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Abstract
The increasing importance of regional rail systems for growing cities and metropolitan areas has been shown more clearly in North America than anywhere else in the world. In spite of extremely auto-oriented developments and policies which do not favor railways, a number of North American cities have extended and improved their regional rail systems in recent decades.

Disciplines
Civil Engineering | Systems Engineering | Transportation Engineering

REGIONAL RAIL DEVELOPMENTS IN NORTH AMERICA

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The increasing importance of regional rail systems for growing cities and metropolitan areas has been shown more clearly in North America than anywhere else in the world. In spite of extremely auto-oriented developments and policies which do not favor railways, a number of North American cities have extended and improved their regional rail systems in recent decades.

1. TRADITIONAL SUBURBAN/COMMUTER RAILROADS

The suburban or commuter railroads in North American cities initially consisted of radial rail lines converging from suburbs into one or several terminals in the central city. Owned and operated by private railroad companies, these lines generally served commuters traveling to and from work in the center of the city. These traditional commuter radial lines were characterized by mostly cumulative boarding toward the city ("many-to-one" pattern) and a very sharp temporal peaking of demand. While frequent services were offered during the peaks, only infrequent and often irregular services existed at other times.

Railroad companies operating commuter rail systems were independent from transit agencies operating metros, streetcars/light rail, trolleybuses and buses. While they usually did have joint terminals, fares and often even information for the two systems were independent of each other.

2. RECENT DEVELOPMENTS AND EVOLUTION OF REGIONAL RAIL

Recent trends in cities have resulted in a steady increase of interest in regional rail. Particularly important have been two factors. First, with the spreading of cities and growth of suburban populations, the highest growth of demand for transit has occurred in the areas served primarily by regional rail networks. Thus, as cities grow into regions, there is a need to develop urban transit into regional transit, and regional rail systems represent the most important regional transit networks. And second, regional rail offers a very high quality of service (particularly speed, reliability, riding comfort and image), so that it can compete with the private automobile much better than other transit modes.

In North America, both of these factors - spreading cities and ability to compete with the automobile - have been extremely strong. However, another factor was also present which had a negative impact on regional rail developments. Unlike railways in

most countries, in the United States and Canada these systems were operated by private companies which have a much stronger interest in freight than in passenger transportation. An even more negative aspect of this private ownership of railroads is that the federal government gives railroads a far less favorable treatment than other transportation modes, mostly highways and air transport.

As the need for extensions and improvements of regional rail intensified in recent years, many cities had to find solutions to the mentioned problems. In most cities (Chicago, Toronto) new regional public agencies were founded to operate regional rail systems; in some areas state agencies assumed responsibility (California, Connecticut, Maryland), while in Philadelphia and Boston urban transit agencies took over the regional rail systems. With these organizational changes various steps toward integration of services with transit (introduction of feeder lines, joint information and, joint fares) have been introduced. Financing from public sources - local, state and federal, and in some cases dedicated taxes approved in popular referenda - has increased substantially, although not sufficiently to meet the increasing demand for high-quality regional rail services.

A brief review of regional rail developments in major urban regions will be followed by an analysis of the types of upgrading and evolution of contemporary regional rail systems in North America.

New York City. The Region of New York City is served by three large regional rail systems: **Metro North**, serving northern suburbs in New York State and Connecticut; **Long Island Rail Road (LIRR)**, consisting of a number of lines from the City toward the east, extending to the eastern end of Long Island; and **New Jersey Transit (NJT)**, which has about 10 lines radiating from Manhattan, Hoboken and Newark to the large area of New Jersey suburbs (Figure 1). These systems carry a total of close to 700,000 weekday passengers.

In spite of continuous financial constraints, a number of major improvements have been made on these systems. Metro North, LIRR and NJT were reorganized into public agencies and they introduced such technical/operational improvements as:

- Extension of electrification;
- Upgrading of stations and expansion of park-and-ride (P+R) lots;
- Construction of high-level platforms on many lines;
- Building of new yards and control centers;
- Improved coordination and transfers with local transit;
- A major new transfer station between Newark and New York will provide an important connection between two sets of NJT lines, increasing their operational efficiency and service convenience.

LIRR has also made improvements to increase capacity at Jamaica, the convergence point of most of its lines toward Manhattan, to accommodate increasing ridership. LIRR has recently acquired, for the first time, a fleet of double-decker cars and ordered several dual powered (diesel-electric) locomotives to reduce the delays

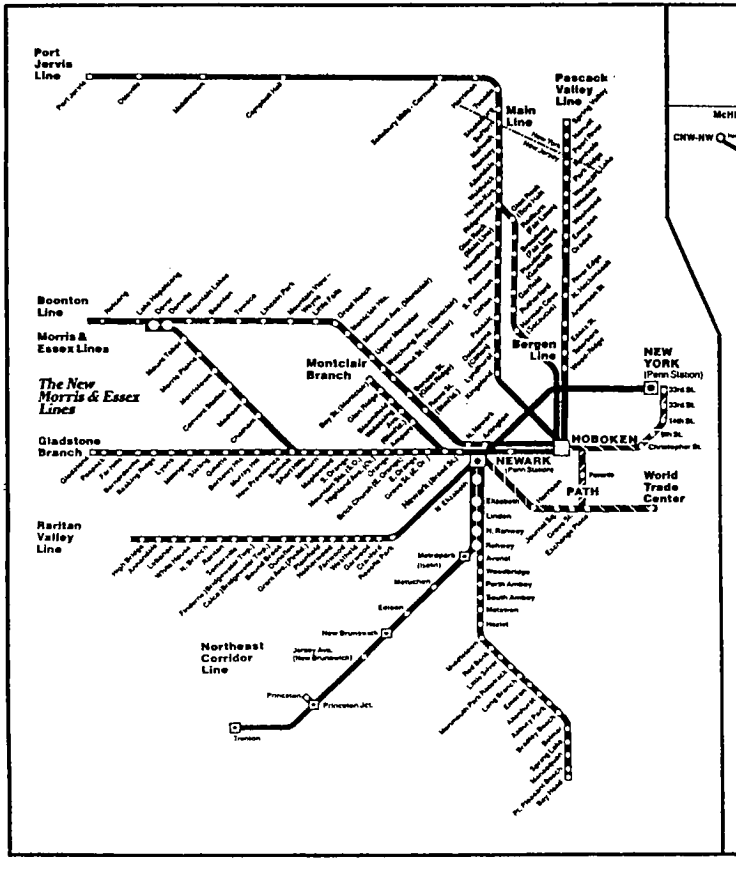

Fig. 1 NJT Regional Rail network

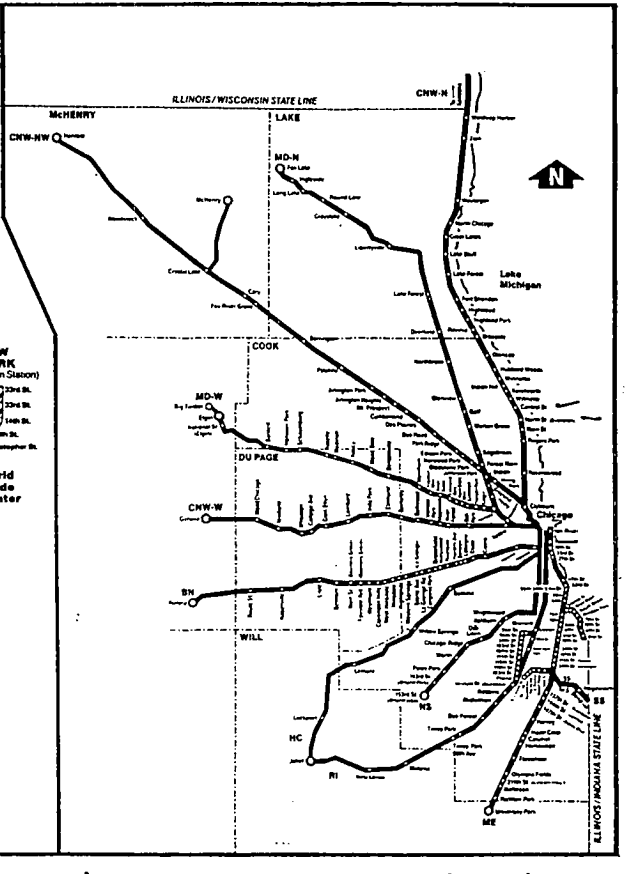

Fig. 2 Metra's network in Chicago

from changing locomotives between electrified and non-electrified sections of lines.

Chicago. The regional rail network in Chicago, which used to be operated by eight railroad companies, is now unified under the **Metra** public agency. As Figure 2 shows, the network consists of 11 radial lines plus four branches which terminate in four different center city stations. The system, most of which has diesel traction, carries 275,000 weekday passengers. Its limitations include access at both travel ends insufficient bus feeders and P+R facilities in the suburbs, and lack of convenient distribution in the Central Business District (CBD). The terminal stations are on the fringes of the CBD, requiring for many passengers transfers to buses on streets. There is a serious proposal to build a circular light rail line to improve this distribution.

Philadelphia. The old home city of the famous Pennsylvania Railroad, Philadelphia is the only North American city with a completely electrified regional rail system. For many decades this extensive rail network was operated by two private companies, Penn-Central and Reading. Since 1980, this network has undergone the most fundamental upgrading of any regional rail system in North America.

Similar to recent construction of diametrical regional rail lines through central cities in Hamburg, Munich, Oslo and Paris, a center city tunnel was constructed which connected the two previously separate radial networks into an integrated network. Twelve former radial lines have been transformed into six diametrical lines, and a new radial line to the Airport has been built. In 1983, the system was taken over by the transit agency, **SEPTA**, and it is now largely integrated with other transit modes. However, in spite of service improvements, the ridership has remained rather low (under 100,000 per weekday) because of high fares, insufficient P+R facilities and long service intervals: except during peak hours, most lines offer only hourly headways.

Boston. An impressive progress with regional rail has been achieved in recent years in Boston. The transit agency - **MBTA** - took over the system and selected Amtrak to operate it. Its rather extensive network with diesel traction and rather long headways has succeeded through improvements of service quality to more than double its ridership in the last decade: from 30,000 to 72,000 daily passengers.

Unfortunately, the Boston network consists of two sets of lines, terminating in two stations on the south and north sides of the Boston CBD. Presently, reconstruction, widening and underground placement of the major north-south freeway through center city (Central Artery), is planned. Yet, this unique opportunity to connect the North and South Stations for the regional rail system (as well as for long-distance trains) is being wasted due to a monumentally short-sided planning and refusal of the highway groups to consider inclusion of the vital transit link in the project.

San Francisco. The State of California took over the regional rail line between San Francisco and San Jose and founded **Caltrain**, a public agency to operate the line.

Recently, the state purchased its right-of-way from the Southern Pacific Railroad. Among various plans for its upgrading and extension, the most important is the improvement of its connection with the CBD area in San Francisco: the terminus is at a long walking distance and has only limited transit connections.

Toronto. This Canadian city is known as the leader on the continent in transit planning and many transportation innovations. Its regional rail system is relatively new: it was started in the late 1960s. Having had a steady growth in ridership, its network was extended several times, so that today it carries close to 100,000 weekday passengers. The double-decker car design developed for its **GO Transit** system has been so successful that several other cities (Miami, San Diego, Los Angeles) have now adopted it for their new systems.

Baltimore-Washington and **Montreal** have regional rail systems which have also been improved in recent years. Single lines of regional rail opened during the 1970s in **Detroit** and **Pittsburgh** have been discontinued due to insufficient funding, while **Miami** has opened a nearly 100 km long line to West Palm Beach to reduce congestion during reconstruction of a parallel freeway in that corridor. If the line is successful, it will become permanent.

Dallas, San Diego and Seattle are presently in advanced stages of planning new regional rail systems. However, by far the most interesting developments are taking place in the **Los Angeles Region**. After decades of construction of extensive freeway networks and total adaptation of the entire urban area to the private automobile, very serious problems of traffic congestion, air pollution and other environmental damages have increased so much, that it became obvious that the basic transportation policies must be changed.

Several popular referenda in California and in the Los Angeles Region have approved multi-billion dollar funding specifically for construction of rail transit systems. Thus, one 35-km long LRT line has been recently opened, while another one and a metro line are under construction. Parallel with these efforts, planning of a new regional rail system is under way. Recently, Los Angeles County Transportation Commission purchased 282 km of railroad rights-of-way for regional rail. The final regional network will consist of 547 km of tracks on which 663 km of lines will be operated, serving 67 stations. The first line will open already in 1992.

Table 1 presents the basic data on regional rail systems in North America.

3. ANALYSIS OF DEVELOPMENTS AND INNOVATIONS

It should be pointed out that the conditions for development of regional rail systems in North American cities in recent decades were much less favorable than in most West European countries and in Japan. The primary reasons for this are that

Table 1. North American Cities with Regional Rail Service in Operation (1989 - 1991 Data)

City	Diesel/ Electric	Transit Agency	Rail Operator	Trains/ Weekday	Passengers /Weekday (thousands)	Passengers /Year (millions)
Baltimore, MD	D	MARC	Amtrak, CSX	64	15	3.5
Boston, MA	D	MBTA	Amtrak	373	76	19.2
Chicago, IL	D(E)	Metra	Metra, BN CNW, NS	598	275	67.8
Miami, FL	D	TRI-RAIL	UTDC	16	6	1.6
Montreal, Quebec	D,E	STCUM	CN, CP	80	31	8.2
New Haven, CT	E	ConnDOT/MTA	Metro North		(See New York)	
		ConnDOT	Amtrak		(New in 1990)	
Newark, NJ	E	NJT	NJT	569	170	46.9
New York, NY	E	MTA	Metro North		200	57.0
	E,D	MTA	LIRR	732	292	75.4
	E,D	NJT	NJT		(See Newark)	
Providence, RI	D	RIDOT/MBTA	Amtrak		(See Boston)	
Philadelphia, PA	E	SEPTA	SEPTA	360	94	25.7
San Francisco, CA	D	Caltrain	SP	52	22	6.4
San Jose, CA	D	Caltrain	SP		(See San Francisco)	
Santa Ana, CA	D	OCTC	Amtrak	2	(New in 1990)	
South Bend, IN	E	NICTD/Metra	CSSSB	39	12	2.3
Toronto, Ontario	D	GO Transit	CN, CP	145	96	24.0
Washington, DC	D	MARC	Amtrak		(See Baltimore)	
		MARC	CSX		(New in 1992)	
			Totals:		1,289	338.0
Under construction:						
Dallas, TX						
Los Angeles, CA						
San Diego, CA						
Seattle, WA						

Source: American Public Transit Association (APTA), individual agencies.

therefore, a non-stop service must be provided. The Airport Line in Philadelphia is a good example of this: it actually passes through areas with large potential ridership without stations, and it carries only 2,000 daily passengers to the Airport. This confirms experiences from many cities that air travelers value frequency of service far more than saving a few minutes by non-stop operation between CBD and airport only.

- **Integration of regional rail with other transit modes**, an important element of passenger attraction, has been introduced to some extent in some North American cities, such as network coordination and some joint fares in Northern New Jersey, Philadelphia and Toronto. More integration is, however, needed.

3.2. Rolling Stock

Network characteristics, physical and operating conditions of regional rail systems vary widely among cities and even within the same regions. This diversity has led to numerous innovations in rolling stock development in recent years.

- **Train types**: multiple-unit (MU) rolling stock is the most common type on electrified lines. Locomotive with trailers are usually operated as push-pull units, with a driver's cab on the last car for reverse travel. Dual power (electric and diesel) locomotives were tried without much success in the past, but a new model has recently been ordered for some lines in New York/Long Island.

- **Double-decker cars**, a rarity a couple of decades ago (only Chicago, Montreal and San Francisco had them), have become very popular in recent years. The need to provide more capacity (up to 160 seats) for increasing passenger volumes and greater comfort has led many cities in Europe and North America which have sufficient profile clearances to introduce double-deck and gallery cars. As mentioned, Toronto's famous double-decker car has been adopted in Miami and Los Angeles, while Boston and New York/Long Island have also recently obtained their first double-deckers.

- **Platform heights** are in most cities low, while the cities in the Northeastern states have a mixture of low and high platforms. The three regional rail systems in New York have built high-level platforms on their main lines in the last 25 years.

3.3. Ownership and Operation

Most regional rail systems have been transferred to transit agencies which either operate them directly (NJT, SEPTA) or contract them out to other operating agencies (Boston to Amtrak, Miami to UTDC). Some regional rail systems are owned and operated by independent public agencies (Metra, Caltrain, GO Transit).

these systems were taken over by public agencies only recently and that national transportation policies are much more favorable toward highway than toward public, particularly rail, transportation. While these policies were improved between the mid-1960s and 1980, they again retrogressed since that time. Extensive direct and indirect subsidies to automobile use, very low gasoline prices and urban planning which neglects transit create great obstacles to transit improvements. Investment fund shortages have usually been severe. Yet, in spite of these difficulties, the described developments do show that many cities have made significant efforts and achieved a number of improvements of their regional rail systems. The types of improvements are briefly reviewed here.

3.1. Network Developments

Major rail network and infrastructure improvements were as follows.

- **Electrification of lines**, done extensively in many countries in recent decades, was rather limited in North America: only some lines in New Jersey and on Long Island have been electrified, while many systems, such as Boston, Toronto and San Francisco, remain with diesel traction only. The reasons for this are low diesel fuel price, lack of investment funds and much less developed long distance passenger railways than in other western countries.

- **Cross-city link**, connecting radial networks on different sides of center city, has been built only in Philadelphia (Figure 3). As mentioned, Boston is now missing a historic opportunity to construct a similar facility which represents the main element in upgrading commuter into regional rail systems. Most other regional rail systems suffer from limited distribution systems in city centers.

- **Positive impact of new rail lines on land use development** has particularly strongly materialized with center city links. For example, in the center of Philadelphia a period of intensive construction of new offices, retail facilities and a new convention center, have been closely linked to the opening of the regional rail tunnel.

- **Line extensions** have been built outward in several cities (Boston, Philadelphia, Toronto) as they grew spatially.

- **Airport rail lines** have been built in several North American cities with results similar to those in many cities in other countries. Extensions of regular rail lines to airports have been generally very successful in attracting riders (Boston, Cleveland, Chicago/O'Hare and Washington), similar to those in Frankfurt and London/Heathrow. However, designs of some exclusive airport lines were based on a belief that airport passengers would not tolerate any stopping of trains between center city and the airport;

4. PROBLEMS AND OBSTACLES TO DEVELOPMENT

Regional rail systems remain different from transit systems by their physical and operational characteristics and passenger demand. Together with their advantages, such as separate rights-of-way and high service quality, they also face some unique problems. Typical major problems are listed here.

- **Very high peak/base ratio of passenger volumes** (Figure 4). This problem is partly caused by the nature of regional rail systems (dominance of commuters), but it is often intensified by the fact that regional rail systems offer poor off-peak services, further suppressing non-commuter ridership. The result is very low utilization of the rolling stock: on some systems off-peak and weekend services can be operated by less than 25% of the fleet. Consequently, unit costs ($/passenger) are very high.

This condition often leads to the incorrect conclusion that the regional rail mode is very expensive to operate. Actually, it is expensive to serve very sharp peaks, and regional rail is usually the most economical mode to serve such concentrated passenger volumes with high service quality.

- **Fare collection** is still labor intensive. Introduction of self-service fare collection has not been done yet, supposedly because stations are not controlled. The fact that many new light rail systems in North America have proven the feasibility of self-service fare collection without controlled stations is being overlooked.

- **Labor-intensive operation** makes running of long trains the most economical, resulting in long headways which are unattractive for the public. Labor unions may also represent an obstacle to automation and introduction of more efficient operations.

- **Federal railway technical standards**, designed for long distance operations, include many items (regarding brake tests, signals, etc.) which are excessive for regional services and represent a burden that causes unjustified delays and costs.

- **Complex regional jurisdictions and parochial mentalities** often make serious obstacles to introduction of changes that would benefit the region. Examples of this are opposition to land use controls or to provision of P+R facilities at stations.

- **Deeply rooted "hidden" favoring of private automobile**, such as subsidized parking, business- or tax-supported use of automobile and lack of charges for the social and environmental costs which auto use in cities causes, represent by far the most serious obstacles to the development of all transit, including regional rail.

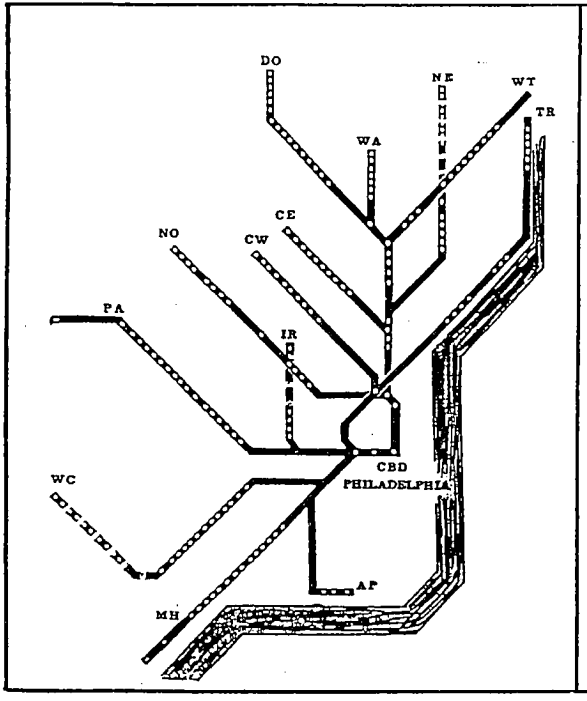

Fig. 3 Philadelphia Regional Rail

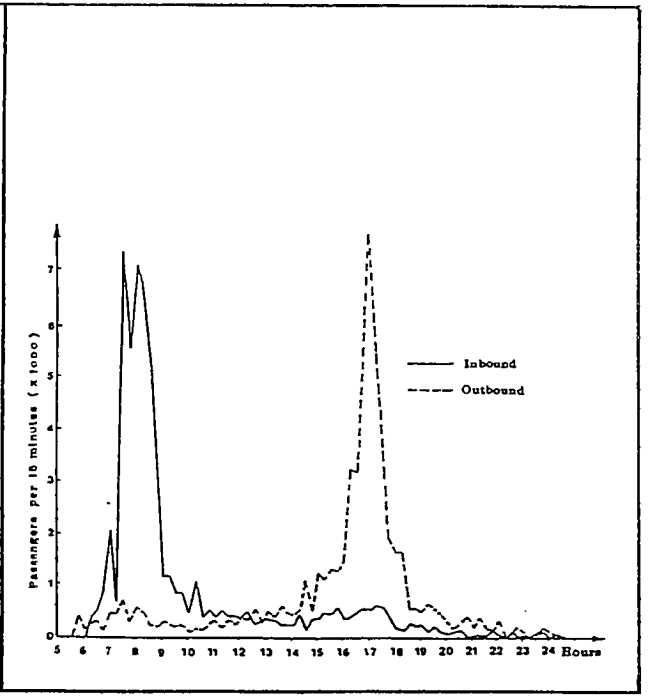

Fig. 4 Passenger volumes (SEPTA)

5. NEEDED FURTHER IMPROVEMENTS AND INNOVATIONS

The preceding discussion shows some of the major problems many regional rail agencies are facing today. The most common needs for improvements in services and operating efficiency, partly aimed at solving the existing problems and partly directed toward innovations and system upgrading, are defined here.

- **Increased reverse commuting, intrasuburban and off-peak ridership,** which greatly improve operating ratios (revenue/expenses), should be achieved by further conversion to transit-type services. One of the basic elements to achieve this is an increase in service frequency during off-peak hours. This requires lowering of direct operating costs for minimum train size operation.

- **Reduced minimum train size.** Many regional rail systems operate 2- or 3-car trains as minimum units; the minimum crew has two or three persons. Both of these must be reduced through various measures which allow operations similar to those of light rail transit: design of cars and signals which permit single-car, driver-only operation with good security supervision and easy fare collection.

- **Further adaptation of technical standards to the needs of regional rail systems.** The standards and operating rules which are not necessary for safety of regional rail systems should be eliminated. For example, until recently, there was a position of a "brakeman" on fully signalized rail lines!

- **Improvements to suburban access.** Depending on local conditions, these improvements should focus on some or all of the potential access modes, such as walking, bicycles (successfully used in some cities, neglected in others), bus feeders, kiss-and-ride (passenger drop-off) and P+R. The last two modes, access by automobile, are particularly important in North American cities.

- **Further institutional cooperation** that will allow full integration of services for passenger convenience, where this has not yet been achieved.

- **Integration of urban and transportation planning.** The strong interaction between rail systems and urban form has been used in some cities successfully for effective urban planning (Toronto). In U.S. cities coordination between urban and transportation planning was practiced in the era of early development of railroads, but it has been largely neglected in recent decades.

- **Adoption of rational transportation policies and financing methods.** The sharpening crisis of highway congestion, air pollution and other negative impacts of transportation on quality of life in some parts of the country (Los Angeles, Dallas) has

now led to corrections in these individual state and regional policies. However, many of the improvements in federal policies and financial allocations to different modes introduced during the 1970s, have been eliminated during the 1980s. **Fundamental changes in the national transportation policy will be needed to prevent further deterioration of U.S. cities.** Canadian policies have been generally more balanced and far-sighted.

6. THE NEW REGIONAL/METRO SYSTEMS

This review of North American regional/commuter rail systems would be incomplete if it would not mention recent construction of regional rapid transit or regional/metro systems. Systems like the Bay Area Rapid Transit (BART) in the San Francisco Region and Washington Metro are usually classified as rapid transit or metro systems. By their technology and operation (enclosed stations, extensive automation, frequent services) they do represent metro systems; yet, by their geographic and network characteristics they definitely also play the role of regional rail systems. By their length of lines, spacing of stations, reliance on P+R in suburbs they offer services similar to that of regional rail. A more detailed comparative analysis of these two groups of systems is very interesting, but it exceeds the scope of this paper.

The new regional/metro systems which serve metropolitan regions include, in addition to the San Francisco BART and Washington Metro, the Lindenwold (PATCO) Line in Philadelphia, Atlanta, Baltimore and Miami Metro systems.

Indications are that with the increasing highway congestion and recognition of the need to better coordinate urban planning and transportation, regional rail systems will have an increasing role in shaping North American cities and increasing their vitality. Further expansion and innovations in this classical mode of urban transport should be expected in the future.

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