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Internal Circulation Within Major Activity Centers: Issues and Problems

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ABSTRACT

Several different issue or problem categories are outlined in this paper followed by a review of three examples of internal circulation planning for major activity centers. The issue and problem categories include size and geographic dimensions, internal travel volumes, congestion levels, and special-purpose travel features. The examples include Post Oak Center in Houston, Woodlands Metro Center north of Houston, and Las Colinas in Irving, Texas. Potential negative impacts associated with internal circulation needs are described in association with (a) discontinuous or poorly designed facilities for pedestrian flow, and (b) excessive levels of internal automobile traffic. Remedies or solutions for these problems, as advanced in the three case studies, are evaluated; these remedies cover pedestrian improvements, automobile access and parking improvements, surface transit, and automated guideway transit.

IDENTIFICATION OF ISSUES AND PROBLEMS

Four major issues involving internal circulation within major activity centers can readily be identified. These issues reflect the basic land use configuration and geographic dimensions of activity centers themselves, as well as their functional role within an urban area. [Central business districts (CBDs) have not been included, in order to allow more attention to be devoted to the emerging major diversified center (MDC), as well as other types of major activity centers (MAC) in outlying and suburban areas.] The general sequence of issue and problem categories in priority order includes size and geographic dimensions, internal travel volumes, congestion levels, and special-purpose travel features.

Size, Land Use Mix, and Geographic Dimensions

Major activity centers have been defined as concentrations of office, retail, hotel, entertainment, and related land uses that generate daytime popula-

tions of 25,000 persons or more (1,2). Major diversified centers, such as a large-scale type of major activity center, may be expected to have daytime populations of 100,000 or more. The sheer size of major activity centers is certainly a primary determinant of internal circulation needs, together with the mix of land uses. For example, office and retail mixes (which generate travel between one another), density (employees per acre), and shape (particularly strong linear patterns of development) all are significant in influencing internal circulation patterns. Where circulation demands are high, other related problems may occur.

Internal Travel Volumes

Overall size, extent of sprawl (lower densities), and linearity (more than 1 mi long) are all physical characteristics of major activity centers that affect internal travel volumes. These internal travel volumes, and the modes chosen for them, reflect in turn both the land use-mix and the typical lengths of desired trips. Volumes of travel generated by workers, shoppers, visitors, tourists, and others can begin to tax the capacity of available facilities or vehicles, including both pedestrian and vehicular travelways. Nodal concentrations of land developments can create associated internal travel concentrations.

Congestion and Peaking

Depending on land use mix, major activity centers may experience morning and evening peaks (office employment-oriented), midday peaks (retail and service-oriented), or both. For very large centers, these peaking patterns may lead to automobile congestion, pedestrian congestion, or both. Where both office and retail and service concentrations are large, congestion may in effect stretch throughout the day for as long as 12 hr. The severity of congestion at particular street or walkway intersections depends, of course, on the specifics of travelway network geometry. Congestion-related travel delays and traveler aggravation are perhaps the most serious internal circulation problems facing major activity centers, especially the emerging MDC.

Special-Purpose Centers

A number of special-purpose centers, particularly recreational ones, may not meet the 25,000 daily population threshold, but may still have unique internal circulation needs. For example, the Mud Island automated transit linkage in Memphis and the Harbour Island automated transit linkage in Tampa both provide river crossings that involve vital, direct linkages between specialized land uses (recreational and new community) and the adjacent CBD. Bus shuttle systems in Vail and Aspen, Colorado, provide similar recreation-oriented services.

Trip Purpose, Frequency, and Length

In general, secondary issues associated with internal travel volumes and congestion may be associated with more detailed travel characteristics. For example, increasing average trip length may be an issue for strongly linear activity center configurations, and it is likely to be a factor dictating automobile versus pedestrian mode choice. Density of activity center development may well influence trip frequency (especially for shopping trips, including multiple-stop trips). Multiple-purpose pedestrian excursions are facilitated by the variety and mix of land uses in a major activity center. Issues associated with these travel characteristics are tied to the spatial distribution of travel opportunities and capacity constraints.

DESCRIPTION OF EXAMPLES

Three examples in Texas illustrate the kinds of issues and problems that can emerge within MDCs and, to a lesser extent, within smaller major activity centers. One of these examples, the Post Oak Center in Houston, has been under development for a number of years and experimented with a minibus distributor system a few years ago. Though that system was abandoned because of the slow travel times due to surface street congestion, the bus alternative may well merit attention in other activity centers. The second example, the Woodlands Metro Center, is part of a major new town north of Houston. Here, a linear trolley shuttle is currently being considered to link several nodes within the major activity center of the project. In the third case study, the Las Colinas development project in Irving (Dallas region), plans for an automated guideway transit (AGT) distributor system have recently been formulated, tied as well as to a planned regional rail transit line.

Post Oak, Houston

The Post Oak area, under development for the past 20 years by a number of different large landholders, currently maintains a daytime population of about 100,000 (3). Office employment is about 45,000 and retail square footage about 2,500,000. Traffic congestion already stretches throughout much of the day and is a major problem for the center. Projected development to the year 2000 would accommodate a daytime population of 150,000, with appropriate percentage increases in office, retail, and hotel facilities. Such growth indicates that congestion problems will persist, in spite of some increase in street capacities. Figure 1 shows the estimated 1980 employment and daily shopper and visitor population for subareas within the center. The total land area of the activity enter is estimated at 1,300 acres; the longest north-south dimensions is 2.25 mi.

Las Colinas, Dallas

Las Colinas is a major office-commercial development, under single ownership, currently experiencing major development activity. Most of the 1,000-acre project is planned for completion by the year 2000; ultimate development is anticipated to contain about 25,000,000 ft^2 of office and retail space, almost 4,000 hotel rooms, and more than 4,500 multi-family dwelling units. The daytime population at that point is estimated to be approximately 150,000. A meandering lake forms a spine within the project, with high-density office uses scattered along its shore, flanked by hotel, commercial, and residential structure (see Figure 2). The development is to be served by two regional rapid transit stations. Internal circulation needs, due in part to the linear pattern of the nearly 2-mi long center, have suggested that some form of grade-separated distributor system be considered. Such a system is now in the initial planning stages (5).

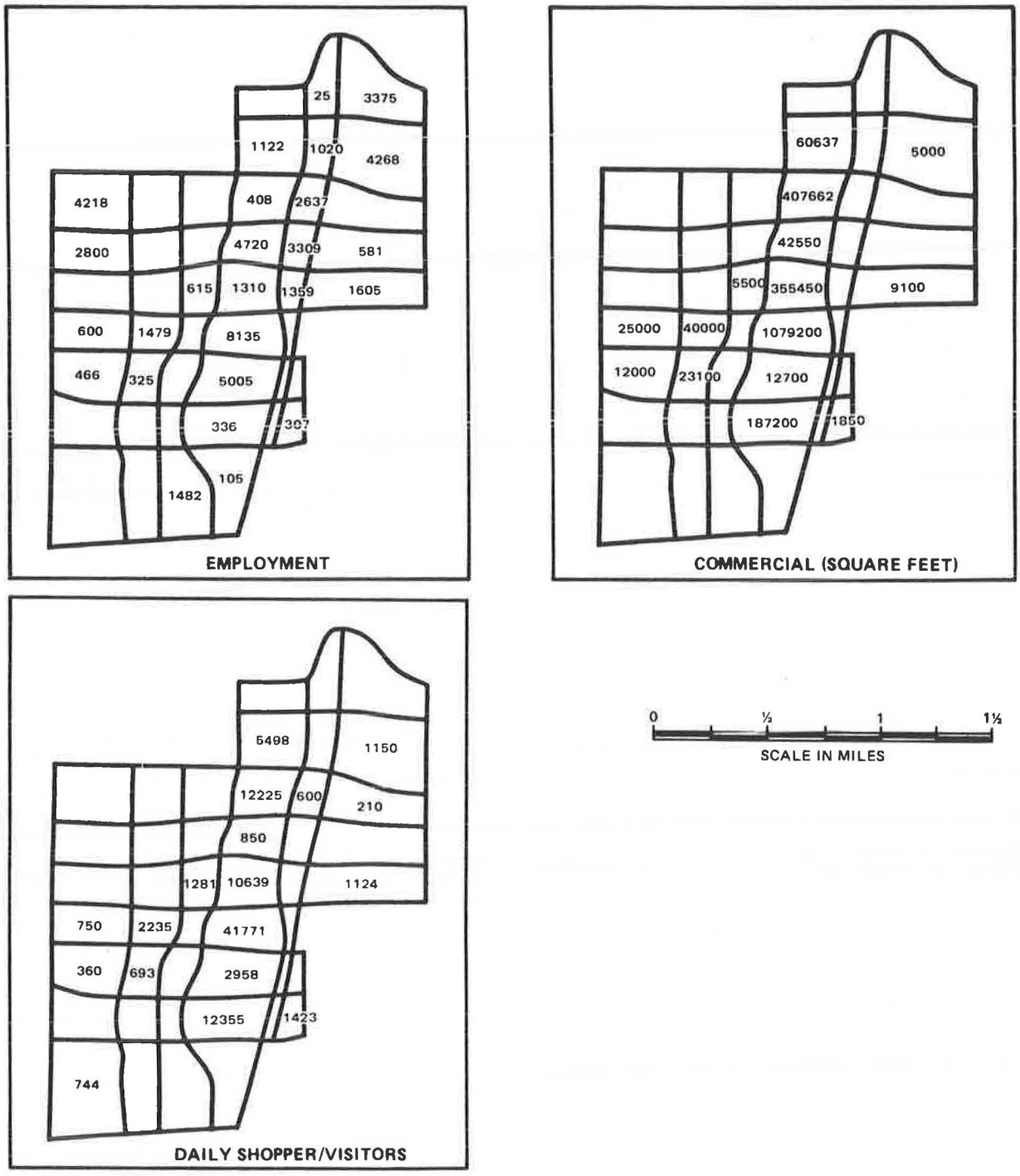

FIGURE 1 Estimated 1980 employment, commercial space, and shopper and visitor distribution: Post Oak Center.

Woodlands Metro Center, Houston

The Woodlands Metro Center, intended as the office and commercial core of the major Woodlands new town some 30 mi north of Houston, is at an earlier stage of development than the other two examples. Nevertheless, its ultimate concept is also of major scale. Total projected employment for this center is more than 50,000, involving 13,400,000 ft^2 of office development, 1,700,000 ft^2 of retail and commercial development, 1,300 hotel rooms, and 1,600 high-rise and mid-rise multi-family dwelling units. This center comprises a total land area of about 1,300 acres and has an ultimate daytime population of about 90,000. A number of alternative transit options were assessed for a linear distributor that would link several development nodes within the central core, parallel to a canal that would also be a part of the project (5).

SEVERITY OF NEGATIVE IMPACTS

A more specific set of negative impacts, or undesired consequences of internal circulation needs within major activity centers, can readily be associated

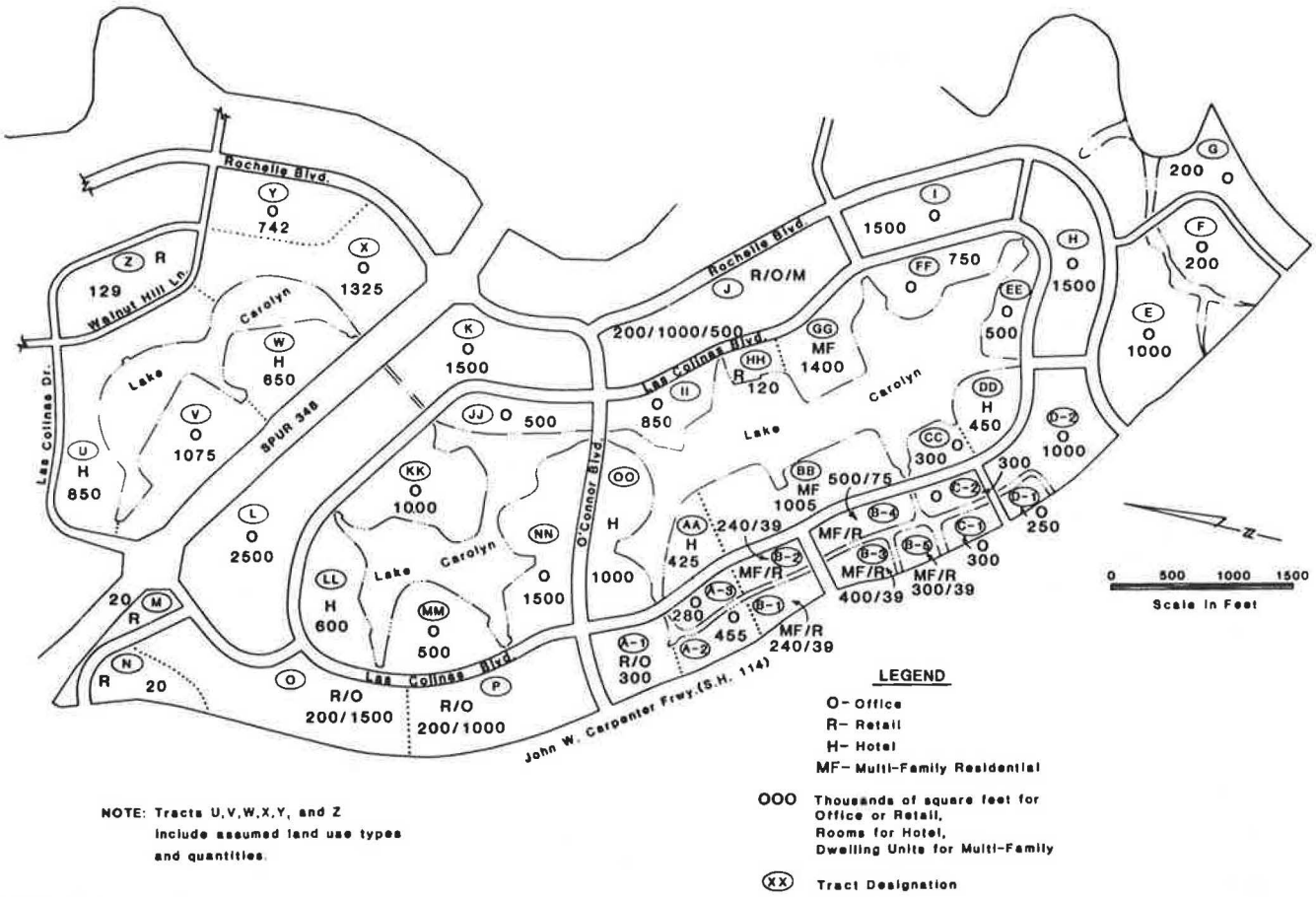

FIGURE 2 Las Colinas development plan.

with the broader issues or problems listed previously. In general, these areas of negative impact are associated with either (a) discontinuous or poorly designed facilities for pedestrian flow, or (b) excessive levels of internal automobile traffic.

PEDESTRIAN FLOW

Pedestrian-Vehicular Conflicts

For major activity centers that involve multiple land developers and an underlying grid-like street network, opportunities for pedestrian-vehicular conflict are numerous. Post Oak represents a classic example of these potentials. Grade separations for major flows of pedestrian and vehicular traffic represent clear, but costly, alternatives. The vehicle-free pedestrian mall associated with both regional shopping centers and revitalized central business districts represents another kind of solution. Pedestrian-vehicular accidents offer a direct measure of such conflicts.

Lack of Pedestrian Amenities

Multi-developer or multiple-node activity centers may vary in the extent to which pedestrian connections are fully designed to be integrated with adjacent land uses. Unevenness in the provision of amenities (landscaping, walking surfaces, street furniture, etc.) can represent a kind of negative impact (or at least the incomplete achievement of overall urban design goals). Long walks through hot asphalt parking lots or along sidewalks adjacent to busy arterial streets can represent these kinds of undesired pedestrian environments.

Clear Identity as a Center

Recognition and image as a specific, identifiable, and unique urban place is one of the important goals of MDCs and other major diversified centers. However, as such centers become large and as multiple developers are involved, the maintenance of an overall theme becomes more difficult. This is an elusive kind of negative impact, and again represents an achievement of less than what might be desired. In other words, disjointed and unclear pedestrian-transit-automobile connections to the fringes of major centers tend to diminish the participation of those fringe areas in the overall retail sales volume, achievable office rental rates, and marketability of the center itself.

AUTOMOBILE TRAFFIC FLOW

Traffic Congestion

Morning and evening peak-hour traffic congestion of employees at major activity centers reflect access problems (rather than internal circulation problems). Congestion that extends throughout the day reflects both (a) internal circulation by employees who use their automobile for short internal trips, and (b) access and egress and internal circulation during the day by shoppers or visitors. The threat

of all-day congestion represents perhaps the most serious negative impact of "growing large," though the severity again varies by street configuration and size of center, as well as mix of traffic along any given arterial (including through travel).

Air Quality Impacts

The level of air pollutant emissions is related to the extent of traffic congestion and internal automobile traffic flow. Development of carbon monoxide "hot spots" is not uncommon for major intersections near MDCs, and as a general rule the level of air pollutant emissions associated with high volumes of automobile traffic flow is undesirable for immediately adjacent land uses (and pedestrians).

Energy Consumption

In a similar vein, the energy consumption associated with high volumes of short-trip vehicular flow within a major activity center can be of concern. Though energy conservation is currently less of a transportation issue today than it was several years ago (6), any improvement in internal circulation options that reduces vehicular flow, and thereby also reduces energy consumption, is additionally desirable.

REMEDIES AND SOLUTIONS ATTEMPTED

Attempts to resolve internal circulation problems within major activity centers, particularly as those centers grow, have been straightforward. They either involve the expansion, extension, or improvement of an existing mode, or the introduction of a new mode. In the first instance, existing pedestrian facilities and services could be improved, as could the configuration and capacity of existing roadways and parking areas. In the second instance, a variety of surface street transit modes could be introduced for internal circulation purposes. Conventional buses, trolley buses, or light rail streetcars could all be considered. Grade-separated automated guideway transit systems, though more costly, represent another alternative.

Pedestrian Improvements

Nearly all major activity centers have one major shopping and commercial core with enclosed, weather-protected pedestrian malls connecting a variety of department stores and related shops. In Post Oak, for example, the Galleria development plays this role whereas in the Woodlands Metro Center an enclosed regional mall is under design. Because such cores are typically self-contained and surrounded by parking, it is difficult to effectively extend their enclosed pedestrian environments across adjacent streets and parking areas. Grade-separated extensions are costly, yet they may be desirable to improve linkages with other areas of a center. A variety of surface treatments, edgings, street furniture, lighting, and other "theme" features could be used to strengthen overall pedestrian walkway systems, involving both open and weather-protected elements.

Automobile Access and Parking Improvements

The most common approach to solving automobile congestion is to seek ways to provide additional street capacity, via appropriate traffic engineering measures or reorganization of traffic flow patterns in accommodating new street segments. Double-decking or other structure treatment for parking facilities is also common. Because convenient automobile access is generally the key to discretionary shopper and visitor travel to such centers, major attention legitimately should be devoted to improving vehicular circulation. In many cases, however, options for expanded capacity reach space or cost limits or both, and it may become prudent to consider investment in and encouragement of the use of alternate transit modes.

Surface Transit

A number of conventional bus and specialized trolleybus and streetcar services have been inaugurated in several major centers, with mixed success. One of the keys to success has been the extent to which such services provide easily recognized and available linkages (e.g., in a strongly linear corridor) and the extent to which they are not themselves impeded by at-grade street traffic congestion. Unique vehicle design treatments (e.g., trolleybus vehicles outfitted as old-time rail trolley cars) have also been effective. Bus or trolley vehicles that hold from 15 to 55 passengers may be appropriate.

Automated Guideway Transit

Through automated guideway transit circulation systems have been well proven in a growing number of airport and theme recreation park settings, they have yet to be implemented in non-downtown, mixed-use major activity centers. The downtown people-movers currently being implemented in Miami and Detroit should be examined carefully for their transferability to other MAC/MDC settings when they become operational (6). Grade-separated AGT alternatives have been evaluated for the Post Oak area (2) and are currently under consideration for the Las Colinas development (4). They have been examined, with varying degrees of seriousness, for other special-purpose linkages and are being implemented in some instances (Mud Island in Memphis and Harbour Island in Tampa, are examples but not ones in which the AGT distributor forms an integral element of major mixed-use developments lying along its length). Vehicle size may also vary for such systems, but typically 20 to 100 passengers is considered.

EVALUATION OF RELATIVE SUCCESS OF ATTEMPTED REMEDIES

Using the three case studies outlined earlier, the evaluation of supplementary transit distributors within major activity centers is emphasized. Such internal circulation and distribution services have either been attempted or preliminarily investigated for feasibility. Although improvement in pedestrian and vehicular facilities (particularly grade separations) can certainly help resolve some of the negative impacts associated with pedestrian environments (described earlier), these remedies tend to be quite site-specific in nature. They also have less dramatic potential for resolving the more serious problems associated with traffic congestion within activity centers. In addition to the three types of vehicle miles of travel (VMT) reduction-related impacts listed previously, three other criteria for comparing supplemental transit options (surface versus grade-separated) include the range of longer trip opportunities offered, mode choice percentages, and cost

TABLE 1 Preliminary Evaluation of Internal Transit Distributor Options: Three Examples

Evaluation Criteria	Transit Distributor Option				
	Post Oak		Woodlands Metro Center		
	Surface Bus or Rail	AGT	Surface Bus or Rail	AGT	Las Colinas, AGT
Gross leasable area (million square feet)					
Office	12.4		13.4		24.9
Commercial/retail	2.5		1.7		
Daily population (000)	100,000		90,000		140,000-150,000
Average speed (mph)	10-15	20-25	20	20	15-20
Daily ridership	22,000-44,000	40,000-90,000	24,000-30,000	24,000-30,000	150,000
Mode split percentage	4-8	8-17	8	8	20
Annualized cost per passenger (1983 dollars)	0.09-0.26	0.20-0.59	0.06-0.26	0.45-0.87	NA
VMT reduction, %	-1	-1-2	NA	NA	-5
Air pollutant emissions reduction, %					
CO	+4	-1			-8
NO_x	-10	-5-10			-4
NC	-	-			-8
Energy consumption change, %	+4	+14	NA	NA	-5

Note: NA = not applicable.

per passenger. Table 1 gives a summary of the preliminary evaluation.

Range of Trip Opportunities

This impact reflects the number of discretionary trip opportunities (shopping, lunch, personal services, etc.) that may be available to activity center populations within a given travel time, for example, 15 min one-way by walking. The implicit assumption here is that, if a person could reach a desired destination by walking or by transit within 10 to 15 min, this would usually be preferable to making the same trip between parking lots via an automobile.

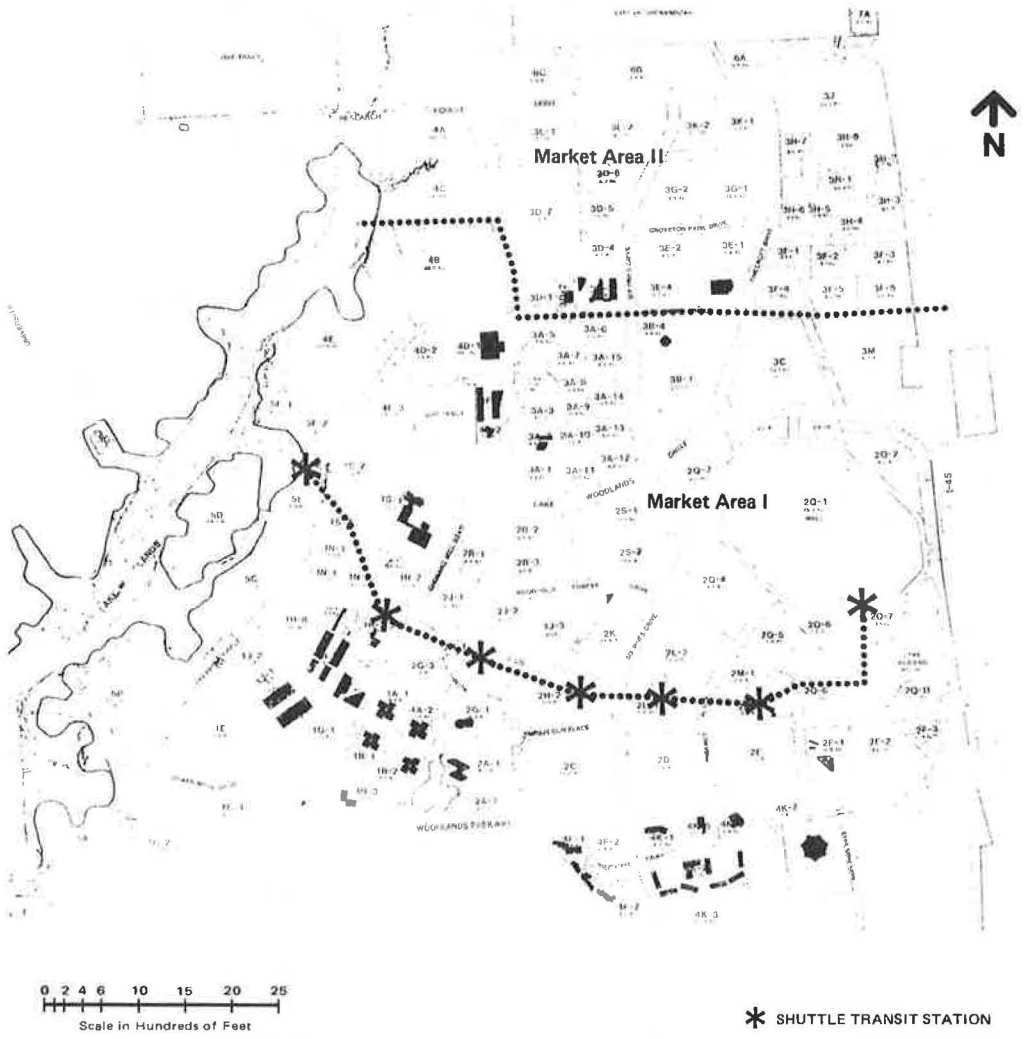

FIGURE 3 Proposed shuttle transit alignment: Woodlands Metro Center.

Increasing the range of trip opportunities would tend to draw a spread-out activity center closer together, and it could conceivably increase the total number of internal trips, and thereby the total number of shoppers or visitors and retail sales and economic vitality of the center.

A crude measure of this potential for internal transit distributor systems is the average speed that can be achieved. As might be expected, grade-separated systems can generally achieve a faster average speed than surface systems. In a study of distributor options for the Post Oak area, average speeds for AGT options were 20 to 25 mph, whereas average speed for surface options was 10 to 15 mph). In the Woodlands Metro Center example, the available right-of-way was grade-separated for all options (see Figures 3 and 4), and speeds were assumed equivalent at 20 mph for both AGT and conventional bus, streetcar, and trolley modes. Because of its large size and linear character, the Las Colinas Center (Figure 5) could particularly benefit from an AGT speed of 20 to 25 mph.

Mode Split

Because of equivalent speeds, station spacing, and frequencies of service (headways of about 5 min) assumed in the Woodlands example, ridership estimates for the various modal options were also the same--about 3 percent or 24,000 to 30,000 daily trips. In the more comprehensive Post Oak example, ridership for AGT options ranged from 8 to 17 percent (40,000 to 90,000 daily trips), whereas for surface street options (with slightly lesser service frequency of every 5 to 8 min, versus service every 2 to 4 min for AGT), these ridership estimates declined to 4 to 8 percent (25,000 to 45,000 daily trips). It should be remembered that these mode split percentages apply against a total base of

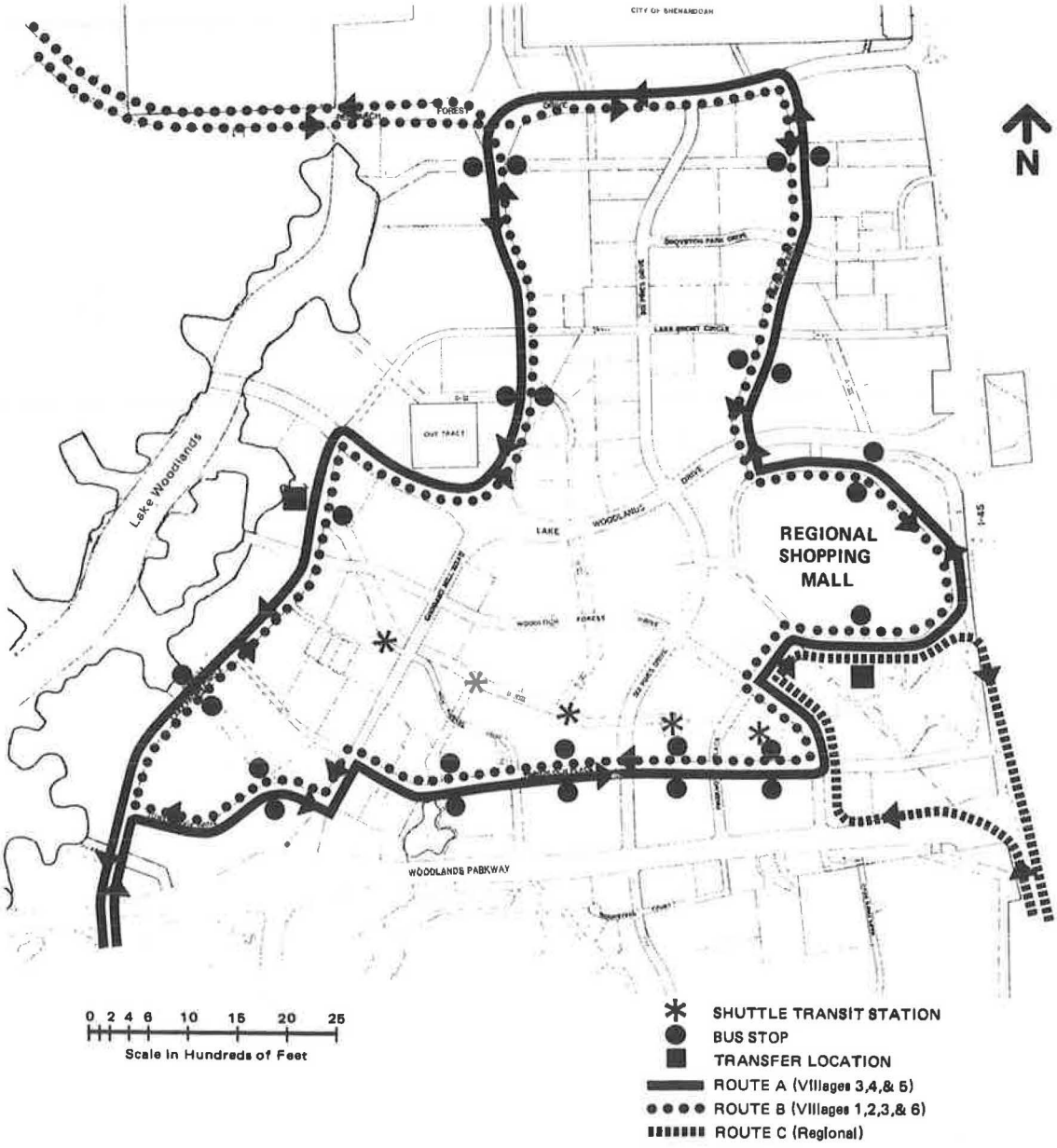

FIGURE 4 Interface between shuttle transit and local and regional bus system: Woodlands Metro Center.

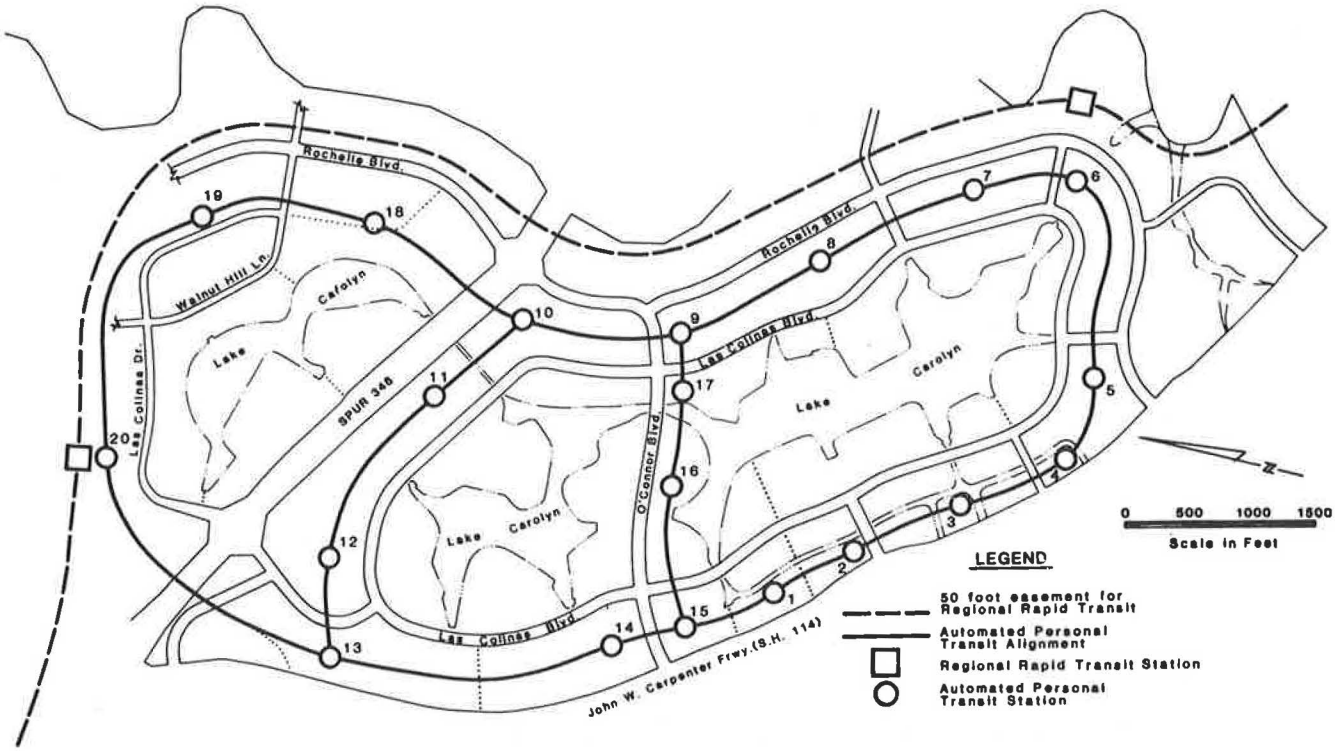

FIGURE 5 Proposed internal circulation system: Las Colinas.

internal trips, which are more than 70 percent pedestrian. In the Las Colinas example only AGT was investigated, and a mode split of about 20 to 25 percent (150,000 daily trips) was estimated.

Cost Per Passenger

These ridership estimates reflect fairly intensive use of the supplementary transit options analyzed. Annualized costs per passenger for Post Oak and the Woodlands Metro Center, covering both capital and operating costs, suggest that the surface street modes could achieve operating costs of under 25 cents per passenger (1983 dollars), perhaps as low as 6 cents per passenger. The bulk of these costs would cover operations and maintenance. For the grade-separated modes, however, capital cost amortization significantly raises required costs to as high as 90 cents per passenger, with considerable variability between the Post Oak and Woodlands example (see Table 1). If, to encourage usage, modest fares on the order of 10 or 20 cents are desired, some form of subsidy for capital investment should be considered.

Although the results shown here for grade-separated modes are not based on real-world experience (only on preliminary feasibility studies), it is important to examine the mixed experience with surface bus distributor modes in activity centers across the country. A shuttle bus distributor along the north-south axis of Post Oak was implemented several years go, but terminated because of low ridership levels. These low ridership levels reflected in turn the slow speeds achieved in mixed traffic congestion and led to an unacceptable operating cost per passenger. Similar low ridership experience was encountered in an internal shuttle bus operation associated with the sprawling Tyson's Corner, Virginia MDC in 1982-1983. An initial total of 10 different routes across the center was reduced to two routes; both routes were terminated after about a year of operation, in spite of free fares. On the other hand, a linear shuttle bus service along Central Avenue in Phoenix is currently experiencing economically viable ridership levels, and bus shuttles in such recreation and mixed-use centers as Aspen and Vail, Colorado, are also regarded as successful.

Congestion Reduction

It is important to realize that the supplementary transit ridership levels described previously largely represent diversions of former pedestrian travelers. The impact on internal automobile vehicular travel is estimated to be quite modest. As indicated in Table 1, this reduction ranges from only 1 to 5 percent for all three case studies. This certainly represents a desired impact but not a dramatic one. Significant ridership levels for an internal transit distributor mode might therefore best be regarded as an additional environmental plus, improving discretionary travel opportunities within the center. However, internal shuttles do not really solve the major congestion problems of activity centers, although they contribute to such solutions.

Air Quality and Energy Consumption

Associated with these modest impacts on VMT reduction are equally modest impacts on the reduction of air pollutant emissions and energy consumption. As indicated in Table 1, the estimated air pollutant emission reductions for each illustrative case study range from 1 to 8 percent for AGT modes, but CO emissions may actually increase slightly for diesel-powered surface bus modes. When the energy to operate a transit distributor mode is considered, there may

be no net energy savings, and possibly an increased energy requirement of 10 percent or more for AGT modes.

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An Application of the Lens Model in Measuring Retail Attractiveness and the Effects of Alternative Public and Private Policies on a Retail Area

KARLA H. KARASH

ABSTRACT

The objective of this research was to use the lens model as a technique to measure the effect of an automobile-restricted zone and other private and public policies in the downtown Boston retail area on shopping trips to the area. The lens model accounts for perceptions and preference in the individual choice process. Findings were that individual's preferences for hypothetical futures for the Downtown Crossing could be linked to actual choice of shopping area only by explicitly accounting for measurement errors and feedback effects of preferences on perceptions. Removal of the automobile-restricted zone was predicted to decrease shopping trips to the shopping area by about 8 percent. Better maintenance and security were predicted to increase trips by about 5 percent. New retail development was predicted to increase trips by 10 to 11 percent; and vastly improved parking was predicted to increase trips by 6 percent.

In 1978 the city of Boston made a major effort to improve its major downtown retail area by implementing an automobile-restricted pedestrian mall known as the Downtown Crossing. More than $5 million were spent on capital improvements from combined city and federal funds. Traffic was removed from streets in the heart of the retail district and rerouted to other corridors. Streets were bricked over and new lighting and benches were provided.

Although consultant reports after the first 2 years of the pedestrian zone showed that sales in current dollars were up by about 12 percent and thus keeping pace with inflation (1), a feeling of gloom overshadowed the area in the summer of 1981. The city of Boston was suffering from a tax limitation law that severely limited the budgets of city departments. The result for the retail area meant that maintenance was inadequate, the area was quite dirty, and there were concerns about safety because of limited police protection. Spokespersons for the two major department stores in the area asked the city to consider ending its experiment and put the automobiles back on the street. They argued that automobile traffic would make the area feel safer, particularly at night.

At this same time the Boston Redevelopment