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Planning Procedures for Transit-Station Renovation

JOHN R. GRIFFITHS AND LESTER A. HOEL

The application of planning and design procedures to the problem of transit-station renovation is described. The process is illustrated by using as an example the 69th Street Terminal in Philadelphia, a complex transit terminal that handles many transfer movements and transit vehicle connections and has a variety of system elements that are badly in need of renovation. The performance of the existing station was evaluated based on selected objectives and criteria and in light of its conformance with current policy guidelines. A series of alternative renovation layouts was produced to improve the processing of passengers by reducing conflicts, trip times, and level changes. These plans included consideration of horizontal and vertical separation, station access for fare collection, passenger volumes on each transit line, and accommodations for the disabled. Each alternative renovation plan was then evaluated along lines similar to those for the evaluation of the existing station. The results indicated the priority of each interest group and showed where conflict existed. The next step in the process is the preparation of detailed architectural and structural design plans and specifications, cost estimates, and a financial plan.

The renovation of transit stations is becoming increasingly important because the cost of new construction has been rapidly increasing while transit has been attracting new riders because of fuel shortages. Major capital investments in most new transit systems, such as those in Baltimore and Buffalo, are being built incrementally. In cities that have existing transit services, particularly Boston, Chicago, New York, and Philadelphia, greater reliance on present systems will be necessary. As newer systems begin to age, they too will be considered for renovation as recycling of transit structures becomes more productive and necessary.

Since the public's impressions and acceptance of transportation services depend heavily on the performance of modal interchange facilities, and since travelers generally place greater weight on time spent transferring between modes than on time spent in the vehicle, it is the abrupt transitions and delays at interface facilities that can reduce the service advantages offered by high speeds, frequent service, and advances in line-haul technology. In the case of older stations, these impedances are reflected in deficient designs, deterioration of physical plant, and changes in the public's perception of acceptable services.

This paper describes the application of planning and design procedures to the problem of transit-station renovation. The transit-station design process, as developed by Demetsky, Hoel, and Virkler (1), involves a series of procedural steps that assist the designer in ensuring consistency and comprehensive treatment in transit-station planning and evaluation. The methodology also uses analytic techniques, decision rules, and separate criteria for each interest group that uses the facility. Figures 1 and 2 illustrate the process. To demonstrate how the procedures are implemented, they have been applied to a complex station-renovation problem.

DESCRIPTION OF TRANSIT STATION STUDIED

The purpose of this study is to develop the planning process for transit-station renovation by applying each procedural step to an older, existing station that has deteriorated and is not functioning according to modern standards. The 69th Street Terminal just outside of Philadelphia was selected to demonstrate the planning process for transit-station renovation. This selection was based primarily on the station's need for renovation, the variety of system elements contained within the station complex, the availability of information, and the willing assistance of the agency that owns and operates the terminal [the Southeastern Pennsylvania Transit Authority (SEPTA)].

The 69th Street Terminal is located just north of West Chester Pike at its intersection with 69th Street. It is west of the city limits of Philadelphia in the township of Upper Darby in Delaware County and is the western terminus of the Market Street-Frankford subway-elevated line and the eastern terminus of a high-speed light rail line from Norristown. The station also serves two trolley lines and many bus lines that terminate in a well-established retail-commercial district in Philadelphia's western suburbs. Figure 3 shows the transit lines that are served by the terminal, and Figure 4 shows the terminal layout.

Approximately 50 000 persons/day (transit users and shoppers) pass through the terminal. In 1971, more than 70 percent of the daily subway-elevated users--about 13 200 persons--arrived at the terminal by means of public transportation. Of the 1200 daily users who drive, about 70 percent approach from either the West Chester Pike or Garrett Road. The morning and evening peak hours each account for about 30 percent of the daily users, or a total of 60 percent of daily traffic. The subway-elevated Frankford line operates 24 h and carries approximately 18 000 riders bound for the central business district (CBD).

The subway-elevated line operates six-car trains at headways from 3 to 30 min. The Norristown High-Speed Line is a light rail segment that uses single or tandem cars between the terminal and Norristown. The trolley lines to Media and Sharon Hill operate as single, low-level platform cars. Bus feeder service totaling 62 coaches in the peak hour is also provided. None of the rail lines are compatible or interchangeable with each other.

The terminal faces West Chester Pike, a major commuter route into the Philadelphia CBD. This arterial has a typical weekday volume of 25 000 vehicles and a peak-hour volume of 1100 vehicles in the peak direction. The terminal is located on a site of nearly 35 acres and consists of three inter-

Figure 1. Transit-station evaluation process.

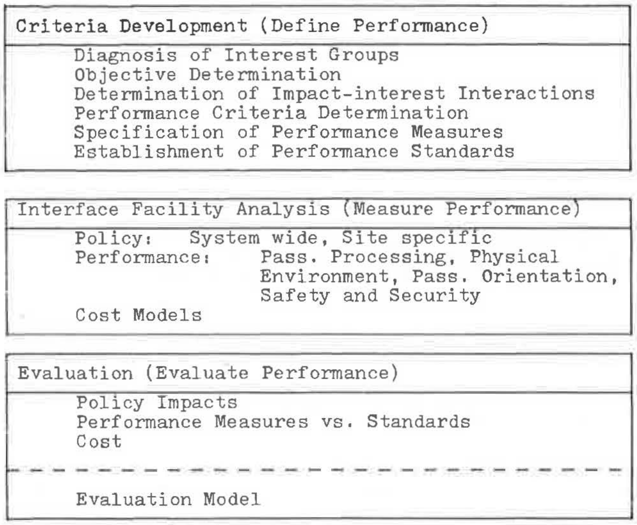
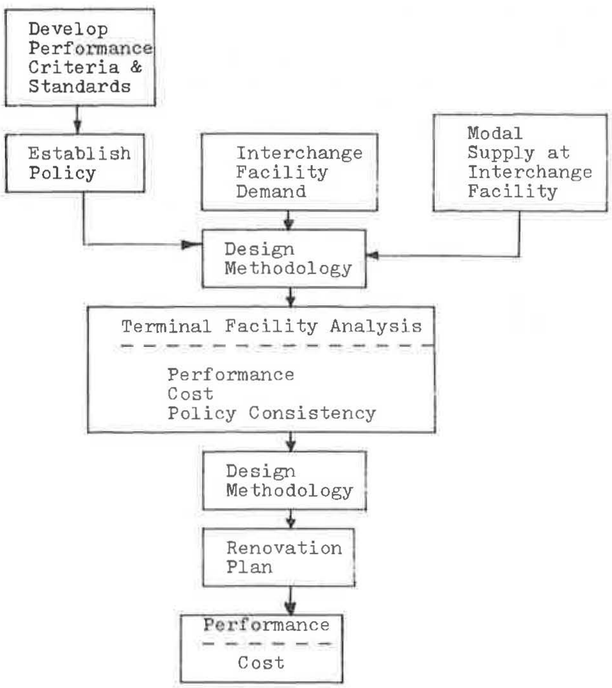


Figure 2. Transit-station renovation process.



connected structures: the old Philadelphia Transportation Company (PTC) building, the Red Arrow Suburban Bus and Tram Line building, and the Norristown High-Speed Line addition.

The PTC building, built in 1907, is the oldest structure and provides direct access from the West Chester Pike entrance to the high-level subway-elevated platforms situated below and behind its lobby. The Red Arrow building, constructed in the 1930s, is located adjacent to and west of the PTC building. Four platform areas serve both buses and trolleys. The Norristown High-Speed Line platforms are located in a structure that was constructed in 1963 to replace a 55-year-old "temporary" facility. This structure was an addition to the rear of the PTC building. It contains a stub-end, three-track, four-platform layout and has roofs over platforms only and an enclosed waiting room at the east end of the platforms. Access to the waiting room is provided from the lobby level of the PTC building and by stairs that ascend from the subway-elevated unloading platform.

The land that surrounds the terminal is urban in character. Lower- to middle-income homes dominate the area behind the retail outlets that line both sides of West Chester Pike and 69th Street. There are isolated commercial concentrations and some industrial development.

EVALUATION OF THE PRESENT STATION

The first step in the planning process is to evaluate how well the present station performs its required functions and to estimate the performance level that can be expected in the future if the station is not renovated. The present station is examined in terms of stated goals, objectives, and criteria and its conformance to SEPTA policy guidelines (e.g., the availability of restrooms and telephones). The results of the evaluation are depicted graphically on a factor profile diagram.

The basic goals set for transit stations by SEPTA are grouped as (a) architectural, (b) interchange function, (c) community related, and (d) transit. The objectives to be achieved by station renovation are grouped as (a) passenger processing, (b) environmental, (c) economic, (d) design flexibility, and (e) community. Each of the goals and objectives, and their interactions, is given in Table 1. For example, the architectural goal "to provide safety" is consistent with the environmental objective "to provide adequate lighting". In the analysis, it is the objectives that will be used to test the performance of the station because the goals represent general statements of system attainment.

The groups affected by transit-station changes are users, special users (such as the handicapped and the elderly), and operators. Since we are concerned primarily with the internal functioning of the station environment, the role of nonusers is not considered. The following table demonstrates how each of the system objectives (except community-related objectives) directly affects each of the interest groups:

Impact	User	Special User	Operator
Passenger processing			
Crowding	X	X	
Travel impedances	X	X	
Conflicts	X	X	
Disorientation	X	X	
Safety	X	X	X
Reliability	X	X	
Fare collection and entry	X	X	X
Level changes	X	X	
Physical barriers		X	
Emergencies	X	X	X
Environmental			
Ambient environment	X	X	
Lighting	X	X	
Personal comfort	X	X	
Aesthetic quality	X	X	
Services	X	X	
Weather protection	X	X	

Figure 3. Location of Philadelphia's 69th Street Terminal.

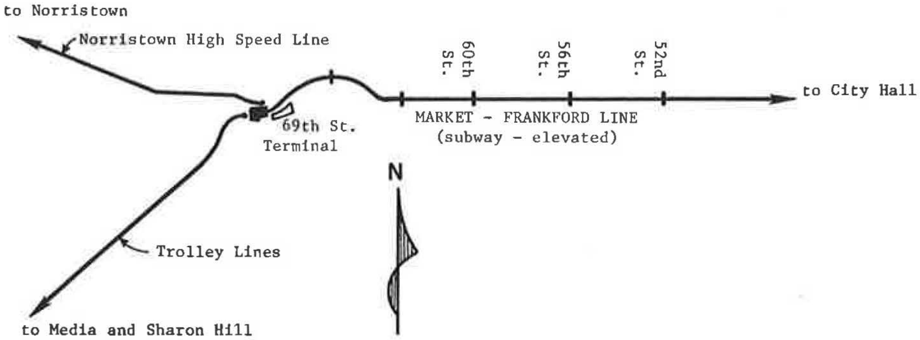
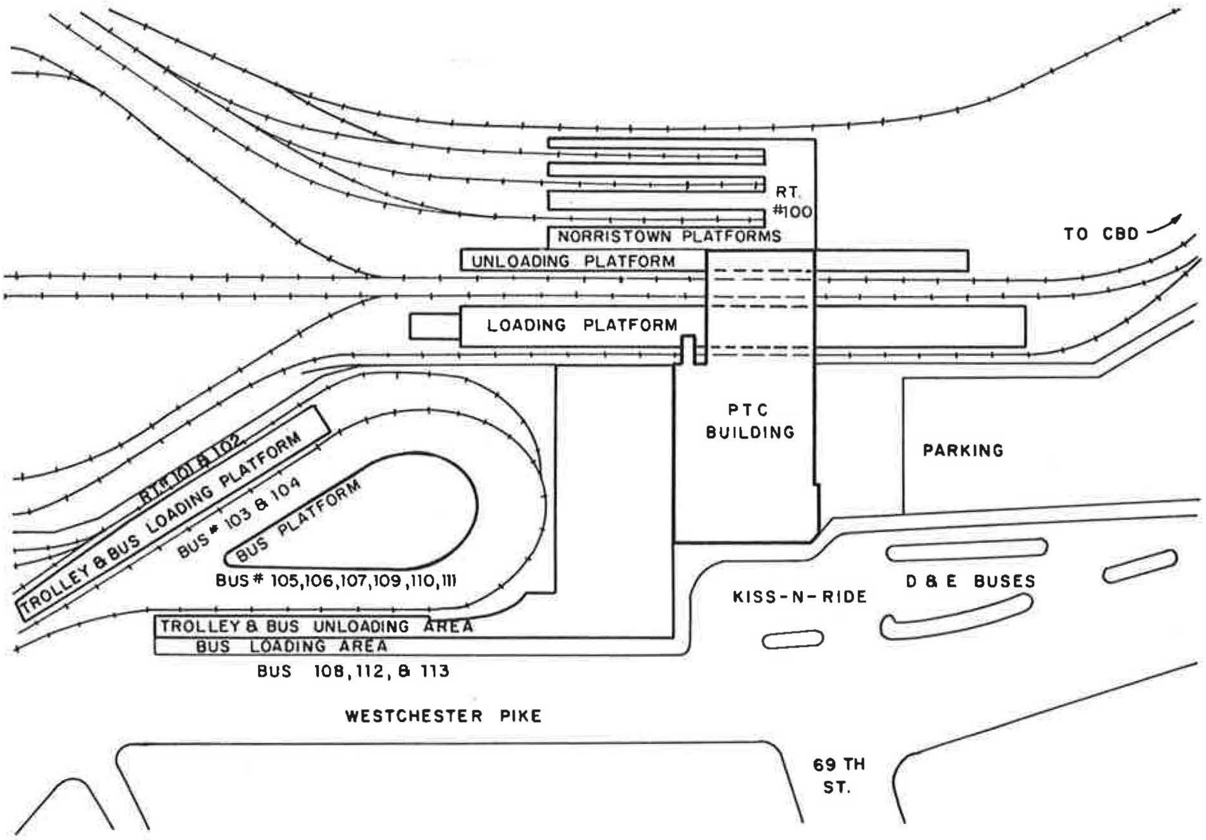


Figure 4. Layout of present 69th Street Terminal.



Impact	User	Special User	Operator
Security	X	X	X
Economic			
Costs			X
Income			X
Energy			X
Design flexibility			X

Clearly, users and special users are affected primarily by passenger processing and environmental objectives, whereas the operator is directly concerned with fare collection, safety and security, and economics and indirectly concerned with user satisfaction.

Finally, the criteria describe the performance measure that will be used to evaluate the station's performance for each objective. Table 2 gives several of the criteria and performance measures that were used in this study.

The present conditions at the 69th Street Terminal were evaluated for each of the objectives. Performance measures for each criterion were quantitatively calculated or qualitatively described. For example, to see how the station rates in terms of the objective of minimizing conflicts, the number of severe conflict areas was calculated. The procedures used to obtain each performance measure involve a lengthy process, and a detailed description of the process is beyond the scope of this paper (2).

The results of such an evaluation are summarized as a factor profile in Figure 5 for several criteria that apply to station users. These indicate the station performance for two periods: 1971 and 1985. Factor profiles as part of a decision-making process were used originally by Oglesby, Bishop, and Willeke (3) in evaluating freeway location alternatives. This method is selected because it includes all factors including those that cannot be stated in precise monetary terms. An estimate of degree of attainment is produced as the percentage of the max-

Table 1. Goal-objective matrix.

Objective	Goal: Provide Information	Provide Safety	Remove Barriers	Provide Convenient Transfers	Integrate Intersecting Lines	Reflect Community Character	Promote Mixed Station Use	Best Service at Least Cost
Passenger processing								
Minimize crowding			X	X				
Minimize travel impedances			X	X	X			
Minimize conflicts			X	X				
Minimize disorientation	X		X	X				
Maximize safety		X		X				
Maximize reliability				X				
Provide for efficient fare collection and entry control				X	X			
Minimize level changes			X	X				
Minimize physical barriers			X	X				
Provide for emergencies		X		X				
Environmental								
Provide comfortable ambience				X				
Provide adequate lighting	X	X		X				
Provide for personal comfort				X				
Provide aesthetic quality		X						
Provide supplementary services				X			X	
Provide protection from weather		X		X	X			
Provide adequate security				X		X		
Economic								
Minimize costs								X
Maximize net income							X	X
Use energy efficiently								X
Design flexibility					X		X	
Community								
Minimize impacts on local traffic						X		
Promote desired growth						X	X	
Minimize local disruption						X		

imum expected negative or positive effect of each factor. Where quantitative data are available, values are used that represent the limits of full attainment and nonattainment of objectives. For qualitative data, estimates of attainment were made according to SEPTA standards as well as subjective judgments.

Finally, the existing station is reviewed in light of its conformance with current policy guidelines. For example, if the managing agency's policy is to require telephones in the station, the present facility is rated in accordance with this policy. It was found that the station failed to meet policy guidelines in the areas of placement of advertising signs, aesthetics (art, music, and landscaping), construction materials, passenger orientation, and safety. Policy guidelines were partly met for security, personal care facilities, parking, and provisions for special users. The station was noted to be in conformance with policy in the provision of concessions and services, telephones, and the physical environment (the station areas are enclosed, although not climate controlled). Attention to the items identified as deficient could result in a significantly improved station without the need for extensive redesign of the station layout.

GENERATION OF ALTERNATIVES

Each of the alternative station-renovation plans developed for evaluation will involve the rebuilding of the station's interior, the realignment of platforms, and other structural changes. The plans were selected because of their potential for reducing walking distances, minimizing conflicts, and consolidating bus platforms. Other considerations that led to layout modifications were the need for improved weather protection, for a logical layout, and for long sight lines and high ceilings to facilitate surveillance.

A brief description of each alternative is given below:

1. Alternative 1 (see Figure 6) retains the present terminal layout. Minor relocations and modifications are provided for bus platforms and taxi and kiss-and-ride areas. The entire terminal is upgraded to the quality of a new station. The capital cost is $3.1 million.

2. In alternative 2 (see Figure 7), the aboveground building portion of the bus circle area west of the original subway-elevated structure would be removed. The platform arrangement for taxi, bus, and kiss-and-ride areas is changed. The ramp from the West Chester Pike bus platform to the main ramp is closed. A level corridor from the bus platform to the subway-elevated main corridor is added, thus eliminating two level changes and reducing congestion on the present ramp. The capital cost is $2.4 million.

3. In alternative 3 (see Figure 8), bus platforms in the center of the bus and trolley circle are removed, thus eliminating two-way traffic. Most bus routes would discharge passengers directly in front of the terminal. The western section of the subway-elevated is removed, and the taxi and kiss-and-ride areas are relocated between the subway-elevated and the parking lot. The cost is $1.9 million.

4. In alternative 4 (see Figure 9), much of the present terminal is removed and a new section is constructed over the subway-elevated tracks. Sections of the terminal described in alternative 3 are removed, as is the subway-elevated lobby. Elevated corridors are provided to all bus platforms, and the taxi area is relocated. The estimated construction cost is $2.9 million.

5. In alternative 5 (see Figure 10), all passenger-terminal structures between West Chester Pike and the subway-elevated tracks are removed. The trolley loop is placed below grade at the elevation of the subway-elevated line. Bus platforms are constructed at street level above the trolley loop. A new addition to the present structure spans the subway-elevated alignment. The taxi areas and bus area are located together, and the kiss-and-ride area is

located between the bus unloading area and the parking lot. The estimated construction cost is $4.4 million.

EVALUATION OF ALTERNATIVE RENOVATION PLANS

The evaluation of each of the alternative renovation plans outlined above follows the procedure used earlier. For each criterion for which significant differences in performance are noted, a performance measure is obtained. These are plotted on a factor profile for each interest group. The factor profile is used to establish a dominant alternative and to carry out a trade-off analysis when one alternative is not dominant in every category.

The following discussion illustrates the result from the user's viewpoint and how the trade-off analysis produces a selected plan. Figure 11 shows the factor profile for these conditions (the numbers in circles represent the degree of attainment of the various alternatives).

In a comparison between alternatives 1 and 2, alternative 2 is superior to 1 in almost every category. It provides a slight improvement in station aggregate walk time and conflict, lessens the complexity of path choice, and provides a more unified visual theme.

In a comparison of alternatives 2 and 3, both have advantages. Alternative 2 is favored because it is slightly less complex and safer (because of fewer stairways), requires fewer level changes, and provides more concession space. On the other hand, alternative 3 requires less walking, reduces conflicts, eliminates exposed platform areas, and has more observable space. Since some of the advantages of alternative 2 make it only slightly better than 3 whereas those in which alternative 3 excels are quite significant, alternative 3 is more desirable from the user's point of view.

In a comparison of alternatives 3 and 5, alternative 5 dominates alternative 4 and thus alternative 4 is eliminated from consideration. Analysis of the positive attributes of each alternative would indicate that users prefer alternative 5. Among the advantages of this alternative are reduced walking time, elimination of conflicts, fewer level changes, enclosed platforms, and a unified architectural theme.

A similar analysis of the alternative plans was carried out for special users and operators. The preferred alternatives are given below:

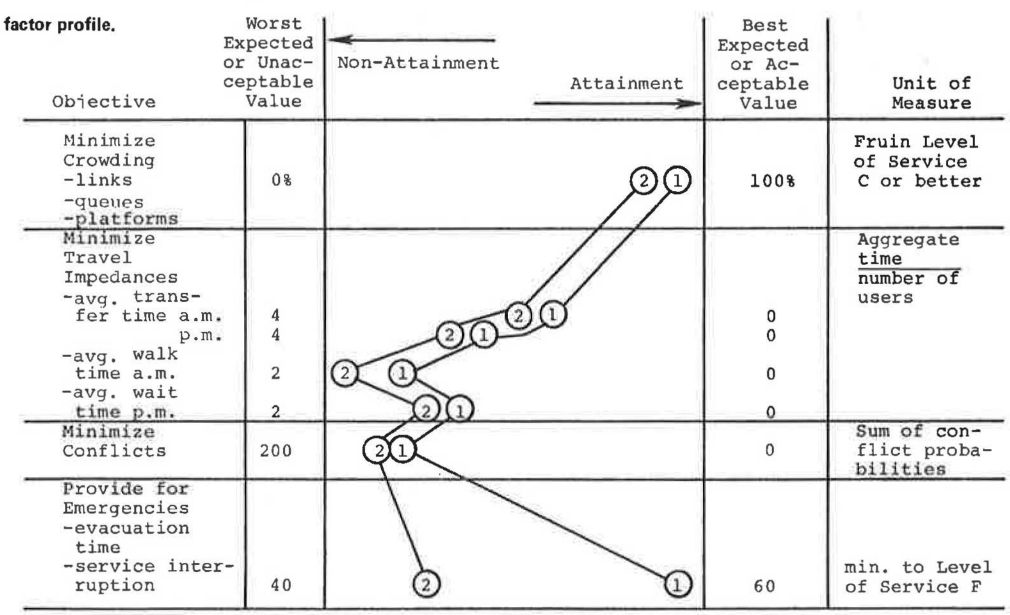
Group	Preferred Alternative Versus Second Choice
User	5 versus 3
Special user	5 versus 3
Operator	3 versus 4

The selection of alternative 3 by the operator is largely influenced by the cost involved: Alternative 3 costs $1.9 million, whereas alternative 5 costs $4.4 million. Since alternative 3 is the second choice of both users and nonusers, it will probably be selected. If alternative 3 were not a possible compromise, other situations would be examined until a final plan was reached.

Table 2. Relations among selected objectives, criteria, and performance measures.

Objective	Criterion	Performance Measure
Minimize crowding	Fruin level of service	Percentage level C or better
Minimize travel impedances	Path walk times	Minutes per path
	Path wait times	Minutes per path
	Aggregate walk time	Person minutes
	Aggregate wait time	Person minutes
	Aggregate transfer time	Person minutes
	Average transfer time	Minutes
Minimize conflicts	Fruin probability of conflict	Number of severe conflict areas
Provide comfortable environment	Thermal conditions	Temperature and humidity
	Noise level	dB(A)
Provide adequate lighting	Illumination level	Footcandles
Minimize costs	Capital cost	Dollars
	Operating cost	Dollars per year
	Maintenance cost	Dollars per year
Minimize impacts on local traffic	Additional delays	Person minutes
	Additional accidents	Increase in accident rates

Figure 5. User factor profile.



NOTE: Attainment values are given only where there is a significant difference between 1971 (1) and 1985 (2) values.

Figure 6. Plan view and elevation for alternative 1.

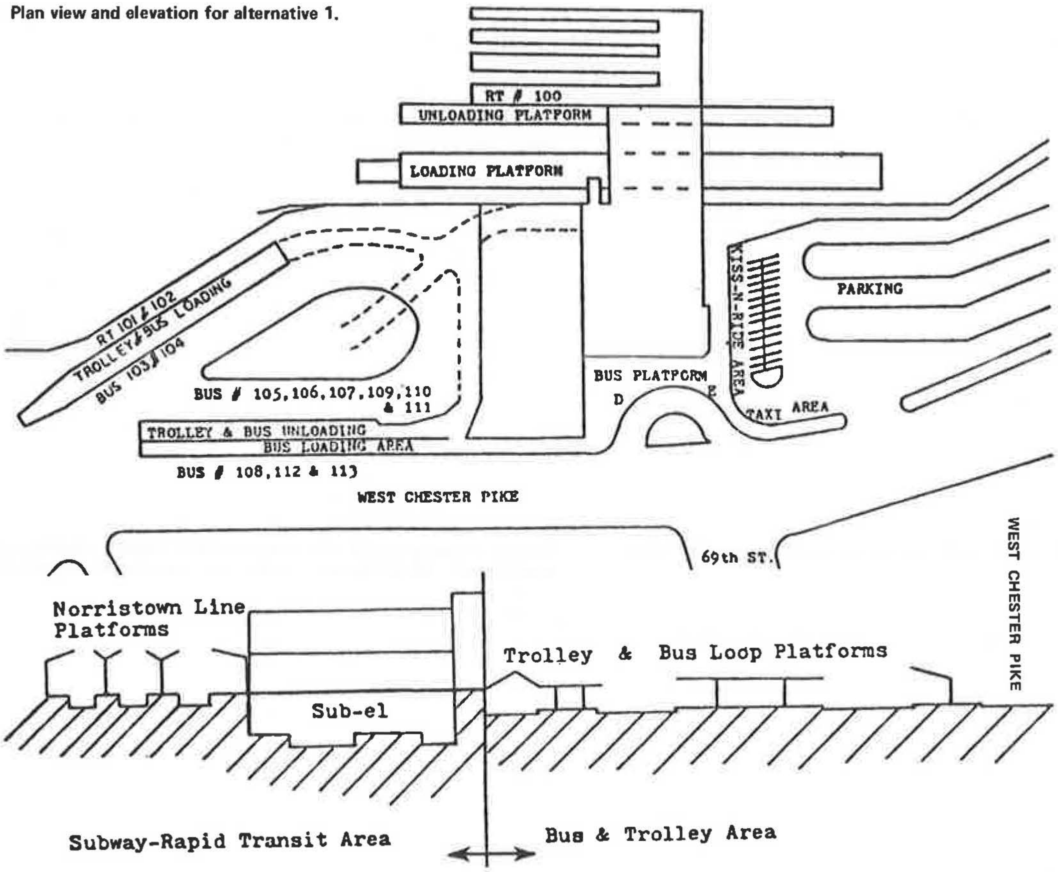


Figure 7. Plan view and elevation for alternative 2.

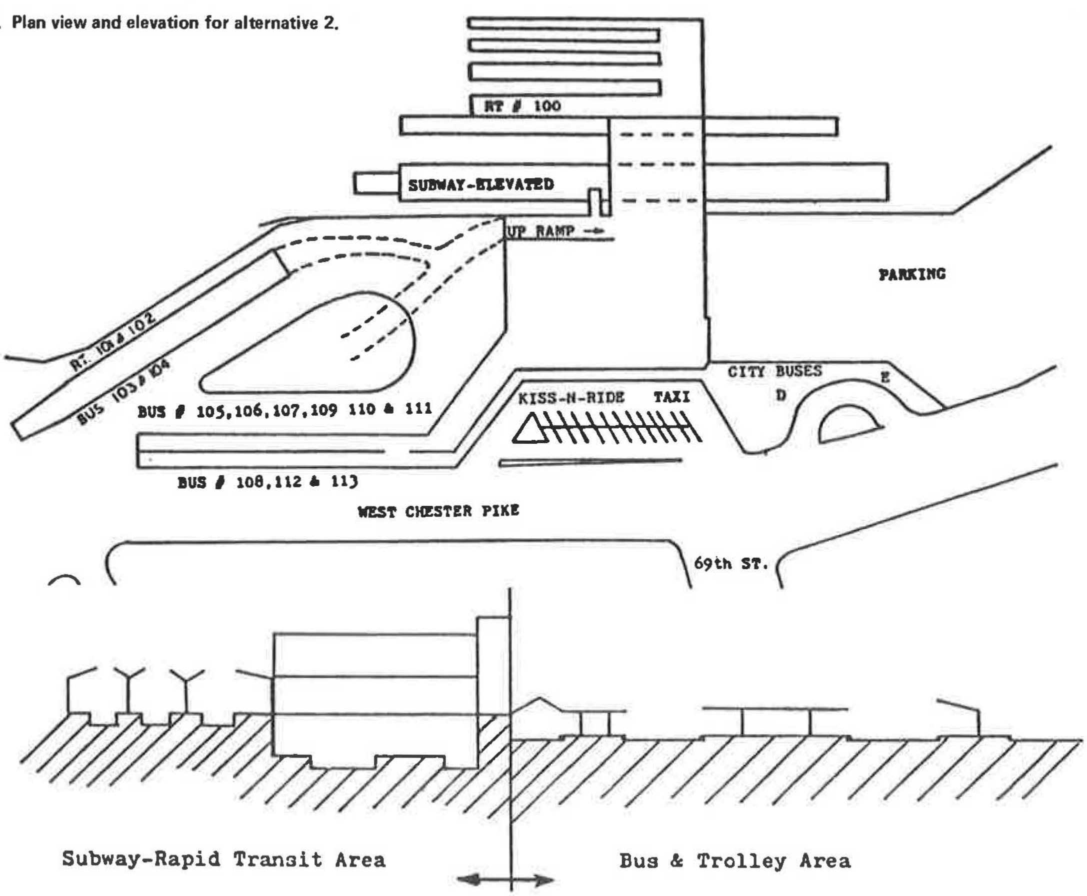


Figure 8. Plan view and elevation for alternative 3.

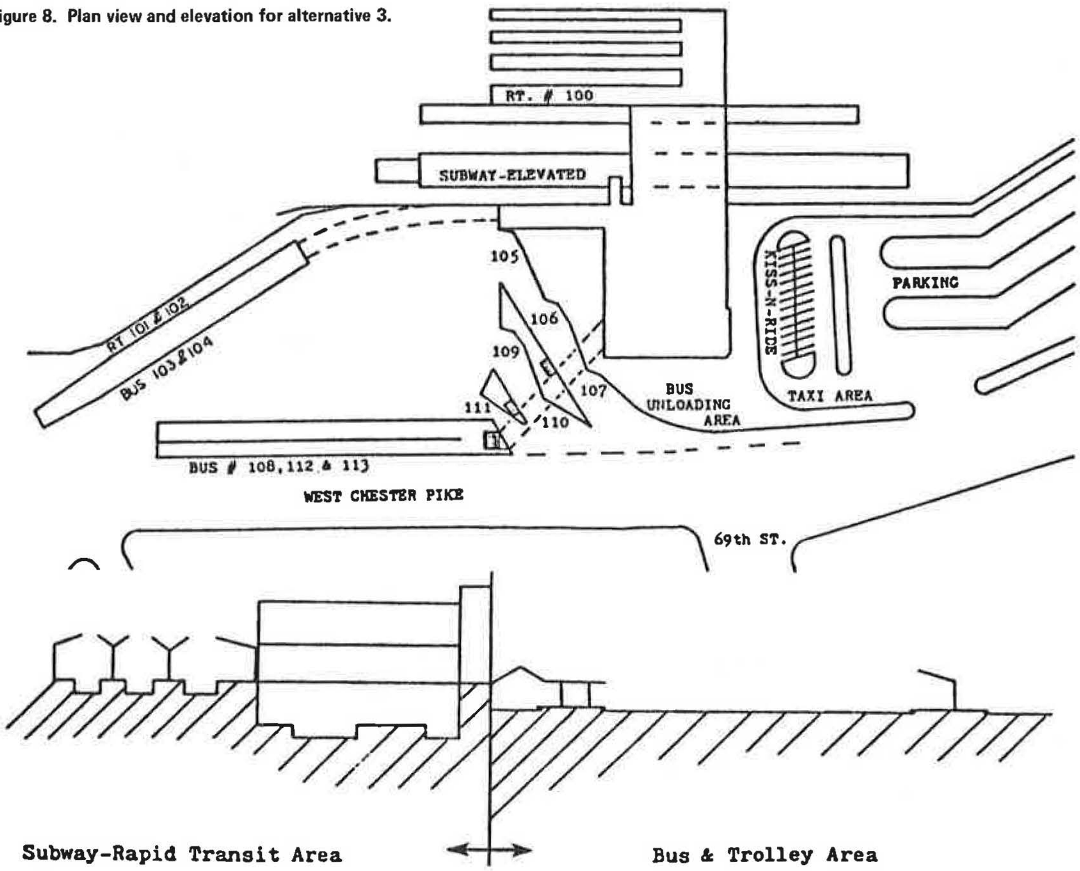


Figure 9. Plan view and elevation for alternative 4.

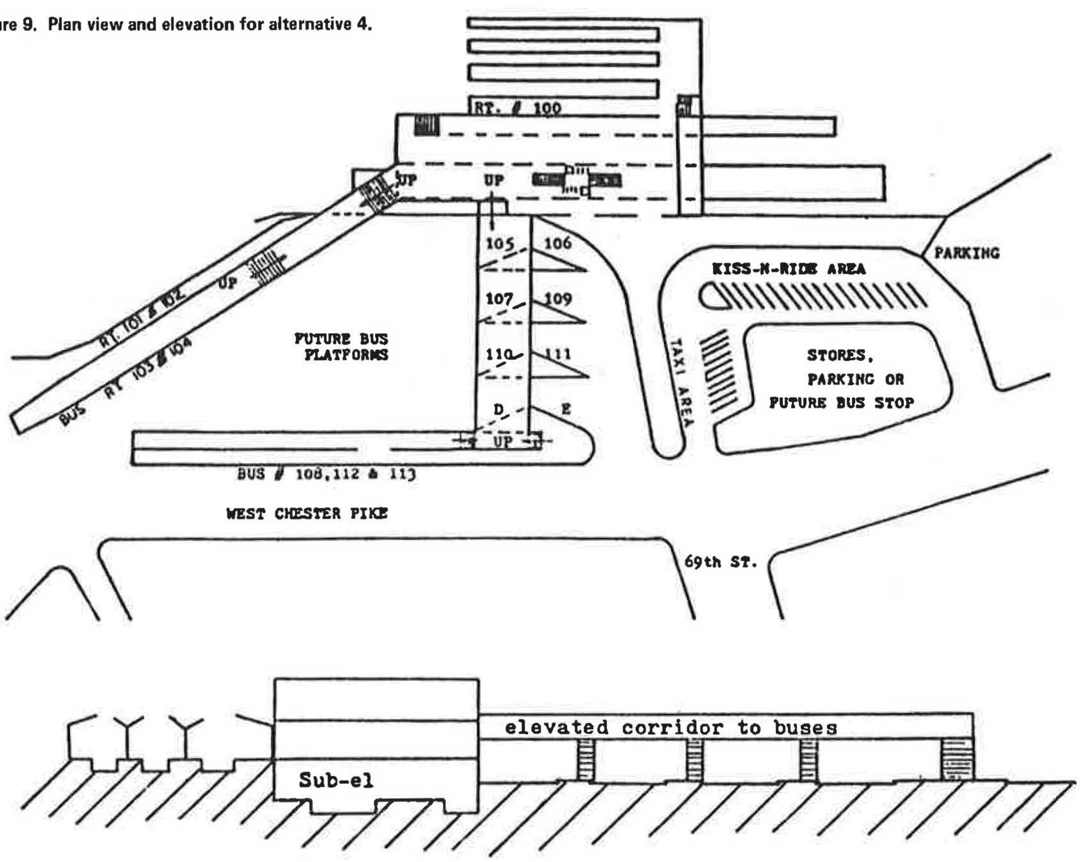


Figure 10. Plan view and elevation for alternative 5.

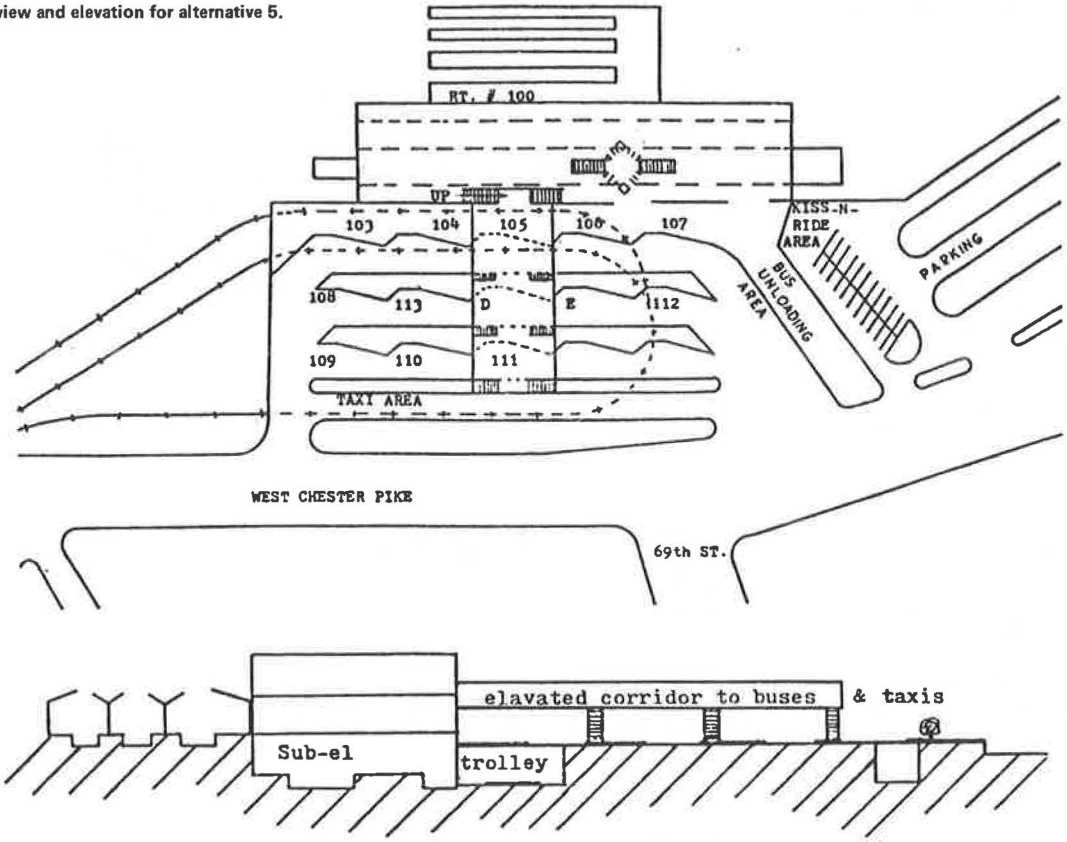
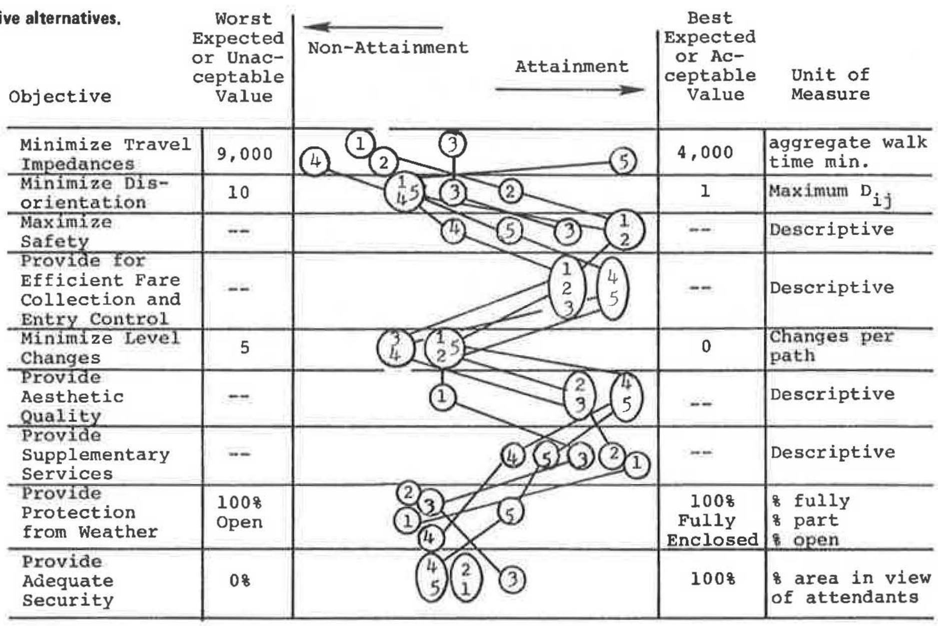


Figure 11. User factor profile for five alternatives.



REFINEMENT OF SELECTED PLAN

After the basic renovation plan has been selected, modifications are considered that will further refine the design. Among the elements considered are (a) reducing delays and movement conflict in the subway-elevated corridor, (b) reducing evacuation time, (c) accommodating additional bus stops, (d) improving turnstile and door reliability, (e) reducing transit noise, and (f) improving station orientation.

After the station-renovation plan is completed, detailed architectural and structural design plans and specifications, as well as detailed cost and finance estimates, must be prepared. A detailed construction plan that describes the staging of the work and the provisions required to maintain transit service during renovation is also required. The required provisions could include the rerouting of buses to other stations along the subway-elevated line. These would be undertaken if the project were selected for renovation and funds were allocated by the agency.

SUMMARY

The process for selecting a renovation plan for transit-station improvement has been described and illustrated by using a complex urban terminal facility. The process involves the establishment of goals, objectives, and criteria for each affected interest groups and evaluation of the existing terminal in terms of its performance and present policy. Alternative station layouts that improve movement patterns, reduce conflicts, and limit walking are developed. Each alternative is evaluated from the viewpoint of the interest groups affected, and the results are depicted in a factor profile diagram. Dominance and trade-off analysis are used to select an alternative for implementation.

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Joint Development Around Intermodal Transfer Facilities

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Efforts undertaken in the city of Baltimore to initiate joint development around transit stations are examined. Under the provisions of the 1974 amendment to the Urban Mass Transportation Act of 1964, the U.S. Department of Transportation could make grants or loans for the establishment of transit corridor development corporations and for the purchase of land and the development of property adjacent to transit stations. Baltimore was one of the first cities to apply for funds under the new legislation. Although the Urban Mass Transportation Act of 1964 has since been amended to remove specific authorization for the funding of transit-corridor development corporations, the Urban Initiatives Program, established in 1979, provided funding for the Baltimore program. The key factors underlying the successful development of the Baltimore program are identified. Specific joint-development projects are examined, and the main points of the joint-development application are discussed. Observations are offered on the nature of contemporary joint development and the involvement of the public sector.

A fundamental premise of the Urban Mass Transportation Act of 1964 is that mass transportation systems are required for desirable urban development. Yet new rapid transit systems have not fulfilled their promise of inducing beneficial urban changes. These changes can be implemented if transit planning and land use planning are linked and are strengthened by the authority and resources to implement land development. This was the impetus behind enactment of the 1974 Young Amendment to the act, which provided for federal funding of transit corridor development corporations (TCDCs).

Since the 1974 amendment, only a handful of cities have taken steps to obtain Section 3 grants (discretionary capital grants) for use in setting up TCDCs. Among these, Baltimore is the closest to receiving funding. Portland (Oregon) and Denver are also likely candidates. A number of other cities have undertaken preliminary joint-development studies and, under a grant from the Urban Mass Transportation Administration (UMTA), the Rice University value-capture team has studied several cities (1,2).

This paper examines the efforts undertaken in Baltimore to initiate joint development around several stations planned for the first section of the regional rail rapid transit system now under construction. Factors contributing to the joint-development program are discussed, and the history of the Baltimore effort is described. The organizational framework within which the joint-development plans were developed is discussed, and the joint-development application and constituent project plans are presented. The paper attempts to identify the key factors for a successful joint-development project. It is recognized, however, that each project is unique and no universal conclusions can be drawn from only one example. The paper concludes with some observations on the nature of contemporary joint development and the role of the public sector.

FACTORS LEADING TO JOINT DEVELOPMENT

The major factors that led to the joint-development projects undertaken in Baltimore can be summarized as follows:

1. A rail rapid transit system was already being built.
2. Baltimore was actively pursuing urban