Metropolitan Area Transit Authority (WMATA), Washington, D.C.	1981	0	4/train		X	X	$15 permit and training class required; M–F after 1900; weekends all hours
	Metropolitan Atlanta Regional Transit Authority (MARTA), Atlanta, Ga.	1981	0	4/train			X	Sunday only
Canada	Toronto Transit Commission (TTC)	n.a.	0	n.a.	X[a]	X[a]	X[a]	Permit issued by station personnel
	Montreal Metro	1982	0	4/train			X	Permit required
England	London Transport	n.a.	35% full fare	n.a.		X	X	M–F 100–1600, 1900–2400; weekend all hours; district and metropolitan lines only
France	Régie Autonome des Transports Parisiens (RATP), Paris	n.a.	n.a.	8/car	X	X	X	Suburban regional metro lines only
Netherlands	Amsterdam Metro	1980	50% full fare	No limit	X	X	X	All stations, all times
	Rotterdamse Elektrische Tram (RET), Rotterdam	1980	0	No limit		X	X	M–F 900–2400; weekends all hours
West Germany	Berliner Verkehrs-Betriebe (BVG), West Berlin	1980	50% full fare	2/car		X	X	M–F 900–1400, 1800–0100; weekends all hours; bike hooks provided in cars
	Hamburg Verkehrs Verbund (HVV)	1981	Full fare	4/car		X	X	M–F 900–1600, 1800–2400; weekends all hours
	Munich Verkehrs Verbund (MVV)	1982	Low fare	8–16/train			X	Saturday 1400–Sunday 2400; S-bahn and U-bahn
	VAG, Nuremberg	1982	1.40 DM	n.a.			X	–
	Verkehrs Verbund Stuttgart	1982	0	n.a.		X	X	S-bahn except commuter trains; M–F 830–1600, 1830–2400; Saturday 1400–2400, all Sunday
	Frankfurt Verkehrs Verbund	1982	2 DM	n.a.			X	–
	Verkehrs Verbund Rhein-Ruhr	1982	2.40 DM	n.a.		X	X	M–F 900–1530, 1800–2400; weekends all hours
Norway	Oslo Sporveir	1966	Full fare	No limit	X	X	X	–

SOURCE: *The Carriage of Bicycles in Metropolitan Railway Cars (12)* and other sources.
[a]At discretion of TCC station personnel.

It should be noted that it has been a common and approved practice for cyclists to carry bicycles on escalators in many areas of the Netherlands, most notably at tunnel crossings of some waterways. The Dutch experience with this practice appears to have been favorable.

A few public transportation organizations have evaluated possibilities for retrofitting rail cars to accommodate bicycles. The Danske Statsbaner (DSB), in Denmark, estimated that removal of eight seats from a heavy rail coach and installation of four bicycle racks would cost 60,000 kroner (about U.S.$7,500) per coach. They also evaluated the feasibility of modifying S-bahn (commuter rail) cars to provide interior bicycle racks. Conversion costs were estimated to range from 6,650 to 10,000 kroner (U.S.$830 to $1,250) per unit of bicycle capacity for 6 to 12 bicycle racks per car. A simpler and far less expensive bicycle hook storage system like those now being used in many DB and Swiss rail coaches was not considered. DSB officials decided against any retrofitting because of anticipated costs *(14)*.

Although nearly all rail coaches can accommodate a limited number of bicycles on an ad hoc basis, it makes far more sense to design new rail cars with luggage areas capable of holding several bicycles, as several railways (e.g., BART, WMATA, SP, DB, several Swiss streetcar companies, and NS) are now doing.

With careful design, this can be achieved with no loss of capacity or increase in capital cost.

European systems have generated significant positive revenue by carrying bikes on trains and charging fares for bicycle carriage rather than requiring permits. This makes it easier for occasional users and tourists to take their bikes on a train and minimizes administrative costs, unlike the American required-permit systems. A recent article noted that "from the point of view of operational economics, allowing the conveyance of accompanied bicycles on HVV [Hamburg's Metro system] has had a positive result. The additional fare revenue from accompanied bicycles far exceeds the expenditure on information for passengers on the facility" *(11)*.

FOLDING BICYCLES

A little-used strategy for dual-mode transportation involves the use of folding bicycles, which the majority of rail and bus operators allow aboard their transit vehicles. Although folding bicycles offer great compactness, ideal for bike-on-rail and bike-on-bus transportation, they have thus far played a relatively minor role in dual-mode travel. Several factors limit their usefulness. Folding bicycles are relatively expensive, often costing $300 or more. Compactness can be achieved only by sacrificing some elements of comfort, handling, and riding performance.

Advances in folding-bicycle design are being made, however, and such vehicles may attain greater acceptance in the future, particularly for peak-period, peak-direction dual-mode travel. One action that transit agencies could take to foster greater use of folding bicycles would be to offer such vehicles for rent to cyclists on a trial basis. This would give transit passengers the opportunity to make an informed decision about whether they should invest in their own folding bicycle. BART undertook such a demonstration in 1983–1984. Although a strong level of interest was evident on the part of transit passengers, the particular folding bike used had recurrent maintenance problems.

BIKE-ON-BUS PROGRAMS

In the past decade, another form of dual-mode transportation has reemerged, gaining its strongest hold in the small cities and suburbs of America. This new concept, the bike-on-bus program, has taken several forms as transit agencies have experimented with different technologies.

Bike-on-bus service appears to be rare in Europe and nonexistent in Japan, although bicycles were formerly carried on a widespread basis by rural and intercity bus services in Europe several decades ago. Several Danish and Swedish bus companies providing suburban and regional services have relied for many years on rear-mounted bicycle racks or baggage compartment storage for dual-mode transportation. Since 1983 bike-on-bus service using bicycle trailers has been initiated in Hanover, Detmold, Holzminden, and Bonn, in West Germany, and in Amsterdam. The latter experiment was unsuccessful because of poor route choice and system design *(11)*. European ventures in this area have been looking to the more extensive recent American experience for guidance.

More than a dozen American public transportation organizations have adopted some type of bike-on-bus service since the early 1970s. Although most offer only limited service on one or two routes, a few transit agencies have developed more extensive bike-on-bus programs. The Santa Barbara Metropolitan Transit District (SBMTD) in California carried more than 42,000 bicycles on six routes in 1981. On one route, one-fourth of all riders brought bicycles with them *(15)*. In San Diego, California, 40 bicycle-rack-equipped buses on three routes handled more than 20,000 passengers with bicycles in the same year *(16)*.

Bike-on-bus service is functionally similar to bike-on-rail programs, but often operates in much lower-density corridors than rail transportation. By expanding a bus line's access and egress service areas, bike-on-bus programs can attract many passengers who would not otherwise be able to use transit for their trip, particularly in suburban areas where transit coverage is sparse.

There are several methods for accommodating bicycles on buses. The most common technology relies on a bicycle rack on the rear of the bus. Commercially available rear-mounted racks holding four to six bicycles have been used by at least eight American bus operations. Front-mounted racks, accommodating two or three bicycles, have won favor from several other transit agencies. Only one bus service has used a bicycle trailer towed behind a 20-passenger minibus. This system, found in Santa Barbara, California, can move up to 12 bicycles at a time. The simplest technology for bike-on-bus service permits bicycles to be stored inside the passenger compartment. This can be done without any modification on buses designed to accommodate wheelchairs. For vehicles not equipped for handicapped access, secure on-board bicycle storage usually requires the removal of several seats or the installation of jump seats. The locations of each of these approaches are given in Table 3.

Development of Bike-on-Bus Service

San Francisco

The initial impetus for bike-on-bus transportation arose from the lack of bicycle access to many major highway bridges in the United States. In the early 1970s, bicycle activists in the San Francisco Bay Area pressed local transportation authorities for bicycle shuttle service across the Oakland Bay Bridge, which was closed to cyclists. AC Transit, a local bus agency, removed half of the seats from a bus to make room for up to 24 cyclists and their bicycles, initiating the Pedal-Hopper, which offered limited weekend service across the bridge *(17–19)*.

California cyclists pressed ahead and won the attention of the state legislature, which in 1974 required Caltrans to develop solutions to the problems of bicycle and pedestrian access to state-owned toll bridges *(20)*. Shuttle van service using bicycle trailers was introduced by Caltrans at several locations, including the Oakland Bay Bridge and the San Diego–Coronado Bay Bridge. Although these services were popular and well used, the costs were considered excessive.

San Diego

Seeking a cheaper way to provide bicycle access across the Coronado Bay Bridge, Caltrans initiated a bike-on-bus demonstration project. Three San Diego Transit buses operating

TABLE 3 BIKE-ON-BUS PROGRAMS

Technology Used and Location	Date Program Began	Bicycle Capacity		No. of Bicycles Carried per Year
		Per Bus	System Total	
Rear-mounted racks				
San Diego Transit (San Diego, Calif.)	1976	5	80	22,000 (1981)
Santa Cruz Mass Transit District (Santa Cruz, Calif.)	1980	5	30	6,000 (1981–1982)
Southern California Rapid Transit District (Los Angeles, Calif.)[a]	1980	5	90	1,500–2,000 (1981)
Lane County Mass Transit District (Eugene, Oreg.)	n.a.	5	n.a.	n.a.
Lincoln Transportation System (Lincoln, Nebr.)	1981	5	5	n.a.
Tennessee Valley Authority (Knoxville, Tenn.)	1982	5	5	n.a.
Willamette, Connecticut, Transit Agency	1982	5	10	n.a.
Bettendorf Transit System (Bettendorf, Iowa)	1982	5	10	n.a.
Thinggaards Rutebiler (Copenhagen-Aalborg and Copenhagen-Fjerritslev, Denmark)	n.a.	8	n.a.	n.a.
Front- and rear-mounted racks: Lawrence Livermore Laboratory Shuttle Bus (San Francisco area, Calif.)	n.a	9	60+	8,000+ (1982)
Front-mounted racks				
Seattle Metro (Seattle, Wash.)	1978	2	40	4,000 (1980)
North County Transit (Oceanside, Calif.)	n.a.	5	50	n.a.
Evergreen State College (Olympia, Wash.)	1981	2	4	n.a.
Bicycle trailer towed by minibus: Santa Barbara Metropolitan Transit District (Santa Barbara, Calif.)[b]	1976	12	60	42,000 (1981)
Bicycle accommodated in wheelchair tie-downs: Westchester County Transit (northern New York City suburbs)	1979	2	210	n.a.
Seats removed from bus for bicycle storage rack: AC Transit (San Francisco, Calif.)	1973	24	24	n.a.
Bus baggage compartment for bicycle storage: HT Landevejsbus (Copenhagen, Denmark)	n.a.	2	n.a.	n.a.

[a]Bicycle rack service discontinued in 1982.
[b]Service with bicycle trailers sharply curtailed in January 1982 because of budget cutbacks.

across this bridge were equipped with rear-mounted bicycle racks in 1976 to replace shuttle van service.

The number of bicycles carried across the bridge fell substantially when the bike-on-bus service was first introduced. The van-trailer system had carried an average of about 1,500 bicycles a month during its 9 months of operations at an average cost of $1.53 to $1.72 per bicycle. The bike-on-bus program drew an average of about 500 cyclists a month during the first 9 months of service, at an estimated net cost of $1.28 per bicycle.

Several factors accounted for this performance. The price of crossing the bridge with a bicycle increased from $0.25 to $0.45 when the bike-on-bus program was initiated. Boarding locations changed and the frequency of service dropped from every 30 min to every 40 to 50 min. Whereas the trailer accommodated eight bicycles at a time, the racks held only five bicycles. Moreover, many people could not figure out how to use the rack properly (*16; 21*, p. 2).

Persevering, San Diego Transit continued the service after the Caltrans demonstration program ended. The coin-operated bicycle rack locks were replaced with locking pins to eliminate excessive coin-box maintenance costs; the $0.10 surcharge for rack use was eliminated. In 1977 additional racks were purchased. The former frequency of service on the bridge was restored and two other bike-on-bus routes were initiated in other parts of San Diego. Those measures paid off in increased rack use and ridership.

By 1981 San Diego Transit operated 40 rack-equipped buses and carried more than 20,000 passengers with bicycles. According to a San Diego Transit official, "A large number of the passengers currently using the bike rack system would not be riding the bus if the rack service were not available and therefore the revenue generated would be lost" (Ron Weisman, unpublished data).

Seattle

In Seattle, Washington, limited-access highway bridges across Lake Washington posed major barriers to cyclists. Responding to pressure from local bicycle activists, in 1978 Seattle Metro installed rear-mounted bicycle racks on their buses that cross the lake. A year later, front-mounted racks were substituted because of unconfirmed reports that children were hitching rides on the rear racks. The front rack accommodates only two bicycles, but folds flat against the bus when not in use. More than 4,000 bicycles a year are now being carried on the eight bike-on-bus routes. Twenty-three buses were rack equipped in 1981.

Bus company management support for extending bike-on-bus service appears to be weak, however. When a recent bid went out for temporary bicycle transport service across a Seattle area ship canal to provide continuous bicycle access during an 18-month bridge reconstruction project, Metro would not allow additional buses to be outfitted with front bicycle racks. Instead, a shuttle van service is planned to transport cyclists with their vehicles around the canal barrier.

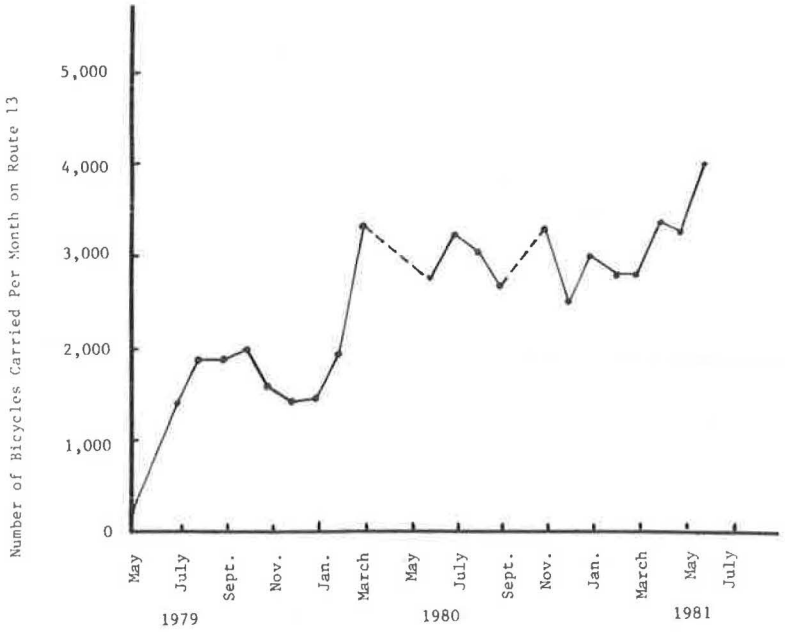

FIGURE 1 Growth in bike-on-bus use in Santa Barbara, California *(22)*.

Santa Barbara

SBMTD was the first American transit agency to institute bike-on-bus service unrelated to bridge-access problems. As an SBMTD official noted, "The project had as its primary goal, the development of new transit ridership by facilitating bicyclists' access to public transportation. A secondary goal was reduction of point-to-point travel times by transit, particularly for non-downtown trips, since bicycles are a faster access mode than walking. In this way, it was hoped to make transit more closely competitive with the private automobile in regard to door-to-door travel time" (22, p. 1).

An experimental bike-on-bus operation was initiated in 1975 using a 6.1-m (20-ft) Mercedes bus towing a custom-designed trailer that held 12 bicycles. The service operated over a single 16-km (10-mi) express route between the downtown Santa Barbara Transit Center and the University of California at Santa Barbara (UCSB). The prototype bicycle trailer was mechanically unreliable and awkward to use; numerous breakdowns led to service unreliability and customer dissatisfaction. Nonetheless, the experiment demonstrated substantial community interest in this form of dual-mode transportation.

After several years of intermittent bike-on-bus operations with two different designs of bicycle trailers, the SBMTD substantially upgraded the service under a Service and Methods Demonstration project grant from UMTA. A 2-year demonstration project began in mid-1979 using an improved trailer design, longer and different routes, and scheduling more suited to community needs.

Beginning with one 28-km (17-mi) bus route centered on the downtown Santa Barbara Transit Center, bike-on-bus service was gradually extended to six bus routes through the course of the demonstration. Demand was strongest on longer-distance express bus routes where dual-mode travel offered travel time and convenience competitive with other modes. One short route from the Pacific Coast to Westmont College in the coastal mountains also proved attractive to cyclists, who could avoid the steep uphill climb. Two other short and relatively slow bus routes failed to attract bicyclists because the dual-mode service could not compete effectively with the bicycle or automobile in terms of travel time. Bike-on-bus service was dropped from these two routes after several months of trial operation.

Good service reliability helped to bolster and maintain bike-on-bus ridership. The fleet of six new trailers experienced no major maintenance problems. One of the older trailers and one new trailer were held in reserve to ensure continual service delivery.

Ridership rose dramatically throughout the demonstration period. From December 1979 to the final quarter of 1980, the number of passengers with bicycles increased by 70 percent on bike-on-bus routes. On the principal bike-on-bus routes during this same period, ridership rose by 46 percent, and the level of bus service increased 19 percent. Systemwide SBMTD ridership grew only 15 percent in the corresponding time period. By 1980–1981, more than 42,000 passengers a year were bringing their bicycles with them by using the trailers *(15)*.

The most successful bike-on-bus operation was on Route 13 between the downtown Santa Barbara Transit Center and UCSB campus. Figure 1 shows the growth of bicycle carriage on this route. Between November 1979 and November 1980, the number of passengers with bicycles on Route 13 increased 118 percent. A further 20 percent increase in the number of bicycles carried on the Route 13 bus brought the monthly volume of bicycles transported in June 1981 to nearly 4,000, accounting for one-fourth of the total ridership *(15)*.

On other bike-on-bus routes, between 10 and 20 percent of the ridership used the bicycle trailer service. Figure 2 shows the level of trailer use for the SBMTD dual-mode system (*15*, pp. 6–8).

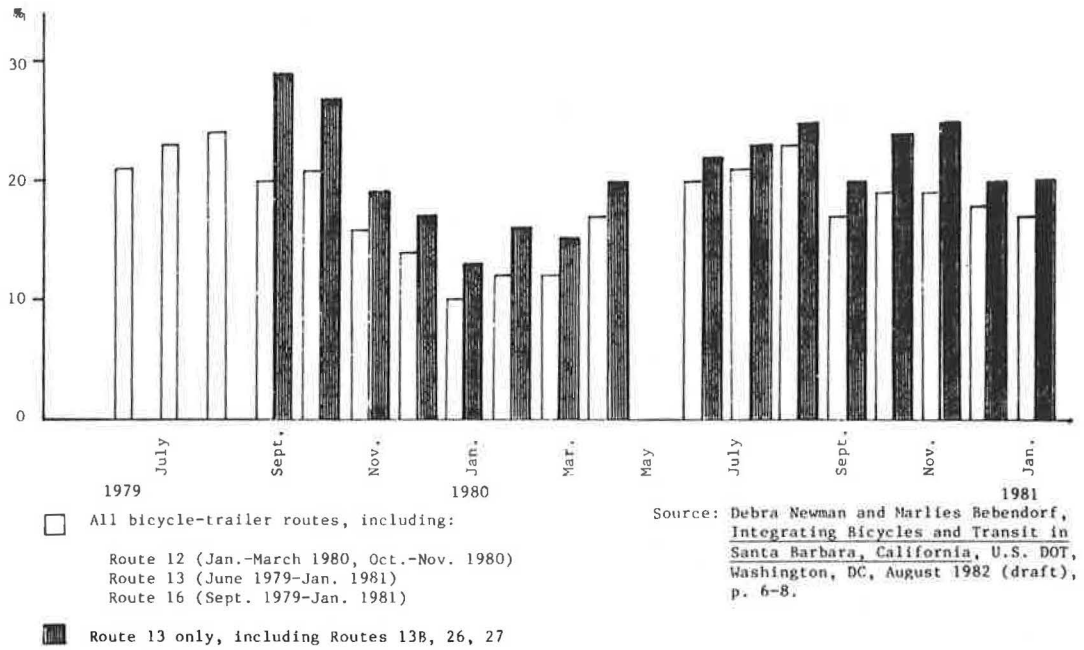

FIGURE 2 Bicycle trailer routes: passengers with bicycles as percentage of total weekday riders (*15*, pp. 6–8).

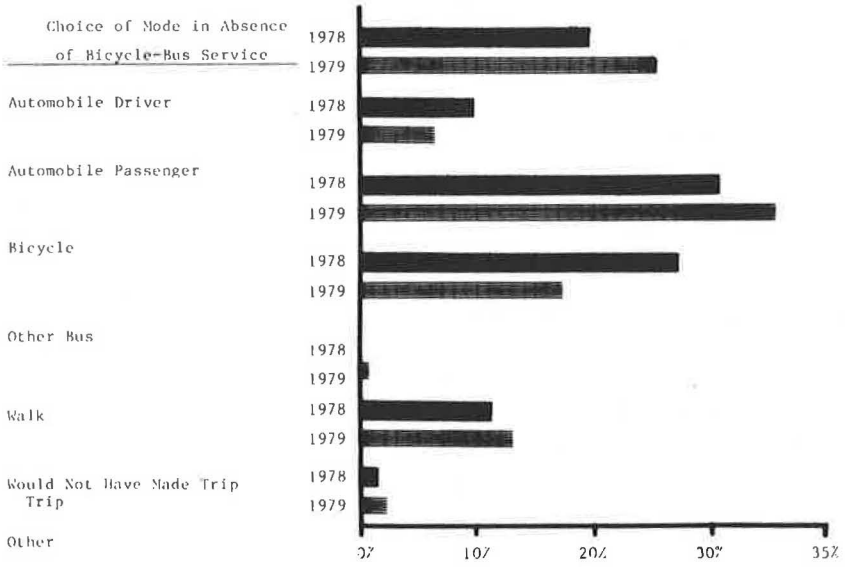

FIGURE 3 Diversion from other modes induced by bicycle-trailer service (*15*, pp. 6–19).

Surveys conducted as part of the demonstration program showed that the bike-on-bus service attained its goals of building transit ridership and reducing automobile use. More than 80 percent of the bicycle trailer users would not have used transit in the absence of bike-on-bus service; 31 percent would have used automobiles to make the trip instead. About one-third of the passengers with bicycles would have cycled the full distance if there had been no bicycle trailer. Figure 3 shows the diversion of travel induced by the bike-on-bus service (*15*, pp. 6–19).

The provision of bicycle parking at bus stops combined with the bicycle trailer service had a significant effect on access-mode choice. Although only 1.5 percent of access trips to the bike- on-bus routes were by bicycle in 1978, this share rose to 23 percent in 1980. Feeder-bus and automobile access-mode shares remained steady at about 18 and 4 percent, respectively. The proportion of passengers who walked to bus stops fell in this same period from 80 to 54 percent, although the number of pedestrian access trips rose as ridership increased. In 1980 more than 21 percent of egress trips from the bike-on-buses were by bicycle *(15)*.

The success of the bicycle trailer services led the SBMTD to continue bike-on-bus operations after the end of demonstration project funding in December 1980. However, cutbacks in

federal transit operating assistance under the Reagan administration forced the SBMTD to scale back services in 1982. All but one of the bike-on-bus routes were eliminated. The one remaining route, which climbs from the coast to Westmont College in the mountains, continued to carry about 300 passengers a month with bicycles in mid-1982, representing one-fifth of this route's ridership.

In an example of successful technology transfer, the Santa Barbara bike-on-bus trailers were sold to the Port Authority of New York and New Jersey in 1984 and put into operation carrying bicyclists across the George Washington Bridge between New Jersey and Manhattan. The bike trailers were well received and attracted substantial use until service was discontinued with the opening of bridge walkways *(23)*.

Westchester County

Although most transit agencies offering bike-on-bus service have relied on various devices to secure bicycles outside the bus, two agencies have decided that added hardware is unnecessary and allow bicycles inside their buses. The first, AC Transit in San Francisco, removed half the seats from a standard bus to provide space for bicycles. The second, the Westchester County Department of Transportation (WCDOT), located in the wealthy suburbs of New York City, simply adopted a permissive policy toward bicycles. A third agency, the Regional Transportation District in Denver, Colorado, is reported to allow bikes informally inside at least some buses equipped with baggage bins.

Like many American bus operators, WCDOT bought many lift-equipped buses in the late 1970s to comply with U.S. government regulations regarding handicapped access to public transportation. To maximize the use of these wheelchair-accessible buses, WCDOT adopted the policy that "everyone's welcome aboard." The space provided for wheelchair-bound passengers can be used by those traveling with baby carriages, shopping carts, bulky packages, or bicycles.

WCDOT has made this "welcome aboard" policy a significant element in their marketing efforts. As one of their promotional brochures states, "whether you are very young or old, whether you use a wheelchair or ride a bicycle, whether you are traveling to work or going shopping, our new buses were bought with you very much in mind and we hope you will ride them frequently" *(24)*.

In Westchester County, bicycles are permitted aboard only handicapped-accessible Advanced Design Buses and only in nonpeak periods. Wheelchair users are given priority over bicycles at all times. Two bicycles can be secured in the wheelchair tie-downs on each of the 105 lift-equipped buses.

Bike-on-bus service is operated on 27 of the 70 bus routes operated by WCDOT. Although there are no counts of how many bicycles are carried, WCDOT officials report light to moderate use of the dual-mode system and say that in several years of operation there have been no accidents or safety or insurance problems related to bicycles inside buses.

Costs of Bike-on-Bus Service

The capital and operating costs of providing bike-on-bus service vary widely depending on the technology used. Programs that permit bicycles inside lift-equipped buses entail no additional capital or operating costs related to bike-on-bus service and are therefore the cheapest way to provide dual-mode transportation. Bicycle racks and trailers may provide more bicycle capacity but they impose added costs on the transit agency.

Front-mounted racks holding two or three bicycles are commercially available for less than $200 each. The racks used in Seattle were fabricated in house for about $200 each and are specially designed to fold flat against the bus when not in use. Rear-mounted racks holding five or six bicycles can be purchased for about $1,250. The final working version of the Santa Barbara bicycle trailer cost $3,740 to fabricate. The design is unpatented and available for public use from the SBMTD.

Operating costs are subject to equally great variation and are generally not accounted for separately by transit agencies offering bike-on-bus service. Seattle reports that their front-mounted racks are virtually maintenance free. However, they must be removed frequently for bus cleaning. Removal and remounting takes about 6 min per rack. If one accounts for this added labor cost, it amounts to about $72 per rack each year, or $36 per unit of rack capacity *(16)*.

Maintenance is not insignificant for rear-mounted racks. Because they block the engine access panels, rear racks must be removed more frequently than front racks. The placement of rear racks also necessitates a built-in light, which may malfunction. San Diego Transit has identified four major costs related to rear-mounted racks: cleaning, repairs, road calls, and rack removal for bus servicing. Although it takes only 2 min to remove a rack from a bus, this action must be repeated at least once a day for engine servicing. Because it takes two people to remove a rack, a second person is required to handle bike-on-bus road calls.

In 1980 San Diego Transit estimated that the maintenance cost for their 16 racks then in active service was about $80 per rack per month, or about $192 per year per unit of capacity. Operating delay related to bike-on-bus use was negligible, because loading or unloading a bicycle takes only 10 to 15 sec *(21)*.

The Santa Barbara bicycle trailers, in contrast, cost $87 per year per unit of capacity for maintenance and cleaning. Four trailers in active service were each cleaned weekly by hand at an annual labor cost of $1,444. Maintenance costs were about equally distributed between parts and labor and averaged $0.0082 per vehicle mile of trailer service, amounting to $3,041 over a 12-month period in 1980–1981 *(16)*.

To date, there have been no major claims for accidents or damage related to any bike-on-bus service. In Santa Barbara liability claims over a 29-month period between May 1978 and September 1980 totaled $179. These and all subsequent claims have related mainly to minor damage to bicycles and ranged between $1.70 and $80. Although the SBMTD retained insurance on their trailers at a cost equal to insurance on their buses, this appears to be unwarranted *(15)*.

The costs of bike-on-bus service in several cities are summarized in Table 4. From a cost standpoint, allowing bicycles inside buses is preferred except for peak-period travel. Front-mounted racks are certainly less expensive than rear racks but offer less capacity, which may restrain demand in some locations. Trailer service offers lower marginal operating costs than rear racks where dual-mode demand is high, but trailers have thus far only been operated with small buses.

TABLE 4 COMPARISON OF BIKE-ON-BUS SERVICE COSTS IN SEVERAL CITIES *(16)*

Item	Santa Barbara, Calif.	San Diego, Calif.	Seattle, Wash.	Westchester County, N.Y.
Type of service	Trailer towed by minibus	Rear-mounted bicycle rack	Front-mounted bicycle rack	Bicycle inside bus (wheelchair tie-down)
Bicycle capacity per bus	12	5	2	2
No. of units in service	4 trailers	16 racks	20 racks	105 buses
Capital cost per bus ($)	3,740	1,350	200	0
Capital cost per unit capacity ($)	87	192	72	0
No. of users per year (1980–1981)	42,090	13,000	4,380	n.a.
Maintenance cost per user (1980–1981) ($)	0.10	1.20	0.65	0

The 19-passenger minibuses in Santa Barbara cost 32 percent less to operate per vehicle mile than SBMTD conventional-size buses. However, because larger buses can carry more passengers, overall efficiencies favor increased size. In Santa Barbara, the average cost per passenger for minibuses was 58 to 69 percent higher than that for conventional buses. The average number of passengers per mile ranged from 64 to 80 percent lower for minibus routes *(15)*.

It may be possible to develop bicycle trailer service with full-size buses, but several barriers would need to be overcome. The SBMTD found that conventional American transit buses lack sufficient structural strength to pull a 900-kg (2,000-lb) bicycle trailer *(15)*. Reinforcement would add substantial cost. European or Japanese buses may or may not be suitable for trailer towing without modification. Permits might be required for added length in any case. Special permits were required for rear-mounted racks on full-size buses in California, although these extended the bus length by only 1.1 m (44 in.). The successful operation of articulated buses (very long, high-capacity buses with articulated chassis) in many cities, however, suggests that the length added by a bicycle trailer would not pose an insurmountable problem.

Articulated buses themselves would be well suited to bike-on-bus service; jump seats could be used that would fold up to reveal bicycle racks or wheel wells in the floor for securing bicycles. This approach to bike-on-bus operation has not yet been attempted.

Growth in Bike-on-Bus Service

Nearly half the American bus operators now offering bike-on-bus service have initiated their programs since 1980. Only one transit agency, the SCRTD in Los Angeles, ceased bike-on-bus operations after initial experimentation because of a combination of low use, insufficient marketing, and resistance from the maintenance staff. Several transit agencies are planning to implement bike-on-bus service in the near future. The Humboldt Transit Authority, which serves a 50-mi rural corridor along the northern California coast, recently installed rear-mounted racks on its entire 11-bus fleet.

The popularity and feasibility of bike-on-bus programs has been amply demonstrated in a number of cities. Despite continued resistance to the concept by many transit agencies, the prospects for further growth in bike-on-bus service in both Europe and America appear good.

CONCLUSIONS

Integration of bicycles with public transportation can offer substantial help to transportation agencies seeking to increase the usefulness and competitiveness of public transport services in lower-density suburban areas. Indeed, the greater use of bicycles for express transit access and egress helps to account for the relatively healthier condition of European suburban transit services relative to their American counterparts *(22)*. U.S. transit agencies have become overreliant on automobiles for express transit access.

The lack of diversity in the U.S. transit access and egress system relative to that in Europe and Japan has reduced the size of the markets for suburban transit ridership from what they would be with a wider range of choices and options for getting to and from express transit stops. Although providing secure bicycle parking and improved access routes near transit stops are the most important areas for access system diversification, liberalized bike-on-transit policies have an important role to play in improving consumer transportation choices and adapting transit to the modern suburban environment *(25)*.

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