

Published in Transportation Research Record #1760

BUS TRANSIT IN THE 21ST CENTURY -
PERSPECTIVES AND PROSPECTS

BY

HERBERT S. LEVINSON

INSTITUTE FOR TRANSPORTATION SYSTEMS
CITY COLLEGE OF NEW YORK
CONVENT AVE & 138TH STREET
NEW YORK, NY 10031
PHONE: 212-650-8050
FAX: 212-650-8374

PREPARED FOR

ANNUAL MEETING
TRANSPORTATION RESEARCH BOARD
JANUARY 2001

JULY 31, 2000

Revised November 9, 2000

ABSTRACT

BUS TRANSIT IN THE 21ST CENTURY – PERSPECTIVES AND PROSPECTS

This paper gives a broad overview of the role and opportunities for bus transit in the Twenty-first Century. Drawing from the inputs of a millenium paper prepared by the Bus Transit Committee, it reviews the past experience, present status, and future prospects. It identifies the many policy choices, likely dimensions of change, and various opportunities for improvements in service design, vehicles, bus technology and management.

Bus transport will continue to provide important service to Metropolitan America. Therefore, continued support at all levels of government is essential. Growing community concerns about traffic congestion, sprawl, air pollution, and sustainability, the progressive revitalization of cities and towns, and continued advances in transport technology argue for improved bus transit in the new century. A greater effort to establish residential areas, employment centers, and shopping areas that are more transit-friendly will further enhance the future of bus transit in the 21st Century.

CONTENTS

	PAGE
LOOKING BACK	1
PRESENT STATUS	2
LOOKING FORWARD	3
A. POLICY CHOICES	4
B. DIMENSIONS OF CHANGE	5
C. SERVICE DESIGN	8
NEAR TERM	8
LONGER TERM	9
D. ROADWAY DESIGN	10
E. PROPULSION SYSTEMS	11
F. VEHICLE DESIGN	12
G. NEW TECHNOLOGY	13
H. FARES AND REVENUE COLLECTION	15
I. BUS STOPS	16
J. MARKETING	16
K. MANAGEMENT, COORDINATION AND PLANNING	18
THE CHALLENGE	19

BUS TRANSIT IN THE 21ST CENTURY - PERSPECTIVES AND PROSPECTS

BY HERBERT S. LEVINSON

Bus transport is ubiquitous in North America. It is an integral part, and in many respects, an extension of our street and highway systems. Since streets and highways will be with us in the 21st century, bus systems will be too. To understand their future in Metropolitan America, it is necessary to look at their growth over the last century and their present status.

LOOKING BACK

If one were looking ahead at transport, technology, and development in 1900, one would find electric railways dominant, and cities growing along electric railway lines; automobiles, buses, and airplanes were still to be proven, and computers, space travel, radio and television were future dreams. Each of these means of transport and communication progressively evolved in the years that followed.

The first common carrier bus transport in American cities was the Fifth Avenue Coach Company's 24-passenger double deck motor bus placed in service in 1905. In 1914, "jitneys" proliferated in Los Angeles, usually running along electric railway lines.⁽¹⁾ In 1920, there were hardly half a dozen examples of rail and rubber-tire coordination, and to suggest that any vehicle but a trolley car could carry people en masse was deemed treason. But by 1923, more than 100 electric railways had found a place for the bus.⁽²⁾ And, at the onset of World War II, gasoline, diesel and/or trolley buses furnished all local service in 200 U.S. Cities, and some 171 other

cities operated combined bus and electric railway service; only 11 cities relied exclusively on electric railways.⁽¹⁾

The last half of the Twentieth Century (1950 to 2000) was characterized by population and employment growths in suburban areas with corresponding declines in many central cities. Automobile ownership increased as population densities decreased; highway systems - especially Interstate and other express routes usually became the backbone of urban transport. During this period, bus service replaced street cars in most cities; service expanded into suburban areas; and express and limited stop services increased in importance. Bus priority roadways and lanes emerged in many cities, sometimes as part of High-Occupancy Vehicle (HOV) lanes; sometimes as part of downtown streets. Significant examples include the I-495 Contra-flow bus lanes in New York City and New Jersey; the Shirley Highway leading to Washington DC; and the Fifth and Sixth Bus-Only Streets in Portland, Oregon. Busways in a few cities - Ottawa, Pittsburgh, and Miami provide de-facto rapid transit; and Seattle has an extensive bus tunnel in its central area that is tied to Interstate 5.

Most bus systems are operated by public agencies. U.S. DOT (UMTA, then FTA) provides financial and technical assistance. States and regions also help to finance capital and operating costs, and bus transit research has increased in scope and importance.

PRESENT STATUS

Buses provide important mobility today in most U.S. and Canadian urban areas; they are the dominant form of public transport in cities. They provide both

line-haul and feeder services, as well as special transit service for the elderly and handicapped. And in the very large cities, they complement and feed rail transit lines.

Nationally, nearly 80,000 buses carry more than 60% of U.S. public transport riders annually and account for more than half of the transit passenger miles. In 1997, there were 5.2 billion bus passenger trips in the U.S. Ridership has remained relatively constant over the past two decades.⁽³⁾

Bus transport carries a substantial proportion of the peak-hour and daily person-trips in major travel corridors and on downtown streets especially in large cities. Many bus lines in cities such as Boston, Chicago, Los Angeles, New York City, San Francisco and Washington DC carry more than 20,000 riders daily.

Existing bus systems vary widely in the quality of service provided, passenger acceptance and ridership. Many services are well liked and patronized. However, too often, service is perceived as slow and unreliable; the image is poor; and concerns are expressed over safety and security.

Bus service is indeed important. It provides mobility for all, since many people do not have access to cars; increases person-capacity in heavily traveled corridors, and preserves urban land for more productive use. And it is more energy efficient than driving. Therefore, maintaining and improving bus service will be essential to keep urban areas vital and vibrant in the years ahead.

LOOKING FORWARD

The Twenty First Century will be one of unprecedented growth and change. Population will increase, especially in Metropolitan areas, the economy will expand,

and technology will advance. There will be more cars, commuters, and travel. Public transport in general and bus transport in particular will play an important (albeit selective) role in the future metropolis.

A. Policy Choices

The key issue in the coming century is not whether bus transit will survive, but how well it will function in Metropolitan America. As long as there is a need for automobiles and roads, there will be a need (and facilities) for buses.

The policy choices are clear. Will the trends following World War II accelerate, or will the increased desires to avoid congestion, minimize sprawl, reduce air pollution, revitalize communities and serve the carless be translated into actions that enhance the operating environment for bus transit in the new millennium?

Within this context, three basic policy challenges underlie bus transport in the 21st Century.

1. Bus transport should make a worthwhile contribution to future urban transport needs. It should be recognized as an essential community service, and it should continue to be supported and sustained.
2. Federal, state and local support of capital and operating costs should continue. They are essential for attractive bus services.
3. Urban development patterns and policies should recognize bus transport needs in planning, designing, and operating street systems; creating transit friendly suburban environments; revitalizing central cities; and achieving sustainable urban regions.

These policy choices could enable bus ridership to more than double over the next century.

B. Dimensions of Change

Forecasting the future is no easy task. There will be many variables and many uncertainties. What changes in population, life style, and attitudes are likely? How will they be affected by new technology or global economic growth? What will be the form of our future cities? And finally, how will the many changes affect the role and ridership of bus transport in the next century?

1. Population will grow. The nation's population will likely increase from about 260 million in 1990 to about 350 million by 2050. Most of this growth will take place in the South and West. The numbers of elderly, single parent households, working women, and minorities will increase faster than other population components.
2. Life Expectancy will increase. There will be more elderly (senior citizens) whose residential location decisions and travel patterns will be different from those for the working age population. There will be more integration of residences with essential support services.
3. Household and family size will reduce. The trend towards smaller families and more unmarried individuals also argues for condominium and central city living.
4. Incomes will continue to rise. This translates to increased space requirements (often larger houses farther from central cities) and increased private vehicle ownership and use.

5. Income disparities will likely increase. This could result in increased marginalization of underclasses, heightened security concerns, and in some cases, less travel.
6. Urban areas will grow. Urban areas will absorb most of the nation's population growth. There will be about 20 million additional urban residents by the year 2050 - a gain of nearly 1.2 million each year. An additional 400 square miles of land will become urbanized annually.⁽⁴⁾
7. Suburban and exurban areas will continue to grow. More people, occupying more land will increase travel volumes; growing commercial activities will result in more dispersed travel patterns, that generally are difficult to serve with conventional transit services.
8. Urban Densities will increase. As some central cities grow there will be more in-filling of space, and vertical growth in many cities and older suburbs. This will accelerate as a result of both public policies toward urban revitalization and economic forces, specially as the 21st Century progresses. "Smart and sustainable" growth policies will also contribute to the clustering of people and jobs.
9. Employment patterns will change. Employment will be more based on information, finance, and personal services with greater automation of manufacturing and food processing. City centers will remain dominant focal points of emerging regional cities, but they will be complemented by megacenters that follow each new wave of urban growth.

10. Telecommunications will increase. The continued advances in telecommunications technology coupled with rapid decreases in price will permit greater integration of home and work place, and computer-based in-home schooling. It will facilitate more electronic commerce, telecommunications, home entertainment, and possibly voting and civic involvement.
11. Medical technology will improve. Improved medical technology will not only contribute to life expectancy but will also change the way many senior citizens (and others) live and travel. Common procedures such as cataract surgery allow many individuals to continue active lives. Often, they will enable people to own and drive automobiles; however, many will rely on public transport.
12. There will be no dramatic change in the availability and costs of energy in the foreseeable future.

As in the past century, travel will outpace population growth. The greater separation between home and work place will increase trip lengths and will more than offset the growth in work-at-home, telecommuting and video-conferencing.

These trends and policies will influence future public transport demands. The greater dispersion of urban population and activity will reduce riding on a per-capita basis. However, overall population growth and increased life expectancy will increase demands. More significantly, land-use policies (as " smart growth") and urban revitalization actions will increase transit ridership. In the next century, public transport riding will remain important to a growing number of riders and will increase in some travel markets.

C. Service Design

Bus service design will reflect likely changes in urban development and revitalization over the next century. Service patterns will vary widely among areas in their mix of corridor, crosstown, suburban, and edge-city services.

Near Term. Much of 21st century urban America is already in place; therefore, existing development patterns will continue to influence bus services - at least in the next several decades. Bus systems will continue to operate as they do today with little change in service coverage or frequency. Routes and ridership will remain concentrated in older portions of urban areas that are characterized by pre-1940 patterns of land-use and streets. In these older settings, networks of bus routes that link homes with various destinations of daily life are practical.

The post-1945 suburbs contiguous to central cities will continue to be served by bus routes mainly along highways from the city center. Large malls, and major suburban activity centers will remain local points of bus service. Suburban residential bus routes will expand, but they will be limited by lower development densities, high auto ownership and inadequate secondary streets.

Traditional scheduled fixed route bus service will remain the predominant mode. It will include local, limited-stop and express services, sometimes operating in bus lanes or busways. Express services to airports and major suburban employment centers will increase. Bus rapid transit (as in Pittsburgh, Ottawa, and Miami) will emerge in many cities. Most systems will also offer paratransit services that use smaller, specialized buses to serve elderly and handicapped individuals. And private, employer-sponsored services may increase and be progressively

integrated into regional systems. There will be more timed-transfer or “pulse” points, especially in suburban areas.

Longer Term. The following service design opportunities are likely to emerge.

1. Modify services to fit suburban travel patterns. Traditional radial and crosstown services will be complemented by new routes that reach suburban markets. These will include reverse commute routes and in some cases, demand responsive services.
2. Focus suburban services on Edge City Centers. Growing “edge city” complexes will rival many CBDs in employment and flow space. As these centers become more intense (and transit friendly), they should be the foci of suburban routes.
3. Expand express bus and bus rapid transit services. These faster and more reliable services will provide viable alternatives to driving. Bus rapid transit offers promise in many cities, especially where densities may not warrant rail lines. They will improve bus identity, reliability and speed. They will include: downtown bus tunnels (as in Seattle), grade-separated busways (as in Pittsburgh), regional busways with some at-grade crossings (as in Ottawa), and median priority lanes with special loading facilities (as in Curitiba).

“Circumferential” express bus service to transit friendly “Edge City” centers will emerge where new activity centers are designed in a transit-friendly manner, and where existing centers are progressively retrofitted. Park-and-ride facilities may be desirable along many of these 21st Century express transit lines.

4. Increase stop spacing. Lengthening the spacing between stops will improve travel speeds. A 300 to 400 m spacing is desirable where street and development patterns permit.
5. Improve service coordination. Bus services will be increasingly coordinated among different carriers and modes, and service duplication will be minimized.
6. Improve service identity. Bus service identity will be improved by concentrating services along major routes, providing frequent headways, and minimizing service dispersion. It will also be enhanced by well designed bus stops and shelters.

D. Roadway Design

Public roadway systems constitute the basic infrastructure over which buses operate. Likely developments over the 21st century follow:

1. Busways will be more common in cities. They provide a cost-effective bus rapid transit as compared with light rail. Guided busways, such as found in Essen and Adelaide, may be developed in urban areas especially where rights-of-way are constrained. Buses can join and leave the system to better penetrate areas, and they can share the same corridors as light-rail systems in the core of cities. Bus priority treatments will be more widespread. They will include freeway and arterial bus lanes and bus preference at traffic signals. They will improve bus speeds and reliability, thereby attracting transit-by-choice riders (a large potential market) and reducing operating costs. They will include more traffic signal priorities for buses.

Street design, subdivision design and urban development will be pedestrian friendly and more conducive to transit. This includes (a) providing sidewalks along streets, (b) installing pedestrian islands on wide streets, (c) building bus turnouts or laybys, (d) improving pedestrian access to bus stops, and (e) improving street continuity in suburban areas. More significantly, it includes designing new employment and activity centers so they can be served by bus. Accordingly, transit agencies will increasingly provide input to local plans, zoning and building codes, and subdivision regulations.

E. Propulsion Systems

Transit buses will increasingly use alternative fuels in the next century to lower emissions. Selective applications of electric trolley buses and dual-mode buses, along with the emergence of new fuels will help improve bus transit's image with both riders and non-riders.

Diesel bus technology will continue to improve. The modern "clean" diesel bus is about 5 to 10 times as energy efficient per passenger kilometer than the average passenger car. Weight reductions and tire improvements have made it about 25% more fuel-efficient over buses of 30 years ago. It will continue as a primary energy source along with electric trolley and dual-mode (electric-diesel) buses at least for several decades. Low sulfur fuel will make diesel buses more environmentally friendly. Hybrid diesel-electric buses, such as those being tested in New York City will reduce emissions, and offer promise in reducing emissions.

However, future bus vehicle technology will also focus on developing environmentally friendly vehicles that do not rely on fossil fuels because of air quality

and resource depletion concerns. Compressed natural gas (CNG) is already used by several transit systems and its use is likely to increase. Alternative fuels such as ethanol-diesel, hydrogen, alcohols, bio-fuels and synthetic fuels, might become practical. Other long-term possibilities include dual-mode buses (as in Seattle), or electrically powered vehicles with multiple forms of power generation (i.e. fuel cells)

Development of an advanced high-capacity energy storage cell would permit substantial energy gain, as well as minimize pollution. This involves improvements of existing lead-acid batteries - perhaps zinc air and nickel cadmium powered batteries. Such improvements may emerge during the next millennium.

F. Vehicle Design

Future buses will be both eco-friendly and passenger friendly. Both the external and internal appearance will differentiate future vehicles from those of the present and past. Passenger perception and new standards of customer care should (and will) be reinforced by modern, perhaps even futuristic, styling and design.⁽⁵⁾ There will be greater reliance on articulated and low-floor buses.

1. A move from shared to individual seating will offer improved levels of comfort for premium and/or express services. Better interior design will also contribute improved passenger perception and acceptance.
2. Low floor buses - now increasingly in revenue (i.e. Denver, 15th St. Bus Mall) make it easier for passengers to enter and leave buses. This is beneficial to mobility impaired travelers, to senior citizens, and to riders with young children, babies in carriages, or large packages. It will

eliminate the need for special wheel chair lifts. When installed in buses with smaller engines and modified transmissions, the entire floor of the bus could be as low as 300 mm. Low floor buses will also reduce dwell times at stops.

3. New door configurations - made possible by new fare collection methods - will also make boarding and alighting easier. Passenger service times at stops would reduce as a result of the wider doors, low floors, and simplified fare collection practices. Some buses might have "left-side" doors to permit passenger loading and unloading from a central platform in bus rapid transit operations.
4. Buses will continue to be built in many sizes and with many body styles. They will range from 20-to-30 vehicle buses used for paratransit and lightly patronized routes up to the 60 to 90-passenger single and double articulated buses.

G. New Technology

New technology has the potential to significantly improve transit operations, customer information and marketing. Technology is becoming increasingly available that will provide more reliable bus service.

1. The growing use and sophistication of computers and (ITS) Intelligent Transportation Systems technology will improve system efficiency and reliability. ITS technologies such as automatic vehicle location, (AVL), and automatic vehicle information (AVI) - are used today by many transit systems, and their use will increase.

2. Global positioning systems (GPS) will become more widespread. Using global positioning equipment, bus travel along a route can be tracked and transmitted to the dispatcher's office. The data can be recorded by computer over many days, telling when every trip passed every time point. This information makes it possible to develop more realistic schedules that reflect the typical progress of buses for each run during the day.
3. Automatic passenger counting systems (APC) now relay to dispatchers the approximate number of passengers aboard a bus along various points along a route. The data can be aggregated by computer, and shown as a passenger load profile for each run (or route). These profiles can provide a basis for balancing the supply and demand of services - to show where service adjustments are needed to prevent buses passing waiting patrons, to reduce overcrowding, or to change service frequencies. Emerging equipment and software (and attendant cost reductions) will make APC available to even smaller transit systems in the years ahead.
4. Progressive advances in automatic passenger counting (APC), automatic vehicle location (AVL), and global positioning systems (GPS) will afford opportunities for (a) improving route design, (b) building timetables that allow for more sophisticated inter-depot vehicle scheduling, (c) better crew scheduling, (d) improving bus maintenance procedures, and (e) improving schedule adherence.

5. New "ITS" technology such as automated fare collection systems, electronic passes and selective transit-based traffic signal priorities can allow new bus door configurations, reduce bus dwell and travel times, and improve service attractiveness. Signal advances, extensions, or preemption will be advantageous when buses are running late.
6. Silent alarm systems on buses will be progressively complemented by on-board camcorders that monitor misbehavior.

H. Fares and Revenue Collection

Fare structure and collection methods will be progressively improved to enhance ridership, obtain needed revenues, minimize driver handling of money, and reduce journey times.

1. Ideally, pre-purchase should be encouraged. This not only minimizes delay at bus stops, but also eliminates drivers handling money. "Prepayment" also will be encouraged by placing "fare-machines" at heavily traveled stops.
2. Technology for "stored-values" or "smart" cards has improved rapidly in recent years, and additional advances will likely occur. These cards, which include microchips, can be inserted into fare-boxes, or alternatively checked by inspectors (honor system).
3. The use of daily, weekly, or monthly passes will increase. These can be priced by zone, and, like smart cards, can permit intermodal rides. The goal is to "encourage transfers" between buses, urban rail transit, and commuter railroads by means of a single pass or ticket. Passes

also reduce passenger service times from about 3 to 2 seconds per passenger.

5. From a marketing perspective, fares will be increasingly customized to serve particular markets (i.e. students, senior citizens, off-peak riders, express service etc.) daily, weekly, monthly passes.

I. Bus Stops

Bus stops will be progressively improved by protecting passengers from inclement weather, providing clear information regarding bus routes and schedules, and by incorporating telephones and amenities at major stops. These will form an essential part of the overall bus marketing package, and will improve service identity.

One of the biggest deterrents to bus travel is the uncertainty of when buses will arrive at stops - especially where service is infrequent. This condition will be alleviated by variable-message signage at major stops that is keyed to the AVL system. Audio units can "speak" to passengers when they press buttons.

Security at stops will be enhanced by providing push buttons that notify transit or municipal police directly.

J. Marketing

Transit marketing efforts will complement service and technology improvements in making bus systems more user-friendly. A principal goal will be to gain and hold every customer. This will require outreach to a public that is often indifferent to the bus system or unable to use it well. Price-product-promotion will

be increasingly people oriented. Transit management will be more receptive to constructive inputs from transit user groups.

1. Innovative marketing programs will explore new ways to provide service and attract riders. These include (1) encouraging transit rides to special events, (2) providing specialized services, (3) selling transit fare cards at banks and retail outlets, (4) encouraging University students to ride buses (i.e. bus pass included in registration fee etc.), and (5) encouraging employer fare assistance (there is a federal tax allowance today of up to \$55 monthly per employee).
2. Examples of "service innovations" include: (1) premium fare commuter express service, (b) bargain fares for reverse commuting, (c) free and low-fare zones, (d) special service for niche markets.
3. Passenger service information will be improved. Transit system maps and route guides (timetables with route sketches) will give people clear information about routes, schedules, fares, transfer points and key places along the route or system. [For some people, telephone information will prove helpful even though the cost of the average inquiry is about half an adult fare.] The usual "how to ride" pamphlet might be augmented by a video cassette that illustrates actual rides, transferring, and other rider know-how, as well as the use of timetables. The cassettes could be lent or viewed through the public library system.

K. Management, Coordination and Planning

Future changes in bus transit management, coordination, and planning will reflect national and local attitudes and needs.

1. System management/policy oversight will be done by public agencies. Private operation of specific services may be cost-effective - but will be provided within the context of overall public policy objectives and controls.
2. The system management will cover all modes, encompass the areas where each mode operates, and have a suitable revenue base that augments fares.
3. Cost containment will be important even where additional resources are available. The many ways that costs can be controlled and efficiency improved include: (a) setting performance standards, (b) competitive contracting for specific services, (c) establishing differential rates for drivers (such as for paratransit services) and increasing use of part-time drivers. Ongoing review of individual route performance will make it possible to revise services and to reallocate resources.
4. Bus, rail, paratransit, and ferry services will be planned, financed, and operated as a unified system. Bus routes will feed rail lines, rather than compete with them. Services, schedules and fares will be coordinated.

5. Bus and taxi night service will be integrated (as now done in several European cities). During late night hours, taxis will operate along bus routes under transit agency supervision of services and fares.
6. Urban transportation policy, parking policy in particular, will be transit sensitive. In larger cities, parking will be encouraged along outlying express transit stops, rather than in established city centers. Similarly, in some settings, investment in Transportation System and Demand Management efforts may yield greater ridership gains than just providing additional service. Effectiveness of such programs will be increased by transit agency cooperation with other agencies and institutions.
7. Bus transit management will work with local planning agencies and developers to encourage development that is pedestrian-friendly and conducive to transit use. An important challenge is to plan for bus transport in developing or to-be developed in advance of actual development (i.e. reserving rights-of-way, providing suitable streets, properly siting development). Where practical, bus service will “lead” development to establish the desired “riding habits”.

THE CHALLENGE

Bus transport in the next century will continue to provide important service to Metropolitan America. This calls for continued support at all levels of government. An accelerated and continuing program of research and experimentation will help make bus transit integral and dynamic in the decades ahead.

In prospect, the future of bus transit in the next century looks promising, for we will have learned from our past experiences about the importance of public transport as an essential community service, and we will progressively take the necessary policy actions to enhance and foster transit in the years ahead. The growing community concerns about traffic congestion, sprawl, air pollution and sustainability, the progressive revitalization of cities and towns, and continued advances in transport technology argue for improved bus transit in the new century, and enhanced revenue sources.

A greater effort to establish residential areas, employment centers and shopping areas that are more accessible to public transit, and to revitalize central cities will further enhance the future of bus transit in the 21st Century.

ACKNOWLEDGEMENTS

This paper was initially prepared as inputs to the Transportation Research Board's Bus Transit Systems Committee's paper "Bus Transportation in the New Millennium – A Look Forward". The final version also draws from the Millennium Paper.

The materials and insights of the New Millennium Subcommittee are especially appreciated. This committee included John Dockendorf (Chairman), Herbert S. Levinson, Donn Fichter, Ali Hashani, Ronald S. Hudenski, and Charles E. Prestrud. Benedict G. Barkan reviewed the final manuscript.

References

- (1) Miller, J.A. "Fares Please" Dover Publications, New York, NY 1941.
D. Appleton, Century Co., 1960, Dover Publications, New York.
- (2) Blake, H.N. and Jackson W. Electric Railway Transportation,
Second Edition, McGraw Hill Book Company, New York, NY.
- (3) APTA 1997 Transit Fact Book
American Public Transport Association, Washington, DC Jan. 1997.
- (4) Levinson, Herbert S., "Cities, Transportation and Change", Transportation
Quarterly, Vol. 50, No. 4, 1996. ENO Transportation Foundation.
- (5) Bradshaw W.P. and McGreery, M.V. "Buses" in Passenger Transport After
2000 AD, Edited by Feilden, G.B., Wickens, A.H., and Yates, R.R.,
The Royal Society, E & F.N. Spon Publishers, an Imprint of Chapman and
Hall, London, UK, 1992.