Table 3. Comparison of activity at American and United Airlines Terminals.

| Item | November 19, 1976 | | November 21, 1980 | | Change (%) | |
|---|---|---|---|---|---|---|
| | American | United | American | United | American | United |
| Traffic volumes, 4:00-5:00 p.m. (vehicles) | | | | | | |
| Frontage roads | 705 | 480 | 875 | 575 | +24 | +20 |
| D-road opposite terminal | 790 | 840 | 1250 | 950 | +58 | +13 |
| Traffic volumes, 4:00-7:00 p.m. (vehicles) | | | | | | |
| Frontage roads | 1620 | 1185 | 1850 | 1525 | +14 | +29 |
| Inner through road opposite terminal | 2300 | 2075 | 3100 | 2300 | +35 | +11 |
| Passenger volumes—departures, 4:00-7:00 p.m. | 1280 | 1265 | 1350[a] | 1410[a] | +6 | +12 |
| Vehicle dwell times, private automobile (min) | | | | | | |
| Arrival | 2.4 | 2.2 | 2.3 | 2.0 | | |
| Departure | 2.6 | 3.1 | 2.6 | 2.5 | | |

[a]Estimated number of passenger departures includes transfer passengers and an estimate of all other passengers served at the terminal.

was undertaken on Friday, November 21, 1980, four years after the original survey. Table 3 presents a summary of comparative activity at the American and United Airlines terminals at Kennedy International Airport. In summary, the table indicates that a greater amount of vehicular and air passenger traffic is accommodated at the two respective terminals. During the peak hour, a 20 percent increase in vehicles that use the curb frontage roadways was observed as compared with 1976 conditions. Of importance, however, is that the roadways that serve the two terminals operated in the absence of delays and provided improved levels of service to the airline passengers. The increased capacity has also enabled the airlines to manage their respective curb frontage roadways better, as indicated in the reduced vehicle dwell times observed. Overall, the plan has been well received by both air carriers, airport officials, and air passengers. Like many planned improvements, however, there are both disadvantages as well as benefits when the planned improvements to the overall airport are weighed. Implementation of this plan has had the following adverse effects at Kennedy International Airport:

1. Travel times between some terminals have increased due to the discontinuation of the through roads;
2. As a result of increased traffic on the inner through road the Port Authority has widened the inner through road in front of the American Airlines terminal, modified the parking lot access-egress operations, and made other minor roadway improvements at other terminals and revised signing; and
3. A slight reduction in short-term parking use in the central terminal area (parking lot 3) has been noted.

Some of the more noticeable benefits at the terminal roadways that serve the American and United Airlines terminals include the following:

1. Improved vehicle ingress and egress,
2. Substantial increase of curb frontage area,
3. Elimination of the majority of non-American or United Airlines terminal traffic,
4. Better traffic management capabilities,
5. Segregation of private and commercial vehicles at the American Airlines terminal,
6. Separation of arrivals and departures at the United Airlines terminal,
7. Individual taxi queue areas that have direct terminal access to reduce the problem of illegal taxis,
8. Reduced passenger complaints about terminal traffic,
9. Increased area lighting for driver comfort, and
10. Individual terminal VIP parking areas.

Prior to construction of the new roadways and curb frontage areas, during peak periods of activity, terminal traffic congestion caused significant delays. The completion of the project reduced this problem substantially and provided order in traffic operations at the two terminals.

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# Automating the Delivery of Ground Transportation Information

MARK GORSTEIN AND RICHARD TILLES

**This paper introduces the concept of an automated ground transportation information system (AGTIS) for use at major intermodal transportation terminals. The AGTIS uses a touch-sensitive cathode-ray-tube terminal to facilitate input to a computer-based information-retrieval system. The patron uses the touch-screen terminal to indicate an ultimate destination and then receives visual information on the travel time, cost, and availability of transportation services to that destination. After selecting the most appropriate service, the patron then receives detailed printed instructions for its use. A prototype system has been set up at the Transportation Systems Center. Full working demonstration projects are expected to be installed at Boston's Logan Airport and Washington D.C.'s National and Dulles Airports. These systems will be closely monitored to assess their efficiency in delivering transportation information and to evaluate their impact on the mode choice of air passengers.**

The traveler who arrives by plane, train, or bus at a major transportation terminal is often faced with an immediate problem, how to get to his or her final destination. This problem becomes particularly complex at a large hub airport where a wide variety of taxicab, bus, limousine, and sometimes rail services are provided. Because air travelers are usually in a hurry, information they receive on the availability and current status of such services must be delivered quickly. Otherwise, most will be inclined to use low-occupancy vehicles, such as taxis, rental cars, or private automobiles, and thereby increase traffic congestion and energy consumption.

A similar problem is presented to the airport operator. The operator wants to dispense ground transportation information efficiently and accurately to the airport user. However, the increasing number of air passengers combined with rapidly escalating personnel costs make it more and more difficult to provide the level of information that passengers need to select the ground transportation service best suited to their time schedule and budget.

Traditionally, airports have used three basic methods for delivering ground transportation information: (a) brochures, (b) personnel (at booths or via phone), and (c) signs. A brief survey of 12 large hub U.S. airports evaluated the effectiveness of these methods against the criteria listed below:

1. Is the information comprehensive?
2. Is it easy to understand?
3. Can it be easily updated?
4. Does it provide quick access to the air traveler?
5. Is it location specific (i.e., can information for a particular destination be isolated)?
6. Does it permit intelligent decision making? and
7. Can it be set up, operated, and maintained at low cost?

Analysis indicates that none of the current methods rates very highly when evaluated by the criteria. The brochure can be made comprehensive, but it then becomes difficult for the passenger to extract information quickly. Updating of brochures to account for frequent schedule, route, and fare changes can be very expensive and confusing to the air passenger. Trained personnel are usually able to respond to a variety of questions. However, the cost of maintaining sufficient personnel to respond to ground transportation questions during peak periods is prohibitive. Space constraints limit the comprehensiveness of signs. A well-designed sign can provide quick information on where to go, whom to call, and perhaps provide more detailed information for downtown trips. However, signs are difficult to update and rarely contain enough information to permit intelligent decision making.

## AUTOMATING THE DELIVERY OF INFORMATION

Problems with current information systems point up the need to improve three areas of information delivery:

1. Speed of access,
2. Ease of updating, and
3. Comprehensiveness of information.

These shortcomings could be overcome by taking advantage of the speed and comprehensiveness possible through computer-based automated information systems that are being instituted with increasing frequency in virtually all areas of modern society.

Automated systems are starting to appear at airport terminals. In December 1977, London's Heathrow Airport installed a "route-finder" system that provides subway routing information in three languages for passengers who press a button to indicate their desired destination. Denver's Stapleton Airport has a transit information display board that indicates routes and departure times for all buses that serve the airport (1). These systems provide fast, easily updated, and accurate information for passengers who have already chosen to use transit as a means of getting to their ultimate destination. They do not provide information that would enable a patron to select from a variety of transportation services.

To examine the effectiveness of a more comprehensive system, the Operations Analysis Branch of the Transportation Systems Center (TSC) currently is planning automated ground transportation information systems (AGTIS) at Boston's Logan Airport and Washington, D.C.'s National and Dulles Airports. The work in Boston is sponsored jointly by the Federal Aviation Administration (FAA) and the Urban Mass Transportation Administration (UMTA). The system for the Washington airports is sponsored by the FAA.

## BOSTON LOGAN AGTIS

Boston is a logical location for a demonstration of AGTIS because it contains a wide variety of ground transportation services, including bus, limousine, rapid transit, and share-a-cab (a system where reduced taxi fares are charged to patrons who are willing to share a taxi with persons who are going in the same general direction). Boston also experiences frequent heavy traffic congestion in the Sumner and Callahan Tunnels, which connect the airport with most of the metropolitan area and would really benefit from any program that could divert air passengers from low-occupancy to high-occupancy vehicles and rapid transit. The reduction of vehicular traffic to the airport has been given high priority by the airport operator, the Massachusetts Port Authority (Massport) (2).

The heart of the proposed system at Logan Airport is touch-sensitive cathode-ray-tube (CRT) terminals located throughout the airport terminals (Figure 1). A touch-sensitive CRT is recommended because it is easier for an untrained patron to use than the traditional keyboard. The passenger would touch the screen of the terminal and be guided through a sequential series of screen displays to determine the user's local destination and specify the various transportation options that can be used to get to the destination. The sequence is indicated in Figure 2.

The user is asked to select a type of destination, either (a) an area municipality, (b) a landmark (e.g., hotel or university) or (c) another airline terminal at the airport. In the first option, the screen asks a series of questions that the user answers to provide a precise specification of the user's destination zone. When this zone is reached, a service choice display is produced on the screen. If the user specifies a landmark, a service choice display can be referenced directly. Patrons who request another airline are given information on Massport's shuttle bus.

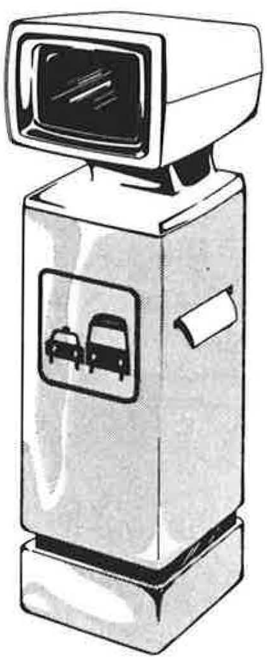
The service choice display indicates a variety of potential means of getting to the destination, including taxicab, share-a-cab, limousine, bus, and rail transit. The information provided for each service is

1. Type of service,
2. Travel time,
3. Service frequency, and
4. Cost.

After reading the service choice display, the user can then touch the screen to receive a detailed service information display for any selected service, including the following:

1. Directions for getting to the point from which the vehicle departs,
2. Name and phone number of the company that provides the service,
3. Fare information,
4. Schedules,
5. Location of stops at destination points,
6. Services available at destination points, and
7. Instructions for use of service.

**Figure 1. Conceptual drawing of AGTIS terminal.**



The air passenger would receive, if desired, a printed copy of the detailed information to provide a reference during the trip from the airport. The sequence of displays a passenger would go through in the selection of transit service to Cambridge, Massachusetts, is shown in Figure 3.

The system is also intended to provide information on short-term transportation changes and events such as major traffic congestion problems or transit system problems, for example,

1. "Accident in Sumner Tunnel--delays of up to one hour",
2. "Power failure on Blue Line--do not take MBTA transit", or
3. "Hudson Bus Lines reports that its 7:30 a.m. limousine to Concord, New Hampshire, will not depart until 8:10 a.m.".

A functional diagram of the Boston AGTIS is shown in Figure 4. A prototype system, which consists of a touch-screen terminal, printer, and microcomputer with floppy disc storage, has been set up for demonstration at TSC's Cambridge offices.

WASHINGTON AIRPORTS AGTIS

The FAA's metropolitan Washington airports division, operator of National and Dulles Airports, is currently upgrading ground transportation services and considers the automation of the delivery of ground transportation information to be a key part of this program.

A recently completed study of the Washington AGTIS (3) recommended that the Washington airports AGTIS use the data base being developed for Washington, D.C.'s new automated public transportation information system. The Automated Information Directory System (AIDS) will speed up information retrieval for Washington Metropolitan Area Transit Authority (WMATA) staff who answer travel telephone requests for WMATA-operated transit services. WMATA operates rail transit and public buses to National Airport, but the WMATA system does not include airport-based bus or limousine services.

AIDS determines optimal routing information when origin and destination addresses or landmark names

**Figure 2. Boston AGTIS flow chart.**

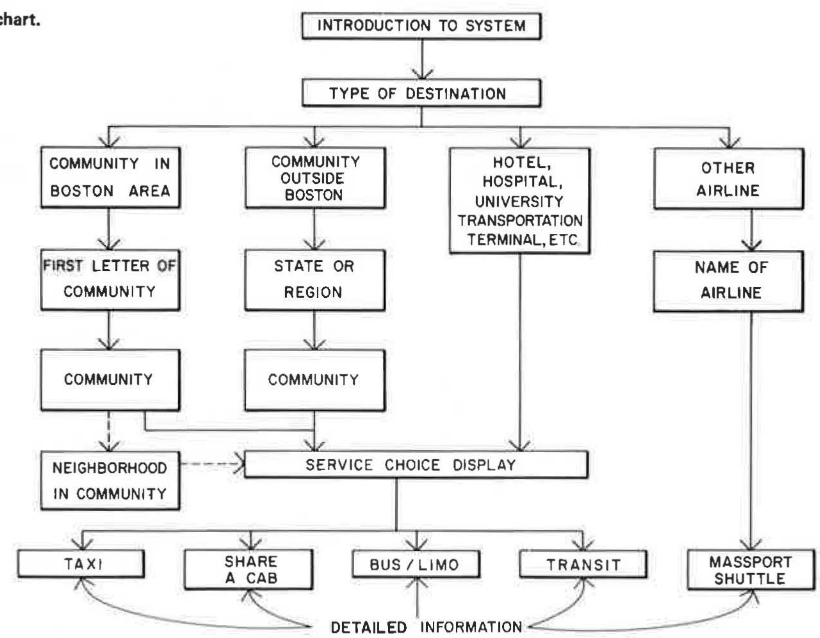


**Figure 3. Sample sequence of displays for Boston Logan AGTIS.**

| WELCOME TO BOSTON | BEM VINDO A BOSTON |
| --- | --- |
| FOR INFORMATION ON TRANSPORTATION PLEASE TOUCH THE ASTERISKS BELOW | PARA INFORMACOES DE TRANSPORTE MECHA NAS ESTRELAS EM BAIXO |
| *** | *** |

SELECT A DESTINATION OR SERVICE

HOW TO GET TO OTHER AIRLINE TERMINALS (AIR-PORT-SHUTTLE)
*** BOSTON AREA AND MASSACHUSETTS DESTINATIONS ***
SELECTED LOCATIONS IN NEARBY STATES
DOWNTOWN RAIL AND BUS TERMINALS
LIMOUSINE AND BUS SERVICES
MILITARY INSTALLATIONS
UNIVERSITIES
HOSPITALS
HOTELS

TOUCH THE GROUP OF LETTERS CONTAINING THE BEGINNING LETTER OF YOUR DESTINATION

| | |
| --- | --- |
| A | M |
| B | N |
| C*** | O, P |
| D, E | Q, R |
| F | S |
| G, H | T, U, V, W |
| I, J, K, L | X, Y, Z |

SELECT A DESTINATION

| | | |
| --- | --- | --- |
| CAMBRIDGE | *** | CENTRAL AVENUE (MILTON) |
| CAMPELLO | | CENTRAL SQUARE (CAMBRIDGE) |
| CANTON | | CENTRAL SQUARE (E. BOSTON) |
| CANTON JCT. | | CHARLES ST. CIRCLE |
| CAPEN ST. | | CHARLESTOWN |
| CARLISLE | | CHELMSFORD |
| CARVER | | CHELSEA |
| CEDAR GROVE | | CHESTNUT HILL |

COMMUNITIES IN CAMBRIDGE

| | | |
| --- | --- | --- |
| CENTRAL SQUARE | | PORTER SQUARE |
| HARVARD SQUARE | | |
| INMAN SQUARE | | |
| KENDALL SQUARE | *** | |

KENDALL SQUARE
CHOICE OF TRANSPORTATION

| MODE | TRAVEL TIME | COST | AVAILABILITY | MORE INFO |
| --- | --- | --- | --- | --- |
| TRANSIT | 30 to 40 | $ .75 | 6.00 AM to 11.30 PM | *** |
| TAXI | 15 | $8.00 | on demand | |
| LIMOUSINE | 20 to 46 | $3.50 | 6.30 AM to 11.05 PM | |

KENDALL SQUARE
HOW TO GO TO BY TRANSIT
(Available from 6 AM to 11 PM)

TAKE AIR-PORT SHUTTLE BUS TO THE MBTA STATION
TAKE THE INBOUND TRAIN TO GOVERNMENT CENTER
CHANGE TO THE GREEN LINE TO PARK STREET CHANGE TO RED LINE TO ALL POINTS

FOR MIT EXIT AT CENTRAL SQUARE and walk back 1/2 MILE ALONG MASS AVE.

FOR HARVARD U EXIT at HARVARD SQUARE

FOR DOT-TSC EXIT at KENDALL SQUARE

FOR POLAROID EXIT AT KENDALL SQUARE walk about 1/4 mile along MAIN STREET

(NOTE: Have exact change $ .25 ready for airport shuttle)

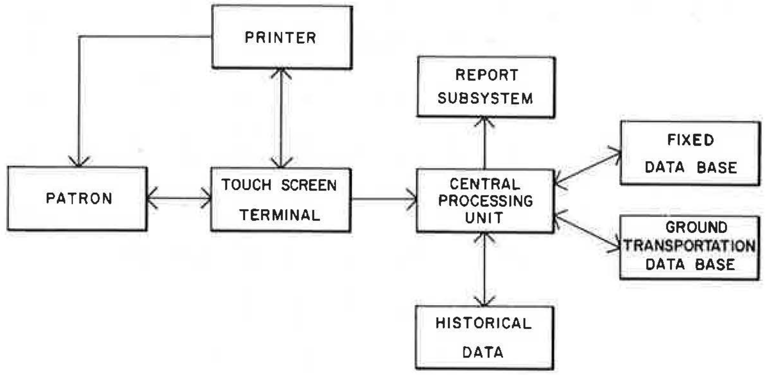



**Figure 4. Boston Logan AGTIS functional system.**

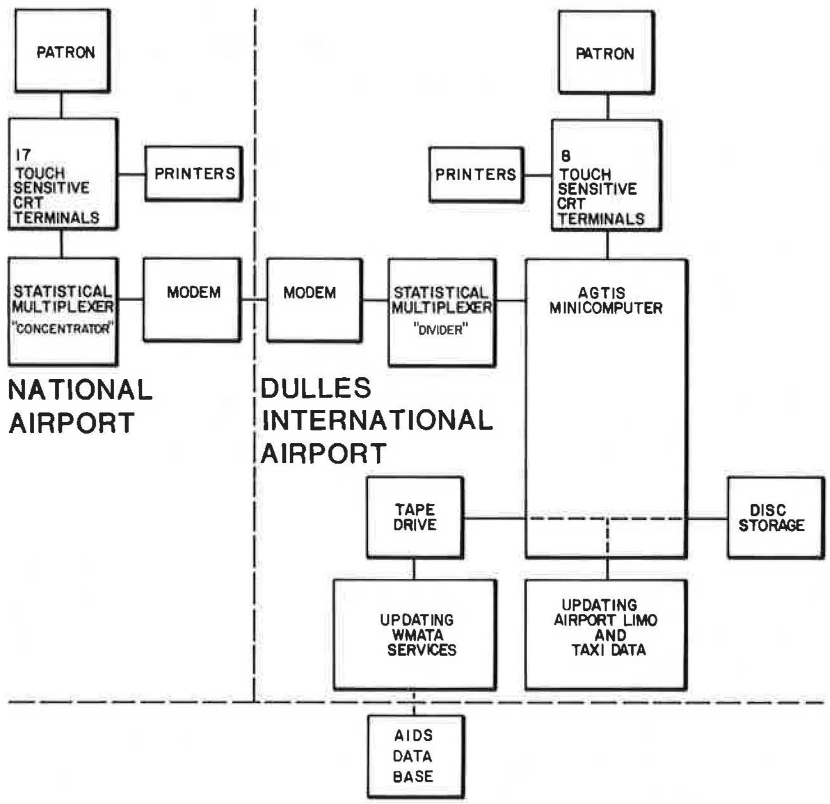



**Figure 5. Proposed AGTIS configuration for Washington airports.**

as well as either desired departure or arrival times are known. AIDS is capable of selected optimum routings based on either minimum travel time, minimal number of transfers, lowest cost, or shortest walking distance, depending on the desires of the patron. The two major data files required by AIDS are the geographic and transit files. The geographic data file is essentially a computerized map of the WMATA service area. Given an address, an algorithm developed for AIDS uses this file to generate a set of coordinates. These coordinates are then used to determine routing information. The transit file contains information regarding routes, schedules, and stops for both Metrorail and Metrobus.

AIDS is designed for use by trained WMATA agents, but AGTIS must be available for use by untrained air passengers without assistance. Consequently, a system that uses some features of both AIDS and AGTIS had to be designed.

A proposed system configuration for Washington is shown in Figure 5. Additional study will be required to determine whether it is more cost effective to link terminals at National with a minicomputer at Dulles or have separate computers at both airports. To provide for input of addresses and street intersections on these terminals, an alphabet and number format displayed on the screen is recommended. The patron could spell out a destination by touching the screen, and the address name is displayed on the screen (see Figure 6 for sample).

By using the AIDS data files for WMATA services and new files for taxis and limousines, the AGTIS software would most likely be set up to retrieve transit information that has been preprocessed and stored in a large data file. One way to do this is to generate a grid over the Washington metropolitan area and then relate AIDS destination coordinates to each grid point for WMATA services while predetermining travel distances and times from both airports to each grid point to store taxi information. The portion of the AGTIS data base that consists of WMATA's routes and schedules can be updated as required by duplicating the AIDS route and schedule tape and then running it through the AGTIS central

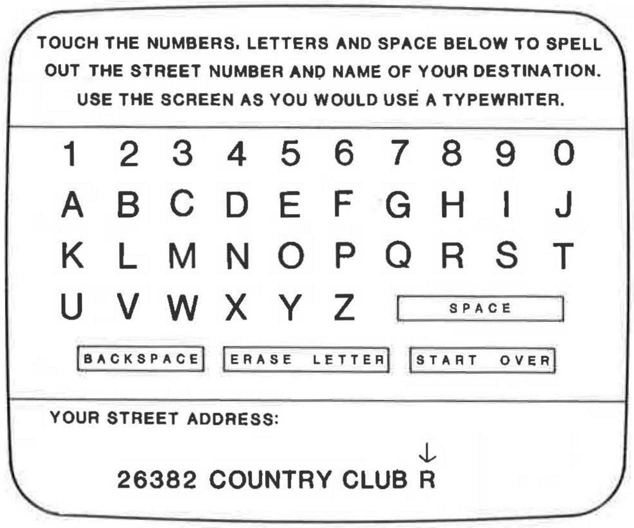



**Figure 6. Possible CRT display for street address input.**

processing unit to create an updated AGTIS data file.

EVALUATING THE EFFECTIVENESS OF AGTIS

As a demonstration project, the performance and impact on travel habits of the AGTIS project will be comprehensively examined. Four general aspects of the AGTIS will be evaluated:

1. System reliability and performance--Appraisal of the system's hardware and software components in meeting system specifications and in providing comprehensive and relevant information;
2. System use--Information about the extent of the system use and its usefulness in providing relevant and comprehensive information in an understandable format;
3. System costs--Tabulation of the capital, operating, and maintenance costs so that the system's cost-effectiveness can be assessed; and
4. System effectiveness--Evaluation of the impact of the AGTIS on transit services and on ground travel habits of air passengers.

A program for collecting data at Logan Airport to evaluate all four aspects of the AGTIS is currently being developed. The program (which is only preliminary at this stage) consists of the following ten elements:

1. Air passenger survey--Questionnaire handed out either before or during a sample of departing flights. This survey component is needed primarily to measure change in passenger mode choice and to determine the characteristics of passengers who are not using AGTIS.
2. AGTIS user questionnaire--Distribution of prepaid, mail-back questionnaire survey forms at the AGTIS terminals. The questionnaire would provide a profile of the AGTIS user, including non-air-passenger users of the system, and user perceptions of the AGTIS.
3. Transit carrier questionnaire--Questionnaire mailed to all private bus and limousine operators who provide service at Logan Airport to assess the AGTIS' impact on carrier operations and on the availability and further need for other transportation mechanisms employed by the carriers.
4. Massport interview--Interview to determine Massport's perspective on the feasibility and effectiveness of the AGTIS demonstration at Logan Airport. The interview would focus in on system reliability, user acceptance, impact on Massport's operations and costs, and suggestions for other airports.
5. Rapid transit rider count--Count riders who enter and leave the Massachusetts Bay Transportation Airport Station for one day both before and after AGTIS implementation to assess AGTIS impact on rapid transit.
6. Internal roadway count--Traffic counts conducted at selected roadway locations to measure AGTIS impact on vehicular traffic. The counts would be taken during the duration of both air passenger survey periods (seven days each).
7. System observations--Observations of persons who use AGTIS will provide information on system comprehensibility and human factors problems. Data received from these observations will be used to correct the AGTIS data base and procedures as well as evaluate the system.
8. AGTIS maintenance records and operator logs--System records will be used to provide an objective record of system performance throughout the life of the project. Maintenance records would be prepared for every preventive maintenance, failure, or malfunction observed.
9. AGTIS data files--AGTIS user tabulations will be compiled by using an AGTIS Report Generator subsystem that will summarize data stored in the historical data files on patron use. These data will be used to provide general information concerning system use and to provide base data for comparison with the air passenger and AGTIS user surveys.
10. Massport records--Ridership data currently collected by Massport for limousine, private bus, taxi, and share-a-cab services on a monthly basis will be summarized by the contractor for a period of time before and after AGTIS implementation. These data will identify long-term trends in public transporation use and verify results obtained from the air passenger surveys.

CONCLUSIONS AND FUTURE APPLICATIONS

Computer systems are becoming less expensive and more powerful while costs are rising in virtually all other areas. An automated information system may be one of the least costly means of increasing transit ridership (although this assumption has not yet been tested) and therefore decrease traffic congestion and energy costs. If the system proves successful, it could be applied to major rail and bus transportation terminals as well as airports.

ACKNOWLEDGMENT

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# Airport Access: Case Study of a Remote Terminal Operation

MARGORIE KAPLAN

**Interest has developed in recent years in remote airport terminals as a means of reducing landside congestion at metropolitan airports. A prime consideration in assessing the suitability of the remote terminal concept for a particular airport lies in its economic feasibility (i.e., Can it attract sufficient patronage and be operated efficiently enough to be cost effective?). This paper analyzes the costs of operating the FlyAway bus system, an express bus service that links Los Angeles International Airport with a suburban area that contributes about 15 percent of the airport's passengers. Although it does not offer baggage check-in, other services, such as ticketing, are offered on a limited basis and expansion to a full-service remote terminal is a distinct possibility in the future. The objective is to identify actual costs relative to all aspects of the operation to assist planners in determining the costs of such systems for other airports. Included are overviews of physical characteristics, operational problems, passenger market segment, airport and bus patronage growth rates, cost-revenue ratios of bus operation and terminal maintenance, bus fuel price impacts, foregone bus terminal site rental income, break-even patronage, facility replacement costs, and prognosis for future activity. After five years of operation, many of them beset with problems, FlyAway appears to be thriving. A recent passenger survey revealed that much of the system's attractiveness lies in its economical fare, frequent headways, low-cost parking, and dependable service. As passenger volumes rise and roadway capacity continues to be stretched beyond design standards, remote terminals offer the best hope for alleviating airport congestion on the ground. FlyAway demonstrates that, not only do they work, but they work well and cost effectively.**

Enthusiasm for new rail systems for express ground transportation service to airports has been dampened by mechanical malfunctions, design inadequacies, and the high capital expenditure associated with building and operating such systems. Therefore, many airport operators are turning to express bus services as an alternative to expensive (in terms of cost and land use) roadway and parking lot expansion. Express buses have a number of decided advantages over other forms of transit:

1. Buses are relatively affordable, they generally cost about $120 000 for standard models;
2. Buses are dependable and durable, the art of bus design and construction is rather advanced;
3. Buses require minimal start-up time for initiating service because buses generally require no special roadway adaptation or elaborate driver training;
4. Buses may be disposed of readily if a system is unsuccessful in attracting patrons because there is a large market for used buses in the United States; and
5. Buses are adaptable in route selection because they are free moving and are not bound to fixed guideways.

Given all these positive characteristics and an awareness that the ground access network at Los Angeles International Airport would soon be inadequate if forecasts of passenger demand were accurate, the Los Angeles Department of Airports inaugurated the FlyAway bus service on July 10, 1975. FlyAway was a pilot express bus service designed to provide residents of the San Fernando Valley--a large sprawling suburban community located 20 miles (32.2 km) north of the airport--with a direct bus line to Los Angeles International Airport. The motives for creating this service included the following (1):

1. Establish a pilot program to study the effectiveness of the remote terminal concept;
2. Alleviate curb-side and parking lot congestion at the airport;
3. Alleviate airport, roadway, and freeway vehicular congestion (2);
4. Conserve energy; and
5. Reduce air pollution.

Most importantly, given the prevailing ground access modal split of 90-10 for private automobile versus bus or limousine transport (3), the airport's central terminal area roadway had a passenger capacity of approximately 28 million passengers annually, which is well below the capacity of the runways and terminal buildings. Consequently, the primary physical constraint to growth at Los Angeles International Airport was ground access capacity.

This problem was due not to faulty design but rather to optimistic planning: The airport had been built under the assumption that a complete freeway network would encircle it and bring traffic from all directions. A set of underground tunnels had also been planned to channel traffic from airport environs directly into roadways and parking lots at the western end of the terminal area loop (4). These improvements were supposed to eliminate bottlenecking at the airport's main entrance, reduce queueing at the curb sides, and relieve congestion on the interior roadway.

Unfortunately, because the extreme high passenger volumes predicted for the late 1960s failed to