barriers are required when there is a high incidence of property damage due to conflicts at intersections or junction points.

The criteria for spacing the actual crossing of LRT lines by both pedestrians and motor vehicles were reviewed. Pedestrians can be handled in a variety of low-cost and effective ways. European experience indicates few safety problems with pedestrians in any state of physical or mental alertness. With respect to motor vehicles, the spacing of crossings depends on local circumstances. The volume of average daily traffic and peak-hour traffic on both highways and the LRT line would have to be considered to competently determine the spacing necessary. Objections to numerous street closings should be met by pointing out that this measure limits or restricts the movement of through traffic in the inner portions of neighborhoods. Although it does restrict some local trip operations, its value to the community lies in the channeling of through traffic to the major corridors that are provided. Regulations designed for the control and operation of LRT in a variety of urban settings must be developed. Although California's Public Utilities Commission is currently drafting such regulations, these should probably not be the basis for national standards.

The community and the traffic engineering profession have in LRT a mode that has a very limited impact on the urban fabric and street network. LRT systems can preempt traffic flows in a manner that does not create sizable congestion problems. The use of European tramway and light-rail standards can permit major savings in capital and operating costs. Dusseldorf, Cologne, and some of the Rhine-Ruhr cities were cited as examples of cities where such standards can be observed.

Strategies for protecting level crossings were reviewed. The participants concluded that the maximum design standard for grade-crossing protection should be class 1 railroad gate procedures. Both the regulatory authorities and the operators and union personnel may seek stricter protection of grade crossings, but this is mainly because they are unfamiliar with methods of deploying modern LRT operations.

Cities that initiate totally new LRT operations should undertake major driver-education measures on how to make left turns in the face of LRT operations. It may be politically and socially possible in some communities to restrict left-turn operation at low-volume intersections. Where major left-turn movements will be generated, proper traffic engineering criteria should be used to minimize potential conflicts. In effect, a dual method of traffic signaling for through traffic and light-rail vehicles should be made. Left turns should not be made from locations on the track structure; special lanes to the right of the track should be provided if sufficient widths are available.

Within the corridors served by LRT, special evaluations should be made for feeder bus services to terminal stations and intermediate stops. In the alternatives analysis evaluation, planning should determine what percentage of the corridor residents or potential transit users would be directly served by the LRT line and what percentage by a feeder bus operation. In many European cities, more than 70 percent of the central city population resides within 400 m (1300 ft) of arterial public transport services. In cities like Hannover, Cologne, Dusseldorf, and Essen, such a percentage more frequently resides within the influence area of LRT lines. Bus and LRT transfer areas need careful planning and continual evaluation of the needs of all types of passengers. Direct cross boarding between bus and LRT could be provided and, depending on climatic conditions, covering or heating should be maintained.

In light of the difficulties that Santa Clara County, California, has had in proposing rail alignments for LRT operations, it was concluded that more information should be gathered on the institutional and regulatory aspects of joint LRT-railway operation along common rights-of-way and on common trackage. Although former street railways had dual operation and interurban routes frequently had freight-train and light passenger-car operation, current vestiges of such systems do not have these dual purposes today. Examples in Germany, Belgium, and California indicate that such sharing of trackage becomes legally much more difficult than has been appreciated. Handling of accidents and aspects of liability and maintenance should be further documented to aid the advancement of LRT technology.

Finally, the requirements for handling elderly and handicapped patrons with LRT systems was reviewed. The most significant problem identified was passenger loading on street levels with and without high platforms. Although the Boeing Vertol light-rail car has a proposed wheelchair lift, it was indicated that such a lift was not able to relate adequately to normal, narrow pedestrian and passenger platforms unless the width is doubled.

A pervasive theme throughout the workshop dealt with the trade-offs between reduced physical, design, and cost alternatives, including more at-grade (or surface) operation, some mixed-traffic operation, and selective single tracking, on the one hand, and on the other hand, reduced LRT performance characteristics and operating economy and increased interference, conflicts, accidents, and so on.

Intermodal Integration

Brian E. Sullivan, British Columbia Ministry of Municipal Affairs and Housing, workshop moderator
Christopher Lovelock, Harvard School of Business, workshop recorder

Intermodal integration is successful in situations in which there is ease of transfer, compatibility in scheduling, and carefully designed and located facilities. A fare structure that supports transfer is equally critical. Intermodal integration is especially important to light-rail transit (LRT) because LRT will never be the sole transportation mode in an area; it must be one part of a family of modes that serves an urban area.

It was observed that there is no simple solution to the problem of modal transfer. The facility design, for example, depends on whether the transfer point serves a distribution or collection function. The size of the passenger volume involved is equally important.

Two schools of thought were identified in regard to the layout and functions of transit systems in metropolitan areas. One holds that there is only need for services that run point to point (a radial system) without transfers. The other holds that, in a comprehensive service (a grid system) for a metropolitan area, there are too many trips that have too little volume to permit all-day point-to-point service and that, therefore, some transferring is essential. Further discussion of this issue centered on two points. First, in the United States a transfer has a negative consumer connotation because in recent years the use of transfers has not been well executed; there are a few cities in Canada in which they have been handled well. Second, pricing is very important in making transfers acceptable. In addition to financial disincentives, it was also felt that inclement weather and the fear of crime deterred the use of transfers.

The idea of time as a factor in choosing whether or not to take advantage of a transfer was also discussed. This is important in facility design in terms of providing a dispersal function for two modes that have different headway characteristics; i.e., if one mode is delayed, the transfer is missed, and the transfer ride is lost. The particular circumstances in local situations should be the factor that dictates the facility requirements. How quickly people can be moved from one mode to another may determine the success of the design. If a large volume of people must be moved through a transfer point, grade separation may become a major means of making transfers workable and attractive to riders. However, in other settings it may not be needed at all. It depends entirely on the make-up and match of the headways involved. Reliability is seen as critical.

It was observed that in Europe one mode is selected to serve one particular travel desire and other modes are coordinated with it. In the United States, United Kingdom, and Canada, bus and rail usually compete, but this depends on local circumstances. One participant stated that in Boston, for example, the commuter bus competes with the commuter rail because of their bases in historic services. Before the Massachusetts Bay Transportation Authority (MBTA) owned both, they competed; now that MBTA owns both, they still compete. In Cleveland, before the rapid transit system was established, the buses operated several express services directly into the central business district (CBD). Now that the buses turn back at the rapid transit stations, many patrons were lost and have still to be regained. In the case of Toronto, there were never large express surface services into the CBD. Participants stated that many communities are beginning to realize the utility of having two services.

It was felt that damaging competition was the result of organizational in-fighting and that the United States has not been very sophisticated in terms of finding ways of constructing incentives within the marketplace for coordination and cooperation between competing operators. The growth of federal programs that subsidize operations should permit the development of ideas that support cooperation. Furthermore, there has been a tendency in the last 10 years to believe the solution to this problem lies in the acquisition of the competing operators and their consolidation into a larger and larger operation under public ownership. It was felt that this creates larger and more difficult management problems. It is more difficult to promote coordination in operations that cover a large area with thousands of buses but have a very narrow range of management control. More attention should be given to finding ways of creating incentives for the operators and looking for new markets.

Sophistication and Complexity Versus Economy: The Problem of Gold-Plating

Tom E. Parkinson, Transit Services Division, British Columbia Ministry of Municipal Affairs and Housing, workshop moderator

All aspects of overdesign were considered in this workshop session. Overdesign is not necessarily bad if it attempts to increase reliability, extend component life, or reduce maintenance; it can also improve public acceptability, reduce energy consumption, and lower noise levels. The problem is to distinguish between good design that advances the state of the art in a cost-effective way and unnecessary overdesign.

In view of the limited experience with new light-rail transit (LRT) systems in North America, how can one define overdesign? It was proposed that the experience in heavy-rail transit over the last 15 years could in part be extrapolated to LRT. Furthermore, overdesign is often introduced early in the planning stages when system designs for civil engineering, railroad or rapid transit power supply, signaling, and fare collection are being selected; e.g., LRT in Buffalo was burdened with inefficient fare collection, and subway standards were applied to signaling and power supplies on Toronto's Scarborough line. It was stated in rebuttal that the Urban Mass Transportation Administration (UMTA) applied sufficient monitoring and safeguards to avoid blatant modal bias in alternatives analysis. In Toronto, the extra costs of applying subway standards are only a small proportion of the estimated total cost and represent the engineer's desire to be conservative and to ensure that the system can be built within estimates. The objection was raised that others, seeing the high quotes for Toronto's signaling and power supply systems, would be suspicious of the lower estimates in their own studies, despite the fact that actual costs in Edmonton, for example, are less than half Toronto's for power supply