a case-by-case basis (as is now done with U.S. Army Corps of Engineers projects).

Another participant thought that the relative weakness of the transit industry itself was a formidable barrier. The organizations that should be initiating new proposals and policy initiatives are primarily occupied with operating what they have. In this same vein, it was felt that the industry trade association, the American Public Transit Association (APTA), has proved to be a weak advocate for transit in general and for fixed-guideway solutions in particular. Since the membership of APTA consists primarily of bus operators, the organization reflects an emphasis on the bus mode.

The workshop closed with a short summary highlighting the following points: the definition of LRT is blurred; there are different planning criteria, funding ratios (federal-local), and approval processes for highway and transit projects; state departments of transportation have a lack of commitment to nonhighway projects; and the problems do not originate only at the federal level. Barriers to implementation of both LRT and mass transit projects in general are found in abundance at all governmental levels.

# Motor Vehicle and Pedestrian Interface With Light-Rail Transit

Henry D. Quinby, Consultant, San Francisco, workshop moderator
Lee H. Rogers, Institute of Public Administration, Washington, D.C., workshop recorder

The main issue dealt with in this session was the problem of finding the space within which to develop a surface-level light-rail transit (LRT) system. It is necessary to find sufficient, well-located space in the major corridors of a city if the challenge of providing optimal development of LRT is to be met. In the discussions of this subject, it was indicated that several American cities have primary and secondary arterial routes that no longer have as much through traffic as they used to, largely because of the expanded urban freeway system. These arterials seem likely candidates for future deployment of LRT systems.

It was asked how LRT lines could be placed into arterial or other roads of limited width. Discussion related to the use of medians in highways not built to interstate standards and to the development of side-of-road operation with and without vehicle accident barriers. The use of coupled one-way streets and curb lanes was also discussed as a way to improve the capacity of urban transport while minimizing the impact on private vehicles and the owners of abutting property. Restricting the use of narrow downtown streets to pedestrians and LRT operation was reviewed.

Every urban community must deal with the need for greater capacity in handling passengers and goods in the face of the negative aspects of increasing the width of existing surface transport networks. LRT can provide a low-cost solution to this problem, since it does not require a heavy investment in aerial structure or underground facilities. The use of existing or abandoned railroad rights-of-way and other corridors should be looked at judiciously and not perceived simply as an expedient.

LRT also provides the best potential for obtaining surface-level linear parks; it was felt that the concept of linear parks, as applied in San Francisco and various European operations, should be reviewed. There is a great need to introduce planners, architects, and community leaders to methods of developing linear parks.

The merits of substituting grass or other materials for the usual ballast-and-gravel or dirt-track foundation was discussed. Outside of mixed-traffic locations in public streets, it was felt that asphalt and concrete should be limited in their use because of their rather dull and uninteresting appearance. Some types of gravel-and-brickwork and grass rights-of-way were described that strike a balance between track-structure service life and perceived aesthetic impacts. New Orleans was cited as an excellent example of heavy landscaping of median LRT lines; there are shrubs, trees, flower beds, and visually attractive landscapes that blend the uses and the activities of the transport corridor. Such measures reduce the visual and automobile pollutants within the areas traversed.

There is some difficulty in placing LRT operation in existing streets, particularly in cities that no longer have street railway operations or laws that effectively promote LRT. In some cases, public service commissions have set unrealistically low operating standards because of their inexperience in regulating this mode. The use of mixed-traffic lanes was considered acceptable in outlying areas where congestion infrequently occurred. Within the central city area, preferential treatment through traffic signals or actual physical barriers was desired to maintain reliability and productivity for LRT operations. Speed limits for other powered vehicles were considered to be applicable to LRT vehicles within the street as long as the velocity was not more than 70 km/h (40 mph).

The participants agreed that standards for grade separation of LRT at principal perpendicular avenues and arterials should be developed. If LRT systems operate at headways of up to 6 min, there seemed to be little difficulty in maintaining surface-level crossing of principal arterials. In the case of interstate highways or expressways, more expensive solutions would be required. LRT has the ability to use variable speeds or to dampen its performance when required to do so by other considerations, although the latter should be extremely limited since greater reliability is considered a specific asset of this technology. However, in mall operation, for example, LRT should not be operated at speeds higher than 24 km/h (15 mph); there are various methods to enforce such speed limitations. In mixed traffic, some physical

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 trans-