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A CONCEPTUAL ANALYSIS AND EVALUATION FOR THE HARRISBURG INTERNATIONAL AIRPORT AS AN INTERMODAL AND MULTIMODAL FACILITY

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The Pennsylvania State University
University of Pennsylvania
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West Virginia University

The Pennsylvania State University • The Pennsylvania Transportation Institute • Research Office Building
University Park, PA 16802-4710
Telephone 814-865-1891 • FAX 814-865-3039

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6. AUTHOR(S)
Rachel D. Tait

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The Pennsylvania State University
Pennsylvania Transportation Institute
Research Office Building
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Intermodal transportation facilities are designed to accommodate various modes of transportation and to allow for the transfer of passengers and/or cargo from one travel mode to another. Modern intermodalism involves the systematic, integrated use of two or more modes in order to maximize the efficiency of the total movement. With the growing concerns over congestion and pollution air quality levels, there is an increasing interest in providing these types of facilities. Airports are a natural location for strong intermodal connections. By their nature, airports require passengers and freight to access facilities in a mode other than the airplane, thus creating great opportunities for intermodal efficiencies.

The objectives of providing an intermodal rail facility in this area are: 1) providing an option of access and higher quality of service and flexibility to passengers, 2) develop a rail terminal that is accessible to persons with disabilities, 3) offer a more environmentally compatible and cost-effective mode that may attract passengers who would otherwise travel by automobile, 4) provide a means for reducing congestion on airport roadways and access routes, 5) enhance the area's image as a modern city that may attract businesses and tourism, and 6) improve safety. The purpose of this paper is to incorporate these objectives while identifying a specific site location, or alternate locations of the rail terminal, preparing conceptual alternative designs, providing cost estimates, recommending a final design, and discussing conceptual commercial opportunities (i.e. possible hotel/convention center) which might arise as a result of a new rail station.

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ABSTRACT

Intermodal transportation facilities are designed to accommodate various modes of transportation and to allow for the transfer of passengers and/or cargo from one travel mode to another. Modern intermodalism involves the systematic, integrated use of two or more modes in order to maximize the efficiency of the total movement. With the growing concerns over congestion and pollution air quality levels, there is an increasing interest in providing these types of facilities. Airports are a natural location for strong intermodal connections. By their nature, airports require passengers and freight to access facilities in a mode other than the airplane, thus creating great opportunities for intermodal efficiencies.

An example of an intermodal/multimodal facility is the proposed rail stop on Amtrak's main line opposite the Harrisburg International Airport (HIA) terminal, which has been under consideration for a number of years. As early as 1970 the Commonwealth of Pennsylvania has discussed the opportunity of developing a rail passenger station stop adjacent to the HIA. A rail stop at this location offers an outstanding opportunity for intermodal development, an opportunity for a good financial return on investment due to the potential induced traffic and new markets that would be developed, and the fulfillment of the public's needs for improved transportation services in the region.

Rail service is not usually a viable option for most airports, however the Harrisburg International Airport location does have desirable characteristics where an intermodal rail facility will offer some benefits. Establishing a rail terminal adjacent to the HIA would afford passengers convenient intermodal connections between airline and rail travel to and from the Harrisburg/Lancaster area.

The objectives of providing an intermodal rail facility in this area are: 1) providing an option of access and higher quality of service and flexibility to passengers, 2) develop a rail terminal that is accessible to persons with disabilities, 3) offer a more environmentally compatible and cost-effective mode that may attract passengers who would otherwise travel by automobile, 4) provide a means for reducing congestion on airport roadways and access routes, 5) enhance the area's image as a modern city that may attract businesses and tourism, and 6) improve safety. The purpose of this paper is to incorporate these objectives while identifying a specific site location, or alternate locations of the rail terminal, preparing conceptual alternative designs, providing cost estimates, recommending a final design, and discussing conceptual commercial opportunities (i.e. possible hotel/convention center) which might arise as a result of a new rail station.

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Chapter 1

INTRODUCTION

Problem Statement

A proposed rail stop on Amtrak's main line opposite the Harrisburg International Airport (HIA) terminal has been under consideration for a number of years. As early as 1970 the Commonwealth of Pennsylvania and others have discussed the feasibility of developing a rail passenger station stop adjacent to the HIA. The very first discussion is thought to have taken place between the Commonwealth of Pennsylvania and Penn Central in 1967-68. A rail stop at this location offers an outstanding opportunity for intermodal development, an opportunity for a good financial return on investment due to the additional traffic and new Purposes that would be developed, and the fulfillment of the public's needs for improved transportation services in this region.

Background

Intermodal transportation facilities are designed to accommodate various modes of transportation and to allow for the transfer of passengers and/or cargo from one travel mode to another (Shapiro et al. 1996, p. 167). Modern intermodalism involves the systematic, integrated, use of two or more modes in order to maximize the efficiency of the total movement. With the growing concerns over air quality level, there is an increasing interest in providing these types of facilities.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) established a National Commission on Intermodal Transportation to study the status of intermodal standardization, intermodal impacts on public works infrastructure, legal impediments to efficient intermodal transportation, financial issues, new technologies, research and development needs, and the relationship of intermodal transportation to productivity (Transportation Research Board 1994, p. 17). The Clean Air Act Amendments of 1990 (CAAA) and ISTEA confronted transportation planners for improving the air quality and intermodal linkages at airports.

Airports are a natural location for strong intermodal connections. By their nature, airports require passengers and freight to access facilities in a mode other than the airplane, thus creating great opportunities for intermodal efficiencies (Transportation Research Board 1994, p. 161). Airports can serve as a major generator of economic activity, and effective intermodal access is a critical element in maintaining this activity.

In the airport environment, intermodal passenger transportation facilities should provide efficient and convenient transfers from one mode of travel to another while facilitating trips to and from the airport. According to Phillip Shapiro et al. (1996), the Center for Transportation Studies states that:

> ...the design of an intermodal facility is dictated by the nature of the transfers occurring there. Fundamentally, the transfer is perceived as an impediment to travel. All trips involving more than one mode of travel require a transfer, as do many trips on a single mode. Experience has shown that where the difficulty of transferring has been reduced, user satisfaction and the amount of travel have both increased. Since transfers cannot be entirely eliminated, it is essential to make them as quick and pleasant as possible. (p.167)

To do this, four "C's" have been identified as the core of intermodal transportation facility planning (Shapiro et al. 1996, p. 167):

- Connections- The convenient, rapid, efficient, and safe transfers of people and goods among modes that characterize comprehensive and economic transportation services.
- Choices- Opportunities afforded by modal systems that allow transportation users to select their preferred means of conveyance.
- Coordination- Providing timed transfers and connections to minimize delays and limiting baggage carrying.
- Cooperation- Collaborative efforts of planners, users, and transportation providers to resolve travel demands by investing in dependable, high quality transportation service, either by a single mode or by two or more modes in combination.

Greater integration among modes is one of ISTEA's key provisions. Federal regulations now require the following (Lacombe 1994, p. 385):

- Metropolitan transportation plans consider all transportation projects, regardless of the funding source.
- Metropolitan Planning Organizations (MPOs) develop transportation plans and transportation improvement programs (TIPs) in coordination with airport sponsors, port operators, rail operators, and other transportation providers.
- In nonattainment areas, MPOs include in TIPs, for informational and air quality

analysis, all regionally significant transportation projects, including airport projects.

- For MPOs designated or redesigned since December 18, 1991, the voting membership includes representation of major airports and of transportation providers. Other MPOs are encouraged to include airport sponsors in the formal decision making process.

Effective planning should consider the goals that the system is trying to achieve. The most obvious goals are to improve the access in terms of travel time, cost, and convenience. The first step in designing a transfer facility is to estimate the demand for the facility. The relationship between demand and facility design is one essentially of balancing the demand and physical constraints. The physical constraints are typically the governing concerns (Mounce and Stokes 1985, p. 7). Another important step in designing a transfer facility is to perform an operational analysis. This includes developing or modifying the bus, airplane, and rail schedules so that they will be in coordination with each other.

A transfer facility should consider having planning guidelines for 1) passenger need, 2) passenger arrival and departure patterns, 3) land requirements, availability, and impacts, and 4) costs. These factors, along with obvious economic and environmental considerations, should be used to determine when a facility should be developed, where it should be developed, and how it should be designed and related to urban land use and development patterns (Mounce and Stokes 1985, p. 112).

Evaluation of potential sites for a transfer facility should consider the following criteria (Mounce and Stokes 1985, p. 113-114).

1. Land Availability and Costs. Transfer facilities should be located on land that is vacant or easily acquired. Land acquisition should be reasonable relative to the total number of passengers served and the site's proximity to major interchange points. The site should be large enough to accommodate expansions for possible future growth.

2. Land Use Compatibility. The transfer facility should be located where it can complement nearby land uses. Land near industrial uses should be avoided. The location should result in minimal adverse operation effects on adjacent areas in the immediate vicinity of the site. Careful study of the present/future traffic projection, circulation patterns, future construction projects, and the projected impact of the facility are essential.

3. Passenger Attraction. The transfer facility should be located to make the service as effective as possible. An analysis should be made of existing transit schedules to determine the number of trips and usage, and the flexibility to adjust schedules to use the facility. The facility and its relation to nearby areas should maximize passenger attraction. This implies an attractive design and clear signing.

4. Security. Passenger security has become a major issue for urban mass transportation systems. Perceived security is a primary determinant of transit mode and use patterns. Fear of harassment or crime is the most significant factor preventing transit use. Attempts to control crime may involve manpower, technology, or design. Many security problems may be viewed as design oriented or architecturally based. For example, stations often have unused spaces or extensive open areas, planned as overflow areas, which may become problem areas used for loitering, drug dealing, illicit sexual activities, or other undesirable activities.

Problems Unique to this Project

Several problems were encountered when deciding on the alternative designs for this intermodal rail facility. One of the most significant problems was the physical constraints of the rail terminal and the adjoining passage to the airport. One example is the restriction of vertical clearances at the rail terminal, such as the electric lines and exit ramps located above the railroad tracks. Other issues that had the potential of creating substantial problems were superfund locations, ADA regulations, and parking.

To aid in developing a recommended design, a preliminary project flowchart was constructed to better guide the thought process. This preliminary flowchart and a brief outline can be seen in the following pages.

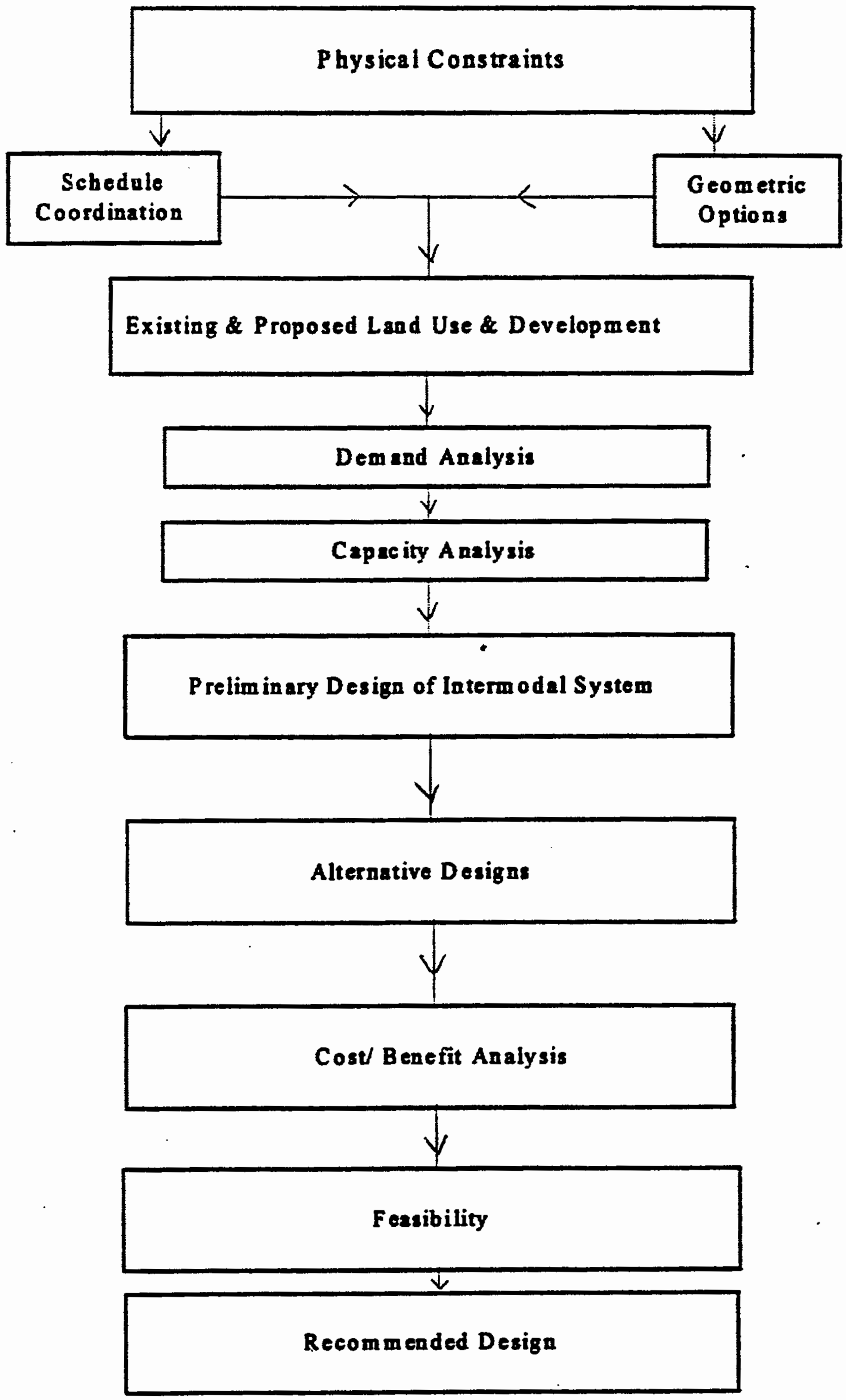


Figure 1.1: Preliminary Project Flowchart

PRELIMINARY PROJECT OUTLINE

I. Examine Physical Constraints of the Sites
  1. Schedule Coordination
    - Rail
    - Air
    - Road
  2. Geometric Options
    - Rail
    - Air
    - Road
II. Determine Existing and Proposed Land Use and Development
  1. Demand Analysis
    - Rail
    - Air
    - Road
    - Walkways
  2. Capacity Analysis
    - Rail
    - Air
    - Road
    -Walkways
III. Preliminary Design of Intermodal System
  1. Rail Service Operations
  2. Rail Station Terminal
  3. Air Service Operations
  4. Bus Service Operations
  5. Pedestrian Walkway/ Feeder Bus/ People Mover
  6. Commercial Opportunities
  7. Parking
  8. ADA issues
IV. Alternative Designs
V. Cost/Benefit Analysis
VI. Feasibility
VII. Recommended Design

Chapter 2

DESCRIPTION OF EXISTING CONDITIONS AND TREND ANALYSIS

History

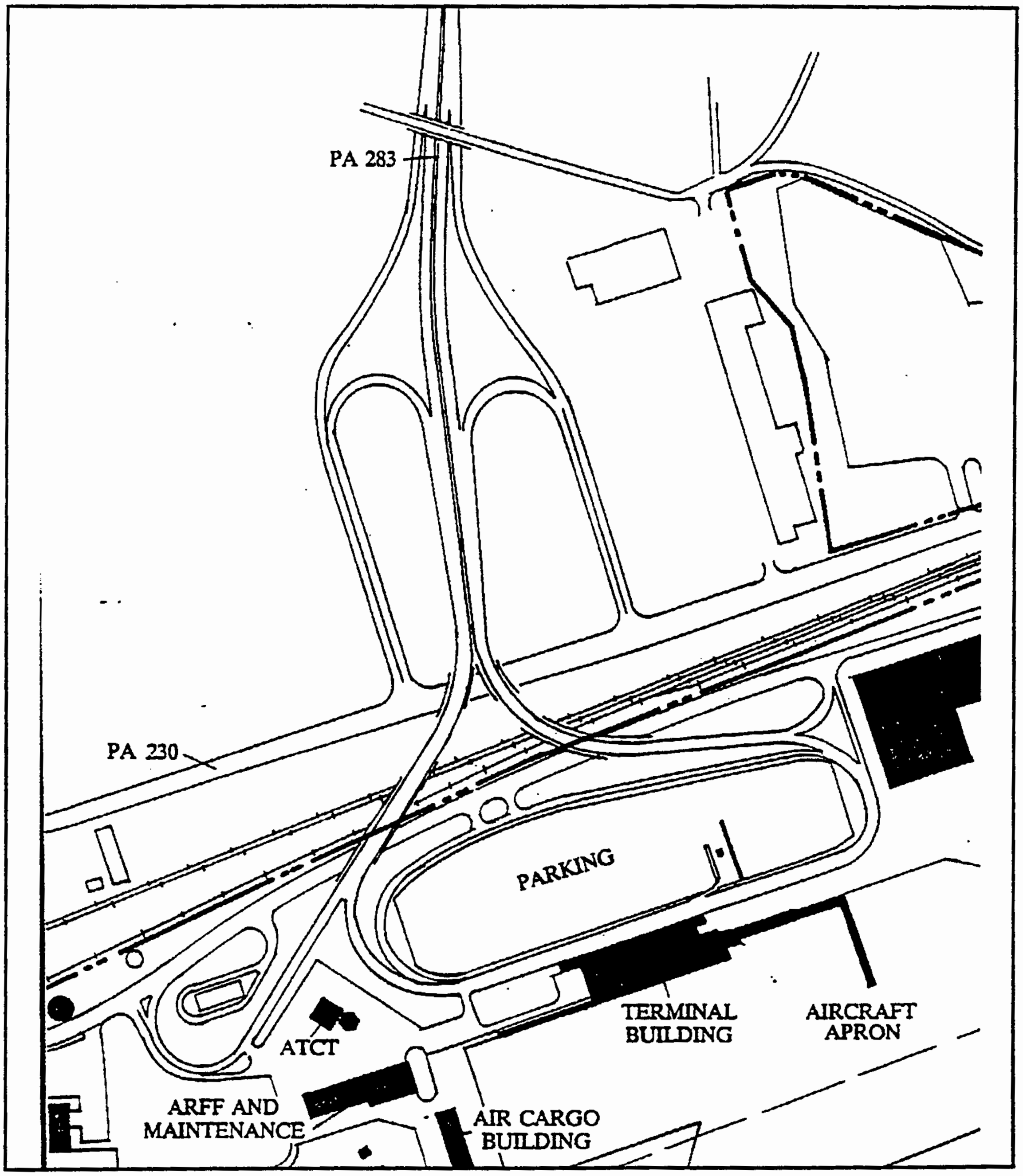
The Harrisburg International Airport is still in its formative years. In 1967, ownership of the Olmstead Air Force Base was transferred to the Commonwealth of Pennsylvania. This marked the beginning of commercial air service to this field. Since then, the airport has been christened Harrisburg International Airport, and it has become the primary airport serving a ten-county area. In 1986, a new $16 million passenger terminal was built to better serve the customer. This new terminal was designed to offer customer friendly services and conveniences (HIA Master Plan 1990, pp. I-1-2).

Existing Conditions

The following aspects were examined in the existing conditions: ground access, parking, the air terminal building, and the airfield operations.

Ground Access

Ground access to the Harrisburg International Airport consists of one primary mode, which is the automobile. The airport is approximately nine miles southeast of the downtown center of Harrisburg, and it is not served by the main public transportation system in Harrisburg, Capital Area Transit (CAT). There is a major rail corridor on the boundary of the airport property, but there is no passenger rail service at this location at this time. Local hotels have courtesy shuttle buses that serve the airport, and taxi services are available. Ground access is achieved mainly through a limited-access roadway, PA 283. The airport's location between the Susquehanna River and the Conrail and Amtrak railroad lines limit the airport's ground access. PA 230 runs parallel to the rail lines on the far side of the airport and continues into downtown Harrisburg as Front Street. PA 283 is the major access route running between Harrisburg and Lancaster to the airport which functions as a limited access, four lane roadway. Approximately three miles away from the airport grounds, PA 283 intersects the Pennsylvania Turnpike at Interchange 19. There is an interchange with PA 230 just north of the tracks. This interchange's ramps end at Airport Drive, on the south side of the tracks. This roadway provides a high-quality access point for all automobile travelers, because of its connections with other major roads including the Pennsylvania Turnpike, I - 81, and I - 83. Encouraging travelers to leave their automobiles behind, when there is such an attractive roadway system in place, is difficult. A diagram of existing airport facilities is shown in Figure 2.1. An overview of the surrounding area can be seen in Figure 2.2.



Legend: ARFF= Aircraft Rescue and Fire Fighting, ATCT= Air Traffic Control Counters

Figure 2.1: Existing Airport Facilities and Surroundings

Source: Master Plan Harrisburg International Airport. The Pennsylvania Department of Transportation and Bureau of Aviation. October 1990, p. I-15.

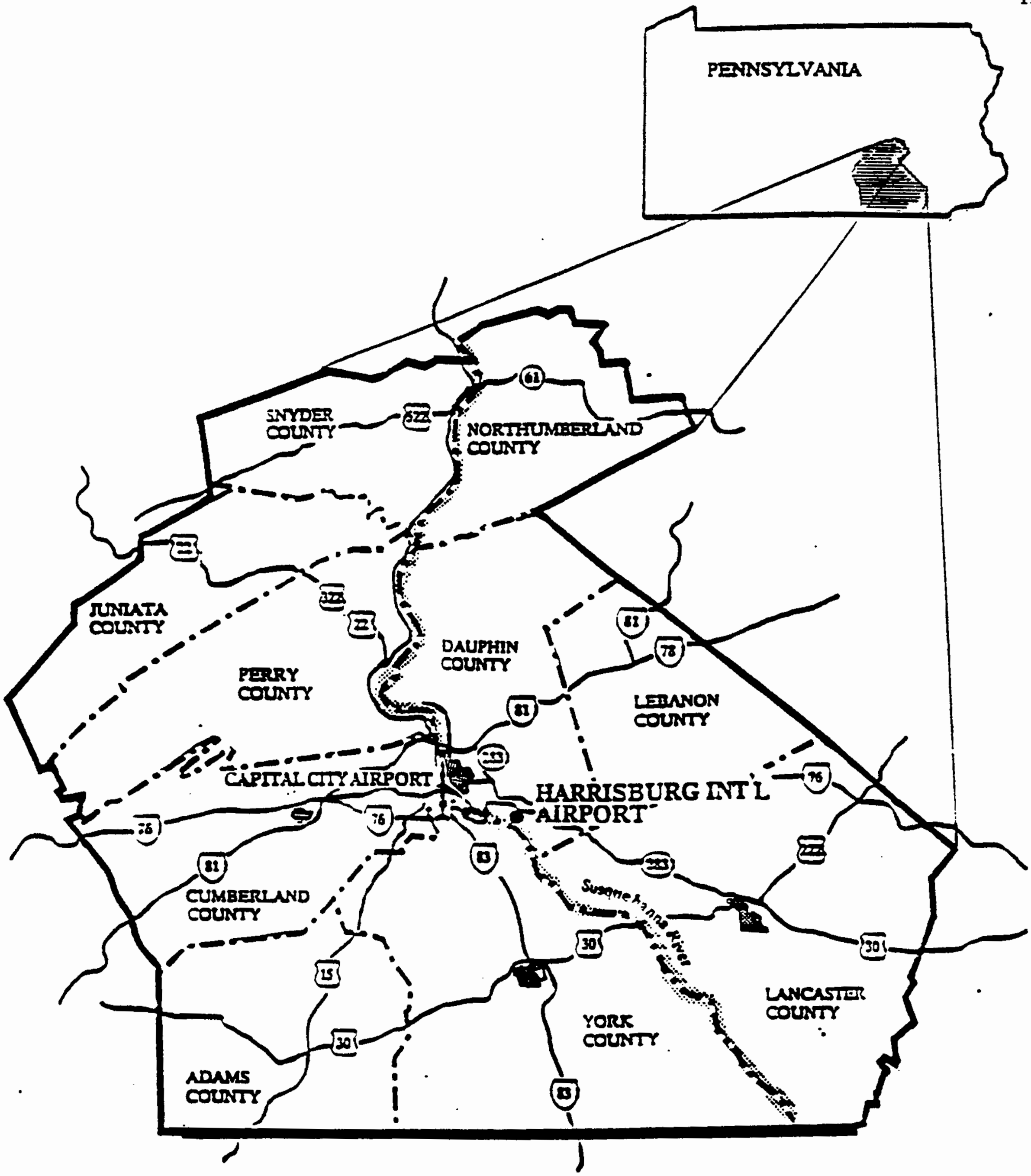


Figure 2.2: Overview of the Area Surrounding the Airport

Source: Master Plan Harrisburg International Airport. The Pennsylvania Department of Transportation and Bureau of Aviation. October 1990, p. I-3.

Parking

HIA currently has parking for 2,050 vehicles. This includes the main parking area that is encircled by the airport driveway, which has 1,250 spaces, and the long-term parking lot, which is on the far side of PA 230. The long-term parking currently has space for 800 vehicles. The airport parking situation may soon be supplemented by new construction of a parking area on the east end of the airport property (HIA Master Plan 1990, p. VIII-10). Also, if development plans continue on schedule, there is potential for a hotel/conference center to be built over the current main parking lot, and a multi-story parking garage could be built into the hotel building to help alleviate parking congestion.

Air Terminal Building

As previously noted, the air terminal building was built in 1986, but according to the HIA Master Plan (dated 1988), the terminal building is expected to outgrow its facilities by 1998 (HIA Master Plan 1990, pp. IV-14-39). This indicates a definite need to improve the existing facilities, including space for ticketing operations, baggage handling, waiting lobbies, concessions, and administrative offices. It is noted in the master plan that sufficient property is owned by the airport to accommodate increased landside space requirements. However, to fulfill future needs of airside operations, it may be necessary to acquire more land.

Airfield Operations

There is currently one 9,000 foot long runway at this airport, and addition of runways seems prohibitive, due to the airport's location along the Susquehanna River. Currently, seven commercial carriers serve the airport, including Continental, Delta, Northwest, American, United, and USAir. These carriers total approximately 120 flights (arriving plus departing) per day. In addition, general aviation accounts for approximately 350 flights per day. This airport is currently (1997) operating at approximately 80-85 percent of its capacity. Eighty percent of capacity is considered an 'action level' for capacity improvements. When an airport reaches 60 percent of its capacity, a plan for airfield expansion should be investigated, and that plan should be put into use at the 80 percent threshold. Projections indicate that the airport will reach airfield capacity in the 2000-2005 year range (HIA Master Plan 1990, p. II - 81).

Trend Analysis

Ridership at the Harrisburg International Airport is growing, according to the HIA Master Plan. At the rates of growth predicted in 1988, the operations shown in Table 2.1 can be expected. With this growth, it can be expected that congestion will increase on the landside means of access to this airport. Planning should consider these forecasts to determine how much traffic will be generated by the airport. Along with growth in air operations, there will be a corresponding growth in landside operations. Surface transportation modes will be stressed, and public transportation options can ease some of this burden.

Table 2.1: 1988 Harrisburg International Airport Operations Forecast

Year	Enplanements # Passengers	Passenger Air Operations # Planes	Mail Tons	Freight Tons
1983	309,447	23,814	2,377	12,656
1988	580,086	47,402	3,940	27,550
1993	908,700	65,600	4,950	37,689
1998	1,133,300	77,300	6,322	48,155
2003	1,315,500	86,500	7,986	58,859
2008	1,516,300	94,000	9,975	69,890

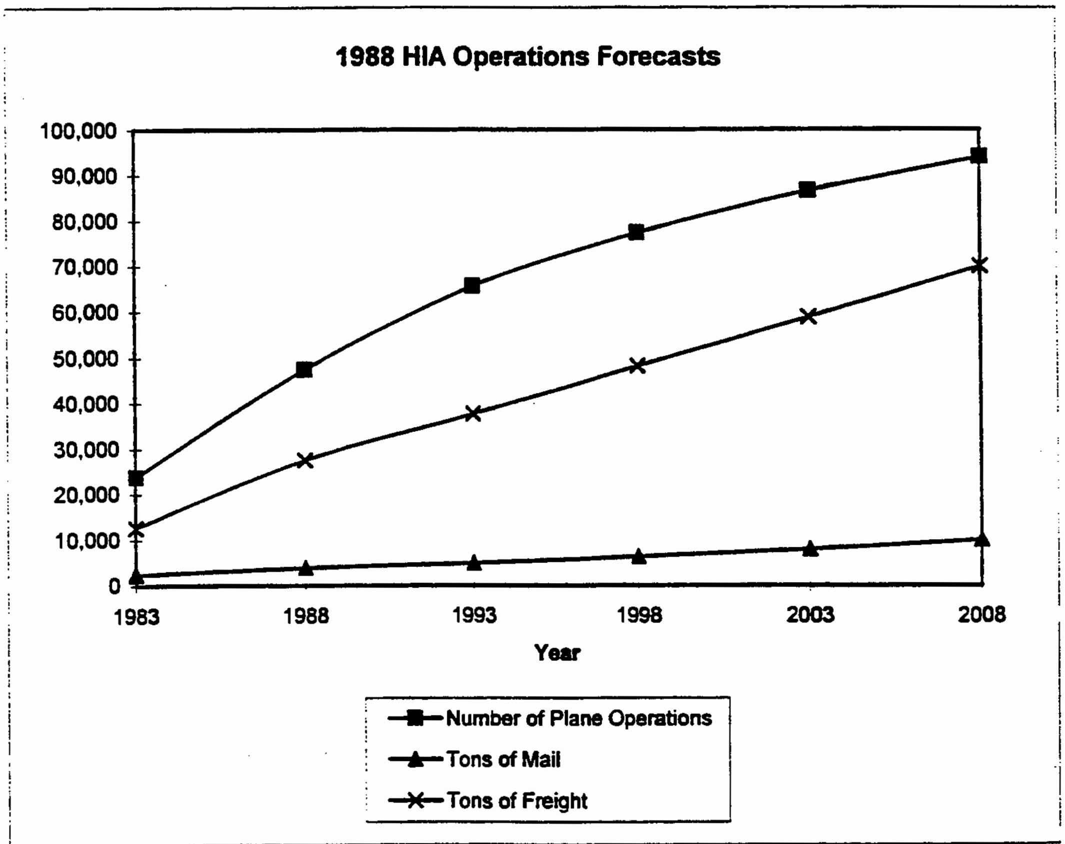


Figure 2.3: 1988 Harrisburg International Airport Operations Forecast

Chapter 3

OBJECTIVES, GOALS, AND PERFORMANCE MEASURES

Objectives

Even the most successful airport access rail service in the United States carries less than 10 percent of originating and terminating passengers to and from the airport (Shapiro et al. 1996, p. 154). Rail service is not usually a viable option for most airports, however the Harrisburg International Airport location does have desirable characteristics where an intermodal rail facility would offer some benefits. Establishing a rail terminal adjacent to the HIA would afford passengers convenient intermodal connections between airline and rail travel to and from the Harrisburg/Lancaster area. The objectives of providing an intermodal rail facility in this area would include the following: 1) provide a choice of access and higher quality of service and flexibility to passengers, 2) develop a rail terminal that is accessible to persons with disabilities, 3) offer a more environmentally compatible and cost-effective mode that may attract passengers who would otherwise travel by automobile, 4) provide a means for reducing congestion on airport roadways and access routes, 5) enhance the area's image as a modern city that may attract businesses and tourism, and 6) improve safety. The possible alternative designs for the intermodal facility at the Harrisburg International Airport were built upon these objectives.

In designing an intermodal facility, it is necessary to consider the associated human factors variables. Hoag and Adams (1974, p. 5) state that the major classification of human factor variables that must be considered are the following:

- Vehicle and Station Interior
- Convenience and Mobility
- Time
- Operations, Schedule Reliability
- Information Systems for the Users
- Problems for Persons with Disabilities
- Safety and Security
- Social Factors
- Psychological State (Rational and Irrational Phobias)
- Environmental Impact

Goals

The goals of this study include:

- Identifying a specific site location, or alternate locations of the rail terminal
- Preparing conceptual alternative designs which incorporate ADA components
- Providing cost estimates

- Recommending a final design
- Discussing conceptual commercial opportunities (possible hotel/convention center) which might arise as a result of a new rail station.

Performance Measures

In order to generate feasible solutions, performance measures were developed. Developing performance measures is an important step in any project where a variety of alternatives exist. A planner should establish what measures of performance and effectiveness will be used to monitor and evaluate the alternatives at an early stage.

The performance measures for this project included the following: capital cost, operating cost, user convenience, ADA requirements, safety, security, aesthetics, and rail operations. An evaluation of the possible alternatives against the performance measures can be found in Chapter 8.

Capital and Operating Cost

The capital cost refers to the initial cost to build the facility. Cost estimates for the various alternatives have been determined in Chapter 9 of this paper. The operating cost refers to the actual operation, maintenance, and improvements needed to maintain a quality facility. Operating costs were beyond the scope of this project and are not provided in this paper.

User Convenience

Convenience and flexibility are two basic requirements for any facility that is designed to compete with the automobile. Many people will not use a mass transit or intermodal facility because it is too inconvenient for them. In a recent study, it was found that 1) speed and travel time are two of the most prominent factors affecting mode choice, 2) waiting for vehicles is distressing to travelers, and 3) schedule reliability is an important determinant of modal choice. Convenience seems to be a major reason for choosing to travel by automobile rather than other modes of travel. Lack of comfort is another negative determinant that eliminates certain modes. Other factors that riders may consider inconvenient are 1) the vehicle ride quality, 2) the entry and exit, and 3) the internal vehicle environment. Vehicle ride quality includes features such as acceleration, vibration, noise, temperature, and humidity. Entry and exit includes the perceived effort of entering and exiting the vehicle. It includes discomfort for handling packages or children, handicapped access, crowding, and access to overhead storage racks. The internal vehicle environment references the area in which the passenger travels. These factors greatly affect the style in which a person feels when he/she is traveling. Factors here include the following: perceived security and safety, control over one's situation, personal space, and the ability to communicate with the operator of the system. The effect of interaction with strangers may also influence an individuals choice of mass transportation.

ADA Requirements

Making sure the facility is accessible to people with disabilities is a very important step in determining the recommended design. The 1990 American with Disabilities Act (ADA) requires that new or altered rail stations be accessible to and usable by persons with disabilities, including wheelchair users. In a study conducted by the Northern Virginia Transportation Commission, an ADA design requirement checklist was developed. This checklist should also be used when considering the recommended design. The checklist can be seen on the following pages.

ADA DESIGN REQUIREMENTS CHECKLIST

Parking

Accessible spaces are to:

- have enough accessible parking spaces:

  Total in lot _____ Regular Accessible ____ Van Access ____

- be closest to the boarding platform or the route to the boarding platform.
- be painted with the correct dimensions (13' [4.0m] or 8' [2.4m] sharing, 5' [1.5m] free space; 16' [4.9m] for van)
- have signage properly mounted at handicapped spaces
- have curb cuts from the space onto the sidewalks
- have minimum vertical clearance of 8'2" [2.5m] (9'6" [2.9m] for van spaces)
- have slope $\leq$ 2.0%, paved or hard packed

Drop Off Area

Drop off area is to:

- be 20' [6.1m] by 5' [1.5m] and with accessible path to the boarding platform
- have a minimum clearance of 9'6" [2.9m]
- have signage for required drop off areas

Accessible Paths of Travel

Accessible paths of travel are to:

- provide signage where accessible path varies from standard path
- have walkways at least 36" [0.9m] wide and clear
- be 60" [1.5m] by 60" [1.5m] passing every 200' [61m]
- include pedestrian bridges and overpasses ramped to standard
- include curb cuts at all intersections with curbs, aligned with cross walks and at correct dimensions:

  Slope $\leq$ 8.33%

  Adjoining walkways $\leq$ 5.0%

curb cuts ≥ 36" [0.9m], excluding flared sides

curbs cuts through street islands

- have tactile warning of 36" [0.9m] at vehicle travel lanes without curbs
- have clear head room of 80" [2.0m]
- be surfaced paved or hard packed
- have all slopes ≥ 5.0% treated as a ramp:

    Slope ≤ 8.33%

    Cross slope ≤ 2.0%

    Rest spaces ≥ 60" [1.5m] level at every 30' [9.1m] linear or 30" [0.8m] rise

    Hand rails

        round or oval with diameter 1.25" [3.2cm] to 1.5" [3.8cm]

        on both sides @ 34" [0.9m] to 38" [1.0m]

        continuous through ramp

        12" [0.3m] extension

            top

            bottom

    Properly drained

- have cross slopes throughout path of travel ≤ 2.0%
- have non-slip surfaces
- not have vertical surface changes > 0.5" [1.3cm]
- have vertical changes≥ 0.25" [0.6cm] and ≤ 0.5" [1.3cm] jointed and beveled ≤ 50.0%
- have gratings in pathways ≤ 0.5"[1.3cm] lined up across the direction of travel

Boarding Platform

Boarding platform:

- should have a portion that provides direct access to vehicles

    with: Vertical gap < 1 to 1.5" [2.5 to 3.8 cm]

    and Horizontal gap < 3" [7.6cm]

- accessible area is not to be isolated from main boarding area
- access area is to be sheltered to same standard as regular boarding area
- lighting at accessible boarding area to same standard of station
- is to have 24" [0.6m] tactile warning strip with regular raised pattern, recognizable underfoot and of contrasting color for full platform length
- is to have ramps conforming with path of travel standards
- is to have guard rails around back and side perimeters of raised platform

Signage and Communication

Signage and communication should:

- show variations in accessible routes from common route marked
- show accessible boarding areas marked as such
- show conforming station name signs visible from train
- if suspended or projected, have ≥ 80" [2.0m] clearance or is protected by barrier
- have width to height ratio between 3:5 and 1:1 and stroke to height ratio between 1:5 and 1:10
- have non-glaring surface and background color
- have high contrast lettering and symbols
- include station name Braille signs at entrances and/or ticket windows or vending machine
- include visual warnings and announcements provided wherever audio warning and announcements are made
- show permanent station line maps and/or lists comply for accessible format
- include raised and Brailled station ID at consistent location on platform mounted @ 60" [1.5m]

Other Considerations

Some other items which must be considered when designing for accessibility to the handicapped include the following:

- Steps and handrails (required only where no accessible alternative is provided)
- Ticket windows or vending machines
- Telephones

Safety and Security

Safety and security issues are of major concern when designing mass transportation systems. Transit management, employees, and commuters who use or those who want to use a mass transit system are directly affected by and have perceptions about the security of the transit system. Ridership is directly affected by negative perceptions of social behavior. Elements such as graffiti, loud radios, boisterous behavior, and bad language are disturbing to most commuters. Some people believe that the development and incorporation of a public transportation system will hurt their property values, bring strange and unwelcome people into their neighborhoods, and deliver crime to their doorstep. These types of transportation systems connect communities that might otherwise not have come into contact with one another. In this situation, it is not strange for some social, economic, and ethnic tensions to arise.

Four major problems arise with transit security. These are 1) intergenerational, ethnic, and cultural conflicts, 2) problems with safety and drugs, 3) homelessness in these areas, and 4) lack of order and cleanliness which relate to a safe and civil transit environment.

One study (Mierzejewski and Ball 1990, p. 37) found that auto users' concern about crime on public transportation is highly correlated with trip origination point. Around 10 percent of the city residents commuting to their job within the city expressed concern about crime on public transportation as opposed to 5 percent of the city to suburb commuters, and 3 percent of the suburb to city and suburb to suburb commuters. The fact that one believes he or she may be assaulted while approaching a boarding area is reason enough to avoid riding the transit system. Fear of harassment or crime is one of the most significant factors preventing transit use.

The approach to reducing criminal and social problems on transit must include the community from which these problems originate. To have a better quality environment, it must be understood that the origin of the anti-social behavior is within the community and that the transit system is only a vehicle for transporting this behavior (Rumford 1995, p. 264). However, several actions which may be taken to convince the public that this type of transportation facility is a safe and efficient mode of transportation. These actions include enhancing public relations, increasing policy enforcement, and developing a creative community outreach program. Other attempts to control crime may involve manpower, technology, or design. Increasing the police task force is very effective. It sends out the signal that these transportation areas will not be used as a conduit for criminal misconduct. Cameras at mass transit stations are currently being installed in some areas to deter crime.

Aesthetics

Aesthetics refers to the physical appearance or perception that a person has about the facility. This measure of effectiveness is not a true scientific quantitative measure, but rather a matter of opinion. Different people will no doubt have different views.

Rail Operations

This measure of performance is directly related to the options for the platform design. The platform options have varying degrees of rail operation complexity. For example, some options will need a fully centralized track control for the reversed signal control and other options may require automated traffic control, electrified control, and/or manual control.

Chapter 4

CURRENT AND FUTURE MARKET SEGMENTATION BASED DEMAND

One of the first steps in designing the intermodal rail facility was to estimate the current and the potential demand for the airport and the intermodal rail facility. The demand analysis for the airport for 1996 and the design year of 2020 is detailed in this chapter. The intermodal rail facility demand is provided in Chapter 6. Estimating the demand for the facility was primarily a task of balancing the airport modal split demand and the physical constraints.

In order to justify the construction of the intermodal rail terminal and to design the terminal for capacity constraints, an analysis of the existing and future demands had to be completed. The analysis is done using the following studies:

- PennDOT's Harrisburg International Airport survey to determine user satisfaction
- Keystone Corridor Origin / Destination Study
- Harrisburg International Airport Master Plan
- The 1990 Population Census for Pennsylvania
- Intermodal Ground Access to Airports: A Planning Guide from the FHWA
- The Terminal Area Forecast (TAF) for Harrisburg International Airport from the Federal Aviation Administration (FAA)
- ITE Trip Generation Manuals
- Airport Landside Operations and Air Service Record

The remainder of this chapter details the methodology used to estimate the current and future trips to and from the HIA for the purpose of either business or pleasure. It also estimates the daily trips to the airport and a proposed new hotel and mall. This chapter considers two categories of trip purposes: 1) the air passengers and those people accompanying them to get to the airport for non business or leisure travel, and 2) the commuters who want to go to the airport, hotel and mall for business.

Current Trip Estimation, by Purpose

In order to estimate the demand for an intermodal rail facility at the Harrisburg International Airport, an understanding of the current conditions at the airport itself was needed. It was necessary to determine the number of people currently emplaning and deplaning at the HIA and the number of commuters (i.e., people employed by the airport and its allied service and maintenance organizations, and the proposed hotel and mall). It was also necessary to determine the purpose of trips (i.e., whether leisure, business, or commuting). After analyzing these factors, it was possible to estimate the number of trips that would be attracted to and from the airport, hotel and mall. Table 4.1 shows the current, 1996 airport passenger estimates by Purpose and city of origin/destination. These trip estimates for 1996 were based on the total enplanements and deplanements estimated by the HIA Master Plan. Note that the total number of enplanements and deplanements was assumed to be equal, a typical planning assumption. The Harrisburg

International Airport's Master Plan (1990) was then used to calculate the split between the purpose of trip, whether it was for business or leisure. According to the Master Plan, 75 percent of passengers travel for business and 25 percent travel for leisure.

The next step in estimating demand was to determine the destination of these trips. Within each trip purpose, the destinations were determined using the PennDOT HIA User Satisfaction Survey (1990). Harrisburg and Lancaster are the two major cities served by the HIA, together accounting for about 57 percent of the total passenger acivity. According to the survey 29 percent of the passengers were from Harrisburg and 28 percent of the passengers were from Lancaster. Knowing these destinations, it was possible to estimate the number of passengers boarding at Harrisburg International Airport per year from either Harrisburg or Lancaster and also the number of passengers who arrive at HIA and travel to Harrisburg or Lancaster.

By knowing the number of emplanements per year, it was possible to determine the number of passengers for the average day and peak day. The peak month and peak day factors were used in this part of the demand analysis. The numbers for the peak day emplanements and deplanements were estimated using the Terminal Area Forecast for HIA (1997) and the HIA Master Plan (1990). A peak month factor of 0.0960 was given in the HIA Master Plan. The peak day factor was calculated by dividing the peak month factor (0.0960) by 30.4375 (the average number of days in a month). The peak day factor explains what the percentage increase will be for the busiest day in the month.

Table 4.1: 1996 Passenger Counts by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	147667	404	466
	Lancaster	142575	390	450
	Total	290243	795	915
Leisure	Harrisburg	49222	135	155
	Lancaster	47525	130	150
	Total	96748	265	305
Total	Harrisburg	196890	539	621
	Lancaster	190100	520	600
	Total	386990	1060	1221
Deplanements				
Business	Harrisburg	147667	404	466
	Lancaster	142575	390	450
	Total	290243	795	915
Leisure	Harrisburg	49222	135	155
	Lancaster	47525	130	150
	Total	96748	265	305
Total	Harrisburg	196890	539	621
	Lancaster	190100	520	600
	Total	386990	1060	1221
All Passengers				
Business	Harrisburg	295335	809	931
	Lancaster	285151	781	899
	Total	580485	1589	1831
Leisure	Harrisburg	98445	270	310
	Lancaster	95050	260	300
	Total	193495	530	610
Total	Harrisburg	393779	1078	1242
	Lancaster	380201	1041	1199
	Total	773980	2119	2441

Table 4.2 shows the current, 1996 passenger and non-air traveler estimates by purpose and city of origin/destination. The same methodology was used as the 1996 passenger counts by trip purpose (75 percent business and 25 percent leisure), however, for this portion of the study the number of non-air passengers was also taken into account. According to the HIA Master Plan (1990), 0.25 non-air passengers accompany business travelers and 0.92 accompany those traveling for leisure. What this means is that for every four air passengers traveling for business there will be one person accompanying them to the airport. Similarly, for every 10 passengers traveling to the airport for leisure there will be about nine persons accompanying them.

Table 4.2: 1996 Passenger and Non-Air Traveler Estimates by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	184584	505	582
	Lancaster	178219	488	562
	Total	362803	993	1144
Leisure	Harrisburg	94507	259	298
	Lancaster	91248	250	288
	Total	185755	509	586
Total	Harrisburg	279091	764	880
	Lancaster	269467	738	850
	Total	548558	1502	1730
Deplanements				
Business	Harrisburg	184584	505	582
	Lancaster	178219	488	562
	Total	362803	993	1144
Leisure	Harrisburg	94507	259	298
	Lancaster	91248	250	288
	Total	185755	509	586
Total	Harrisburg	279091	764	880
	Lancaster	269467	738	850
	Total	548558	1502	1730
All Passengers				
Business	Harrisburg	369168	1011	1164
	Lancaster	356438	976	1124
	Total	725606	1987	2289
Leisure	Harrisburg	189014	517	596
	Lancaster	182496	500	576
	Total	371510	1017	1172
Total	Harrisburg	558182	1528	1761
	Lancaster	538935	1476	1700
	Total	1097117	3004	3460

Future Trip Estimation, by Purpose

An understanding of the future conditions of the Harrisburg International Airport was needed in order to determine how much the airport demand would grow and correspondingly if the demand for a rail station would grow. Passenger predictions by Purpose and city of origin/destination for the year 2020 are shown in Table 4.3. An airport growth factor of 4.32 percent was established using the Federal Aviation Administration's Terminal Area Forecasts for the HIA. This growth factor was applied to the 1996 conditions thus giving the future demand.

Table 4.4 (like Table 4.2 for the existing conditions) not only includes the air passenger demand estimates but also the non-air traveler demand estimates. Again, the same percentages of 0.25 and 0.92 (as previously explained in the current trip estimation by Purpose section of this chapter) obtained from the HIA Master Plan were used for the non-air traveler estimations.

Table 4.3: 2020 Passenger Predictions by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	278577	763	879
	Lancaster	268971	736	848
	Total	547547	1499	1727
Leisure	Harrisburg	92859	254	293
	Lancaster	89657	245	283
	Total	182516	500	576
Total	Harrisburg	371436	1017	1172
	Lancaster	358628	982	1131
	Total	730063	1999	2303
Deplanements				
Business	Harrisburg	278577	763	879
	Lancaster	268971	736	848
	Total	547547	1499	1727
Leisure	Harrisburg	92859	254	293
	Lancaster	89657	245	283
	Total	182516	500	576
Total	Harrisburg	371436	1017	1172
	Lancaster	358628	982	1131
	Total	730063	1999	2303
All Passengers				
Business	Harrisburg	557154	1525	1757
	Lancaster	537941	1473	1697
	Total	1095095	2998	3454
Leisure	Harrisburg	185718	508	586
	Lancaster	179314	491	566
	Total	365032	999	1151
Total	Harrisburg	742871	2034	2343
	Lancaster	717255	1964	2262
	Total	1460127	3998	4605

Table 4.4: 2020 Passenger and Non-Air Traveler Estimates by Purpose and City of Origin/Destination

		Year	Pk Hr	Pk Day
Emplanements				
Business	Harrisburg	348221	185	1098
	Lancaster	336213	179	1060
	Total	684434	364	2159
Leisure	Harrisburg	178289	95	562
	Lancaster	172141	91	543
	Total	350430	186	1105
Total	Harrisburg	526510	280	1661
	Lancaster	508355	270	1603
	Total	1034865	550	3264
Deplanements				
Business	Harrisburg	348221	185	1098
	Lancaster	336213	179	1060
	Total	684434	364	2159
Leisure	Harrisburg	178289	95	562
	Lancaster	172141	91	543
	Total	350430	186	1105
Total	Harrisburg	526510	280	1661
	Lancaster	508355	270	1603
	Total	1034865	550	3264
All Passengers				
Business	Harrisburg	696442	370	2197
	Lancaster	672427	357	2121
	Total	1368869	727	4317
Leisure	Harrisburg	356578	189	1125
	Lancaster	344282	183	1086
	Total	700861	372	2211
Total	Harrisburg	1053020	559	3321
	Lancaster	1016709	540	3207
	Total	2069729	1099	6528

Commuters

The estimate for the total number of employees at HIA, as shown in Table 4.5, was given by Mr. Randy Hicks, Resource Manager at HIA. This estimate includes all people employed by the airport and its allied service and maintenance organizations. According to the Intermodal Ground Access Planning Guide (Shapiro et al., 1996, pp. 78-79), an average of 73 percent of all employees are working at an airport on any given day. Since there was no information available on future employee estimates, it was decided to use this percentage for the estimated number of employees on site at the Harrisburg International Airport for a typical day in 1996 and 2020. The results are shown in Table 4.5.

Table 4.5: 1996/2020 Employee (Daily Airport Commuter) Trip Estimates

		Avg Day
Total Employee Estimate		2500
Number of Employees at Airport		1825
No. Trips		3650
No. Trips/ Employee	3650/1825	2

Hotel

For part of the demand analysis, the possibility of constructing a hotel was analyzed. The hotel trip estimates were determined using the ITE Trip Generation Manual (1996). The number of rooms needed was calculated by dividing the number of daily deplanements (which equals 1060) by 10. Therefore, these estimates are based on a hotel with 106 rooms. The following formula, obtained from page 519 of the ITE Trip Generation Manual, was used to calculate the number of al daily trips:

$$T = 8.802\,(x) - 59.208$$

x = # of occupied rooms

The yearly estimate was determined by multiplying the daily number by 365 days. The formula on page 523 of the ITE Trip Generation Manual was used for the peak hour :

$$T = [\,(1.237 / (x)) + 0.00071]^{-1}$$

It was decided to use these same estimates for the years 1996 and 2020 since the size of the hotel is not expected to change over this time period. Table 4.6 shows the results.

Table 4.6: 1996/2020 Hotel Trip Estimation

	Yearly	Daily	Peak Hr.
No. Trips	319229	874	81

Mall

If a mall were to be built in the area, it too would generate some trips. The mall trip estimates were also determined using the ITE Trip Generation Manual. The size of the mall was estimated to be 400,000 square feet of gross leasable area (GLA). The formula on page 1234 of the ITE Trip Generation Manual was used to estimate the number of daily trips:

$$Ln(T) = 0.625Ln(x) + 5.985$$

$$x = 1000 \text{ GLA}$$

The number obtained from these calculations was then multiplied by 365 days for the yearly estimate. The formula used for the peak hour estimate is on page 1240 of the manual:

$$Ln(T) = 0.635Ln(x) + 3.867$$

$$x = 1000 \text{ GLA}$$

Similar to the hotel, it was decided that the same numbers would be appropriate for both 1996 and 2020 since the size of the mall is expected to stay the same. The estimates are shown in Table 4.7.

Table 4.7: 1996/2020 Mall Trip Estimation

	Yearly	Daily	Peak Hr.
GLA		400000	400000
No. Trips	6139487	16809	2146

Parking

The number of necessary parking spaces was determined by looking at several different factors. These factors were employees, passengers, the hotel and the mall.

First, employee parking was taken into consideration. It was estimated that 1,825 employees are present at the airport on a given day. It was assumed that the typical shift is 8 hours long with three shifts daily. Therefore, the number of necessary spaces for employees was estimated by dividing 1,825 by 3. Secondly, passenger and non-air traveler parking was determined. The Airport Landside Operations and Air Service report stated that the FAA suggests a parking space per every one thousand yearly enplanements. As the hotel is airport related, it was decided that the number of parking spaces needed for the hotel should be estimated by dividing the total number of rooms in the hotel by two. The number of parking spaces for the mall was decided to be equal to the number of peak hour trip ends. The parking needs are shown in Table 4.8. Note that handicapped spaces would also be incorporated in these parking space estimates.

Table 4.8: Parking Needs

Number of Spaces	1996	2020
Employee Parking	608	608
Passenger/Non-Air Traveler Parking	549	1035
Hotel Parking	53	53
Mall Parking	2146	2146

Chapter 5

OPERATIONAL ANALYSIS

Operational analysis of an intermodal passenger facility is an important aspect to consider. Operational analysis, as defined in this report, is concerned with several major tasks which include the following: scheduling passenger service on the rail side of the intermodal terminal, providing for the smooth flow of passengers and their baggage, and looking at possible traveler scenarios to check the connectivity of modes.

Rail Passenger Service Scheduling

Scheduling passenger rail service for the Harrisburg International Airport was important to ensure adequate use of the rail station, and to justify the expenditure of construction on a new station. In most transit services, operation of the transit service determines how attractive the service is to a traveler. If the service is not comparable to an automobile, the transit service will not be utilized heavily. It is important, however, to balance the provision of frequent service to all customers with the excessive cost of operating empty vehicles on a system. PennDOT has made the first move toward making this balance more favorable by making a more frequent service available through the purchase of

Diesel Multiple Units (DMU). DMUs can be operated in shorter trainsets than traditional push-pull trains, which allows for service where using a traditional trainset would not be cost-effective. As shown in this chapter, it is proposed that train service be provided by DMUs every half-hour during the peak periods. This would require six DMU trains serving this corridor, having service from Carlisle to Lancaster. This service would need to be available from 5:00 AM to 11:00 PM to serve all airline travelers at the HIA.

Using some basic assumptions about train speed, acceleration and deceleration rates, and dwell times, a preliminary train schedule was derived. This shows that total travel time between Lancaster and Carlisle by rail would be approximately an hour and fifteen minutes. (Gannet Fleming, 1996, p. 74). The preliminary rail service schedule can be seen in Table 5.1. Detailed arrival and departure times of the local commuter rail are then displayed in Table 5.2.

Table 5.1: Preliminary Rail Service Schedule

Stop	Post	Dist.	Travel Time	Acc/Dec Time	Arr. Time	Dwell Time	Dep. Time
	(miles [km])	(miles [km])	(hr:min)	(hr:min)	(hr:min)	(hr:min)	(hr:min)
Lancaster	0	0	0:00	0:01	0:00	0:00	0:00
Mount Joy	12 [19.2]	12 [19.2]	0:12	0:01	0:13	0:01	0:14
Elizabethtown	19 [30.4]	7 [11.2]	0:07	0:01	0:22	0:01	0:23
Harrisburg Apt	**28 [44.8]**	**9 [14.4]**	**0:09**	**0:01**	**0:33**	**0:01**	**0:34**
Harrisburg Center	37 [59.2]	9 [14.4]	0:09	0:01	0:44	0:01	0:45
Lemoyne	40 [64]	3 [4.8]	0:03	0:01	0:49	0:01	0:50
Camp Hill	45 [72]	5 [8.0]	0:05	0:01	0:56	0:01	0:57
Mechanicsburg	49 [78.4]	4 [6.4]	0:04	0:01	1:02	0:01	1:03
Carlisle	55 [88]	6 [9.6]	0:06	0:01	1:10	0:01	1:11

Total One-Way Travel Time (Lancaster to Carlisle): 71 minutes

Assumptions:

Top Speed = 60 mph [96 km/h]
Dwell Time = 1 min
Acceleration =2.5 mph/sec [4 km/h/sec]
Acceleration to top speed = 30 sec
Deceleration from top speed = 30 sec
Each additional stop will increase running time by
2 minutes (1 minute dwell time + 1 minute accel/decel)

Table 5.2: Detailed Local Commuter Rail Arrival and Departure Times

Local Commuter Rail Arrival Times at the Proposed HIA Intermodal Rail Facility								
Time	Eastbound	Westbound	Time	Eastbound	Westbound	Time	Eastbound	Westbound
5:30			11:15	X		17:00		X
5:45		X	11:30		X	17:15	X	
6:00	X		11:45	AMTK		17:30		X
6:15		X	12:00	X		17:45	X	
6:30	X		12:15		X	18:00		X
6:45		X	12:30			18:15	X	
7:00	X		12:45	X		18:30	AMTK	
7:15		X	13:00		X	18:45		AMTK
7:30	X		13:15			19:00	X	
7:45		AMTK	13:30	X		19:15		X
8:00	X		13:45		X	19:30		
8:15	AMTK		14:00			19:45	X	AMTK
8:30	X		14:15	X		20:00		X
8:45		X	14:30		X	20:15		
9:00	X		14:45			20:30		AMTK
9:15		X	15:00		X	20:45	X	
9:30	X		15:15	X		21:00		X
9:45		X	15:30		X	21:15	X	
10:00	X		15:45	X		21:30		X
10:15		X	16:00		AMTK	21:45	X	
10:30	X		16:15	X		22:00		
10:45		X	16:30		X	22:15		AMTK
11:00		AMTK	16:45	X		22:30	X	
AMTK	=AMTRAK Train Arrivals							
5:30	=Peak Enplanements / Deplanements							
	(non peak times have a relaxed frequency of 45 minutes directionally)							

Using this timetable and the desire to serve this line with headways of 30 minutes for each direction during peak hours, it is evident that six DMU trainsets would be required. These peak hours would be from 5:30 AM to 10:45 AM, from 3:00 PM to 7:00 PM, and 8:45 PM to 10:00 PM. During off-peak hours, relaxed train headways of 45 minutes in each direction would be sufficient.

Airport Circulation Patterns

Satisfying passenger circulation patterns within the airport property was the next task. It was estimated that four airport shuttle buses or vans would be required to serve passengers during the peak airport circulation periods from 7:00 to 10:00 AM, and from 4:00 to 7:00 PM. This shuttle service would bring the train passengers to the air terminal, to assist those who cannot or do not want to walk approximately 750 feet [228.6m] between the train and the airport terminal. Using four shuttle buses would provide service between the rail station, long-term parking, and the air terminal, every fifteen minutes. This frequency would be reduced during non-peak hours, to reduce operating costs.

It was determined that in 1996 approximately 150-200 passengers can be expected to use the train in a typical day, with peaks of roughly 20 passengers for both the AM and PM peak hours. This estimate increases to about 350 passengers per day with 35 passengers in the AM and PM peak for the design year of 2020. These estimates were based on averaging of the low and medium demand. Using these estimates, the passenger demand for the rail station would be served with DMU service, airport shuttle bus, rail station parking, and Capitol Area Transit (CAT) bus. Please refer to Table 5.3 and Figure 5.1 for current passenger and plane activity at the Harrisburg International Airport.

Table 5.3: Current Passenger and Plane Hourly Activity at HIA

Time	Total Passengers	Enplane-ments	Deplane-ments		Time	Total Passengers	Enplane-ments	Deplane-ments
0:00	0	0	0		12:00	200	100	100
1:00	0	0	0		13:00	370	310	60
2:00	0	0	0		14:00	180	90	90
3:00	0	0	0		15:00	240	95	145
4:00	0	0	0		16:00	330	170	160
5:00	0	0	0		17:00	355	165	190
6:00	15	15	0		18:00	440	210	230
7:00	400	300	100		19:00	619	569	50
8:00	215	190	25		20:00	150	75	75
9:00	90	40	50		21:00	80	30	50
10:00	310	75	235		22:00	135	0	135
11:00	165	50	115		23:00	190	0	190

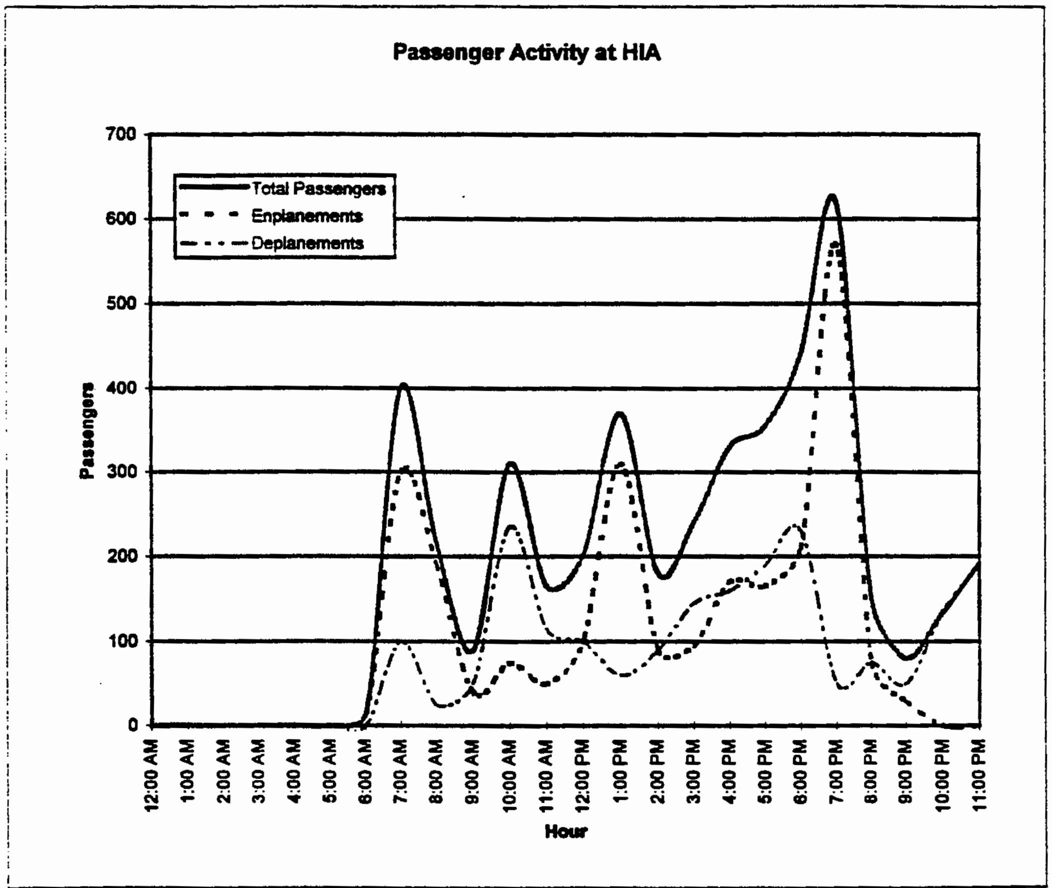


Figure 5.1: Current Passenger and Plane Hourly Activity at HIA

Traveler Scenarios

As the final task for this chapter, a series of traveler scenarios were developed, to help outline how and where the possible rail connections fit in with the proposed rail terminal. A traveler scenario flowchart can be seen in Figure 5.2. Another result of these scenarios is the time at which services need to be started in the morning. As shown, the first DMU should leave Lancaster at 4:30 AM, and leave Carlisle at 5:00 AM. To serve these passengers, CAT transit buses should start service at 4:45 AM. These hours are necessary to serve the main peak of departing flights, which occurs from 7:00 to 8:00AM. Likewise, the time for the last service on the line will be approximately 10:00 PM, to serve the PM passenger peak that occurs from 4:00 to 5:00 PM, and the travelers after this peak.

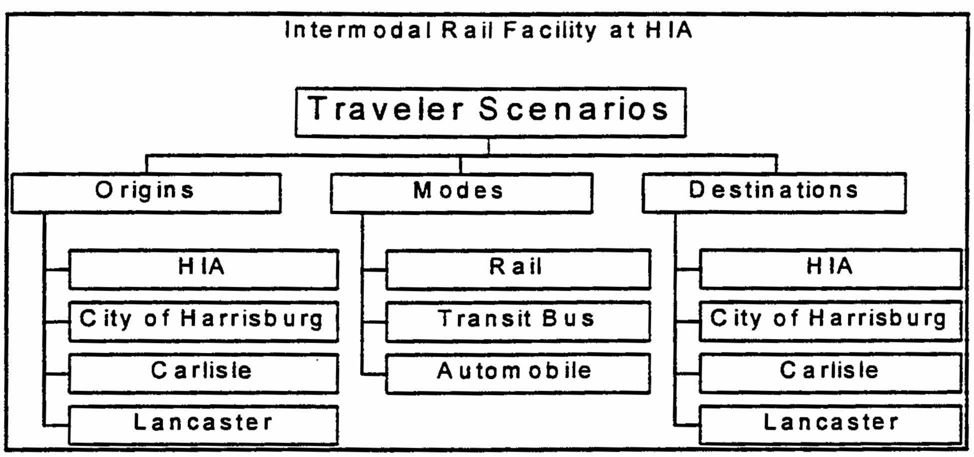


Figure 5.2: Traveler Scenario Flowchart

Scenario one: Traveler from Lancaster to board 7:00 AM flight at HIA (33 miles)

- Rail trip from Lancaster to HIA

  5:00: Arrive at train station at Lancaster

  5:10: Board train at Lancaster

  5:45: Arrive on train at HIA train station

  6:00: Arrive at HIA ticketing counter and check in

  7:00: Board flight

- Transit bus

  No scheduled service from Lancaster to Harrisburg

- Automobile trip from Lancaster to HIA

  5:00: Leave Lancaster in car

  5:45: Arrive at HIA parking lot

  6:00: Arrive at HIA ticketing counter and check in

  7:00: Board flight

Scenario two: Traveler from city of Harrisburg to board 7:00 AM flight at HIA (12 miles)

- Rail - there is no direct rail service throughout Harrisburg; must board train at Transportation Center, requiring another trip link from home to the Transportation Center.

- Automobile trip to Transportation Center

5:05: Drive from home to Transportation Center

5:20: Arrive at Transportation Center and park

- Transit trip to Transportation Center

  5:05: Board transit bus at home

  5:20: Arrive at Transportation Center

- Rail trip from Transportation Center to HIA

- 5:30: Board train at Transportation Center

  5:45: Arrive on train at HIA train station

  6:00: Arrive at HIA ticketing counter and check in

  7:00: Board flight

- Transit Bus

  5:20: Board transit bus at home

  5:40: Transfer buses at Transportation Center

  6:00: Arrive at HIA ticketing counter and check in

  7:00: Board flight

- Automobile

  5:15: Leave home in automobile

  5:45: Arrive at HIA and park

  6:00: Arrive at HIA ticketing counter and check in

  7:00: Board flight

Scenario three: Traveler from Carlisle to board 7:00 AM flight at HIA (27 miles)

- Rail

  5:00: Arrive at train station at Carlisle

  5:10: Board train at Carlisle

  5:45: Arrive on train at HIA train station

  6:00: Arrive at HIA ticketing counter and check in

  7:00: Board flight

- Transit Bus

  No scheduled service from Carlisle to Harrisburg

- Automobile

  5:00: Leave Carlisle in car

  5:45: Arrive at HIA parking lot

  6:00: Arrive at HIA ticketing counter and check in

  7:00: Board flight

As shown, the intermodal rail facility is able to compete in travel time with the private automobile in all three scenarios.

Courtesy Vehicles

At the Harrisburg International Airport, courtesy vehicles can be used for on-airport circulation, to serve the rail station and remote long-term parking lots. At many airports, courtesy vehicles provide service at regular intervals (headway of less than 10 to 15 minutes) regardless of the demand. Please refer to Table 5.4 for courtesy vehicle characteristics (Shapiro et al., 1996, pp. 152-153).

Table 5.4: Courtesy Vehicle Characteristics

	Courtesy Vehicles
Description of Service	Typically shared-ride, on-demand services provided for customers of on- and off-airport rental car agencies, hotels, motels, and off-airport public parking lots
Operating Characteristics	Operators of the primary services (hotels, parking facilities) may provide a variety of vehicles to transport patrons to and from the airport, including vans, minibuses and full-sized buses. Service may be provided at regular intervals (headway of less than 10 to 15 minutes) regardless of demand At locations with low, sporadic demand, passengers may be required to notify respective agencies of their arrival at the airport to arrange for services.
Fare Characteristics	Typically no charge to system users, because transportation is considered part of, or incidental to, primary services being provided.
Purpose Applicability	Employees - low Originating residents - low Originating visitors - high
Ingredients for Success	Frequency of Service Quality of Service

Modes of Access to an Intermodal Rail Facility

The following list outlines the possible access modes for a passenger facility. Most of these are available to some degree in Harrisburg, but the primary mode of access is private automobile.

	Currently Available	Under Consideration
• Automobile	X	
• Light Rail Transit (LRT)		X
• Group Rapid Transit (People-Mover)		
• Buses		X
• Shuttles, Trams	X	
• Limousines	X	
• Taxis	X	
• Bicycles	X	
• Commuter Rail		X
• Intercity Rail: High Speed, Conventional	X	
• Handicapped Services (Para-Transit, Door to Door, etc)	X	X

Successful Rail Service Checklist

Rail service must be desirable to the traveler to be successful. In airports with rail service, the rail systems that capture the highest percentage of travelers have these common characteristics:

- Direct Service - Rail services that allow passengers to travel between the airport and major activity centers without making transfers or incurring numerous stops
- Frequent Service - Rail services that minimize passenger waiting times by providing headways of 10 minutes or less during the peak periods (if supportable by the facility), thereby reducing travel times and enhancing the convenience of the system
- Extensive Regional Coverage - Airport rail systems that are part of a comprehensive network of rail service and feeder buses provide an attractive alternative to a greater number of potential passengers than systems that consist of a single line (e.g., between the airport and the CBD)
- Available Parking - Residents who wish to park at rail station away from the airport and use rail as their airport access mode will be influenced by the availability of parking at non-airport stations. The operators of some commuter rail systems prohibit overnight parking to increase parking availability for typical non-airport commuters
- Through Service - Routes that continue past the airport will likely support more frequent service and attract more ridership than routes that terminate at the airport

Chapter 6

ALTERNATE USER SCENARIOS

This chapter details the methodology used for the analysis and the findings regarding the demand for the intermodal rail facility at Harrisburg International Airport. This chapter specifically considers the choice of rail as the mode of travel used by passengers and commuters.

Modal Split and Demand Scenarios

It was decided that three different scenarios be investigated. These scenarios were the low, medium, and high demand estimates. The 1996 low, medium and high demand estimates by purpose and city of origin / destination were established based on estimates given in the PennDOT HIA User Survey (1990). Of those passengers surveyed, 13.6 percent (39 of 286), stated they would use non-stop service to and from the airport from downtown Harrisburg if it were available. This seemed to be a high percentage. According to the FHWA planning guide (Shapiro et al. 1996, p. 157-168), between 0 and 13 percent of residents use rail as their mode of access to airports. Taking this into consideration, it was decided that this percentage, 13.6 percent, would be used as the high demand estimate. Half of that percentage, or 6.8 percent, was used as the medium estimate and one-fourth of the high estimate, 3.4 percent, was used for the low estimate. The results of the 1996 low, medium and high intermodal rail facility demand estimates are shown in Tables 6.1, 6.2 and 6.3 respectively. Based on the 2020 airport demand estimates, the low, medium and high modal splits for the year 2020 were also calculated. The results are shown in Tables 6.4, 6.5 and 6.6.

Note that the above mode split was applied not only to air passengers, but also applied to non-air passengers accompanying the passengers and the hotel employees and commuters. Caution should be used in examining these results, knowing that the PennDOT HIA User Survey is now being applied to people and purposes other than the passengers and non-air passengers from which the study was based.

Table 6.1: 1996 Low Demand Estimates by Purpose and City of Origin/Destination

			Year	Avg Day	Pk Day
Emplanements					
	Business	Harrisburg	6276	17	20
		Lancaster	6059	17	19
		Total	12335	34	39
	Leisure	Harrisburg	3213	9	10
		Lancaster	3102	8	10
		Total	6316	17	20
	Total	Harrisburg	9489	26	30
		Lancaster	9162	25	29
		Total	18651	51	59
Deplanements					
	Business	Harrisburg	6276	17	20
		Lancaster	6059	17	19
		Total	12335	34	39
	Leisure	Harrisburg	3213	9	10
		Lancaster	3102	8	10
		Total	6316	17	20
	Total	Harrisburg	9489	26	30
		Lancaster	9162	25	29
		Total	18651	51	59
All Passengers					
	Business	Harrisburg	12552	34	40
		Lancaster	12119	33	38
		Total	24671	68	78
	Leisure	Harrisburg	6426	18	20
		Lancaster	6205	17	20
		Total	12631	35	40
	Total	Harrisburg	18978	52	60
		Lancaster	18324	50	58
		Total	37302	102	118

Table 6.2: 1996 Medium Demand Estimates by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	12552	34	40
	Lancaster	12119	33	38
	Total	24671	68	78
Leisure	Harrisburg	6426	18	20
	Lancaster	6205	17	20
	Total	12631	35	40
Total	Harrisburg	18978	52	60
	Lancaster	18324	50	58
	Total	37302	102	118
Deplanements				
Business	Harrisburg	12552	34	40
	Lancaster	12119	33	38
	Total	24671	68	78
Leisure	Harrisburg	6426	18	20
	Lancaster	6205	17	20
	Total	12631	35	40
Total	Harrisburg	18978	52	60
	Lancaster	18324	50	58
	Total	37302	102	118
All Passengers				
Business	Harrisburg	25103	69	79
	Lancaster	24238	66	76
	Total	49341	135	156
Leisure	Harrisburg	12853	35	41
	Lancaster	12410	34	39
	Total	25263	69	80
Total	Harrisburg	37956	104	120
	Lancaster	36648	100	116
	Total	74604	204	235

Table 6.3: 1996 High Demand Estimates by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	25103	69	79
	Lancaster	24238	66	76
	Total	49341	135	156
Leisure	Harrisburg	12853	35	41
	Lancaster	12410	34	39
	Total	25263	69	80
Total	Harrisburg	37956	104	120
	Lancaster	36648	100	116
	Total	74604	204	235
Deplanements				
Business	Harrisburg	25103	69	79
	Lancaster	24238	66	76
	Total	49341	135	156
Leisure	Harrisburg	12853	35	41
	Lancaster	12410	34	39
	Total	25263	69	80
Total	Harrisburg	37956	104	120
	Lancaster	36648	100	116
	Total	74604	204	235
All Passengers				
Business	Harrisburg	50207	137	158
	Lancaster	48476	133	153
	Total	98682	270	311
Leisure	Harrisburg	25706	70	81
	Lancaster	24820	68	78
	Total	50525	138	159
Total	Harrisburg	75913	208	239
	Lancaster	73295	201	231
	Total	149208	409	471

Table 6.4: 2020 Low Demand Estimates by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	11840	32	37
	Lancaster	11431	31	36
	Total	23271	64	73
Leisure	Harrisburg	6062	17	19
	Lancaster	5853	16	18
	Total	11915	33	38
Total	Harrisburg	17901	49	56
	Lancaster	17284	47	55
	Total	35185	96	111
Deplanements				
Business	Harrisburg	11840	32	37
	Lancaster	11431	31	36
	Total	23271	64	73
Leisure	Harrisburg	6062	17	19
	Lancaster	5853	16	18
	Total	11915	33	38
Total	Harrisburg	17901	49	56
	Lancaster	17284	47	55
	Total	35185	96	111
All Passengers				
Business	Harrisburg	23679	65	75
	Lancaster	22863	63	72
	Total	46542	127	147
Leisure	Harrisburg	12124	33	38
	Lancaster	11706	32	37
	Total	23829	65	75
Total	Harrisburg	35803	98	113
	Lancaster	34568	95	109
	Total	70371	193	222

Table 6.5: 2020 Medium Demand Estimates by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	23679	65	75
	Lancaster	22863	63	72
	Total	46542	127	147
Leisure	Harrisburg	12124	33	38
	Lancaster	11706	32	37
	Total	23829	65	75
Total	Harrisburg	35803	98	113
	Lancaster	34568	95	109
	Total	70371	193	222
Deplanements				
Business	Harrisburg	23679	65	75
	Lancaster	22863	63	72
	Total	46542	127	147
Leisure	Harrisburg	12124	33	38
	Lancaster	11706	32	37
	Total	23829	65	75
Total	Harrisburg	35803	98	113
	Lancaster	34568	95	109
	Total	70371	193	222
All Passengers				
Business	Harrisburg	47358	130	149
	Lancaster	45725	125	144
	Total	93083	255	294
Leisure	Harrisburg	24247	66	76
	Lancaster	23411	64	74
	Total	47659	130	150
Total	Harrisburg	71605	196	226
	Lancaster	69136	189	218
	Total	140742	385	444

Table 6.6: 2020 High Demand Estimates by Purpose and City of Origin/Destination

		Year	Avg Day	Pk Day
Emplanements				
Business	Harrisburg	47358	130	149
	Lancaster	45725	125	144
	Total	93083	255	294
Leisure	Harrisburg	24247	66	76
	Lancaster	23411	64	74
	Total	47659	130	150
Total	Harrisburg	71605	196	226
	Lancaster	69136	189	218
	Total	140742	385	444
Deplanements				
Business	Harrisburg	47358	130	149
	Lancaster	45725	125	144
	Total	93083	255	294
Leisure	Harrisburg	24247	66	76
	Lancaster	23411	64	74
	Total	47659	130	150
Total	Harrisburg	71605	196	226
	Lancaster	69136	189	218
	Total	140742	385	444
All Passengers				
Business	Harrisburg	94716	259	299
	Lancaster	91450	250	288
	Total	186166	510	587
Leisure	Harrisburg	48495	133	153
	Lancaster	46822	128	148
	Total	95317	261	301
Total	Harrisburg	143211	392	452
	Lancaster	138272	379	436
	Total	281483	771	888

Middletown Station

The 1996 Middletown Station Passenger counts were obtained from the Keystone Corridor Origin Destination Study. In this study, the number of yearly boardings and alightings was given. From this study, it was possible to calculate the average day counts for the Middletown Station by dividing by 365 (the number of days in a year). The results are shown in Table 6.7.

Table 6.7: 1996 Middletown Station Passenger Counts - Keystone Corridor Demand

	Yearly	Avg Day
Boardings	1139	3
Alightings	1531	4
Total	2670	7

The 2020 Middletown station passenger count estimations were determined using the 1996 counts and multiplying them by a growth factor of 0.23 percent calculated from the 1990 Population Census for Pennsylvania. Table 6.8 has these estimates. Notice that since the Middletown growth factor was very small, there was little difference between the numbers for the years 1996 and 2020.

Table 6.8: 2020 Middletown Station Passenger Count Estimates

	Yearly	Avg Day
Boardings	1204	3
Alightings	1618	4
Total	2821	8

It was believed that the HIA station would become a substitute for the existing Middletown station instead of an addition to the rail service. It was assumed that the Middletown passengers would use the HIA intermodal rail facility if the Middletown station were closed.

Commuters

The 1996 commuter rail demand was also analyzed using the mode split previously discussed in this chapter. The same origin/destination percentages used in the evaluation of the air travelers was applied to the commuters. Although most of the employees probably live in the Middletown area, this was the best alternative since no other information was available. These numbers are expected to stay rather stable into the year 2020. The results are shown in Table 6.9.

Table 6.9: 1996/2020 Employee (Airport Daily Commuter) Rail Demand

		Yearly	Avg Day
Low Demand	Harrisburg	13136	36
3.4	Lancaster	12683	35
	Total	25819	71
Medium Demand	Harrisburg	26272	72
6.8	Lancaster	25366	69
	Total	51638	141
High Demand	Harrisburg	52544	144
13.6	Lancaster	50732	139
	Total	103276	283

Hotel

The hotel-induced rail demand estimation was calculated using the same mode split percentages that were previously described. Again, the same origin/destination percentages as the air travelers were used. It was felt that the estimates would be similar since most of the hotel patrons were assumed to be primarily air travelers. These numbers are expected to be about the same in the year 2020 as in 1996. The numbers are shown in Table 6.10.

Table 6.10: 1996/2020 Hotel Induced Rail Demand Estimation

		Yearly	Daily	Peak Hr.
Low Demand	Harrisburg	3148	9	1
3.4	Lancaster	3039	8	1
	Total	6187	17	2
Medium Demand	Harrisburg	6295	17	2
6.8	Lancaster	6078	17	2
	Total	12373	34	3
High Demand	Harrisburg	12590	34	3
13.6	Lancaster	12156	33	3
	Total	24747	68	6

Mall

The mall-induced high, medium, and low rail demand estimates were calculated by taking the PennDOT HIA User Survey results divided by four for the high estimate. The medium and low estimates were the PennDOT User Survey results divided by eight and sixteen, respectively. Smaller estimates were used for the mall estimates because it did not seem that a mall would be a large attraction for rail passengers. In other words, most people would not take the train if they were going to the mall. The same origin/ destination estimates used in these calculations were the same as for air travelers. These estimates were extremely high due to the high mall demand. Again, the numbers for the years 1996 and 2020 are expected to be about the same. It was decided that mall demand could not be estimated without better data. The results are shown in Table 6.11.

Table 6.11: 1996/2020 Mall Induced Rail Demand Estimation

		Yearly	Daily	Peak Hr.
Low Demand 0.85%	Harrisburg	15134	41	5
	Lancaster	14612	40	5
	Total	29746	81	10
Medium Demand 1.7%	Harrisburg	30268	83	11
	Lancaster	29224	80	10
	Total	59492	163	21
High Demand 3.4%	Harrisburg	60535	166	21
	Lancaster	58448	160	20
	Total	118983	326	42

Conclusion

Table 6.12 shows a summary of the low, medium and high total rail demand estimates for arrivals and departures. The totals include demand from passengers and non-air travelers, commuters, Middletown, and the hotel. For comparison, the table also shows the arrival and departure estimates obtained from the Keystone Corridor Origin Destination Study for the Harrisburg and Lancaster rail terminals.

Table 6.12: Total Rail Demand Estimates for Arrivals and Departures

	1996		2020	
	Year	Avg Day	Year	Avg Day
Low Demand	71,978	197	105,198	288
Medium Demand	141,285	387	207,574	568
High Demand	279,901	767	412,327	1,129
Harrisburg	163,235			
Lancaster	182,724			

Recommendations

From the demand analysis, three recommendations are made. They are the following:

- It is suggested that the Middletown station be closed if the intermodal rail facility is constructed at HIA due to the near proximity of the two stations and the rather low demand for the Middletown station. The intermodal rail station should generate a significant amount of traffic and it is believed that most of the rail traffic generated will be focused between Harrisburg and Lancaster.

- Not much data was available on the type of hotel that may be built on part of the current parking lot of HIA. The number of 106 rooms was based on the number of daily deplanements. If the hotel is a conference center, the estimated demand may change. Therefore, more analysis may need to be done to determine if building a hotel is practical..

- A mall should not be built as an attraction for the rail station. It does not seem that many people would use train service to travel to malls. In addition, there was very little information available on the business activity in the area. A more detailed analysis still needs to be done to estimate demand for a mall.

Chapter 7

ALTERNATIVE DESIGNS

When designing an intermodal facility, each modal system should not be designed independent on each other. How, where, and when a user arrives at a modal system should be of concern. Most travelers choose the familiar route whenever possible. When the destination is not a familiar one, most travelers are not willing to consider an alternative that has more than one mode and travelers will plan trips to use as few modes as possible. Usually the traveler will choose the private automobile to get from origin to destination. Public transportation can never match the flexibility that the automobile offers, but the development of convenient intermodal facilities can possibly substantially increase the flexibility of public transportation over which currently exists. Each alternative design should be aware of the travelers' characteristics. The goal of any intermodal facility is to plan how to get the users as safely and conveniently from one mode of travel to the other.

Intermodal travel is comprised of essentially four basic elements: 1) the routes, 2) fares, ticketing, and baggage checking services, 3) intermodal stations or terminals, and 4) ready accessibility to information of intermodal movements. This project focused on the routes and the intermodal terminal. Baggage checking and ready accessible information will be covered briefly.

Numerous planning and design issues must be considered when deciding on alternatives for the intermodal facility. Philip Shapiro, et al. (1996, p. 142-143) describes the following service and operational issues that should be considered when designing an intermodal facility.

- Maximizing the passengers' level of comfort and convenience.
- Increasing the certainty of travel time (reliability)
- Minimizing the frequency of stops, necessary transfers, and dwell times.
- Identifying operational constraints that may affect passenger level of service.
- Considering potential passenger traffic characteristics. By understanding the characteristics of potential ridership, operators may plan for services efficiently and effectively.
- Developing desired performance measures.
- Establishing operating procedures which would include passenger pick up and dropoff and staging areas.
- Identifying compliance and operational review procedures.
- Considering the needs of disabled passengers in providing services.
- Determining the feasibility of establishing programs to set priorities throughout the region and coordinate efforts with local and regional transit agencies.
- Identifying fare collection methods and procedures that minimize delay.

Shapiro et al. also described airport rail facility characteristics that attract the highest percentage of airport passengers. These characteristics included direct service, frequent service, extensive regional coverage, available parking, and through service. Some other desirable characteristics of an airport rail facility included the following:

- The train terminal being located within convenient walking distance of the airport terminal. Ideally this would be within 500 feet of each other with a minimum number of changing level such as stairs or escalators.
- Making baggage handling convenient between the rail and airport terminal.
- Providing good information systems such as clear sign and signals showing any needed (or various) information.
- Enhancing passenger comfort and convenience.

After reviewing many factors for design, several alternatives were developed. Please refer to Figure 7.1 which displays the various factors affecting physical design. Alternative designs for the site were based on how the passengers on the train would exit the train and enter the terminal. The intermodal rail station was to be located between the I-283 interchange on the side of the AMTRAK lines. The station type and size was determined by the square footage required for the estimated number of people who were predicted to use the station.

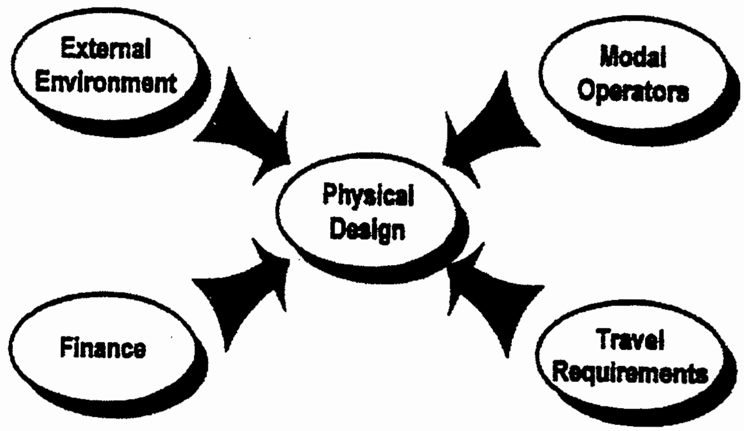


Figure 7.1: Factors Affecting Physical Design

Source: Horowitz, Alan, and Nick A. Thompson. "Generic Objectives for Evaluation of Intermodal Passenger Transfer Facilities." Transportation Research Record 1503. National Research Council, Washington DC, 1995, pp. 104-110.

The first step in the design process was to determine how to get the passengers (on the train who want to go to the airport) off of the train and into the train terminal. It was recognized that some people not riding the train would still want to go to the airport and that all train riders would not want to go to the airport. It was assumed in these cases that the passengers' routines would not be considerably affected by the train terminal to airport link.

Another flowchart was developed showing the possible alternative designs for the rail to airport intermodal facility. This flowchart is shown as Figure 7.2 on the following page.

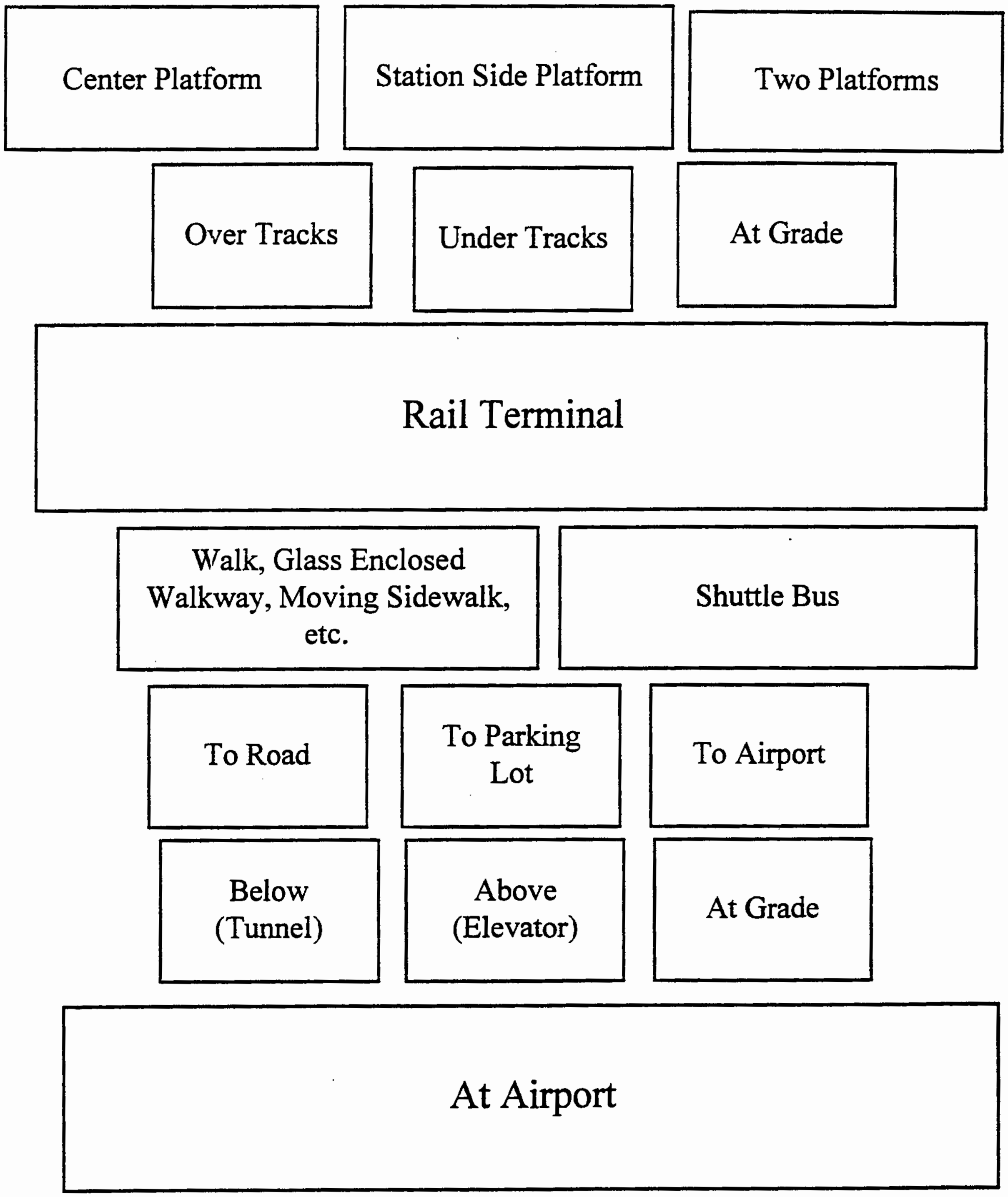


Figure 7.2: Flowchart of Possible Alternative Designs

This overview provides a description for the flow chart showing possible alternatives for flow between the proposed train station and the Harrisburg International Airport. Some alternatives overlap each other with either the same or similar features.

CONSIDERATIONS

Based on the above flowchart, several considerations must be investigated. The three major considerations are: 1) the platform options, 2) the structural options, and 3) the length options. Length options refers to the physical length of each of the structural options, for example where the structure will start and where it will end. Each of these considerations is described further.

Consideration #1- Platform Options

The first feature that was considered was how to get the passengers on or off the train. It was assumed that all passengers would enter the rail terminal or want to go to the air terminal after coming off the train. It was concluded that three options existed:

- Have two platforms, where passengers are transported either:

  1. Under tracks (by elevator and/or stairs and tunnel) to the terminal

2. Over tracks (by elevator and overhead walkway) to terminal
3. On tracks (walking) to terminal

- Have a center platform, where passengers are transported either:

1. Under tracks (by elevator and/or stairs and tunnel) to the terminal
2. Over tracks (by elevator and overhead walkway) to terminal
3. On tracks (walking) to terminal

- Have a station side platform.

Two Platforms

This option would allow trains to arrive from either direction uninhibited by opposing traffic. The platform on the side of the rail station would have direct access to the train terminal. The passengers would be able to walk directly off of the train and into the terminal by using this platform. Because a platform on this side of the tracks would require no elevators or stairs, this would be the most convenient way for those persons with disabilities to get off of the train and into the rail station. The platform on the far side of the rail station would require one of three options: 1) elevator leading to the tunnel below the tracks, 2) elevator leading above to an overhead walkway, or 3) at-grade and walking across the tracks. However, it is not recommended for any of the passengers to be allowed to walk across the railroad tracks. One of these three alternatives would get passengers from this platform to the terminal.

Center Platform

In this option, the passengers would exit the train onto a center platform between the two AMTRAK railroad tracks . The platform would require an elevator and stairs to be located at least on one side of the platform to allow the passengers to go either down into a tunnel or up into an overhead walkway where they can then travel to the rail terminal safely. This option would ensure that the passengers would not have to cross the railroad tracks. However, this option would only work if the capacity of the elevators and stairs can handle the number of passengers who depart the trains. This option also has the disadvantage of not having direct access from the train directly into the rail terminal. The passengers are forced to use an elevator or stairs at least once.

Station Side Platform

In this option, the passengers would exit the train onto a platform connected directly to the rail terminal. The passengers would be able to exit the train and walk directly into the terminal. As stated in the two platforms option, this direct access to the rail terminal from the train would be ideal for persons with disabilities since no elevators or stairs are needed. However, this option would require the trains to load and unload passengers on one track only. This would require fully centralized track control switches for the AMTRAK lines in order for the trains to switch onto and off of this track. Currently, the AMTRAK lines in this area do not have fully centralized control. In order to accommodate this option funding would need to be invested in this type of costly track control.

Consideration #2- Structural Options

The next consideration was how to get the people from the terminal to the airport. The following options were investigated both separately and in combination. We noted that any one of these alternatives may be implemented in successions if a staged design is wanted. Listed below are some of the options considered most significant.

- Walk between terminals
- Enclosed overhead walkway
- Tunnel
- Shuttle service between train and air terminal

A possible "fatal flaw" may exist in any or all of the cases above. In the case of the overhead walkway, this design may not be feasible due to the vertical clearances created by the electric lines and overhead ramps and the slope of the walkway. The overhead walkway's fatal flaw would be vertical clearances for the electrical lines for the tracks. We also recognized that certain factors may not allow a tunnel to be constructed under the railroad tracks (clearances under the tracks). The fatal flaw for the tunnel would be lack of clearance under the tracks to come out at grade with Airport Drive. Walking or having a shuttle bus may have the fatal flaw of being inconvenient to the passengers, especially the passengers with baggage or packages or in times of inclement weather. Note that the option of walking across the tracks was eliminated because passengers shall not be permitted to walk across the tracks at any time.

Consideration #3- Length Options

The next aspect that needed consideration was the length of the trips in consideration #2. The trip length is one of the attributes associated with each of the options in consideration #2, however it is a very important aspect to consider. The length of the structure has a great deal to do with the design, cost, and perceived safety of the structures. A variety of alternatives were examined here.

- Ending at the rail terminal side of Airport Drive

- Ending in the airport's parking lot
- Ending at the airport terminal

Ending at the rail terminal side of the airport presents the problem of getting the people across the road Airport Drive. Trips ending at the airport parking lot or at the airport terminal seems to eliminate this problem, however, several other problems may arise. Such problems include safety of pedestrians walking through the parking lot, convenience of baggage handling, and/or environmental issues.

Chapter 8

EVALUATION OF ALTERNATIVES

Performance Measures and Tradeoff Analysis

Determining the performance measures is a particularly important step in designing any facility. Measures of performance were established early in the planning process (refer to Chapter 3). Capital cost, operating cost, user convenience, ADA convenience, safety, security, aesthetics, and rail operations were the means by which the facility design alternatives were monitored and evaluated. The method of measuring performance for the different options within the alternatives can be seen in Tables 8.1 and 8.2.

Table 8.1: Measures of Effectiveness Ratings for Rail to Air Terminal Passage.

	Capital Cost	Operating Cost	User Convenience	ADA Requirements	Safety	Security	Aesthetics
Tunnel	□	▣	■	■	■*	▣	■
Shuttle	▣	□	■	▣	▣	■	▣
Walk	■	■	▣*	□	□	□	▣
Overhead Walkway	□	▣	▣	■	■*	■	□*

Table 8.2: Measures of Effectiveness Ratings for Platform Design Options.

	Capital Cost	Operating Cost	Rail Operations	User Conven-ience	ADA Require-ments	Perceived Safety	Aesthetics
2 Platforms	□	▣	▣	▣	▣	▣	▣
Center Platform	▣	▣	▣	▣	▣	▣	▣
Station-Side Platform	▣	▣	□	■	■	■	■

*=depending on length of tunnel or overhead walkway

■=excellent

▣=satisfactory

□=unsatisfactory

Identification of Best Alternatives

With all of the available options, there exists a wide variety of alternatives. From researching, it was found that an efficient intermodal rail facility has the following key elements (Vandeveer 1996, p. 89):

- Responsiveness to the overall system. This determines how the facility relates to the overall system to yield an efficient design.
- Ability to accommodate for long-term and short-term expansion. This design may involve a staged-plan development.
- Adaptability to current and future technological advance. Various Intelligent Transportation System technologies may prove beneficial in the intermodal facility design.
- Flexibility for alternative equipment-handling and storage modes. This is necessary when the mode of operation needs to be changed to accommodate variations in storage requirements.
- Accessibility for all transportation movements. This would involve designing to accommodate for anticipated rail, airport, and bus traffic.
- User-friendliness for operators and customers. A facility should be operated as simply, flexibly, and logically as possible.
- Cost-effectiveness and Space-efficiency. This includes designing a facility which will allow for efficiency, flexibility, and expendability without over-designing.

Based on these key elements, the following alternatives were found to be the most feasible.

Alternative #1

The first alternative would include any of the three platforms options in combination with a tunnel. After exiting the train, the passengers would take an elevator or escalator down (if needed) to a tunnel which goes under the railroad tracks. Once in the tunnel, the passengers would have the option of walking to the bottom floor of the rail terminal or walking to the opening at Airport Drive. At the tunnel opening the people would be at grade with Airport Drive. A section of the Airport Drive may be considered strictly for pedestrians. If the traffic or pedestrian volumes are high enough, a signal or pedestrian button may be warranted based on Manual on Uniform Traffic Control Devices (MUTCD) warrants. Another option, if needed, to remedy this problem, would be to have that existing section of Airport Road, where the pedestrians would be in conflict with moving vehicles, to dip under this pedestrian walkway. However, this would be an expensive way to remedy a problem of this sort. The tunnel will end at one of three points from the terminal: 1) Airport Road, 2) Parking Lot, or 3) Airport. Moving sidewalks were considered for all three situations.

Airport Road

With this alternative, the passengers will have to walk across the Airport Road which separates the tunnel from the airport parking lot. This situation would consider traffic volumes on the airport road to validate pedestrian through movement and if a signal may be required. The area at which passengers would cross would have some overhead structure so that the passengers would not be exposed to rain or snow.

At this point a staged plan can be considered. One option is to shuttle passengers from the Airport Drive straight to the airport. This would be the alternative while the enclosed walkway is being built. An enclosed walkway would be constructed at grade with the parking lot pavement or slightly built up on concrete. Moving sidewalks were also considered in the design.

Some of the parking lot capacity would be reduced, but if bays are tunneled under the walkway for motor vehicles the parking lot will not have to be split into two totally separate lots. Again note that tunneling under the parking lot roadway would be very expensive.

Parking Lot

This alternative would require the tunnel beneath the tracks to be deeper in the ground to provide access beneath airport road to come up into the parking lot. At this point the passengers will be brought back to the parking lot surface though elevators or with a moving sidewalk at a gradual grade. This option would also require an enclosed structure to be built across the airport parking lot as in the above alternative. Bays under the structure for motor vehicles will also be considered as in the previous alternative to maximize parking lot capacity. It seems that tunneling may be of high cost for such marginal benefits.

Airport

This would be the most costly alternative, and it would require major excavation. A tunnel would be provided all the way from the intermodal rail terminal to the airport. Once at the airport, elevators would be used to bring people back up to the first floor of the airport. The alternative would also be controlled by how far the superfund site extends and if the tunnel will encounter any water or drainage problems with the nearby Susquehanna River. Moving sidewalks may also be incorporated into this design.

Alternative #2

The next alternative considered was to have an overhead walkway above the railroad tracks and Airport Drive. As stated previously, some problems may exist with the slope and vertical clearances. The walkway would either come down in the airport's parking lot or at the airport terminal itself. The overhead walkway will be governed by engineering constraints. It must first be determined whether it is feasible or even possible to fit a structure above the electric lines and in between the highway ramps. If possible, this structure would go across the airport road and bring passengers back down to the parking lot or would extend all the way across the airport parking lot to the airport terminal building.

Parking Lot

This alternative would require the overhead walkway to be built over Airport Drive and come down in the Airport's parking lot. This option would also require an enclosed structure to be built across the airport parking lot.

Airport

This would be the most costly alternative of the overhead walkway lengths. The overhead walkway would be constructed all the way from the intermodal rail terminal to the airport terminal. Once at the airport terminal, elevators would be used to bring people down into the airport. Moving sidewalks may also be incorporated into this design.

Alternative #3

The third alternative would be to pick up the passengers at the train terminal and have a bus transport the passengers and their baggage directly to the airport. A shuttle would be available at the rail terminal to the passengers to take them to the airport terminal. This option would be a good option for the first stage of the an intermodal service. The disadvantage would be the inconvenience for the passengers to be going from train to bus and then to the airport.

Alternative #4

The next alternative would be to have the people walk from the rail station to the airport. The option of walking from the rail terminal to the air terminal consists of two possibilities. The option of walking across the tracks at grade was not considered since no passengers would be allowed to cross the railroad tracks. Walking across the railroad tracks will not be incorporated in any of the designs.

The first possibility for this walking alternative would be to incorporate the tunnel alternative to this alternative. This would include having an elevator and stairs at the railroad platform and inside the terminal which would go down to a tunnel underneath the tracks. The tunnel may be brought out at grade with the Airport Drive, where the shuttle service would be utilized or walking would be allowed. If walking, a covered walkway could be built to the airport terminal. If the traffic on the Airport Drive was an issue, the Airport Drive could be depressed underneath the walkway providing a safe walk to the air terminal as previously defined.

The next possibility for walking from the rail terminal to the air terminal is a combination of the overhead walkway alternative. This alternative would involve constructing an overhead walkway, connecting the two terminals directly. The disadvantage in this option is the walkway must be constructed above the electric lines and the walkway may have too steep of a slope for those persons with disabilities.

Rail Terminal Design

One of the major problems often facing an intermodal facility is where to place the terminal. Many times the optimal location for one mode does not meet the requirements of the other modes. However, the location of the rail (intermodal) terminal at the Harrisburg International Airport seems to be optimal for all of the modes of transportation involved.

The terminal is an essential part of any intermodal facility. The main function of a terminal is to provide for the entrance or exit of the objects to be transported, passengers or freight, to and from the system. Terminals not only represent a major functional component of the system but also often are major costs and possible points of congestion (Morlok 1978, p. 247).

Terminals are inherently stochastic; all terminals can not be treated without reference to variations in the volumes of the arrivals or the times necessary to process the passengers or freight. Many terminals are often unique, developing a particular design being based on its characteristics. For this project, the terminal was designed to accommodate the various demands based on the alternate user scenarios.

In previous airport rail terminal projects, the airport rail terminals that have the highest modal share have the following desirable characteristics (Shapiro, et al. 1996, pp. 155-156):

- The rail terminal is located within convenient walking distance of the airport terminal. Ideally, this is the following:

    -located within 500 feet of the airport terminal building, avoiding the need for a shuttle bus or use a people-mover system.

    -designed to minimize the need to change levels or climb stairs. Grade separated crossings should be provided for passengers where necessary to avoid crossing airport roadways.

    -designed to accommodate passengers with baggage carts or suitcases with wheels.

    -designed to comply with ADA requirements.

-located adjacent to the baggage claim areas, where passengers usually select from the available travel modes.

- Baggage handling is made easier. Ideally, passengers can use:

  -porter service to assist in transporting baggage between the air terminal and rail platform.

  -baggage trolleys that can accompany a passenger on the entire route between the baggage claim area and the rail platform, including any escalators.

  -baggage handling services that allow the traveler to check their baggage at a rail station, and the baggage is then automatically processed through the airport without further intervention by the traveler.

- The rail terminal station provides good information systems. Good information systems include:

  -clear signs and graphics, posted in highly visible locations at frequent intervals throughout the terminal and rail station to facilitate passenger way-finding.

  -information describing fares, schedules, and best routes to popular destinations. This information should be presented simply and clearly.

  -Pathways that allow passengers to identify their destinations and minimize their reliance on signs.

  -Airline flight information displays in the rail station to assist rail passengers in finding the proper terminal building or concourse.

  -Staffed information booths to supplement available signs and computerized terminals.

- Also, the rail terminal is designed to enhance passenger comfort and convenience. Examples of design features include:

  -Passenger amenities, such as telephones, benches, vending machines, and concession areas.

  -Passive and active security measures.

-Sheltered waiting areas with heating and air conditioning.

These considerations should be taken into account when designing and planning the rail terminal at HIA. Any special requirements of airport travelers, visitors, and employees should be accommodated. This should include minimizing walking distances between any two travel modes, providing timed transfers and connections to minimize delays, and limiting baggage-carrying.

An on-airport intermodal facility can be described as a mini-terminal, a mega-terminal or an intermodal terminal facility. The proposed intermodal rail facility at HIA would be an intermodal terminal facility, which is an airport that, within their terminal facilities, serve as convenient transfer points for various modes of travel. Typically, in this sort of facility there is an integration of air, bus, and commuter rail operations within one transportation center. Some of the planning issues to be considered in designing on-airport intermodal facilities are the following:

- Consider airport policies and studies related to land use planning, terminal area planning, and surface access planning.
- Identify potential constraints at sites, including available area, environmental concerns, signalized intersections near or at capacity, inadequate queuing capacity to enter and exit the proposed facility.
- Identify the type of facilities that should be provided at the intermodal facility versus those that should be located at the airport terminal.

- Design the facility to allow for flexibility to expand or to reassign areas as ground transportation and passenger needs change.
- Design the facility to ease passengers' walking distance, confusion about signs, or baggage-carrying loads.
- Provide rapid and reliable transportation between the facility and the airport.
- Coordinate timed transfers and connections of various modes to minimize passenger delays.
- Consider mode-specific planning and design related to operational and enforcement issues.
- Consider potential passenger perceptions of level of convenience resulting from number of mode transfers and location of the facility in relation to boarding areas.
- Consider availability of funding sources for financing the facility, including both airport and non-airport sources. Identify the need for project support.

While considering all the different alternatives, the rail terminal design changes only slightly. The intermodal rail terminal was designed to be two stories tall. The entrance point for the northside parking lot would be on the ground or bottom floor. There would be no direct access to the second floor from this side of the rail terminal. The design of the rail terminal was based on the two stories having 12,000 square feet [1080 m^2] each.

In the tunnel alternative, the ground floor would accommodate those passengers entering the terminal from the northside parking lot or from the tunnel. The top floor would accommodate those passengers entering the terminal directly from the train (in the case of two platforms or the station side platform). The tunnel seems to be able to end at grade with Airport Drive. The clearance on the other end of the tunnel (the north parking lot side) does not seem to pose a problem since the tunnel connects directly to the rail terminal at this point and could be dug to any depth. This alternative has the advantage that people traveling through the tunnel can exit the rail terminal without going to the top floor.

In the overhead walkway alternative, the ground floor would still serve those passengers entering from and existing into the northside parking lot. The top floor would be the hub of the operations since the passengers would need to enter the top floor to get to the overhead walkway. This alternative has the disadvantage that the people would have to come through the top floor and also continue through to the ground floor to reach the northside parking lot.

Plan and Profile Views

The plan (Figures 8.1A - 8.6A) and profile (Figures 8.1B - 8.6B) views for the best chosen combination of alternatives can be seen in the following pages. These figures show the following alternatives:

Station Side Platform with Tunnel
Station Side Platform with Overhead Walkway
Two Platforms with Tunnel
Two Platforms with Overhead Walkway
Center Platform with Tunnel
Center Platform with Overhead Walkway

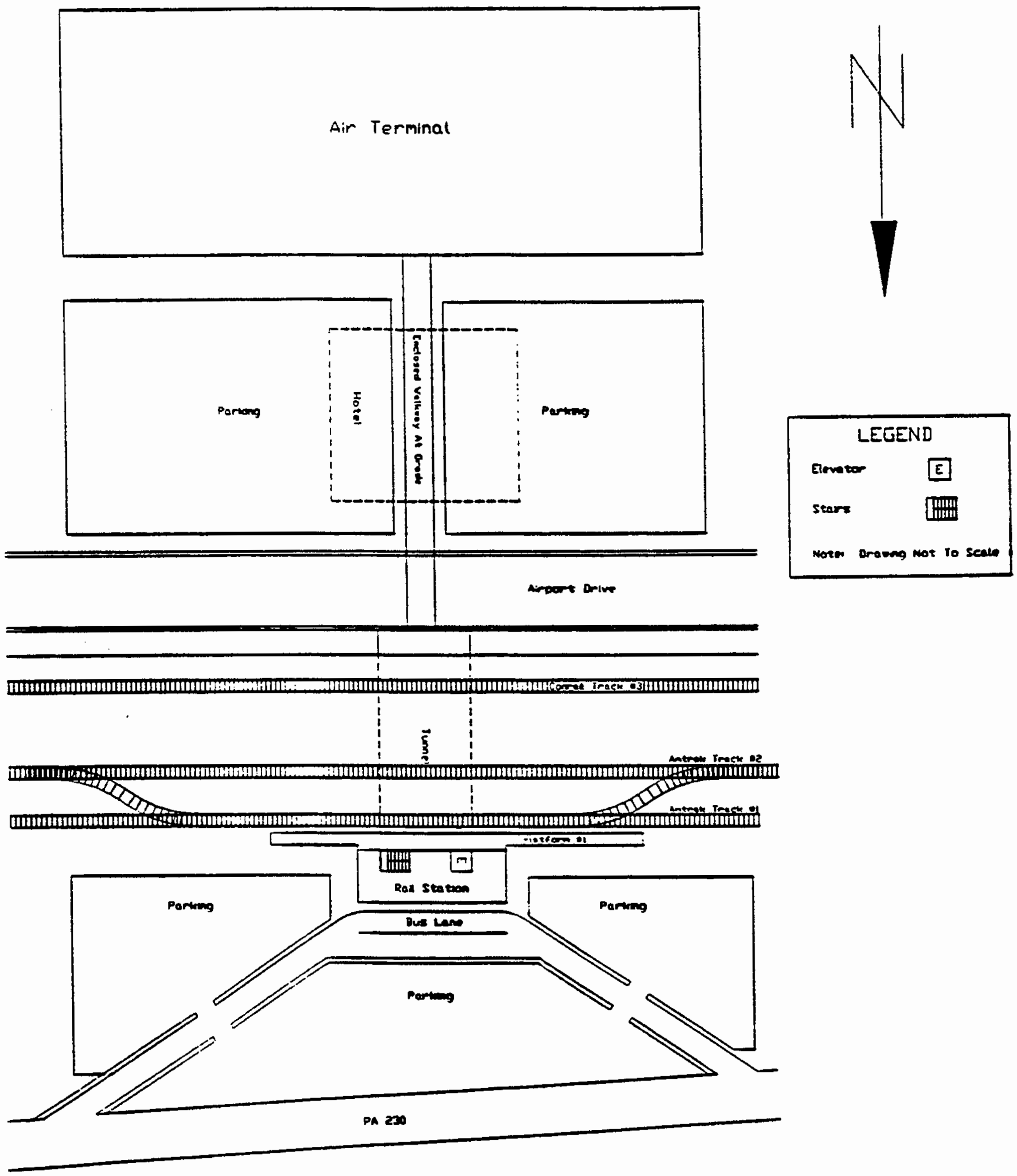


Figure 8.1A: Station Side Platform with Tunnel- Plan View

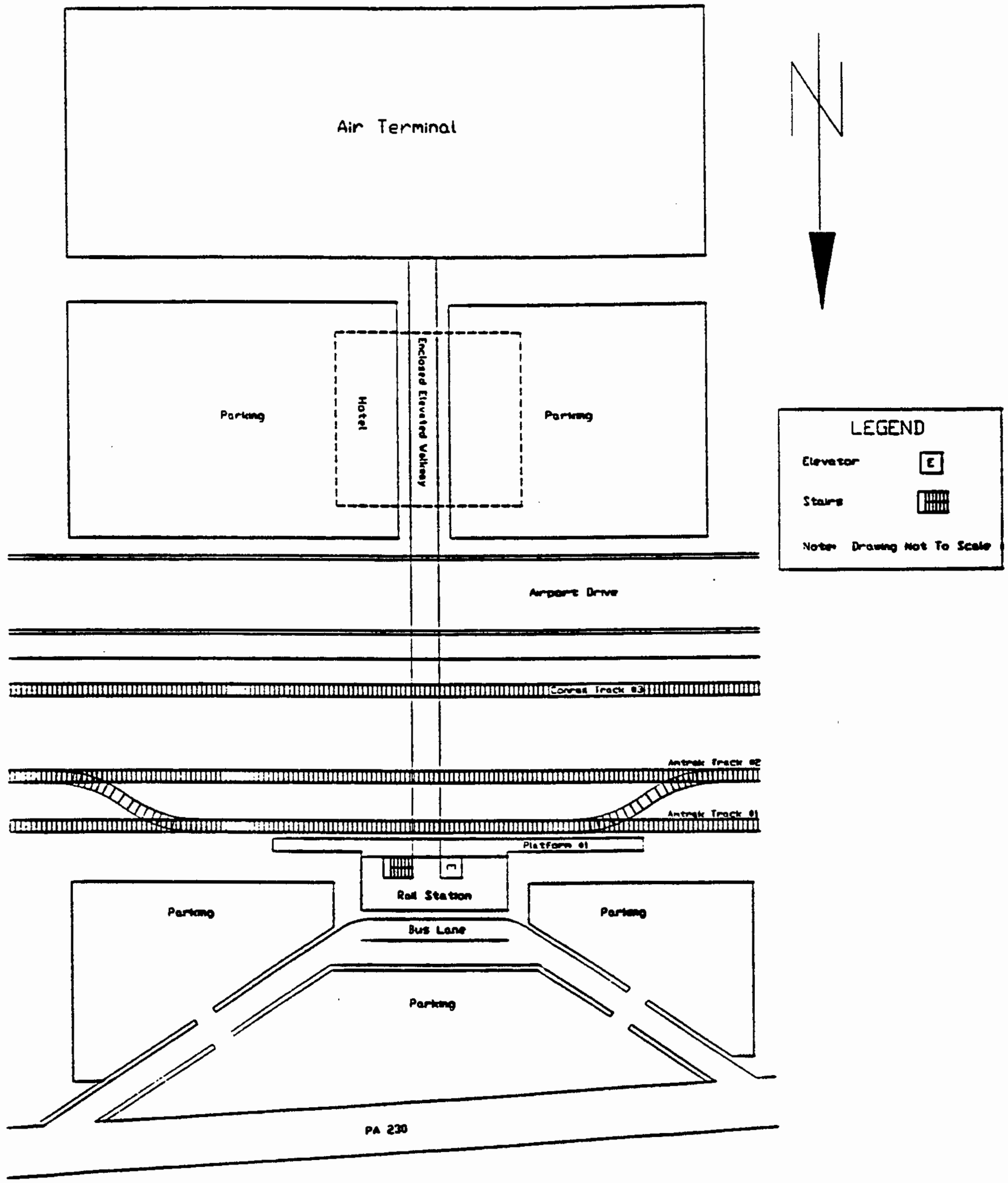


Figure 8.2A: Station Side Platform with Overhead Walkway- Plan View

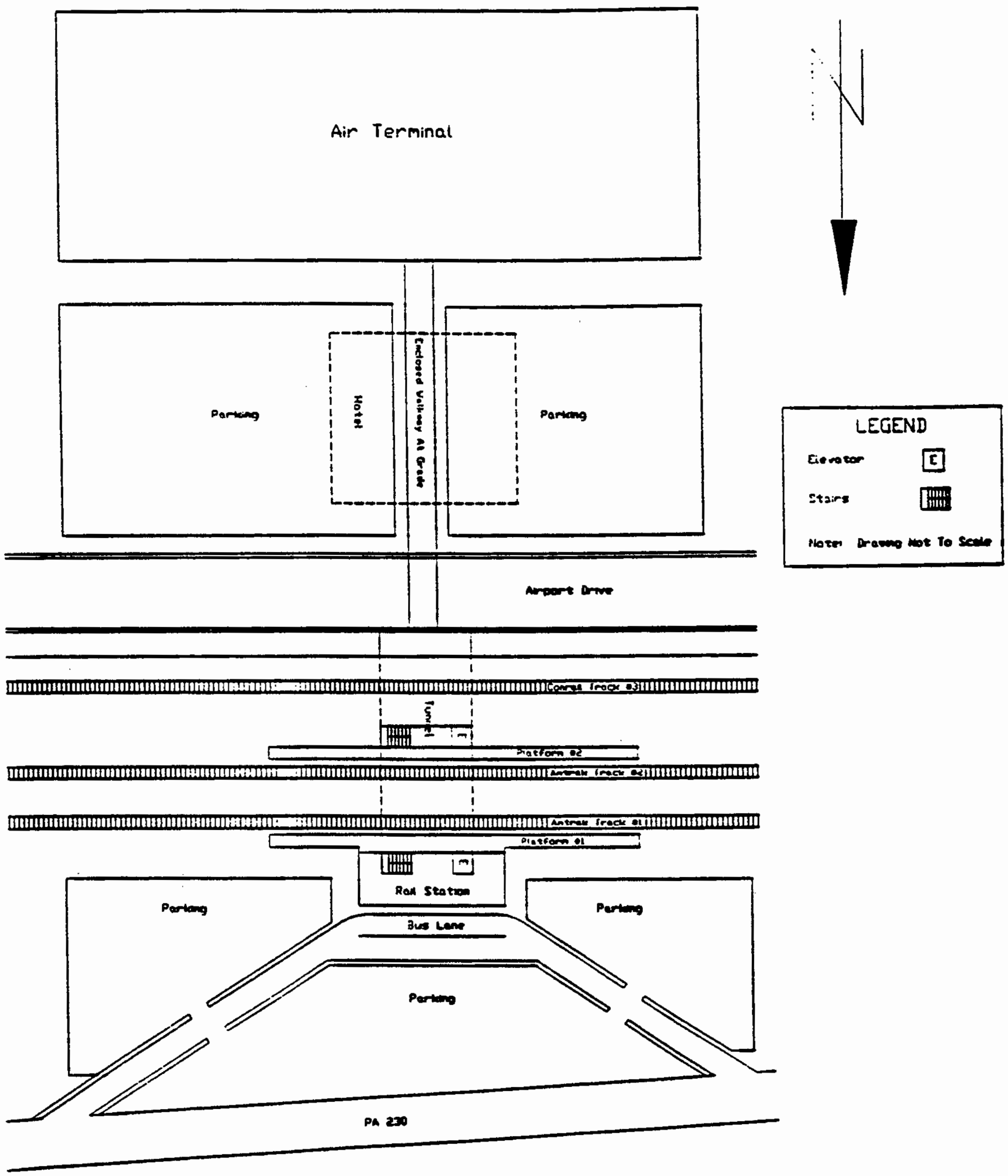


Figure 8.3A: Two Platforms with Tunnel- Plan View

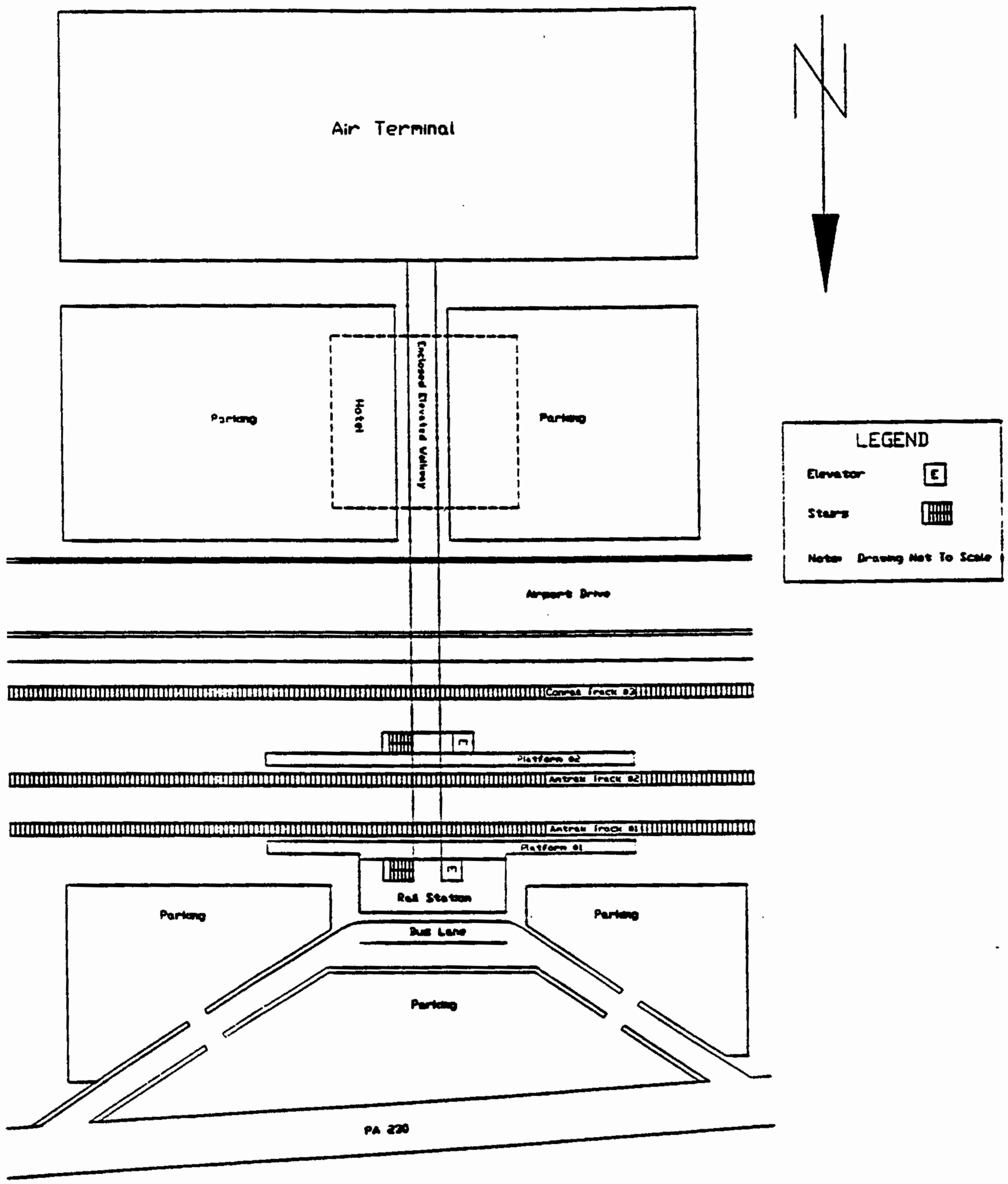


Figure 8.4A: Two Platforms with Overhead Walkway- Plan View

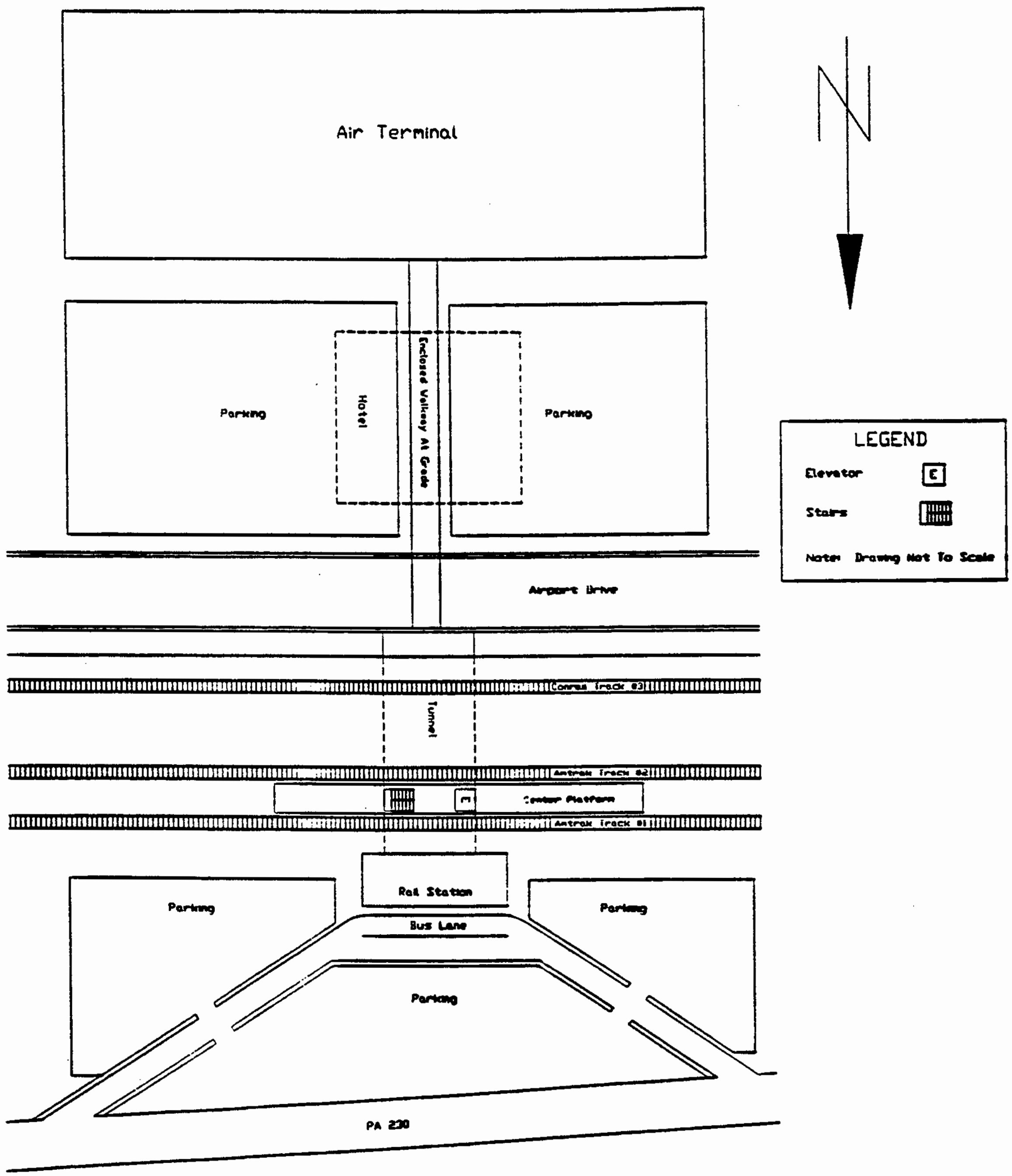


Figure 8.5A: Center Platform with Tunnel- Plan View

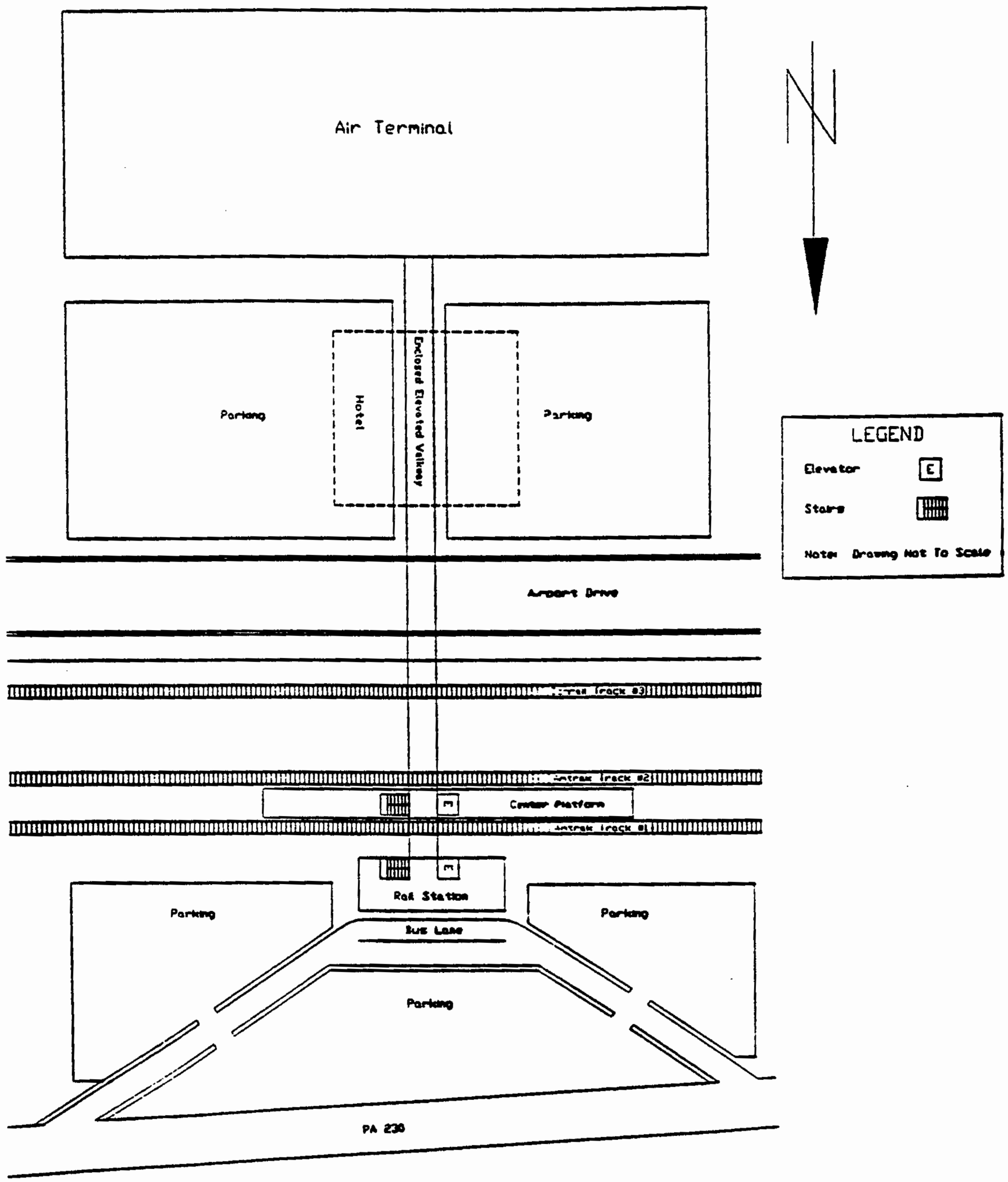


Figure 8.6A: Center Platform with Overhead Walkway- Plan View

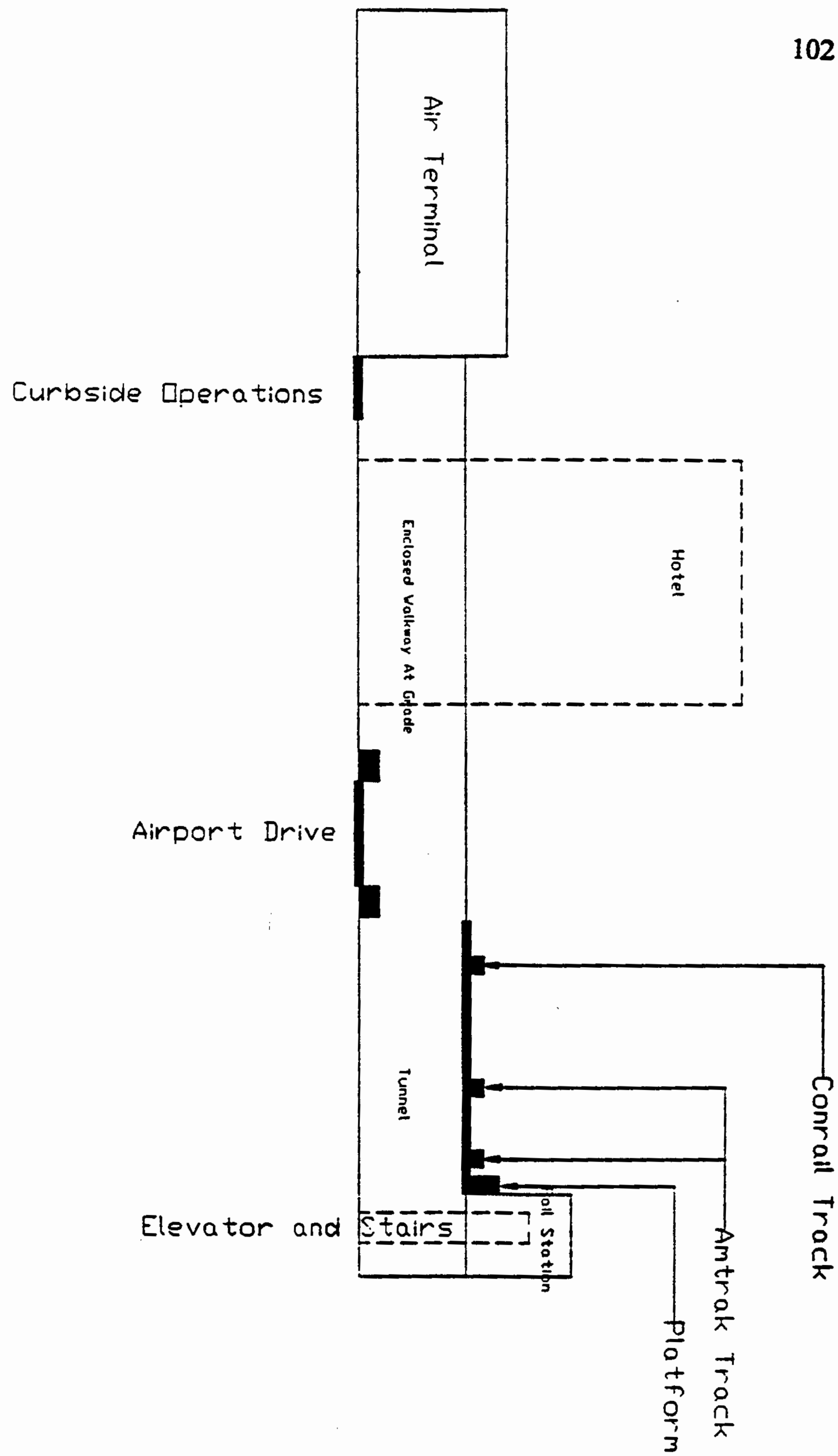


Figure 8.1B: Station Side Platform with Tunnel- Profile View

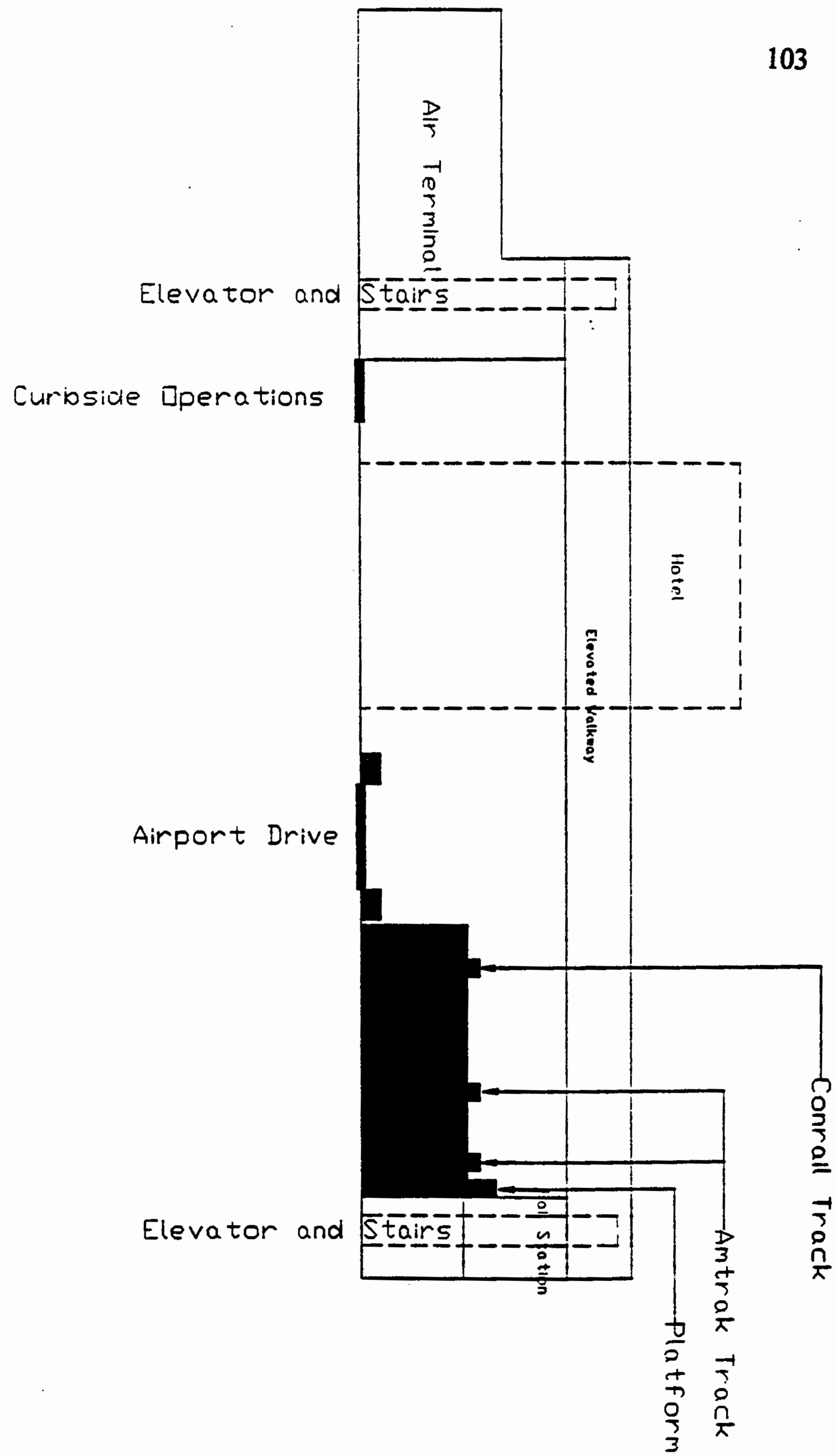


Figure 8.2B: Station Side Platform with Overhead Walkway- Profile View

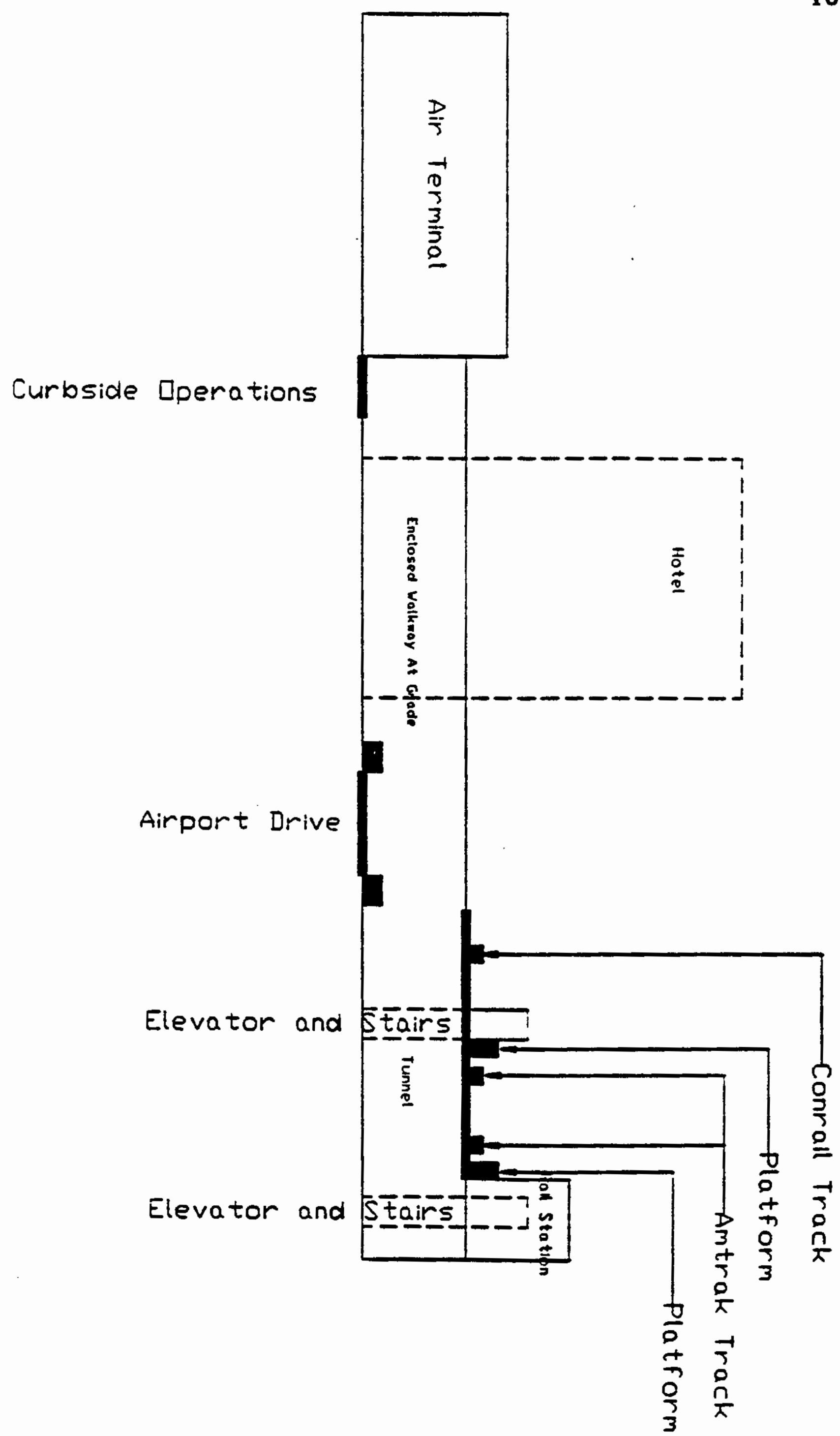


Figure 8.3B: Two Platforms with Tunnel- Profile View

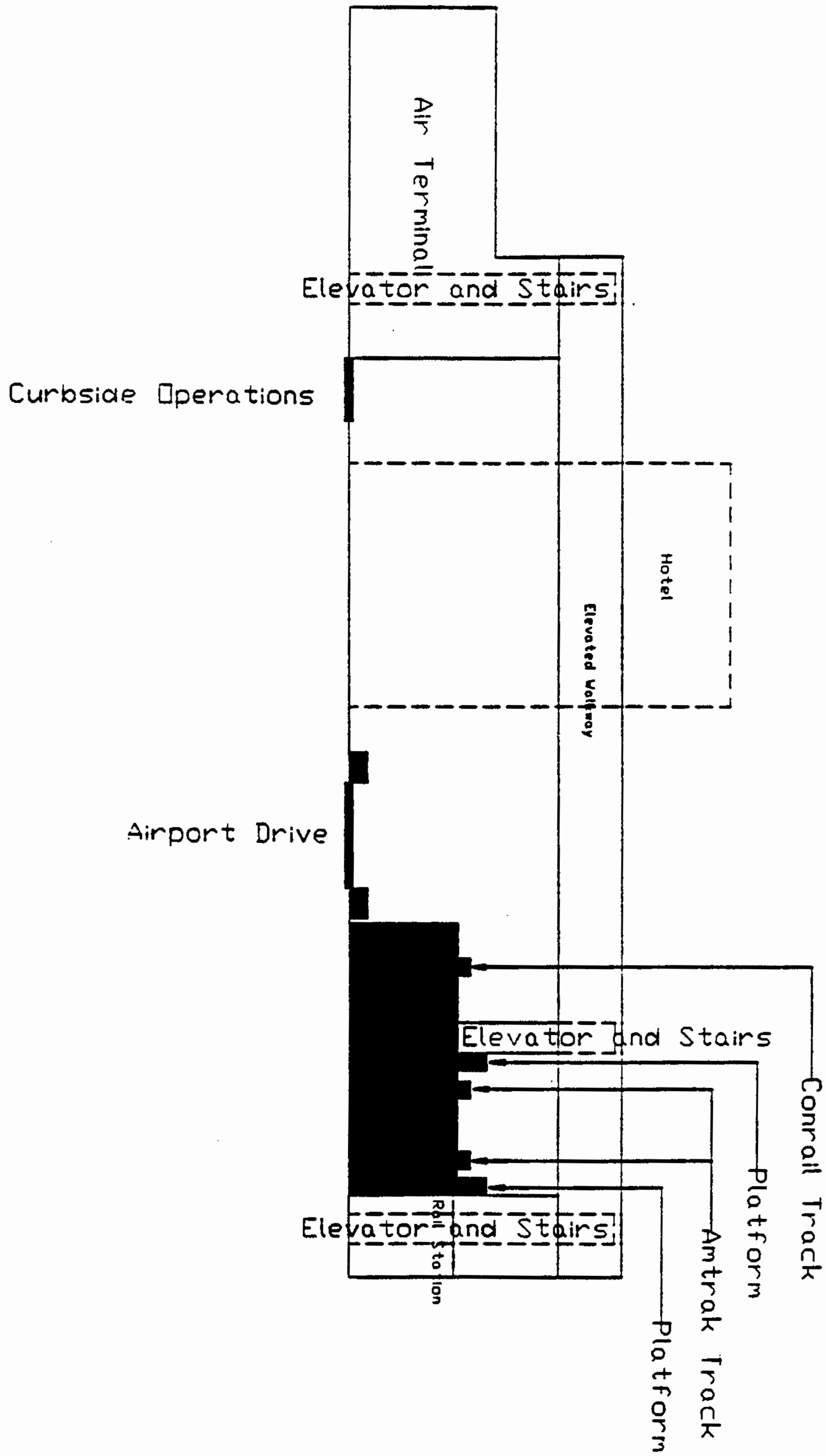


Figure 8.4B: Two Platforms with Overhead Walkway- Profile View

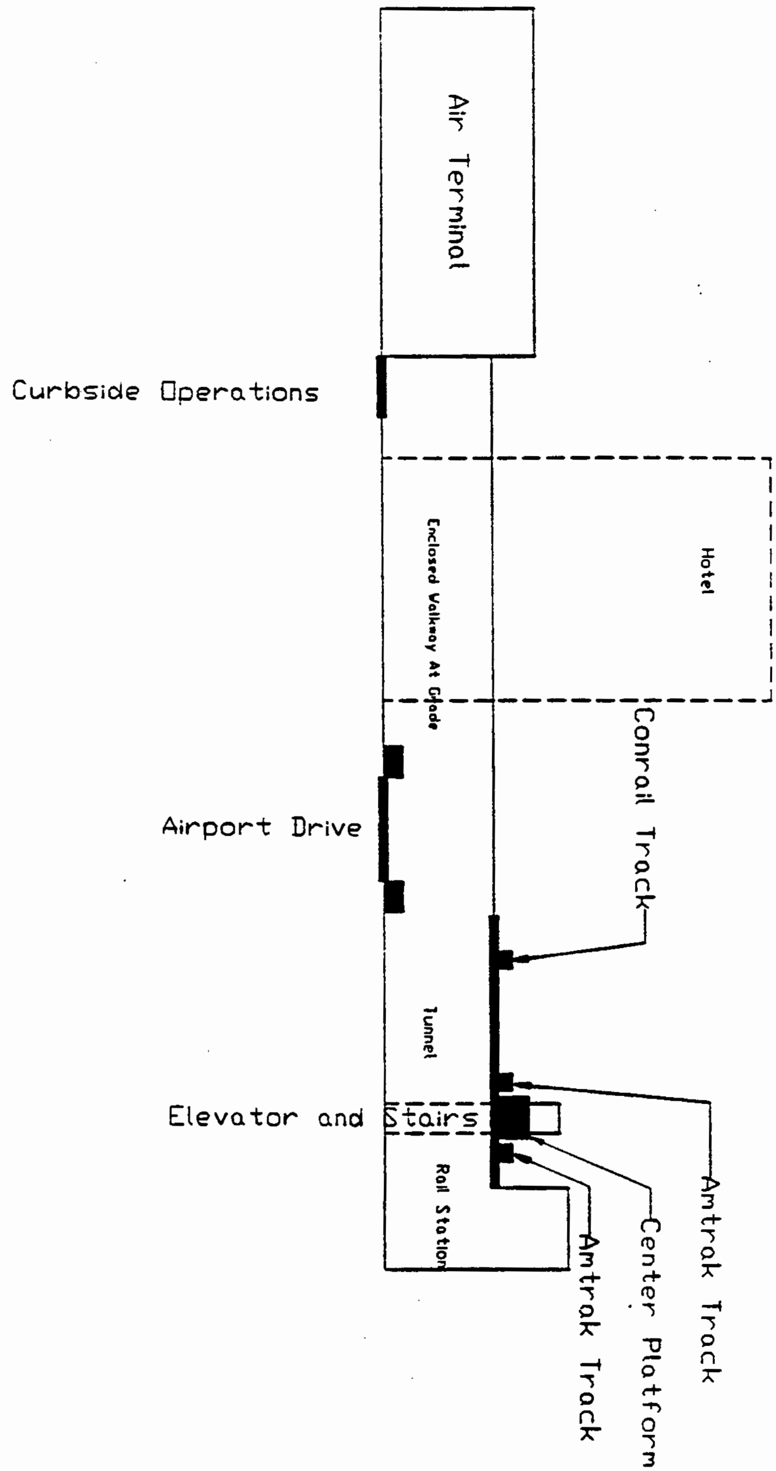


Figure 8.5B: Center Platform with Tunnel- Profile View

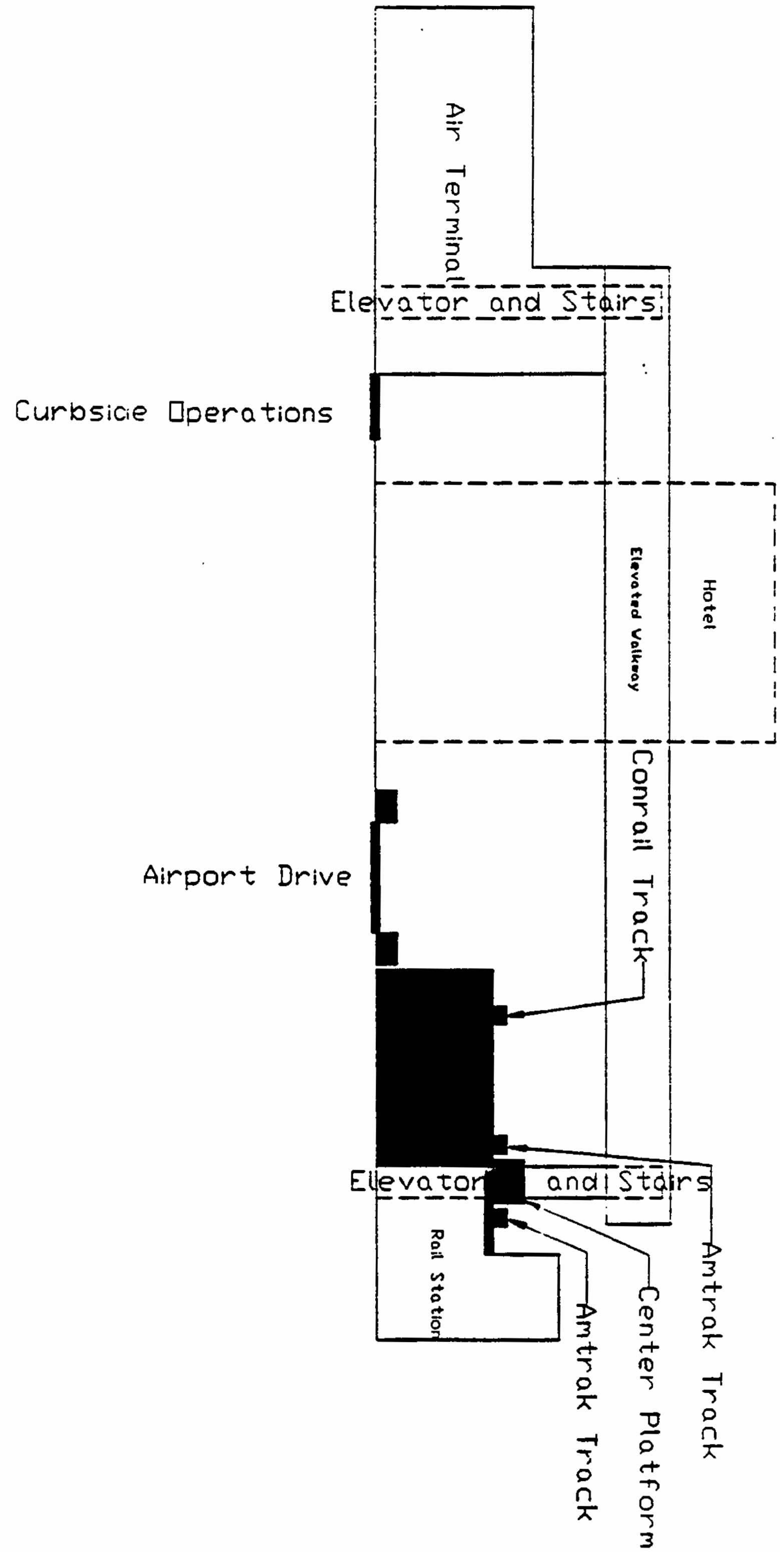


Figure 8.6B: Center Platform with Overhead Walkway- Profile View

Chapter 9

COST EFFECTIVENESS AND FEASIBILITY

The cost effectiveness evaluation compares alternatives in terms of whether the costs of the project (both capital and operating) are commensurate with its benefits. In other words, the benefits shall equal or be greater than the costs. A feasibility study compares alternatives in terms of the availability of funds for construction and operation of the project. This involves use of measures of financial feasibility to examine the likelihood that sufficient and existing, and where appropriate, additional funding sources would be available to cover the capital and operating costs of each alternative.

A thorough breakdown of the prices determined for each of the alternatives can be seen in Table 9.1. The materials and dimensions for each cost item has also been indicated on these cost sheets. The costs reflect the estimates for dimensions and materials needed only. The actual design will specify the types and sizes for each of the items needed for construction. These costs were based on estimates found in the following sources:

Building Construction Cost Data. Robert Snow Means Co., Duxbury, Massachusetts, 1997.

Shaw, A. E. Proposed Rail Passenger Station - Harrisburg International Airport. Interoffice Memorandum. Transportation and Commuter Services, August 2, 1982.

Square Foot Costbook. BNi Building News, New York, Watson-Guptil Publication, 1997.

Table 9.1: Cost Estimates (also continued on the following page)

Tunnel

Item	Unit	Quanity	Unit Cost	Amount
Tunnel 80'L x 15'W x 12'H				
- Excavation	C.Y.	600	2.01	1,206.00
- Concrete (headwall, wingwall, floor, cieling)	C.Y.	300	718.00	215,400.00
- track support (50#'sf steel)	Ea	75	1,769.00	132,675.00
Walkway from Road to Air Terminal				
- sidewalk 650'L x 8'W x 6"D	S.F.	5200	3.12	16,224.00
- roof (shingle)	S.F.	7920	7.51	59,479.20
- sides (glass enclosed)	S.F.	10400	34.95	363,480.00
Total				788,464.20

Overhead Walkway

Item	Unit	Quanity	Unit Cost	Amount
Overhead walkway (rail to air terminal)				
- 750'L x 15'W x 12'H				
- columns reinforced concrete	Ea.	60	99.00	5,940.00
- floor (precast double T-beams)	S.F.	11250	7.29	82,012.50
- roof (shingle)	S.F.	22500	7.51	168,975.00
- sides (glass enclosed)	S.F.	18000	34.95	629,100.00
Total				886,027.50

Rail Station & Parking Lots

Item	Unit	Quanity	Unit Cost	Amount
Rail Station 2 floors @ 12000sf each				
Foundations				
- Footings & Foundations	S.F.	800	6.52	5,216.00
- Excavation & Backfill	S.F.	12000	1.00	12,000.00
- Slab on Grade	S.F.	12000	3.40	40,800.00
Superstructure				
- Columns, Beams, and Roof	S.F.	36000	4.04	145,440.00
Exterior Closure				
- Walls (Face brick with concrete block back)	S.F.	12320	18.84	232,108.80
- Doors (double aluminum & glass)	Ea.	8	3,425.00	27,400.00
- Windows & Glazed wall (front & trackside)	S.F.	3000	15.95	47,850.00
Roofing				
- Roof Coverings (built up tar & gravel w/flashing)	S.F.	12000	2.50	30,000.00
- Insulation (Perlite/EPS composite)	S.F.	38000	1.25	47,500.00
- Specialties (Gravel stop perimeter)	L.F.	220	4.80	1,056.00
Interior Construction				
- Partitions (lightweight concrete block) 15SF floor/LFpartition	S.F.	1600	6.05	9,680.00
- Interior Doors (hollow metal)	Ea.	16	554.00	8,864.00
- Wall Finishes (Glazed coating)	S.F.	12320	1.25	15,400.00
- Floor Finishes (quarry & vinyl composition tile)	S.F.	24000	5.15	123,600.00
- Ceiling Finishes (Mineral fiber tile on zee bars)	S.F.	24000	3.30	79,200.00
- Interior surface/Exterior wall	S.F.	12320	1.20	14,784.00
Conveying				
- Elevators	Ea.	2	53,400.00	106,800.00
Stairways with railing	Flight	2	2,920.00	5,840.00
Mechanical				
- Plumbing (toilet & service fixtures ADA, supply & drainage)				
- 1 fixture/850 sf floor area	Ea.	30	2,159.00	64,770.00
- Fire Protection (Wet pipe sprinkler system)	S.F.	24000	1.65	39,600.00
- Heating/Cooling				
- single zone rooftop unit gas heat, electric cooling	S.F.	24000	10.75	258,000.00
Electrical				
- Service & Distribution	S.F.	24000	2.03	48,720.00
- Lighting & Power				
- flourescent fixtures, receptacles, switches, A.C., & misc.	S.F.	24000	4.65	111,600.00
- Alarm systems & emergency lighting	S.F.	24000	0.78	18,720.00
- Public Address System	Speaker	10	220.00	2,200.00
Specialties				
- Directory Boards (Aluminum glass covered 48"x60")	Ea.	4	1,405.00	5,620.00
New Road (2000' x 24')				
- subbase 6" crushed stone	Ton	450	25.00	11,250.00

Table 9.1 (continued): Cost Estimates (also continued on the following page)

- Bituminous paving 4"	S.Y.	48000	7.10	340,800.00
- wearing surface 2"	S.Y.	48000	4.13	198,240.00
- Bus Lane 50'L x 12'W				
- subbase 6" crushed stone	Ton	125	25.00	3,125.00
- Bituminous paving 4"	S.Y.	600	7.10	4,260.00
- wearing surface 2"	S.Y.	600	4.13	2,478.00
Parking Lots (1100' x 70', 70' x 700')				
- subbase 6" crushed stone	Ton	750	25.00	18,750.00
- Bituminous paving 4"	S.Y.	126000	7.10	894,600.00
- wearing surface 2"	S.Y.	126000	4.13	520,380.00
Total				3,496,651.80

Station Side Platform

Item	Unit	Quanity	Unit Cost	Amount
- footings 16"W x 804' L x 12" T (reinforced concrete)	C.Y.	40	90.00	3,600.00
- sides (brick face block backing) 5'H x 804'L	S.F.	4020	11.15	44,823.00
- concrete floor (reinforced) 12'W x 6"T x 390'L	C.Y.	88	90.00	7,920.00
Total				56,343.00

Center Platform

Item	Unit	Quanity	Unit Cost	Amount
- footings 16"W x 804' L x 12" T (reinforced concrete)	C.Y.	40	90.00	3,600.00
- sides (brick face block backing)5'H x 804'L	S.F.	4020	11.15	44,823.00
- concrete floor (reinforced) 12'W x 6"T x 390'L	C.Y.	88	90.00	7,832.00
Stairways with railing				
- single center platform	Flight	2	2,920.00	5,840.00
Wingwalls for stairs 6'W x 12'H x 1'T	C.Y.	10	65.00	650.00
Elevators				
- single center platform	Ea.	1	53,400.00	53,400.00
Total				116,145.00

Two Platforms

Item	Unit	Quanity	Unit Cost	Amount
- footings 16"W x 1608' L x 12" T (reinforced concrete)	C.Y.	80	90.00	7,200.00
- sides (brick face block backing) 5'H x 1608'L	S.F.	8040	11.15	89,646.00
- concrete floor (reinforced) 2(12'W x 6"T x 390'L)	C.Y.	176	90.00	15,840.00
Stairways with railing				
- two platforms	Flight	4	2,920.00	11,680.00
Wingwalls for stairs 6'W x 12'H x 1'T	C.Y.	10	65.00	650.00
Elevators				
- two platforms	Ea.	2	53,400.00	106,800.00
Total				231,816.00

Track Relocation

Item	Unit	Quanity	Unit Cost	Amount
- Construct track (fit rail)	L.F.	1200	68.00	146,953.44
- Remove track	L.F.	1200	7.50	16,208.10
- Throw track (0' to 8')	L.F.	800	12.00	17,288.64
- Install #15 turnout (L.H.)	Ea.	1	33,000.00	59,429.70
- Remove #15 turnout (R.H.)	Ea.	1	3,000.00	5,402.70
- Track surfacing	L.F.	4,000	1.50	10,805.40
- Restore subgrade	S.Y.	2,000	1.20	4,322.16
- Ballast	T	2,200	4.75	18,729.36
- Electric traction work	L.S.	-	-	45,022.50
- Commun. & Signal work	L.S.	-	-	36,018.00
- switching for tracks	Ea.	2	20,700.00	41,400.00
- resurface and relocate track	L.F.	3000	10.00	30,000.00
Total				431,580.00

Extras

Item	Unit	Quanity	Unit Cost	Amount
Seeding/Landscaping	S.Y.	6000	15.00	90,000.00
Lighting	L.S.	-	-	40,000.00
Mobilization	L.S.	-	-	75,000.00
Schedule Coordinations	L.S.	-	-	55,000.00
Baggage Services	L.S.	-	-	75,000.00
Total				335,000.00

Table 9.1 (continued): Cost Estimates

Station, Track Relocation, & Extras with:	Cost (1997 $)	Cost + 10%
Tunnel with Single Platform	5,108,039.00	5,618,842.90
Tunnel with Center Platform	5,167,841.00	5,684,625.10
Tunnel with Two Platforms	5,283,512.00	5,811,863.20
Overhead Walkway with Single Platform	5,205,602.30	5,726,162.53
Overhead Walkway with Center Platform	5,265,404.30	5,791,944.73
Overhead Walkway with Two Platforms	5,381,075.30	5,919,182.83

Note that the "Cost + 10%" represents the total estimated cost of each alternative plus an additional 10 percent for any error in underestimating these costs. The estimated cost is the one that is reported in this paper.

Cost for each of the alternatives considered:

Tunnel with Single Platform- this price includes the rail terminal, tunnel, track relocation, single platform, and the "extras." Estimated cost is **$5,108,039.00**.

Tunnel with Center Platform- this price includes the rail terminal, tunnel, track relocation, center platform, and the "extras." Estimated cost is **$5,167,841.00**.

Tunnel with Two Platforms- this price includes the rail terminal, tunnel, track relocation, two platforms, and the "extras." Estimated cost is **$5,283,512.00**.

Overhead Walkway with Single Platform- this price includes the rail terminal, overhead walkway, track relocation, single platform, and the "extras." Estimated cost is **$5,205,602.30**.

Overhead Walkway with Center Platform- this price includes the rail terminal, overhead walkway, track relocation, center platform, and the "extras." Estimated cost is **$5,265,404.30**.

Overhead Walkway with Two Platforms- this price includes the rail terminal, overhead walkway, track relocation, two platforms, and the "extras." Estimated cost is **$5,381,075.30**.

Please note that these costs do not include the engineering or architectural fees, but only the cost of the basic materials and labor.

In addition to the provided cost estimates, the possibility of including a moving sidewalk was examined (on the recommendation of PennDOT). The price of the moving walkway was given in the terms of a three foot to six foot wide unit that is 150 feet long which has a capacity of 3,600 to 18,000 people per hour at a cost of $315,200.00 installed including overhead and profit. To install the moving walkway from the rail station to the air terminal a minimum of 750 feet would be required. This would cost approximately $1,576,000.00. The inclusion of a moving walkway may not be justified due to the high cost and ratio of the low volume of users to the high capacity expected at the stations. The cost of a moving sidewalk was not included in any of the cost estimates.

It seems that the construction of an intermodal rail facility adjacent to the Harrisburg International Airport is definitely feasible if sufficient funding is available to cover the capital costs. The recommended design costs approximately 5.3 million dollars. Again note that this price does not include the engineering or architectural fees.

The cost benefit analysis can be looked at from several different prospectives. The basic goal here is to ensure that the demand for this type of facility would be great enough to justify the expenditure of construction of a new station. It also examines if the demand would be great enough in the future to cover the operating costs for each year.

From the demand analysis, it was found that the range of passengers utilize this facility per day is between 118 to 471 for the year 1996. For the design year of 2020, it was estimated that between 222 to 888 passengers per day (81,030 to 324,120 passengers per year) would utilize this rail stop. The average cost for ticket prices for use of this facility was not calculated.

From the traveler scenarios (discussed in Chapter 5 of this report), it was found that this mode of transportation could compete with the private automobile in terms of the total time traveling. The value of time can take on a multitude of values with different people and also within different situations for the same person. The cost benefit savings associated with the value of time was beyond the scope of this project.

It was also felt that the commercial and business opportunities that may be created as a result of the construction of an intermodal rail facility in this area would be great. The facility would seem to benefit from a private/public partnership formed by new businesses. These new businesses may attract more passengers not accounted for in this study.

Chapter 10

RECOMMENDED DESIGN

The recommended design for the intermodal facility at the Harrisburg International Airport was determined to be the tunnel with two platforms costing $5,283,512.00. Based on the performance measures, this option was determined to be the best.

1. User Convenience - The tunnel was determined to be the most convenient option since the user would only need to ride the elevator or use the stairs a minimum of one time compared with using the elevator or stairs a minimum of two times in the case of the overhead walkway alternative. The overhead walkway would require the person to travel from the platform up to the walkway by elevator and from the walkway to the air terminal by elevator. This seemed inconvenient for a handicapped passenger or a passenger with baggage.

Two platforms seemed to be the most convenient from the rail operations point of view with the existing constraints. This option allows the passenger to directly enter the rail terminal from the train or to travel down into the tunnel. If an advanced signaling system existed then a station side platform option may prove to be more convenient. The center platform seems to be the least convenient since the user must use the elevator or stairs to get to the rail terminal.

2. ADA Requirements - The ADA requirements can be met by all options, but the tunnel seems to be the most convenient for the handicap persons. The tunnel option would be more ADA convenient in that it requires only one ride in the elevator and all other operations would be at grade. The center platform seemed to pose the most problems for the handicapped passenger.

3. Safety - The safety in the tunnel is a perceived state that the user would feel. One alternative may not be safer than any other option, but only perceived in that way. It is hoped that the tunnel will be short enough not to hamper the perceived safety of the passengers.

4. Security - The concept of security is also perceived by the user. No one option is essentially more secure than any other option. If the final construction is pleasing to the user, a feeling of safety should also be felt.

5. Aesthetics - The aesthetics of the tunnel was based on factors that set it apart from the overhead walkway. In the recommended design, the tunnel would be hidden from view and the glass walkway going from Airport Drive to the air terminal would not detract from aesthetics of the parking lot area. The overhead walkway, depending on the required vertical clearances, would be extruding through the landscape and would be visible from many of the roads near the airport. The overhead walkway may look out of place in this area, since the area currently has few high buildings.

6. Rail Operations- Using two platforms, eliminates the need for centralized track control. In the center platform and station sided platform some means of track control is needed. Fully centralized track control is of high cost. This cost was not estimated in this design. If, in the future, fully centralized track control is implemented, then a station side platform may be superior to using two platforms.

Chapter 11

SUGGESTIONS FOR FURTHER STUDY OR IMPLEMENTATION

ITS Opportunities

The introduction of Intelligent Transportation Systems (ITS) is another aspect that may be incorporated into the design of an intermodal facility at the Harrisburg International Airport. Intelligent Transportation Systems offer reduced congestion, improved safety, and reduced air pollution at airport locations. Many ITS technologies may be employed in this design. Areas to which ITS may be applied include the following:

- Travel and Transportation Management➤ en-route driver information, route guidance, traveler services information, traffic control, and incident management
- Travel Demand Management➤ pre-trip travel information, ride-matching and reservation, and demand management and operations
- Public Transportation Operations➤ public transportation management, en-route transit information, personalized public transit, and public travel security
- Electronic Payment➤ electronic payment services
- Cargo Vehicle Operations➤ commercial vehicle electronic clearance, hazardous materials incident response, and commercial fleet management
- Emergency Management➤ emergency notification and personal security, and emergency vehicle management

Some ITS initiatives currently being used at United States airports include: 1) Automatic Vehicle Identification Systems, 2) Highway Advisory Radio systems, 3) Automated kiosks, and 4) Traffic Information Systems.

A detailed summary of ITS opportunities that may be deployed at the Harrisburg International Airport can be found in the Appendix.

Commercial/Business Opportunities

Public/Private partnerships may benefit from a commercial or business opportunity near the intermodal rail facility. The possibility of a hotel and a mall being constructed was briefly investigated in this paper. However, further research is still needed in this area.

Future Studies

Several other studies may be investigated if the intermodal rail facility at the Harrisburg International Airport is to be constructed. Such studies include a survey and analysis of users, a traffic impact analysis, development of a preliminary design, and an investigation of HIA Traveler Information Systems.

Survey of Users and Analysis

A survey of people who would use and also would not use the intermodal rail facility would be an appropriate study for this project. The reasons why the facility would or would not be utilized could be investigated and appropriate measures could then be taken. Certain innovations may be introduced to increase the attractiveness of the intermodal rail facility.

Traffic Impact Analysis

A thorough investigation of how the trips are generated and distributed in the area could be performed. Further investigation would require the analysis of the existing traffic conditions, future no build traffic conditions, and the future build traffic conditions.

Preliminary Design

This report was to serve as the basis for a preliminary design. One of the next steps in constructing the intermodal facility at the Harrisburg International Airport would be to develop the preliminary design.

HIA Traveler Information System

Given the potential benefits gained through the use of Intelligent Transportation System technologies and information services, a conceptual design of a traveler system for HIA should be performed.

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Appendix

DETAILED ITS OPPORTUNITIES AT HIA

This Appendix is to serve as a supplement to Chapter 11- "Suggestions for Future Study or Implementation" in this master's paper.

Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) apply advanced and emerging technologies in information processing, communications, control, and electronics to meet surface transportation needs (Euler and Robertson, 1995, p.1). The stated goals of ITS are to improve safety of the nation's surface transportation system; increase the operational efficiency and capacity of the surface transportation system; reduce energy and environmental costs associated with traffic congestion; enhance present and future productivity; enhance personal mobility and the convenience and comfort of the surface transportation system; and create an environment in which the development and deployment of ITS can flourish.

The National Program Plan states that one objective of ITS is to ensure it to be intermodal. The Plan "outlines a deployment vision aimed at smoothing intermodal linkages and integrating a national transportation system." The introduction of ITS is an important consideration that may be incorporated into the design of an intermodal facility at the Harrisburg International Airport. By using advanced technology, Intelligent Transportation Systems offer reduced congestion, improved safety, and reduced air pollution at airport locations.

Advanced Public Transportation Systems (APTS)

The Federal Transit Administration established the Advanced Public Transportation Systems Program as part of the ITS initiative. The APTS Program was established to encourage innovation and to develop worthwhile approaches that use advanced technology to improve public transportation and ridesharing (Robert et al., 1996, p. x). APTS plays an active part of the growing commitment to integrate intermodalism into the ITS arena.

Implementing ITS

ITS alone will not solve problems, however properly chosen and implemented ITS services will aid in improving the surface transportation system. Shapiro et al. (1996, p. 182-186) gives a brief flowchart for the ITS planning process. The first step in implementing ITS is to review those services that can solve those problems that have been identified. Motivation for ITS services should evolve from user demands. It is important that the ITS services selected be the best solution for its needs. The next step in implementing ITS is to determine the potential costs and benefits as well as the technical feasibility. The technical feasibility may be examined by looking at similar applications. The total cost of the system should be analyzed. These costs would include construction, operational, and maintenance costs. The benefits of the system (such as time and cost savings and reduced pollution) should be viewed from the prospective of the passengers as well as the employees and service providers. The final steps would be to develop an architecture to implement the selected ITS services and to develop an implementation plan.

ITS Services

ITS is seen as the enabling technology for intermodalism establishing a truly seamless intermodal transportation system. Many ITS technologies may be employed in this design. Areas to which ITS may be applied are briefly discussed in the following sections.

Travel and Transportation Management

This involves technologies such as en-route driver information, route guidance, traveler services information, traffic control, and incident management. Traveler Information Systems technologies can give real time information such as actual bus and train arrival times, computerized maps and travel directions, information on current delays, and estimated travel times on alternate routes and competing modes via kiosks, variable message signs, and other media. This information has the ability to have a substantial impact on commuters' route and mode choice. Another technology, Automatic Vehicle Locators, offers numerous benefits such as allowing more efficient and on-time operations, giving faster responses to service disruptions, and help to meet ADA requirements. Traffic control technologies can coordinate transit services by managing traffic on roadways. One of the key features in ITS, which is accomplished by this technology, is its ability to coordinate transportation systems in time and space. In-vehicle information is another technology that is most often used on rail modes because of the limited, exclusive right of ways on which they operate (Casey, et al., 1995, p. xiv).

Travel Demand Management

This involves technologies such as pre-trip travel information, ride-matching and reservation, and demand management and operations. These services combine innovative technologies to better utilize the existing infrastructure. The goal of these services is to maximize the ability of the current transportation network to serve the increase in transportation through a combination of strategies (Casey, et al., 1997, p. xv). Pre- trip traveler information technologies provide information such as schedules, fares, delays, and reservations via the radio, cable television, telephone, variable message signs, monitors, or computer. This aids the passengers in selecting the best mode, departure time, and route for their trip. Another technology, Automated Passenger Counters, can collect data such as the number of passengers getting on and off a bus by location and time. This data may then be used in the planning, operation, and scheduling of activities as well as for information for decisions on corrective actions.

Public Transportation Operations

Public Transportation Operation Technologies involve public transportation management, en-route transit information, personalized public transit, and public travel security. It allows for integration of public transit operations, planning, and management functions while at the same time creating a secure environment for the passengers and employees.

Electronic Payment

Electronic Payment is comprised of various electronic payment services. This is one of the most effective ITS services for fixed rail transit. Utilization of an automatic fare card eliminates cash and coin handling while at the same time can better schedule and direct rail car operations, improve flexibility, improve revenue and accountability, reduce fare abuse, improve ridership data, and improve convenience to passengers. Electronic fare payment systems have been in use since the 1970's in rail transit with magnetic strip fare cards. The creation of a multi-provider transportation electronic fare card provides networks which are seamless for the rider but operationally and organizationally sound for the multiple providers (Casey, et al., 1997, p. xiv). This is an ideal ITS service to use in an intermodal/multimodal environment.

Commercial Vehicle Operations

Commercial Vehicle Operations deals with commercial vehicle electronic clearance, hazardous materials incident response, on board safety monitoring, and commercial fleet management. Fleet management is essential in the intermodal environment. It provides the communications between drivers, dispatchers, and intermodal transportation providers. It also makes transit more efficient and reliable, thereby making it more attractive to riders.

Emergency Management

Emergency Management involves emergency notification and personal security, and emergency vehicle management. A technology known as Positive Train Separation involves using Global Positioning Systems to pinpoint a train's exact location. This information can be sent digitally to the traffic management centers. This technology enables immediate notification of an incident and immediate request for assistance allowing for a quicker response in times of emergencies.

ITS Services Currently being Used at U.S. Airports

Some ITS initiatives currently being used at United States airports include: 1) Automatic Vehicle Identification Systems, 2) Highway Advisory Radio systems, 3) Automated kiosks, and 4) Traffic Information Systems. Refer to Table A.1 below for examples of ITS services being used at airports in the United States.

Table A.1: ITS Initiatives Being Used at U.S. Airports

ITS Initiative	Project Description	Examples
AVI System	•Collects revenue and fees; •Controls congestion; •Records trip counts for registered ground transportation vehicles; •Tracks commercial vehicles in and out of the airport; •Controls bills, and bills certain groups using accurate circuit counts; •Provides commercial vehicle location, service quality monitoring, access control; •Predicts the amount of time a vehicle spends in the controlled area; •Provides fee assessment, roadway planning, and fee determination; •Controls all commercial traffic within two facilities: the post staging area, and the terminal commercial roadways	Baltimore/Washington, Dallas/Ft. Worth Denver International, Honolulu, Houston John F. Kennedy, Kansas City Los-Angeles/Ontario, Los Angeles International, McCarran, Miami International, Minneapolis/St. Paul Orlando, Philadelphia, Phoenix, Pittsburgh, San Francisco, St. Louis/Lambert
HAR System	Provides parking information from three transmitters on access road to airport	Washington Dulles International
Automated Kiosk	Provides information on ground transportation services, hotel and airport terminal information; maps, etc.	Metropolitan Oakland International, San Jose International, Sacramento, Burbank
Traffic Information System	Provides information on parking availability and road construction in the airport	Washington National

Source: Shapiro, Phillip S., et al. Intermodal Ground Access to Airports: A Planning Guide. Federal Highway Administration & Federal Aviation Administration. Report No. DOT/FAA/PP/96-6, December 1996.

Institutional Barriers to Deploying ITS Services

ITS is not without its faults. There are a number of important institutional challenges which must be addressed in both the near and long terms. The benefits of ITS can not be fully achieved without overcoming barriers to their deployment. Some of the major institutional barriers that are hindering the deployment of ITS technologies are privacy, liability, procurement, environmental issues, and awareness issues. Along with the institutional commitment, a greater technical integration of research and development efforts is also needed to include intermodalism.

The National Program Plan states the near term challenges that ITS is facing includes the following:

- Lack of Market Information- There is a need for a better understanding of the potential market for ITS.
- Uncertain Public Infrastructure Base- Stakeholders are uncertain of the public/private infrastructure and if their products and services will be compatible.
- Competition for Scarce Resources- ITS must demonstrate that they will deliver significant benefits to gain funding from the government.
- High Cost of Equipment and Media Production- It will be very expensive to get the ITS infrastructure in place.
- Need for New Skills- Public agencies must seek employees with update training and appropriate technical training to keep up with the latest technical and engineering skills that are needed.

- Inexperience with Partnerships- ITS will link services in city, state, and international boundaries which may not be experienced in this type of partnership.

- Potential Loss of Privacy- Substantial issues over privacy concerns could greatly affect the public acceptance of ITS.

- Fare Fraud- Issues over electronic fare payment fraud are already evident.

The National Program Plan also feels that the longer term institutional barriers include the following:

- Implications of ITS Deployment for Society- ITS must ensure benefits to be fairly distributed.

- Concern for the Environment- ITS must assess any environmental impacts and promote involvement in the environmental community.

- Improving the Procurement of ITS- Procurement issues include competitive bidding, organizational conflicts of interest, bonding, treatment of intellectual property, cost accounting and audits, and project uncertainties resulting from the procurement process.

- Managing Liability Risks- ITS services may shift liability to the operators and developers of these services and increase the vulnerability to lawsuits.

ITS Benefits

One goal of ITS is to develop information and data to assist local transit providers to implement appropriate service options and enhancements for serving individuals with disabilities. Technologies such as talking bus stops and signs, talking buses and trains, auditory maps and pathways, automated speech recognition, electronic information signage, assistive listening devices, and telecommunication systems will benefit many handicapped passengers. Many technologies are available for implementation to comply with ADA requirements. A well planned system will accommodate disabled customers with the highest level of service.

An important goal of ITS is to shift demand from the roadways to the railways and public transportation. In making this modal shift happen, several benefits become apparent. They are the following:

- Improving the pre-trip information and providing access to ticket reservation and payment.
- Improving travel information at the intermodal exchange points.
- Making the payment of fare easier through use of the electronic fare payment.

From a recent paper on the Internet (at http://www.its.dot.gov/docs/itibeedoc), a summary of Transit Management and also electronic fare payment system benefits was given. They can be viewed in the tables on the following pages.

Table A.2: Summary of Transit Management System Benefits

Travel Time	Decreased 15-18 percent
Service Reliability	Increased 12- 23 percent in on-time performance
Security	Decreased incident response time to as little as one minute
Cost Effectiveness	45 percent annual return on investment

Table A.3: Summary of Electronic Fare Payment System Benefits

Area	Benefit	Quantitative Gain
Phoenix, Arizona	Patronage Popularity	Express routes report 90 percent of fares paid by bus pass cards
Phoenix, Arizona	Fare Collection	Passes have reduced fare evasion and increase revenue from 3 to 30 percent
Phoenix, Arizona	Data Collection	Estimate of data collection cost reduction ranges from $1.5 to $5 million
New Jersey Transit	Cash Handling	Expected cost reduction of $2.7 million
Atlanta, Georgia	Cash Handling	Expected cost reduction of $2 million

Also from a recent article by D. Goeddel, some benefits of ITS were assessed. It was found that the annual range of annual benefits of APTS Operations were the following:

- Fleet Management-- $1.7 to $3.2 million dollars
- Transit Information-- $0.8 to $1.6 million dollars

A multitude of ITS services may be applied to the Harrisburg International Airport project. However, a complete cost benefit analysis to ensure that the demand will be great enough to overcome the costs will need to be completed before any of the services are implemented.