LIGHT RAIL TRANSIT: 1975 USAGE AND DEVELOPMENT

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It is the nature of citizens, as well as planners, to attempt to discover the ultimate truth or ultimate solution to any problem they confront. The problem of urban transport has been one area of community living that has been given high priority for solution. For more than 3 decades, authorities seem to have been convinced that a single technological system would ultimately satisfy all transport problems. In many ways this system, the private automobile, has given more benefit to urban citizens than any previous transportation mode has. During these decades, people have perceived publicly provided passenger transport to be simply an interim necessity until such time as everyone could drive their own automobiles. By the mid-1960s, some planners and officials realized that this expectation might be extravagant. Many officials were shocked to discover districts within their own constituencies where more than 1 out of every 4 persons still could not avail themselves of private automobile transport. Communities then began to reevaluate their weakened and retrenched public transport networks. Because the problem was approached on a total metropolitan area basis, many analysts and designers still perceived that the solution for public transit would be obtained through the use of only 1 technical mode—the city bus. This philosophy was little challenged by the existence of subways or heavy rapid transit being operated in a few cities. In these cities the planner simply shifted the parameters for transit study to address surface-related operations only. If it were found that a community was in need of high-capacity public transport, a non-surface-level subway solution quickly was proposed. During the last 12 years, existing urban transport technology has been continually challenged by new system technologies. The advocates of these new technologies contended that they would best satisfy all existing and future public transport requirements throughout all the portions of the metropolitan area.

Evaluating the many urban transport studies and urban transport operations in cities of the United States and Canada, one is led to believe that no single technology can accommodate all the transit needs of major communities. Transport in all cities becomes quickly established in and around specific corridors. When capacity requirements are analyzed on a corridor-by-corrdior basis, a more economically efficient and socially effective transport system can be developed.

We are reviewing at this conference a proved technology. Light rail transit currently demonstrates its effectiveness as part of the total urban transport system in more than 300 cities of the world. It dominates the transit of some cities and provides important arterial service in other cities. However, it does not establish a modal monopoly in any situation in which it has been constructed. Light rail transit is not being advocated as a replacement for all buses, all private cars, or heavy rapid transit systems. Although advocates promote the mode, they do not envision it as a panacea for all urban transport problems. However, many corridors currently exist in cities of Canada and the United States that could use this means of transport most efficiently to improve public passenger services.

We should review some of the localities and methods of operation. As is true of many transport modes, LRT does not need to be based on 1 policy involving governmental organization, social objectives, or proprietary interests to be used. It should be stressed that light rail transit is one of the few modern transport modes that is available without the holding by 1 group or 1 company of all proprietary rights to the total system. Some people may see this as a fault. Others, particularly operating authorities, may see it as an advantage. In 1975, more than 300 cities are operating light rail systems of various sizes. Of these communities, more than 70 are involved in study, design, or construction of new lines or new equipment for their LRT operations (Table 1).

Unlike heavy rapid transit systems, light rail transit can use the several types of articulated and nonarticulated, electrically propelled vehicles over various types of rights-of-way. Because of the controlled trajectory of the vehicle through the use of steel guide rails, a high-frequency service can be operated with LRT within conditions imposed by narrow and twisting historic streets and land use constraints.

Several European cities have embarked on incremental programs of public transport improvement by using LRT as a major method of reducing central city automobile traffic volumes and penetrating difficult land use areas. In some instances, portions of streets have been converted for exclusive LRT use. At major street intersections, through-trip vehicular traffic has been grade separated from local urban activities, and the surface levels are for light rail and intensive commercial and retail activities. Such methods of traffic separation permit critical junction points and intersections to be designed in a way that permits public transport to operate without conflict with other modes.

Various cities have taken this incremental approach and have adopted urban transport plans that are being implemented over a 10-to-15-year period, thereby gaining early benefits from crucial portions of the system. One of the first low-cost methods of emphasizing public transport and LRT is to separate transit lanes from private vehicle lanes by signing and striping. In some cities, LRT lines have been placed along the curb to provide safer separation of pedestrians and other vehicles. Such application has improved boarding and alighting times for users and limits the use of public streets for private vehicle parking. In totally new rights-of-way, LRT routes do not require the magnitude of capital investment generally associated with heavy rail rapid transit. This is achieved in part from the ability to be flexible in the type of alignment used. The route can provide direct access to major activity centers while being separated physically or visually from highway lanes. In several cities this has been accomplished by a variety of methods. As a result, separate levels and rights-of-way can be developed for LRT along highway routes.

Because of the controlled guide path of this mode, minimal intrusion occurs in sensitive land use areas such as public parks and green spaces. The LRT mode is used to enter such activity areas without encouragement of private vehicular traffic. As a result of this, a more aesthetically pleasing urban area can be maintained and high-capacity transport can still be offered.

Surface level LRT operation can be brought to new suburban areas with new highways, or it can be constructed almost totally independent from other transport investment.

For conurbations envisioning future heavy rail networks, advanced benefits have been obtained from the construction and use of limited sections of underground routes. With the LRT system, minimum difficulty is experienced with transition between surface and subterranean operations. Such transition can be achieved in limited lengths. With the use of these sections, the reduced travel times within the central business district (CBD) encourage greater ridership and more efficient transport operation.

With the support of citizens and officials, Zurich, the largest city in Switzerland, redesigned its traditional primary retail street into a pedestrian walkway and LRT route. Although peak-hour services involve use of more than 60 vehicles, the guided dual-rail control of the vehicle has low noise levels, and the system has conflicted minimally with pedestrians, shoppers, and merchants. The community was behind the project, and the design and construction of this corridor were achieved with minimal negative visual and aesthetic impact.

In other CBD localities the LRT system has been retained within the existing street

Table 1. Cities involved in construction of light rail transit (1).

Location	Stage: Proposed	Stage: Planning or Study	Stage: Design	Stage: Construction	Opening Year	Remarks
Alexandria, Egypt		x				Ext,[a] rehab[b]
Amsterdam, Netherlands	x	x				Ext,[a] rehab[b]
Antwerp, Belgium				x	1974	Sub[c]
Arad, Rumania				x		Rehab[b]
Basel, Switzerland		x	x			Ext[a]
Bastia, France	x					New[a]
Berlin, GDR[d]				x		Rehab[b]
Bern, Switzerland				x		Ext[a]
Bielefeld, FRG[f]				x		Ext,[a] sub[c]
Bochum, FRG[f]			x	x		Ext,[a] rehab[b]
Bonn, FRG[f]				x		Ext,[a] sub[c]
Boston, USA		x		x		Rehab[b]
Bratislava, Czechoslovakia				x		Ext[a]
Braunschweig, FRG[f]				x		Ext[a]
Bremen, FRG[f]				x		Ext,[a] rehab[b]
Brno, Czechoslovakia				x		Ext[a]
Brussels, Belgium				x		Sub,[c] rehab[b]
Bucharest, Rumania				x		Ext[a]
Bydgoszcz, Poland				x		Ext[a]
Cairo, Egypt			x			Ext[a]
Charleroi, Belgium				x		Ext,[a] arl[g]
Cleveland (Tecside), UK	x					New[a]
Cologne, FRG[f]			x	x		Ext,[a] sub[c]
Constantsa, Rumania	x					New[e]
Cottbus, GDR[d]				x		Rehab[b]
Craiova, Rumania	x			x		New[e]
Darmstadt, FRG[f]				x		Ext[a]
Dayton, USA			x			New[e]
Dortmund, FRG[f]				x		Ext,[a] rehab[b]
Dresden, GDR[d]				x		Rehab[b]
Duisburg, FRG[f]				x		Ext,[a] arl[g]
Düsseldorf, FRG[f]			x			Ext,[a] sub[c]
Edinburgh, UK	x					New[e]
Edmonton, Canada			x		1978	New[e]
Erfurt, GDR[d]				x		Ext[a]
Essen, FRG[f]			x			Ext,[a] sub[c]
Frankfurt, FRG[f]				x		Ext,[a] sub[c]
Freiburg, FRG[f]		x				Rehab[b]
Ghent, Belgium			x			Ext,[a] sub[c]
Gorzów, Poland				x		Ext[a]
Göteborg, Sweden				x		Ext,[a] rehab[b]
The Hague, Netherlands			x			Ext[a]
Halle, GDR[d]				x		Ext[a]
Hannover, FRG[f]				x	1975	Ext,[a] rehab[b]
Helsinki, Finland			x			Ext[a]
Helwân, Egypt		x				New[e]
Hiroshima, Japan		x				Ext,[a] sub[c]
Hong Kong		x				Sub[c]
Innsbruck, Austria			x			Ext[a]
Karachi, Pakistan		x			1980	New[e]
Karl-Marx-Stadt, GDR[d]				x		Ext[a]
Karlsruhe, FRG[f]		x				Rehab[b]
Katowice, Poland				x		Ext[a]
Krakow, Poland				x		Ext,[a] rehab[b]
Krefeld, FRG[f]				x		Rehab[b]
Leipzig, GDR[d]	x					Ext,[a] rehab[b]
Liberec, Czechoslovakia		x				Rehab[b]
Lille, France			x			Sub[c]
Linz, Austria				x		Ext[a]
Lódz, Poland				x		Ext[a]
Ludwigshafen, FRG[f]				x		Rehab[b]
Mannheim, FRG[f]				x		Ext[a]
Melbourne, Australia			x	x		Rehab[b]
Milan, Italy			x	x		Ext,[a] rehab[b]
Munich, FRG[f]				x		Ext,[a] rehab[b]
Naples, Italy		x				Rehab[b]
Norrköping, Sweden				x		Ext[a]
Nuremberg, FRG[f]				x		Ext[a]
Olomouc, Czechoslovakia		x				Rehab[b]
Ostrava, Czechoslovakia		x				Sub[c]
Philadelphia, USA			x			Rehab[b]
Pizen, Czechoslovakia				x		Ext[a]
Plauen, GDR[d]				x		Ext[a]
Ploesti, Rumania	x					New[e]
Portland, Oregon, USA	x					New[e]
Prague, Czechoslovakia			x	x		Ext[a]
Riga, USSR				x		Ext,[a] rehab[b]
Rochester, N.Y., USA	x					New[e]
Rome, Italy		x		x		Ext,[a] rehab[b]
Rotterdam, Netherlands		x		x		Ext,[a] rehab[b]
Ruhr region, FRG[f]		x	x			Ext,[a] rehab[b]
Saint-Etienne, France		x				Sub[c]
San Francisco, USA				x		Sub,[c] rehab[b]
Sarajevo, Yugoslavia				x		Rehab[b]
Schwerin, GDR[d]				x		Ext,[a] rehab[b]
Sheffield, UK		x				New[e]
Sofia, Bulgaria		x				Sub,[c] rehab[b]
Stuttgart, FRG[f]				x		Ext,[a] sub[c]
Sydney, Australia		x	x			New[e]
Szczecin, Poland		x				Ext[a]
Turin, Italy		x				Ext,[a] rehab[b]
Toronto, Canada		x	x			Ext,[a] rehab[b]
Torun, Poland				x		Ext[a]
Tyneside, UK			x	x		New[e]
Utrecht, Netherlands			x			New[e]
Vancouver, Canada	x					New[e]
Vienna, Austria				x		Ext[a]
Warsaw, Poland			x			Rehab[b]
Würzburg, FRG[f]		x			1978	Ext[a]
Yerevan, USSR			x			Sub[c]
Zurich, Switzerland		x	x			Ext[a]

[a]Extension of existing system.
[b]Rehabilitation of existing system.
[c]Underground section.
[d]German Democratic Republic (East Germany).
[e]No existing system.
[f]Federal Republic of Germany (West Germany).
[g]Elevated section.

pattern of the community by judicious use of traffic engineering. Part of the Zurich urban policy has been to reemphasize the use of public rights-of-way for the maximum number of users rather than number of vehicles. Three street locations formerly used for general traffic movement have been redeveloped for major junctions and transfer locations in the LRT system.

With the strengthening of specific corridors as primary routes for local urban passenger movement, residential construction is being undertaken, thereby providing an expanded market for the LRT lines. In the suburban residential areas, public and private transport systems frequently have been separated.

In Geneva, Switzerland, a major LRT route provides a surface level spine for overall public transport operation. Even though public street rights-of-way are limited, this mode can use them with a low investment and provide high throughput capacity. In parts of the CBD, the LRT mode has been given priority by use of restricted private-vehicle access. More people are moved within the old street system as a result. The exclusive use of 8 blocks of the primary retail center by LRT has permitted abutting pedestrian walkways to be expanded and cafes and outdoor sales areas to be established. The minor intersecting streets have been converted for civic activities considered to be of higher priority than parking or low-volume private vehicle movement. As a result, festivals, gatherings, and outdoor markets can be provided without sacrificing transport access to the CBD.

In Basel, Switzerland, LRT use is encouraged by new emphasis on the location and design of principal transit stops, and this has improved access to business and retail centers. The original LRT network has been extended and rehabilitated to provide high-quality links between outlying residential areas and the CBD. Light rail routes are able to abut existing land uses while serving the primary goal of urban passenger movement. Along these routes, the authority operates new, lightweight, well-ventilated articulated modern vehicles. The transit shelters and boarding locations have been located away from direct conflict with highway vehicles in residential neighborhoods. The use of LRT has permitted high-capacity passenger access to many tranquil suburban areas without encouraging greater private vehicle intrusion. The rights-of-way have been designed as an integral part of the community. For the investment level incurred, the LRT placement into the urban setting has been accomplished in a more pleasant and positive manner than that normally found with other transport modes.

Munich has retained major use of LRT even though a heavy rapid rail transit system has been established. The LRT vehicles provide surface transport with minimal conflict and intrusion on the CBD for the passenger capacity provided. The mode satisfied the need for short- and medium-distance trips by use of special surface stations for patrons. In addition the LRT connects some of the lower density suburban areas, including high-income residential areas, with the CBD. In 1 case this has been accomplished through the use of a nonhighway alignment that minimally intrudes on the community. This permits residents of such areas to enter the city without having to use private conveyances. This has resulted in more effective use of the limited street space during peak hours. It has been found that the high-capacity routes can be woven into the existing constraints to a degree that is not possible with other modes.

In several German cities near the Rhine River, a 10-year program of incremental improvement has resulted in greater reliance on LRT systems to encourage high public transport usage. The LRT vehicles are designed as a direct result of German public transport marketing philosophy. The vehicle is large enough to permit base-day or nonpeak users to have a seat and retain the floor area necessary to accommodate peak-hour standing loads. Because such vehicles can be operated in single-unit and multi-unit sets along private or semiprivate routes, several cities of the Ruhr have provided high-capacity public movement. Part of the benefit from such development has been the retention of strong CBD interest throughout the community.

Attractive segregation of conflicting modes can be made with the various options of design and methods of location employed in LRT technology. Landscaping and shrubbery provide barriers to minimize noise and prevent disruption due to motor-vehicle accidents. Lines have been expanded and upgraded to provide new satellite communities

and neighboring medium-sized cities with high-quality public transport access to retail centers of the major cities. The effective blending of this technology within the urban fabric has encouraged the growth of daytime employment and evening civic events within the city. The main commercial areas have been turned over to pedestrian-only activities. The LRT lines link the communities along a corridor in a manner that might be used in the future for heavy rail transit. However, the use of LRT permits low-cost immediate operation and minimum conflict with intersecting streets and abutting structures. Many of the cities have continued to upgrade their passenger-carrying equipment to further reduce travel times and improve travel comfort.

In Brussels, city and state officials have long been aware of the problems of matching the historic city fabric and economic activities with the rising levels of motorization. As a result, they have embarked on a program of improved public transport with major reliance on the use of LRT services to retain the community values and historic buildings and provide greater access to these areas. Originally, many of the LRT routes and passenger stops were located on multiuse streets. As private vehicle congestion increased, some of these LRT routes gradually were changed to private and semiprivate lanes to retain the passenger-carrying capacity available with LRT within street corridors. At selected locations major passenger interchange points were redesigned with an emphasis on the number of people to be served. In 1971, a portion of 6 routes were able to use an early construction segment of the heavy rapid transit system through the center of Brussels. This was accomplished with minimal visual and physical impact within the neighborhoods traversed. The use of these underground sections and the general upgrading of the LRT surface portions have resulted in the reduction of east-west transport travel times during the peak hours from more than 30 min to less than 10 min.

In the older residential neighborhoods the LRT vehicles are operated over conventional street lengths. In one case a new wide boulevard for private automobiles has been provided along the western edge of the community; the existing older arterial through the center of the community is used for LRT exclusively. This has kept high levels of competing private vehicles away from the residential sections while providing the neighborhood with high-quality public transport service. When such options were not available, LRT was placed to 1 side of the arterial road. This offers an additional benefit because bicycle paths can be located along the LRT right-of-way and thus are protected from the busy highway traffic. Public and private residential development for families of all incomes has been encouraged along these LRT routes.

The rapid growth of Brussels' economy has been accomplished without construction of a major system of central city expressways. The use of LRT has relieved pressure for peak-hour volume capacity that would otherwise require major expansion of the CBD street network. The blending of corridor transport methods with LRT has minimized the impact of the urban passenger growth.

The existing high quality of service has not been obtained by reduction of standards for the quality of the surrounding environment. For instance, the LRT overhead electrical distribution system is secured directly to the side of adjacent buildings without severe visual intrusion or structural damage. This placement eliminates the use of poles. The care and consideration used for the placement of such LRT services can be achieved without heavy capital investment. LRT route development impacts minimally on the environment and neighborhood. They are flexible enough in their construction and operation phases to reduce the physical disruption generated within the community. Such effective placement of LRT has provided greater access for citizens in several neighborhoods. New LRT vehicle equipment has been installed on many older lines without major change of the LRT alignment. Because the fixed guideway permits landscaping closer to the operating area of the mode, visual aesthetics are of a higher quality. The overall result of this policy has been that the governmental, institutional, and business employment centers have been located along LRT lines without significantly disrupting existing residential land uses.

Throughout Belgium a growing interest is found for further expansion of existing LRT systems. In Ghent, Belgium, a city of about 200,000 people, a major rehabilitation and expansion program of the LRT system was undertaken. In 1 corridor, expansion

of the LRT was made after the local community opposed expansion of a recently completed elevated expressway that was more than 30 m wide. The community perceived that intracity transport could be better served with something other than an expressway. As a result, a new LRT route was extended through the territory originally envisioned for local services of the expressway. The 6-m-wide alignment of the LRT has greater passenger throughput capacity than the parallel expressway would have had.

In Amsterdam and Rotterdam, Netherlands, the LRT system provides both a CBD distributor function and a high-quality link to the suburban areas. With the use of new, articulated vehicles and good management, the LRT mode has provided high movement capacities within the constrained center of the city. Some streets have been converted to a mixture of LRT operation and pedestrian-bicycle ways. The routes have been strengthened by programs of the city highway engineer that reflect the local priorities for transport of people rather than the movement of vehicles. The modern design of major surface intersections and LRT routes provides track layouts built for minimal conflict with other modes. Terminal areas have been placed off the street. The community has developed a program of providing adequate street capacity for non-peak-hour use by private vehicles and employing LRT to accommodate the bulk of the rush-hour needs.

In The Hague, Netherlands, the LRT system provides high-quality public transport. Major junctions and transfer areas have been engineered to reduce modal conflicts and retain patronage. These junction points have been completed without extremely high costs because of the lack of need for multilevel structures. The authorities consider one of the advantages to be the low cost of terminals and stations. The LRT mode has had the ability to keep stations closer to traffic generation points (both work and residential) than is observed with heavy rapid transit.

The extension of LRT lines into new satellite towns helps establish community identity among the new residents without detracting from their desire to maintain their metropolitan or regional orientation. The physical presence of the guideway aids the community to orient itself to the CBD. In new, planned communities, the alignment has been incorporated into the layout of the neighborhood. By various aesthetic methods, the LRT mode operates near recreational areas without creating danger. This has resulted in high access to the station areas and retention of interstation operation and safety. As a result, the LRT can be perceived without being physically accessible along the nonpassenger areas.

In Canada, Mexico, and the United States, some cities have LRT in their existing urban systems.

In Toronto, the street-oriented LRT system provides an interlinking of CBD employment areas and close-in residential neighborhoods. Well-designed connecting and transfer points are provided at many of the rapid transit stations. There is minimal distance between the subway and the LRT lines. One major line is operated in the median of an expressway. This has provided peak-hour capacities at a capital cost that is lower than would be incurred by providing additional highway lanes.

In Mexico City, the broad park-like medians are used by LRT vehicles with doors on both sides. This permits safe passenger handling even though the vehicles operate in the center of public ways.

Boston has retained a combination subway and surface LRT system providing high-quality movement within the CBD. Its system also radiates lines outward on surface corridors. These corridors have been maintained as transit-priority medians in existing arterial roads. Such routes provide an uncongested means to enter the city's employment district and provide options for nearby park-and-ride. In 1 case, the transit authority was able to purchase an existing abandoned railway alignment and convert it to LRT operation. With minimal investment, an upgrading of the line was made to permit higher speed with frequent schedules to the CBD. This line to Riverside provides dependable access to Boston for some high-income suburbs. Many of the stations and facilities along the route have been designed to blend with the community. As a result, the community has been able to maintain high transit and peak-hour capacities to the city without new major expressways.

In Pittsburgh an LRT system provides communities along a rugged terrain with

access to the central employment and retail areas by judicious use of private rights-of-way. The transit authority has rehabilitated the existing equipment and made it an effective marketing tool to encourage ridership. Without resorting to subterranean levels, the LRT system provides a downtown distribution loop for its patrons, partly through the priority use of access ramps that are located within a major, federally aided highway alignment. One of these ramps is connected to an older, low-volume bridge on which the LRT has an exclusive right-of-way. By a tunnel and the penetration of a narrow valley, the LRT route quickly reaches communities on the south. The LRT is operated in hilly, park-like areas. It uses heavy steel bridges for proper elevation to reach the various neighborhoods. To maintain the sylvan character of the valley, officials had the structures painted black. Therefore, the line is not visually dominant. The Library and Castle Shannon lines provide residents with a practical alternative to their private vehicles for access to the CBD. Park-and-ride lots are positioned between the arterial roads and the LRT lines. These locations provide commuters with an effective alternative to central city driving and parking.

The community of Shaker Heights, Ohio, has a municipally operated LRT system that links it to downtown Cleveland, Ohio. This line has operated for more than 55 years within an upper-income community composed of apartments and private dwellings. The passenger transport demand for business and social activities related to the center of the city has been met without expansion of the highway network. Adequate visibility for the operators means that this service can be maintained without physical separation from the residential areas that it serves. As a result of the fixed-guideway operation, the parklands and green spaces of the community are maintained close to the LRT lines. Passenger stop areas are provided away from the heavily used automobile lanes. The community provides parking for workers whose destination is the CBD. This not only reduces the number of peak-hour private vehicles but also encourages retail trade within the suburban community.

Although the community's policy on urban transit or LRT cannot be considered the solution to all urban problems, it is seen by many residents as a barometer for the overall provision of urban amenities. The Transit Bureau of Shaker Heights has found maintenance, reliability, and cleanliness to be of greater importance to the patrons than the actual age of the vehicles.

In an overall view of LRT, it should be remembered that the design and subsystem components for the guideway, as well as the power distribution technology, exist now. And all the elements are proved in daily use. The vehicle necessary to implement this technology is currently in design or being manufacturered in Belgium, Germany, Switzerland, Canada, and the United States. Reemphasizing LRT is not unique to 1 country as can be seen by the data given in Table 1.

REFERENCE

1. 1975 International Statistical Handbook of Urban Public Transport. International Union of Public Transportation, Brussels, 1975.