the Baltimore experience that a well-defined federal policy toward joint-development funding is necessary.

In spite of the difficulty in obtaining federal funds for joint development, UMTA has clearly articulated the requirement that municipalities that seek funds for rail transit construction must commit themselves to a program of land use plans, zoning policies, and development incentives that will "support or reinforce the developmental impact and shaping influences of the rail transit system" (6). Station areas are to receive specific attention so that high-density private development in the station areas will be maximized. The plans for Baltimore's station area development outlined in this paper should serve as a model for other urban areas seeking funding for rail transit systems.

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Abridgment

Transit Centers: A Means of Improving Transit Services

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The role of transit centers in improving the overall effectiveness of an urban bus transit system is defined and assessed. Transit centers are defined as physical facilities that facilitate the movement of buses and, thus, of bus patrons. Transit centers are more than park-and-ride lots because they can be located in high-visibility locations, even in the downtown core, and thus can serve to increase the attractiveness of transit. They are major transfer points at which several types of routes can come together. Express and local routes, as well as pulse-scheduled circulators, can thus provide the bus user with many potential destinations and greatly reduce transfer time. Transit centers can be located in the central city, on freeways, or in suburban activity centers. Planning guidelines are developed to assist in the successful planning and implementation of transit centers. These guidelines address general locational considerations, bus berths, parking, accessibility, and potential joint-development opportunities. These planning guidelines are used to locate and conceptually design a potential transit center for the Salt Lake City area. It is concluded that the impact of current pioneer transit-center projects in the United States should be closely monitored.

Transit centers are physical facilities that help to coordinate the movement of buses and people and thereby facilitate the use of transit. Each can generally be categorized as either a central-area, an on-freeway, or an outlying transfer center. The purposes of a specific transit center are usually defined by its location. Central-area centers provide off-street downtown distribution for radial express-bus operations. On-freeway transit centers are built right into the right-of-way of the freeway and thus eliminate the need for express buses to leave the freeway and travel on local streets to a suitable location for loading or unloading passengers (1). Outlying transfer terminals help intercept motorists and buses in an outlying area, facilitate passenger transfer to other express and local lines, and also provide convenient access for transit patrons.

The Denver Regional Transportation District has applied for funding to build three outlying transit centers this year and another three next year. The San Diego Transit Corporation has included four on-freeway transit centers and one suburban transit center in its Five-Year-Plan Update (1979-1983). These transit agencies are two of the pioneers in the use of transit centers for bus transit alone. This paper discusses the expanded use of the third type of center--outlying transfer--in medium-density communities with a bus transit system. Basic planning and design guidelines are explained and applied in relation to a conceptual design for a transit center in the Salt Lake Valley.

FUNCTIONS OF AN OUTLYING TRANSIT CENTER

Until recently, transit facilities located outside of the downtown area have been used to collect commuters from residential areas and thus have functioned solely as park-and-ride lots. Although this is still a major function of a transit center in an outlying area, it is not the only one. Such a center can also serve as a main transfer point between bus routes and can offer possibilities for joint development. Because available funding is at a premium, joint-development possibilities become especially attractive and can increase the feasibility of the transit center.

As an interface between line-haul transit and local collection (either by bus or by automobile), the transit center makes it possible to reduce local transit services into the city center. Passenger travel time can be reduced through an expansion of express service and through wider station spacings on express transit routes. Thus, the operation of a transit center as a transfer point to a line-haul

service allows greater productivity for transit personnel and equipment, simplifies routing, and increases line-haul operating speeds and efficiency (2).

Parking at outlying transit centers is essential because automobiles provide important secondary distribution, particularly in areas where the operation of a local bus service is not economical (3). The availability of parking also encourages bus patronage in areas where car travel to the city center is inhibited by congestion and where daily parking is very costly or unavailable. In these areas, both park-and-ride and kiss-and-ride lots are used, primarily in the peak periods.

A transit center can also serve as a major transfer point between local bus routes. It could function either as a local feeder to other local routes or as a "pulse point" for routes that have the same scheduled arrival time. Pulse or timed-transfer routes are routes that arrive at the transit center at approximately the same time, thus facilitating high transfer volumes among the routes. The use of the transit center as the pulse point minimizes the delay involved in transferring and emphasizes the center's role as a major transit node.

Locating the transit center within an existing regional activity center makes the center itself the destination of many trips and encourages the use of public transportation by creating a highly visible, conveniently accessible center of concentrated public transportation. If the trip attractor near the transit center is a municipal building, an office building, or a civic or cultural center, many possibilities exist for joint development. Parking facilities could be shared, and special routes that originate and terminate at the center could be established. This type of location would generate additional business for restaurants, newsstands, and stores included in the transit center. Pulse-point operation and a location near a major trip attractor will extend the service of the transit center beyond peak hours. In addition, it may become feasible to combine urban transit and intercity bus transportation at the transit center.

PLANNING GUIDELINES

The extent to which a transit center will be used is primarily determined by its location, which should reflect land costs and availability, bus and street patterns, traffic conditions, passenger interchange volumes, peaking characteristics, origins and modes, and use of the surrounding land. Terminals should be located where substantial changes in population density form logical breakpoints for express service to the city center. Parking becomes increasingly important as population density declines because the proportions of park-and-ride and kiss-and-ride passengers increase. This occurs as the distance from the city center increases (2). The decision to park and ride is largely determined by the trade-off between the inconvenience of and time lost in changing modes, the higher parking costs downtown, and the strain of driving in congested traffic. Thus, outlying parking facilities are most used wherever the multimodal trip to the city center is cheaper and faster than the trip by car. The bus service from the transit center to the central business district (CBD) must be fast and frequent. Transit fares and parking fees should be less than the cost of driving to and parking in the CBD.

To act as a local-express transit interchange, the transit center should be located where express transit and local lines intersect and/or where there is a natural convergence of bus routes on approaches to the transit station. This convergence is also essential for pulse-point service. The transfer point should be located at an outlying activity center that generates its own traffic. Location near a government or privately developed trip attractor will provide opportunities for joint development. Because all of these conditions may not be satisfied by any one location in the existing transit network, it is important to consider sites at which a transfer would simplify service scheduling and dependability over a direct bus routing, where local bus routes can be rerouted to serve express transit service, or where minor modifications in the existing route structure will make the network more effective or efficient through the use of the transit center.

There should be good highway access to the transit center. Access should be upstream from points of freeway convergence or interchange, where peak-hour congestion is typical. Ideally, the transit center should be located within a major bus corridor that connects it with the CBD.

Outlying bus parking sites should also have adequate land for existing and future needs. The site should be compatible with adjacent land uses, should not adversely affect nearby environments, and should achieve a reasonable level of use relative to development costs. Site selection should give priority to land currently used for parking, undeveloped or unused land now in public ownership, and undeveloped or developed private land (2).

DESIGN AND OPERATING FEATURES

The transfer from car to bus or from one bus to another breaks up a trip and involves penalties in travel time and convenience. Thus, the design and operation of the transit-center terminal should make transfers as quick and easy as possible. Passenger interchange should occur with minimal interruption to vehicle traffic and minimal deviation of buses from their normal routes. Internal site design should minimize pedestrian travel and give priority to interchanging passengers. Priority should be given to various functions of the transit center in the following order (2): (a) bus loading and unloading, (b) passenger-car unloading, (c) passenger-car loading (kiss-and-ride), (d) bicycle parking, (e) short-term parking, and (f) long-term parking.

At stations that have low traffic volumes, buses may share parking area roadways with kiss-and-ride and park-and-ride traffic. Kiss-and-ride drop-off areas should be close to the terminal entrance. A holding or short-term parking area for passenger pickup should also be provided. All parking and circulation areas should be clearly marked. Principal loading areas should be sheltered, and a covered walkway should be provided for any remaining distance to the bus boarding areas.

The size of the transit center depends on (a) the number of bus routes it serves and the headways on these routes, (b) the number of passengers served, (c) the proportion of park-and-ride and kiss-and-ride patrons, and (d) the extent of joint development associated with the facility (parking or ancillary).

The number of bus berths should be based on the maximum number of buses in the terminal at any given time. Berth requirements will depend on peak-hour passenger volumes and berth turnover. Bus layover time should be minimized during peak periods; 5-min dwell times are a desirable maximum. This allows a turnover of 10-20 buses/h/berth (2). Pulse-point scheduling increases the required number of berths and could reduce the turnover rate, since pulsed

buses must dwell at the center to facilitate transfers.

Parking capacity should be scaled to roadway capacity as well as to parking demand and bus-service potential. If, for example, bus service is provided exclusively for park-and-ride or kiss-and-ride, space should be provided for 400 cars to justify 10-min bus service during the peak hour. This relationship assumes that typical peak-period loadings of 45 persons/bus will transport 270 passengers (200 automobile drivers and 70 kiss-and-ride passengers) and that 50-60 percent of the daily arrivals are in the peak hour. Studies of existing outlying transit parking facilities show an average daily turnover of 1.1 cars/space and about 1.2 transit trips generated per parked car. Kiss-and-ride passengers make up 20-40 percent of total peak-hour station arrivals (2). Most transit centers, however, do not cater solely to park-and-ride patrons. Because of the availability of transfers from local routes and the fact that patrons arrive and depart on foot, parking requirements will be decreased.

CONCEPTUAL DESIGN FOR SALT LAKE VALLEY TRANSIT CENTER

Salt Lake City is oriented north-south because of geographic barriers on the east and west sides. A site in Murray, a suburb about 8 miles south of the downtown core of Salt Lake City, was identified as a potential transit center. This site is located one block from the major north-south transportation corridor of the city. The area is a good breakpoint between the residential development to the south and the business and commercial areas that increase in density to the north. The site is in a redevelopment area, adjacent to a proposed new city hall and civic center.

In the existing route structure, a maximum of 15-17 buses/h could use the center. Since each berth has a capacity of 10-20 buses/h, this service frequency can be accommodated by one berth to serve each direction of traffic. Providing two berths for each direction of traffic will allow for a 100 percent expansion of services. Several existing bus routes converge near this area. Thus, although timed transfer routes are not used at this time, they could be established by making only minor modifications to the existing route structure. If pulse-point service were to be initiated, the berth requirements would have to be increased to accommodate the number of buses dwelling simultaneously at the transit center.

Since the transit-center site is adjacent to the proposed site for a city hall, there would be a good opportunity for joint development. Parking could be shared, bus routes serving the city hall could be set up to begin and terminate at the transit center, and fast-food stands, restaurants, newsstands, and shops would have many potential customers. A transit information center could also be provided. This joint development would encourage and facilitate the development of office space adjacent to the city hall, encourage transit use, and facilitate pedestrian and bicycle access to the city hall (4).

Two designs could be developed for the Salt Lake Valley transit center. Concept 1 would include a pedestrian island that has bus circulation on each side. The island could be covered by a canopy that extends the full length of the bus-loading bays and covers all but a portion of the waiting buses. This central pedestrian island could also provide transit information displays, newspaper racks, and other amenities for patrons (5). Concept 2 would provide pedestrian facilities on each side of the transit center. This design would be more costly, since shelters would have to be built on both sides of the street, but it would ease bus maneuvers and turning movements and reduce conflicts between buses and pedestrians.

Standard dimensions must be included in the design of the bus berths. The entire length of the berth must be a minimum of 65 ft, and a minimum of 22 ft of roadway width is required for the bus pull-out maneuver. The depth of the berth must be at least 8 ft (2).

If it is assumed that only half of the transit-center users during the peak hour will be park-and-ride patrons or city hall employees using the parking structure, the minimal number of required parking spaces at the center would be 200. Thus, the first phase of transit-center development would include four sawtooth bus bays (or more if pulse-point service is implemented) with covered shelters, 200 automobile parking spaces, bicycle parking, pedestrian crossings (which could be grade separated between the city hall and the parking lot) and ancillary facilities.

As use of the transit center becomes more popular, its services could be increased. Additional routes could be added where the demand is evident. The number of pulse routes could be increased as the number of common origins and destinations increases. Space is available for the expansion of parking facilities as the number of park-and-ride passengers increases. The facility and the adjacent roadway network will be capable of handling this potentially large increase in bus volumes (4). Since the design allows flexibility in service areas that may be expanded at the center, the transit center would continue to provide fast, dependable transit services to downtown, reduce vehicle miles of automobile travel, and reduce downtown parking space requirements in the Salt Lake Valley for many years to come.

SUMMARY

Outlying-transfer transit centers provide convenient access, collection, and transfer services at a single location within an existing community activity center. Many of the potential uses of a transit center can be developed through only minor modifications in the existing transit and highway networks. Through coordination with city governments, such as in the example given, a public transit agency could effectively reduce the vehicle miles of automobile travel in the region and encourage transit use through the establishment of transit centers. Federal funding support for such centers could be available from the Urban Mass Transportation Administration (UMTA) either under Section 3 (Discretionary Capital Projects Funding) or under the new Urban Initiatives Program. If accepted by UMTA, these projects would be funded on the basis of 80 percent federal and 20 percent local funding.

Since the many uses of outlying transit centers are still being investigated, any experimentation in U.S. cities should be publicized and recorded for use by other cities interested in establishing transit centers.

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Abridgment

Security Considerations in the Design and Operation of Rapid Transit Stations

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Design principles for rapid transit stations and off-peak transit ridership as a function of personal security are discussed. A survey was conducted at two rapid transit stations in Cleveland, Ohio, for the purpose of determining user attitudes toward personal security and developing station design principles based on the findings. The major finding is that a "critical mass" of station patronage seems to be required before people feel secure in rapid transit stations. People avoid underused stations (which exacerbates the problem of poor patronage) and avoid riding in off-peak time periods at all stations. In both cases, survey respondents stated that they feel vulnerable in a transit station when there are few people around. Ironically, poor station patronage, which is considered to be a security problem, is largely a marketing problem, and improving off-peak ridership, which is generally considered a marketing problem, is largely a security problem. People provide the best security. It is concluded that, although traditional security measures such as good lighting, well marked stations, and security patrols are beneficial, improved security and improved transit marketing are closely associated and should be considered together in transit planning.

This paper discusses an issue that is of critical concern to mass transit riders--personal security. A poor reputation for security can undo the public goodwill engendered through efforts to improve public transit. This paper argues that security measures need to be considered in the design of new transit stations and in the refurbishing of existing stations. Neighborhood and microenvironment characteristics need to be considered early in the design process. The selection of major bus-rail transfer stations must also be considered to encourage a "critical mass" of people at each station.

This paper also argues that there is more to increasing off-peak ridership than improving service frequency or destination opportunities. There is considerable evidence that people actively avoid off-peak use of transit for security reasons even though transit would otherwise be convenient. It is necessary to change this before other improvement measures can have the desired effect. This paper suggests that an investment in improved transit security may be an essential first step for troubled systems before public transit can become a full-service travel mode for the average citizen.

The problem that prompted this study is the extremely low rate of use (approximately 250 boardings/day) of the East 120th Street rapid transit station in Cleveland. The view of the station from the street is blocked, because of its location in an industrial railroad right-of-way, and the station must be entered through a tunnel that has a blind turn and a steep stairway. The station also forms a boundary between two neighborhoods that are markedly different in ethnic composition. The combination of a physical design that prevents transit riders from being seen from the street and a location that suffers from neighborhood friction has earned the East 120th Street station the reputation of being unsafe.

By comparison, the University Circle station, located only one stop away, is heavily used. Although this station also suffers from tunnel access with blind turns, it is a major bus-rail transfer center and has denser adjoining land uses.

A platform survey was conducted at each of these two stations on Thursday and Friday, May 3 and 4, 1979, to determine user perceptions of personal security and to test user reactions to proposed security improvements. Although riders perceive the stations quite differently, there are key similarities in the way they perceive personal security. From the survey responses, a set of design principles and operational practices that make for safer rapid transit stations were developed. These principles are presented below and are followed by an analysis of the survey results.

DESIGN PRINCIPLES AND OPERATIONAL PRACTICES

Several design principles and practices that provide guidelines for improving the security of the Cleveland rapid transit system in general and the East 120th Street station in particular emerged from the traveler interviews conducted at the two Cleveland rapid transit stations:

1. A critical mass of people is required in a rapid transit station before people feel secure. The very fact that station use is low, for whatever reasons, will discourage additional users.
2. When a station is shared by two or more neighborhoods that have distinctly different ethnic composition, each neighborhood should have its own access to the station area. Although people will mix satisfactorily on the station platform, they are reluctant to cross neighborhood boundaries to enter a station.
3. People perceive certain stations as safe and others as unsafe depending on the time of day.