Factors to Consider in Designing a Joint Bus-Light Rail Transit Mall

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Cities are turning more and more to bus and LRT transit mall solutions primarily because the costs of building a transit mall for servicing downtown areas are between $15 and $30 million per mile (1981 dollars) whereas building a subway would cost between $60 and $120 million per mile in a CBD environment. Ongoing energy, maintenance, and security costs are also much less with a transit mall than with a subway station alternative, and pedestrian access is much quicker and easier, particularly for elderly and handicapped persons. This paper identifies and describes key design factors considered in the development of a joint bus-light rail transit mall for the downtown area in San Jose, California. Other light rail mall designs researched for this paper include recent projects in San Diego, Buffalo, Calgary, Denver, Portland, and Sacramento. Secondary design considerations are also addressed, as are detailed design elements. A unique design solution was developed for the downtown San Jose transit mall to maximize its potential benefits. This solution utilizes a wide median island from which transit passengers can board either buses or light rail vehicles while maintaining separate lanes for each mode and maintaining auto access to all properties. The two one-way bus-LRT transit malls have thus been designed to interface effectively with three major modes of transportation: light rail transit, buses, and automobiles.

Light rail transit malls are a relatively new phenomenon in North American cities. They are an evolving form of the downtown pedestrian mall, which swept the country in the 1960s, and the bus transit mall, popularized in the past 5 years. Given the renewed interest in both light rail transit as an urban transportation strategy and in high-quality pedestrian environments as an urban redevelopment strategy, light rail transit malls are beginning to appear in a number of North American cities' downtown plans for the 1980s. North American cities that have either recently opened a light rail transit mall or are in various stages of planning, design, or construction of such a facility are listed in Table 1.

At about the same time that North American transit experts were rediscovering the "streetcar" by visiting modern light rail installations in Europe, an interest in bus transit malls began to spring up. First tested on Nicollet Avenue in Minneapolis in 1967, the basic idea of a transit mall is to combine a pedestrian mall with an exclusive roadway for transit vehicles. In 1976, Portland, Oregon, received approval to construct a bus transit mall on 2 one-way downtown streets. In the same year Chestnut Street in Philadelphia was converted into a bus transit mall in time for celebrating the nation's bicentennial. Since 1976, bus transit malls have been constructed with federal assistance in Chicago (State Street), Denver (16th Street), New York-Brooklyn (Fulton Street), New York-Manhattan (Broadway Plaza), and Long Beach, California (Pine-First-Long Beach Boulevard). While these transit malls do not involve light rail transit, they do provide a wealth of useful information regarding mall traffic circulation, paving materials, landscaping, lighting design, utilities, construction costs, maintenance costs, and economic impacts.

Light rail transit malls have a number of advantages over their alternatives—a subway, on one extreme, and mixed traffic, on the other. A subway is very expensive to both build and maintain, takes a long time to construct, and therefore lengthens the construction impacts on businesses. Transit riders, especially the elderly and handicapped, must take considerable time to reach the subway, often 3 stories below the surface. Riders in the subway cannot see the city or its landmarks—only tunnel walls and the car interior. On the other hand, a subway provides total separation, eliminating all interferences from surface traffic, which results in faster vehicle speeds and greater schedule reliability. In adverse weather, a subway provides a shelter from the elements.

LRT surface operation in mixed traffic is inferior to that on a transit mall for obvious reasons. Auto traffic

Table 1. Recent LRT transit mall projects.

City	Mall Name	Type	Status
San Diego	C Street	2-way LRT, 1-way autos	Open July 1981
Calgary	7th Avenue	2-way LRT and buses	Open May 1981
Buffalo	Main Street	2-way, exclusive LRT	Under construction, open 1984
Portland	Morrison and Yamhill Streets	1-way couplet, LRT and autos	Final design, open 1985
Denver[a]	California	2-way LRT, 1-way autos	Concept planning
Sacramento	K Street	2-way, exclusive LRT	Preliminary engineering
San Jose	First and Second Streets	1-way couplet, LRT, buses, and autos	Preliminary engineering

[a]Subway options are also being considered in Denver.

will force a slow, unreliable, and unacceptable LRT schedule. Sidewalks (or small islands) will not be wide enough for safe transit loading and unloading plus normal downtown pedestrian volumes. LRT patronage will be lower and operating costs higher without a reserved right-of-way separated from autos. This can be partially accomplished without the expense of building a mall but will not be as fast and reliable and would not provide the high levels of pedestrian and landscaping amenities usually sought by planners.

Some of the major design factors examined during the conceptual design of the San Jose transit mall, and which should be examined when developing any LRT transit mall design, are street width; transit system orientation; transit vehicle volumes and peaking characteristics; transit passenger volumes and peaking characteristics; auto access, including parking; delivery truck access; traffic circulation; urban renewal; and urban design.

Secondary design considerations, although not as critical as the primary design factors, still must be very thoroughly reviewed and analyzed. Some of these include utilities and sidewalk basement vaults; aesthetics and landscaping; air and noise quality impacts; marketing and imageability; equity; construction costs; maintenance costs; elderly and handicapped considerations; bicycle access; and transit shelters.

FOUR BASIC BUS-LRT TRANSIT MALL CONCEPTS

Four basic transit mall design concepts that accommodate both bus and LRT modes are described below using text and illustrations. Examples of each mall type are also listed for cities where either they have already been installed or serious design work is under way. Mall concepts 1 and 2 involve the separation of bus and LRT modes, each on its own mall or street, whereas mall concepts 3 and 4 involve the combination of bus and LRT modes on the same mall(s) or street(s), albeit in their own separate lanes. Concepts 1, 2, and 3 all involve two or more transitway streets, while Concept 4 requires only one. Concepts 1 and 4 involve two-way street traffic patterns, while Concepts 2 and 3 involve one-way traffic patterns. Limited auto access is possible with all concepts except Concept 4. All will permit emergency vehicle, utility service vehicle, and goods delivery access during most times of the day in most situations.

Mall Concept 1—Separated Bus and LRT Traffic, Parallel Facilities

Mall concept 1 involves two-way LRT-only traffic on one mall or street and one-way or two-way bus and auto traffic on one or more parallel streets. Limited auto access may be allowed on the LRT transit mall. Examples of this concept include San Diego (in operation); Buffalo (under construction); and Sacramento (planned).

Mall Concept 2—Separated Bus and LRT Traffic, Intersecting Facilities

Mall concept 2 contains one-way (or two-way) LRT traffic on one or more malls or streets and one-way (or two-way) bus traffic on one or more cross streets or malls. Limited auto access may be allowed on all streets. Examples include Portland (one-way bus malls in operation; one-way LRT cross streets under final design) and Denver (two-way electric shuttle bus mall under construction; possible two-way LRT cross-mall planned).

Mall Concept 3—Combined Bus and LRT Traffic, Shared Facility but Separate Lanes

Mall concept 3 has both buses and LRT on one-way parallel mall pairs or couplets; bus and LRT traffic will each have their own lanes and will not share rights-of-way in most cases. Limited auto access may be allowed on both mall streets. An example is San Jose (under design).

Mall Concept 4—Combined Bus and LRT Traffic, Shared Facility, Shared Lanes

Mall concept 4 involves both buses and LRT on two-way mall streets; in some instances, most likely at LRT stops, both buses and LRT may have to share the same lane or right-of-way. Auto access is not advisable with such a mall scheme. An example is Calgary (in operation).

PRIMARY DESIGN FACTORS

Many varied factors should be carefully considered and weighed in identifying possible mall location and design alternatives for a given situation and in evaluating those design alternatives. Each city's mall design presents a unique set of design opportunities and constraints. However, it is possible to identify a set of primary or general design factors that can be used as a valuable checklist in the design of any transit mall. These are described below in no particular order of importance.

- Street Width: Existing as well as future "plan-line" street width, property line-to-property line as well as curb-to-curb, is very important. Many downtown streets in the western United States have a standard right-of-way width of 80 ft. Narrower street widths are more difficult to work with and limit the available design options possible.
- Transit System Orientation: Center-city orientation (radial) versus suburban grid (timed-transfer) orientation, the split between express and local services, and the level of transfer activity versus trips beginning or ending in the CBD mall area, all influence transit mode separation, number of lanes required, length of transit loading zones, stop locations, etc.
- Transit Vehicle Volumes and Peaking Characteristics: Local and express buses, light rail, articulated buses, length of LRT trains, headways, dwell times, pulse or random arrival rates, and fare collection systems all influence transit mode separation, number of lanes required, length of loading zones, stop locations, etc.
- Transit Passenger Volumes and Peaking Characteristics: Morning and evening waiting passenger volumes by time blocks (5-minute increments desirable), the number of transfers (line-to-line if possible), the fare collection system, and other sidewalk pedestrian volumes all influence the choice of a mall design concept; the required widths of sidewalks or median; the length, number, and location of transit stops; and the location of bus lines and LRT lines with heavy transfer activity in close proximity to one another.
- Auto Access and Parking: Is auto access necessary? Is it desired? How much? Where—to parking lots, garages, retail stores, drop-off zones? If auto access must be accommodated, it must be managed carefully so as to have a minimum impact on transit vehicles and pedestrians. Will lost curb parking have to be replaced? How and where? Since auto curb parking is almost always eliminated by the implementation of a transit mall, this impact should be faced squarely and early in the planning process.
- Delivery Truck Access: Options for delivery truck access include parking on side streets, access alleys behind stores, or off-street or on-site access. If none of these options are workable, some type of loading zones must be provided on the mall itself, either with loading zone duckouts or by using mountable curbs and allowing small

delivery trucks to park in designated areas on widened sidewalks (or median islands if included in the street cross section).

- Traffic Circulation: Avoid primary auto and truck traffic arteries, through routes, freeway access routes, etc., for transit mall consideration. Find secondary arterials that also provide good bus and LRT access and circulation. What will the impacts be on parallel traffic arteries if one or two streets are removed from the general traffic circulation system? How will truck deliveries be made? Are there any good mitigation measures, such as construction of a new parallel highway by-pass, street widening, elimination of curb parking during peak periods, conversion to one-way street pattern, or the use of alleyways and side streets for delivery truck loading zones?
- Urban Renewal: Would the potential mall street provide a much-needed stimulus to help bring about desired redevelopment projects? Would it act as a catalyst to clean up a blighted area in need of building facelifts or renovations? Would it help rid an area of undesirable land uses, such as porno shops, X-rated movie theaters, seedy bars, and pawn shops? Would it help rid the area of vagrants, drunks, prostitutes, or youth gangs?
- Urban Design: Where is the desired major axis or spine of downtown retail development? A transit investment is most likely to have higher payoffs for a retail and commercial street than for an office and financial center street. A street with hotels, theaters, restaurants, and convention facilities would also benefit greatly from mall landscaping improvements. Where does the city want to call its "heart"? Where does the city wish to stimulate focused new development?

SECONDARY DESIGN FACTORS

In addition to the many and varied primary design factors just identified, there are a number of other somewhat less important design factors to consider when identifying and evaluating bus-LRT transit mall designs for a particular city's downtown situation. These are listed below.

- Utilities and Sidewalk Basement Vaults: The size, location, and condition of existing as well as planned utility lines can influence a mall's location, design, and costs. If urban renewal or expansion requires the street(s) to be torn up for utility work anyway, this may lessen additional costs and the impacts of adding transit mall construction. Sidewalk basements can present some interesting legal, political, and structural problems and are expensive if they have to be completely rebuilt because the sidewalk serves as the roof of the vault.
- Esthetics: The existence of or the potential for a mall street's total esthetic design, including existing and planned building facades, existing street landscaping, etc., can influence a mall's location and design.
- Air and Noise Quality: The localized air pollution and noise impacts can influence a mall's location and design. Significant reductions in both vehicular noise and carbon monoxide levels can be possible with an exclusive LRT transit mall over an existing heavily trafficked street.
- Marketing and Imageability: A transit mall can be an important positive image-builder for both the city as a whole and the downtown area specifically as well as for the area's transit system. As such, it should become an important marketing tool to be exploited.
- Equity: The perceived fairness of distributing both the positive and the negative impacts of a transit mall to the adjacent property owners and merchants can influence a mall's design and location. For example, putting all buses on one street and all LRT vehicles on another may not be acceptable if the businesses along the noisier and more polluted bus mall perceive they are getting penalized to the benefit of other businesses along the quieter and less polluted LRT mall.
- Construction Costs: The choice of a one-street mall design instead of a more expensive two-street mall design solution is highly influenced by construction costs; they can also influence the length of a mall (number of blocks) and choice of construction materials and design "extras."
- Maintenance Costs: The comments on construction costs also apply here. There is a potential for trade-offs, however, between more expensive construction materials that may result in lower maintenance costs.
- Elderly and Handicapped Accessibility: Good access and ease of making transfers for the elderly and handicapped can influence the choice of "separated" versus "combined" transit malls, one-way versus two-way traffic, curb loading versus median island loading, mid-block pedestrian crosswalks, wheelchair lifts versus high platforms for LRT, and the like.
- Bicycle Access: Requests by bicycle groups for mall access to bicycles, bicycles carried on external racks or aboard transit vehicles, bicycle lockers or racks on sidewalk areas, etc., can influence a mall's design, safety, and operation.
- Transit Shelters: The need for and size of transit shelters, their design and placement, lighting, heating, etc., can influence a mall's design, construction, and maintenance costs.

OPTIONS FOR MALL CONCEPT 3

There are a number of different ways in which each of the four basic mall design concepts can be implemented. For illustration, there are at least three different options for the implementation of mall concept 3. All of these options involve 2 one-way transit malls with both buses and LRT on both streets, functioning as a couplet. They use a standard 80-ft street right-of-way and do not use bus duckouts. Each of these alternatives can accommodate auto traffic and delivery truck traffic in various ways. Two of the options use center medians for loading of transit passengers.

Option A would put the automobile traffic in an exclusive lane separated from the bus and LRT transit vehicles by a median. In this way, the transit-only lanes would be almost self-enforcing, as it would be impossible for an automobile to change from the auto lane to a transit lane except at intersections or median island cuts. All bus loading would take place from the median island, while the light rail vehicles would load from the left-hand sidewalk. If right-hand loading platforms are used elsewhere in the LRT system, doors on both sides of the light rail vehicles would be required for this option. The light rail tracks would be paved flush to allow the buses to utilize the LRT land when bypassing stopped buses.

Option B would put the light rail vehicles in the median-separated lane. In this option, the buses would still load from the median, but the light rail vehicles would have the option of loading from either the sidewalk or a wide median island, or both. This option would not be as self-enforcing as option A in keeping the autos out of the bus-only lane, but it does provide the advantage of having all pneumatically-tired vehicles in the same pathway. Transit buses could then use the semi-exclusive auto lanes to bypass stopped buses. With this option, there would be no danger of having the LRT track blocked by either a stalled bus or car. Another advantage to this scheme is that it will require only one transit shelter on the median at each major bus and LRT stop, instead of one shelter on the sidewalk and one shelter on the median, as in option A.

Option C does not include a median. Instead, the sidewalks would be widened to provide room for both the increased pedestrian and transit patron use and for the transit mall street furniture. The light rail vehicles would be located on the left side of the street, in a nonseparated exclusive lane, and would load from the left sidewalk. This option would again require doors on both sides of the light rail vehicles if right-hand loading is used elsewhere in the system. The buses would operate in a semi-exclusive bus-only lane on the right side of the street and would load from the right sidewalk. The autos would then operate in the center lane, sharing this lane with buses that would be bypassing stopped buses. Autos would have to merge into the transit lanes to turn off of the mall.

For the San Jose transit mall project, option B of concept 3 was selected to undergo detailed analysis and comparison against concept 1. Concept 4 was considered for a short time, but because of strong merchant support for auto access on every street, the one-street mall was eliminated early in the scoping process as not having sufficient room to adequately accommodate all three modes of transportation (buses, LRT, and autos). Concept 2 (LRT mall crossing the bus mall) was not applicable to the San Jose project, since the corridor for the LRT line is along the same north-south axis as the proposed bus transit mall.

After completion of the technical evaluation and analysis, concept 3B was chosen as the final bus-LRT mall design. The primary reasons for this selection were as follows:

1. There would be slightly better transit efficiency and significantly better transit convenience with concept 3B, based on the results of the travel time simulations and the percentage and direction of transfers on the mall. The running time savings on a one-way transit couplet versus a two-way transit street is about 20 percent because of the better signal progression possible with traffic moving in only one direction versus two.

2. Vehicular access and circulation would be somewhat clearer and easier with concept 3B.

3. Concept 3B was thought to provide a more unique and esthetic landscape design opportunity for the mall and would tend to improve the downtown environment and economy somewhat better, since the benefits and impacts of both transit modes would be spread equally over two streets.

4. Concept 3B answers the very specific concern of downtown merchants who wanted to separate waiting transit patrons from general pedestrian traffic by providing all transit loading and waiting areas along the mall on the wide median island instead of on the sidewalks in front of their retail shops.

DETAILED DESIGN CONSIDERATIONS

Once a basic mall design concept has been chosen, numerous detailed design issues must then be considered. These considerations fall into two broad categories: (a) design elements that must be considered for any urban street improvement project and (b) design elements that are unique to a transit street improvement project. The fact that the street(s) will be used as a transit arterial will, of course, affect the decisions in both categories.

The basic building blocks that must be considered in the design of any urban street improvement project are given in Table 2. Major items to consider during detailed design include paving materials, landscaping, lighting, and street furniture.

- Paving Materials: A wide variety of paving materials are available for the mall designer to choose from, ranging from granite paving blocks at the high cost end (Denver; $15-$20/sq ft) to unit pavers or brick in the middle cost range (Portland, San Diego, and Calgary; $8-$12/sq ft) to concrete sidewalks and asphalt pavement at the low end of the cost spectrum ($4-$5/sq ft). The choice of paving materials should be based on life-cycle cost estimates, normal maintenance

Table 2. Bus LRT transit mall construction costs (1981 dollars).

Item No.	Description	Units[a]	Unit Cost	Range of Total Construction Cost (Percent)
1.	Light rail track and electrification	lineal ft	250.00-350.00	10
2.	Sidewalk pavement	square ft	4.00-20.00	10-35
3.	Roadway pavement	square ft	4.00-20.00	10-15
4.	Landscaping	square ft	1.00-1.50	2
5.	Street furniture	square ft	5.00-6.00	10-15
6.	General conditions	square ft	4.00-5.00	10
7.	Demolition	square ft	4.00-5.00	10
8.	Utility modifications	square ft	2.00-3.00	6
9.	Art and sculpture	square ft	1.00	2
10.	Contingencies	square ft	2.00	4
	Subtotal	square ft	35.00-43.00	100
11.	Engineering	5-6 percent of the construction cost		
12.	Administration and inspection	5-6 percent of the construction cost		

[a]Note: The quantity measurement for Items 1, 2, and 3 should be the actual lineal and square footages for these items. The quantity measurement for Items 4 through 10 is the total square footage of the proposed mall project.

cost considerations, esthetic considerations, and budget constraints. Because the choice of paving materials can vary the total mall construction budget by 15 to 20 percent, the selection should not be made lightly.

- Landscaping: Street trees are the most predominant part of the landscaping element, and, although they are generally only about 2 percent of the total mall project budget, their selection can be the subject of much debate in the community. Things to look at when deciding on the type of tree include (a) shape, (b) deciduous versus evergreen, (c) hardiness in an urban environment, (d) a nonaggressive root system, (e) availability, (f) suitability to climate, and (g) maintenance costs and problems (droppings, leaf pickup, etc.).
- Lighting: Often subject to the overall city street lighting policy, the design of the lighting system for the mall can either make or break the use of the mall during evening hours. The complete lighting design needs to provide both attractive standards and luminaires during the daytime, and, just as important, it needs to provide a pleasant, adequate, and secure light source during evening hours. A major consideration is the selection of the light source. The mall designer can choose from high-pressure sodium (pinkish-white), low-pressure sodium (pale yellow), mercury-vapor (bright white), incandescent (pale white), or a combination of these light sources. In determining the choice of light source, the mall designer must weigh the adequacy of the light against the cost of energy to provide the light. Other issues to consider include the type of standards (ornamental, modern, or traditional); the height of the standards (low-level standards for pedestrian-oriented light, high-level standards for a broad light pattern for traffic vehicles, or a combination of high and low standards; there is a good possibility of combining high-level light standards and trolley wire support poles in one single pole); the number and position of luminaires on the standard; interference (street trees blocking the light from high-level standards, for example); and normal light intensity versus high light intensity desired at transit stops.
- Street Furniture: The types of street furniture that must be considered for any street improvement project include trash receptacles, benches, fire hydrants, drinking fountains, sculpture, newspaper racks, telephones, bicycle racks, etc. The major criteria for all of these items is durability, followed closely by esthetic considerations.

Design elements that are unique to a bus-LRT transit mall project include the LRT track, overhead wire system, transit shelters, traffic signal transit priority treatment, LRT platform design, elderly and handicapped considerations, and fare collection methods.

- LRT Track: There are a number of acceptable standards to choose from for LRT track on downtown streets. For most installations, girder rail will be the preferred type. Other factors that must also be considered are the desire to minimize noise and vibration and the need to tear up the street for track maintenance, repair, or replacement.
- Overhead Wire System: In the design of the overhead wire system on the mall street(s), esthetics must be the primary concern. Toward this end, the feeder wires for the electrical power should always be buried underground, while the overhead wire should be as unobtrusive as possible. There are at least three options for mounting the overhead wire: (a) a combined pole for both street lighting and mounting the wire; (b) a totally separate pole for mounting the wire (these poles could also be used to hang banners, etc.); or (c) stringing the wire from eyelets placed in adjacent building facades. Any design must ensure that trees will not interfere with the overhead wire, even at maturity.
- Transit Shelters: There are two main decisions to be made with regard to transit shelters: Is there a need for shelters at all? What type of shelter is preferable? Considerations for the first decision include climate, security, marketing, safety, and comfort weighed against esthetics, cost, and maintenance requirements. If a shelter is desirable, there are three types that can be considered: canopy only; partially enclosed; or totally enclosed. Again, the considerations of climate, security, etc., should determine the type of shelter to be installed. Also to be considered are items to be placed within the shelter, such as benches, lighting, transit maps, change machines, fare collection machines, telephones, and electronic transit information systems.
- Traffic Signal Priority Systems: There are two basic options for LRT signal priority systems: signal preemption or signal progression timed to favor the light rail vehicles. Signal preemption, effective for combined transit vehicle headways 4 to 5 minutes or longer, can be achieved either with a standard railroad track circuit connected to the traffic signal, an overhead trolley wire trip switch, or a system that is not physically connected such as the 3M "Opticom" light emitter. Two advantages of the "Opticom" system (used by San Diego) are that buses using the mall can also be allowed to preempt the signal and the driver of the transit vehicle has the option of switching the system "on" or "off." The total number of transit vehicles trying to preempt will have to be considered when calculating the headways, however, and for many systems a signal progression timed for the LRT vehicles may be as effective in the downtown as signal preemption and at much less cost.
- LRT Platform Design: Loading platforms for the mall can be either high-level (Calgary) or low-level (San Diego, Portland, and Buffalo). Things to consider when deciding between the two options include (a) movement of pedestrians on the mall street(s) may be more difficult with high-level platforms; (b) joint use of the trackway with buses would not allow high-level platforms; (c) joint use of a common median island for loading both LRVs and buses may not allow for enough room for both high LRT and low bus platforms; and (d) for elderly and handicapped access, high-level platforms merely move the problem of the elevation difference from the train to the sidewalk. In general, with very high anticipated patronage volumes, a high-level platform is preferable; however, the size of the doors on the LRV, the number of doors used for loading, and the location of these doors are also significant factors. With low-level platforms, the loading area can either be located on the sidewalk, a median, or both.
- Elderly and Handicapped Considerations: In addition to the normal considerations for the elderly and handicapped in urban street projects (i.e., wheelchair ramps or no elevation differentials between sidewalks and crosswalks), a transit improvement project must also provide the means for the elderly and handicapped to use the transit system. The Santa Clara County Transit District is working toward providing a fully accessible bus system by installing wheelchair lifts on all buses.

For LRT, in addition to high-level platforms, there are two options for providing wheelchair access to the vehicles at low-level platforms. The first method is to install wheelchair lifts on each vehicle similar to the bus lifts (San Diego). The major disadvantages of this system are the time delays when operating the lift and the vehicle maintenance and reliability problems associated with on-board lifts. In addition, with double-ended cars, two lifts per car would be required. The second method is to provide a fixed-location wheelchair lift at each LRT station (Portland). The advantage to this system is simpler car design, the avoidance of interference with train operations due to lift failures, and less expensive capital and operating costs. Disadvantages include alignment of the front door of the LRV with the platform lift, time delays to operate the lift, vandalism and security problems in an exposed urban environment, and maintenance at a number of far-flung locations rather than all at the LRV maintenance yard.

- Fare Collection: The fare collection method along the downtown transit mall must be fast, convenient, and easily understandable. Options include self-service fare collection, a free-fare zone within the downtown, or the standard, pay-as-you-enter, front-door farebox system. The advantages of the self-service fare or the free-fare zone include speeding up boarding, reducing dwell times, and reducing the platform space required for passengers. The major disadvantage of the self-service fare is that fare collection machines would have to be installed in a hostile urban environment. The major disadvantage of the free-fare zone in downtown would be the loss of revenue to the transit district.

SUMMARY

In summary, it has been shown that there are a variety of factors that must be considered in the design of a bus and/or LRT transit mall. Analysis of these factors will often indicate the type of mall design that is appropriate for a given situation, and, as has been demonstrated by the diversity of mall designs for the cities mentioned in this paper, there is not a single mall design that can be universally accepted as best.

The proposed San Jose transit mall will use a unique design solution that is expected to provide the maximum transportation and land use benefits to downtown San Jose. This solution was arrived at after consideration of the same common design factors reviewed by the mall designers of San Diego, Buffalo, Calgary, Denver, Portland, and Sacramento. Because of the inherent differences among cities, however, each mall design is unique in its own way.

Once a mall design concept has been chosen, the designer is faced with the task of picking the individual elements. The selection of each mall building block should be done carefully and with a great deal of thought. There will be much community debate over the best paving material to use, lighting fixtures, street trees, etc., and the mall designer will do well to listen to everyone's input in order to tailor the mall to the city and people who will be using and paying for it.

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Traffic Impacts of Light Rail Transit

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In August 1981, the San Diego Metropolitan Transit Development Board (MTDB) began operation of light rail vehicle service from downtown San Diego southerly to the San Ysidro International Border. This 16-mile-long light rail system operates for most of its length in joint use with freight service in an at-grade, double-track operation (Figure 1). In the Centre City, trolleys operate at-grade on an exclusive path within city streets. The general alignment (Figure 2) includes C Street, which is ultimately planned as a transit and pedestrian way.

During the first 4 months of operation, the trolley system carried 1 854 000 passengers. Daily ridership averaged 11 500, with 14 000 to 17 000 passengers using the system on Saturday.

Even before the south line of the trolley was put into operation, MTDB began planning for an East Line extension. The general alignment for the East Line extension is shown in Figure 3. The extension includes 13 passenger stations spaced about 1.25 miles apart. The East Line extension is described in more detail in the Appendix to this paper.

Although the feasibility study for the East Line showed the extension to be practical in terms of patronage estimates, construction impacts, and overall environmental impacts, there were some questions regarding potential impacts of light rail vehicles on traffic operations in the downtown areas of the cities of Lemon Grove and La Mesa. In these two areas, the light rail vehicles would operate parallel to the major north-south streets serving the two business districts. In Lemon Grove (Figure 4) the light rail tracks would actually be located between Imperial Avenue (a citywide arterial street) and Main Street (a business district collector street). The light rail vehicles through La Mesa (Figure 5) would operate at-grade between Spring Street (an arterial street) and Nebo (a local collector street).

Because of the potential effect of light rail vehicle operations on the east-west streets crossing the tracks, the businessmen and city councils of both cities expressed serious concerns over downtown traffic operations that might result from implementation of the East Line trolley extension. The purpose of this paper is to review the existing and potential operations of the streets within the downtown areas of Lemon Grove and La Mesa to evaluate