

A NEW TERMINAL FOR
ATLANTA'S
HARTSFIELD INTERNATIONAL AIRPORT

by

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May 18, 1979

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Susan Karen Funk

Submitted to the Department of
Aeronautics and Astronautics on May 18, 1979
in partial fulfillment of the requirements for
the degrees of Master of Science in
Aeronautics and Astronautics and
Master of Architecture in Advanced Studies

ABSTRACT

Complex determinants influencing the design of airport terminals are discussed, as are the various terminal concepts which comprise the "state-of-the-art" in terminal design. These aspects are addressed from the point of view of each "client" group - the sponsor, the travelling public, the airlines, Federal agencies, and the surrounding community - which has a vital interest in the function of the airport. The role of each member of the "team" charged with designing the airport and terminal is examined.

These influences are then applied to a specific case: the design of a new terminal for William B. Hartsfield International Airport in Atlanta.

Thesis Supervisor:

John R. Wiley
Senior Lecturer in
Aeronautics and Astronautics

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TABLE OF CONTENTS

	PAGE
Introduction	8
CHAPTER	
1 Airport Terminals	9
Background on the History of Aviation	10
Airport Planning Process	16
Airport Terminal Design	34
Passenger Terminal Concepts	39
2 Air Transportation at Atlanta	59
Background	60
Development of Air Transportation	67
Airlines Serving Atlanta	74
Aircraft	87
Historical and Forecasted Traffic	96
3 Terminal Area Requirements	115
4 Terminal Building Design Considerations	120
Existing Facilities	121
Conclusions	130
APPENDICES	
A Atlanta Traffic Statistics	133
B Aircraft and Airline Statistics	144
C Methodology for Forecasting Future Gate Requirements	154
D Methodology for Determining Future Facility Requirements	158
BIBLIOGRAPHY	175

LIST OF EXHIBITS

EXHIBIT

1	Comparison of Aircraft Sizes	14
2	Evolution of the Terminal Planning Procees.	27
3	Terminal Planning Responsibilities and Issues	28
4	Passenger Terminal Adjacency Matrix	40
5	Linear Concept	41
6	Linear Concept - Functional Relationships	42
7	Dallas - Ft. Worth Regional Airport	43
8	Pier Concept	44
9	Pier Concept - Functional Relationships	45
10	O'Hare International Airport	47
11	Transporter Concept	48
12	Transporter Concept - Functional Relationships	49
13	Dulles International Airport	51
14	Satellite Concept	52
15	Satellite Concept - Functional Relationships	53
16	Tampa International Airport	55
17	Unit Terminal Scheme - Kennedy Airport	57
18	Hypothetical PIPE Airport System	58
19	Location Map	61
20	Population Migration Patterns	63
21	Relative Growth of SMSA and National Populations	65
22	Delta Air Lines' Non-stops to Atlanta	68
23	Eastern Airlines' Non-stops to Atlanta	69
24	Existing Airport Layout	71
25	Table of Organization - City of Atlanta	73
26	Existing International Routes	83
27	Future International Routes	86
28	Atlanta - Arrival/Departure Patterns	93
29	Comparison of Arrival/Departure Patterns	94
30	Enplaned Passengers Forecast	101
31	Air Carrier Operations Forecast	101
32	Enplaned Passengers Per Departure	102
33	TPHP as a Percent of Annual Passengers	104
34	TPHP Forecast	106

EXHIBIT	PAGE
35 Hourly Passenger Volumes, 1978	107
36 Enplanements Per Gate	110
37 Gross Terminal Area Per Gate	115
38 Vicinity Map	122
39 Existing Terminal	123
40 Future Airfield Configuration	126
41 Area for Terminal Development	127
42 Terminal Plan Currently Under Construction	128
43 Historical Aircraft Load Factors	146
44 Comparison of Load Factors Before and After Fare Deregulation	147
45 Terminal Counter Frontage.	160
46 ATO Office and Support Space	160
47 Outbound Baggage Area	161
48 Mechanized Claim Devices	162
49 Inbound Baggage Claim Frontage - Less than 5 EQA in Peak 20 Minutes	163
50 Inbound Baggage Claim Frontage - 5 or More EQA in Peak 20 Minutes	164
51 Baggage Claim Area	165
52 Baggage Claim Input Area	167
53 Departure Lounge Area - Type of Aircraft Served	168
54 Ticket Lobby and Counter Area	170
55 Waiting Lobby Area	171

LIST OF TABLES

TABLE		PAGE
1	Decennial Census Population Totals	65
2	Summary of Project Financing	72
3	Airline Market Shares	75
4	Origin/Destination Patterns of Domestic Airline Passenger Traffic	80
5	Scheduled International Flights to Atlanta	81
6	Comparison of Numbers of Enplaned Passengers and Operations at Selected U.S. Large Hub Airports	82
7	Present and Future International Carriers at Atlanta	85
8	Hourly Departures by Aircraft Type	90
9	Aircraft Used in Atlanta Markets	91
10	Annual Enplaned Passengers Forecast	98
11	Air Carrier Operations Forecast	100
12	Typical Peak Hour Passengers as a Percent of Annual Passengers	104
13	TPHP Forecast	105
14	1990 Gate Requirements Based on Equivalent Aircraft	112
15	Consolidated Forecast	114
16	Future Facilities Requirements	117
17	Direct Flights From Atlanta	134
18	Scheduled International Flights to Atlanta	138
19	Hourly Departures by Aircraft Type and Airline	143
20	U.S. Domestic Trunks: Passenger Revenue and Traffic by Type of Fare	145
21	Historical Aircraft Load Factors	146
22	Comparison of Load Factors Before and After Fare Deregulation	147
23	Runway Length Requirements and Range for Various Aircraft	148
24	Survey of the Fleets of the Airlines Serving Atlanta	149
25	Existing Gate Requirements by Airline	155
26	Future Gate Requirements by Airline	156

INTRODUCTION

Aviation plays a dynamic role in local and world development. Not only has the use of air transportation increased personal communication and broadened business markets, but the technological advancement in the "state-of-the-art" itself has compounded socioeconomic development.

This thesis is divided into two sections: the first discusses and examines in a generalized format, various aspects of aviation and the function of terminals. Similar, but much more detailed information can be found in such books as *The Airport* by Edward Blankenship and *Airport Systems Planning* by Richard DeNeufville but is included here to provide a setting for the study. The second section examines the specific factors involved in preparation of a terminal plan for Atlanta's Hartsfield International Airport. This airport was chosen for the study because it is so unique; it experiences the greatest percentage of transfer traffic of any airport. This, coupled with its ranking as the second-busiest airport in the world, makes the study and design quite challenging.

AIRPORT TERMINALS

BACKGROUND

The development of American commerce and cities can loosely be thought to be composed of five major periods, each shaped by the predominant mode of transportation of the time. These modes are: water, stagecoach, rail, auto, and air. It may be interesting as background to quickly explore the distinct influences of each mode on its particular period in history.

The period of dominant water transportation saw cities grow and develop along the coast at a natural harbor, or on rivers or lakes. Boston, Philadelphia, and New York are examples of cities that share their origin during this period. In these cities, the waterfront was the center of concentration of activity. Hotels, restaurants, taverns, and other establishments grew up along the ~~water~~^{wharf} catering to the shipping trade.

In time, sailing ships evolved into steamers, and warehousing facilities expanded in the city to serve the transportation industry. Then came the time when container ships and shipping required more area than was available on the old waterfront. From this need came the development of a new generation of shipping facilities which are still flourishing today. Examples include: Port Newark, the Mystic River in Boston, and the entire shipping system on the Mississippi River.

During the period of western expansion, stagecoaches and wagontrains developed as the fastest means of moving people and goods to the booming cities of the West. The water route around South America took too long. Towns serving as stage depots such as Dodge City, Kansas, flourished during this brief era. Soon, however, these towns faded into oblivion when the transcontinental rail link was completed.

The railroads were faster, more comfortable, and could carry more passengers and goods than their predecessors. They were also much less prone to attack by outlaws, although they, too, suffered from occasional robberies.

Similar urban transportation-related development occurred at the junction of major railroads. Atlanta, Dallas, and Chicago are cities which developed as rail centers. The rail yards became the center of the city. There, the establishments catered to the railroad industry with hotels, restaurants, bars, and warehouses located on adjacent property.

The automobile brought greater personal mobility to the population and enabled people to move their homes out of the city while still continuing to work there. Decentralization of services in the form of shopping centers, office parks, and drive-in restaurants owe their existence to the automobile. The Interstate Highway system is another offspring of this increased personal mobility.

The first three transportation modes and the associated adjustment period for each have many things in common. Each took many years to reach the zenith of its influence on city development. Each concentrated city activities near its terminal, each is more freight than passenger-oriented, and each serves predominantly long-haul traffic.

Auto transportation is somewhat different than the other three, however, since its evolution was much more rapid, it answered the demand for personal mobility, it tended to decentralize city activities, and it is used mostly for short-haul trips.

The airplane, too, has made its mark on the growth of cities. Early airfields were built outside the central city where land was plentiful and cheap. Growing cities have expanded toward the airport and the usual transportation-oriented industries and services sprang up on adjacent land. One important sign of the times is that main city post offices, once firmly entrenched near the city's railroad station, are now being built next to its airport.

This influence of each transportation mode on city development has been quite profound.

Commercial air service began as subsidized mail service and not, as one would imagine, as passenger service. Only a very small section of society used aircraft as a means of transportation in its early days. This was more possibly due to the novelty of flying than for any other reason, since fares were relatively high, and aircraft were small, not wholly reliable, and greatly influenced by bad weather.

Commercial air transportation services nearly ceased during both great wars of this century only to emerge at the end of each conflict with new life and vitality brought on by benefits derived from military technology. For instance, the bomber built by Handly-Page in 1918 was perhaps the first large-scale aircraft to be used commercially when it was converted to carry twelve passengers.¹

¹Edward G. Blankenship, The Airport: Architecture - Urban Integration - Ecological Problems. (Federal Republic of Germany: Praeger Publishers, 1974), p. 12.

The main incentive for use of air transportation over any of the other modes is freedom from geographical hindrances such as deserts, mountains, rivers and lakes. This advantage, coupled with increased speed and reliability which were in part made possible by technological advances originally meant for military aircraft, gave aviation and its related industries a strong foothold. Aircraft improvements, together with increased use of cars and trucks, figured strongly in the demise of the railroad industry. The railroads are still struggling to regain the foothold that was lost to these newer modes of transportation.

In the early days, airports were little more than a reasonably flat field where aircraft could land and take off, along with a small building where passengers waited. When aircraft grew larger, faster, and more susceptible to unevenness of these fields, it became necessary to clear and grade actual runways.

The airfield configuration - runways and taxiways - and planning thereof have changed drastically. This is paralleled by changes in the nature and size of aircraft. As was stated previously, early aircraft were small. Wind and weather conditions figured heavily in whether or not a flight could be undertaken, since these light aircraft were easily blown around in high winds. It was known, however, that maximum lift was obtained by taking off directly into the wind. The logical concept, therefore, was to align the runway with the direction of the wind. Unfortunately, however, in many locations, there is no one predominant wind direction. Airport planners in the 1930s and 1940s envisioned airfields made up of many runways at different headings, the concept being that at least one of these runways would present the correct heading for takeoff, given any foreseeable wind direction encountered. This led to elaborate airfield configurations. Evidence of this philosophy is still visible at many airfields. O'Hare has five different runway headings, for example. Many airports have one or more main runways aligned in a particular direction and other secondary crosswind runways. Today's large aircraft, B-737s on up, really do not require that an airport have runways at headings other than the predominant wind direction of the area. They are so big and heavy that they are affected by crosswinds to a much lesser degree than smaller aircraft. This would doubtless be disputed by anyone "experiencing" a landing in very stormy weather in even a large aircraft, but it is true in most cases.

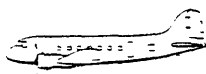
One reason for the continued predominance of airfields having crosswind runways is that sufficient numbers of general aviation operations - small aircraft - occur at air carrier airports to warrant the existence of a crosswind runway. The trend is, however, to do away with unnecessary crosswind runways in favor of more land for terminal and apron area at large hub airports. Removal of crosswind runways necessitates the diversion of considerable general aviation activity to nearby reliever airports built specifically for the purpose of gaining maximum capacity for air carrier operations from existing runways at the large airport.

Runway lengths, strengths and widths required for general aviation aircraft are all less than those for air carrier aircraft. This means that they are also less expensive to construct. With these relative costs in mind, it is often more economical to divert general aviation traffic from crowded large airports even if this necessitates building new reliever airports than it is to construct a new air carrier runway and associated taxiways at the existing airport to alleviate congestion.

It was in the late 1950s and early 1960s that air travel began its phenomenal growth. The advent of jets in the commercial market in 1958 contributed to the increase in demand by providing fast non-stop service. A prime beneficiary was the traveller journeying between distant points previously served by shorter range aircraft that required many refueling stops. Increased competition among airlines and the lower "per seat" cost of jet aircraft brought better service which soon made it possible for increasing numbers of private citizens to enjoy the benefits which air travel provides. Today, air transportation has come to be regarded by the public as a right rather than a privilege. Freedom of mobility is a deeply rooted social value, an inalienable right.

To accompany this tremendous and rapid growth in passenger volumes, airfields had to be expanded to accommodate the runway requirements of the new aircraft and new terminals built to handle extra traffic. Growth in traffic and aircraft sizes during this period was so rapid that often terminals were obsolete by the time they were finally ready for use. This was in part due to the inadequacy of forecasting procedures in use at the time. Another reason for this is the fact that the state of the art was not developed, nor had it dealt with large-scale air travel before. Exhibit I shows the relative sizes of the various aircraft. This illustrates the dramatic change in the size of aircraft encountered

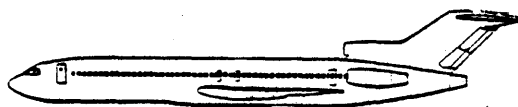
DC3



737-100



727-200



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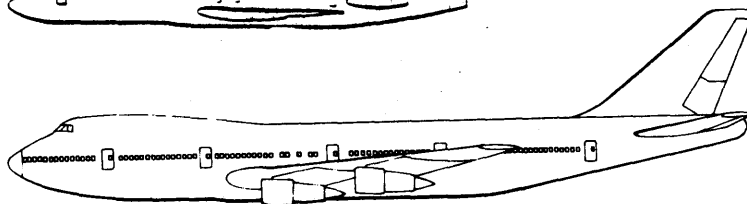


EXHIBIT 1

COMPARISON OF AIRCRAFT SIZES

in the “boom” years. Everything was new. Design was by trial and error. One of the results of this was that a passenger handling system was developed through the design of early terminals that has come to be accepted as the only viable solution. One might question whether more study in the early years of terminal planning might not have led to more efficient methods of passenger and aircraft handling. This thesis will attempt to explore alternate schemes a little further on.

The evolution of passenger terminals has been influenced by several factors. Among these are: the size of aircraft using the terminal, the number of aircraft collecting or discharging passengers at any given time, and the number of airlines served by the facility. Clearly, the size of the terminal is dependent upon the size of aircraft and annual number of passengers it must serve.

AIRPORT PLANNING PROCESS

The design of airports, because of the highly complex function they perform, requires the services of a multi-disciplined team consisting of statisticians, economists, planners, engineers, environmentalists, and architects. The team receives input and direction from the airport owner, the community, the airlines which use the airport facilities, and various governmental agencies. Architects who will be involved in an airport project for the first time should be aware of the various roles of each member of the design team and of the needs and concerns of those other groups which utilize the airport.

This section will give an overview of the planning process and define the responsibilities of each member of the design team and the needs of the various airport users. It will then enumerate the various steps in the formulation of the master plan, showing where each individual's expertise is required.

Design Team

The design team consists of a firm or group of firms made up of individuals of diverse expertise. Large firms often maintain in-house staffs in all the disciplines involved in planning and construction of an airport. In most cases, however, as well staffed as an individual firm may be, it must work with other firms as part of a team. The airport sponsor (owner) often requires that the team consist of one or more nationally recognized consultants and at least one firm from the local area. There are several practical reasons for requiring shared responsibility in the team. Compromise and discussions between consultants can lead to a final design scheme that is more responsive to the actual requirements of the specific airport under consideration because no one major consultant can impose his own particular design philosophy. The requirement that a local firm be a member of the team minimizes possible complaints that the airport sponsor (usually a governmental entity) lacked confidence in the abilities of local professionals. Further, communities like to see consulting fee revenues recycled into the local economy and will have better communication with the team when a member is one of their own. Practicality, also, is an inducement for having a local firm on the team, since he often can anticipate local attitudes.

With the idea that, as previously mentioned, some firms may consist of experts in all of the various disciplines, a description of the responsibilities of each member of the team follows.

Airport Planner

This individual or group is given the overall role of coordinator of the planning process. He is primarily responsible for the functional plan - how it works, and is the one member who is throughout the process in closest communication with the sponsor.

His responsibilities include supervision of the members of the team, dissemination of information to the community, collection of and response to community sentiment. He ultimately must analyze the input of team members' recommendations and client requirements and derive from this a Master Plan for the airport which is economical, buildable, expandable, and responsive to needs of the various client groups.

Together with the Airport Engineer, the airport planner formulates the final layout of the runways, taxiways, aprons, and terminal and ground access systems.

In the case of an entirely new airport site, the planner must make necessary studies to ensure that the use of the site as an airport is compatible with surrounding land use.

Statistical Analyst

The statistician or forecaster is responsible for collection of historical traffic (passengers and operations), population and economic data from the area served by the airport. He discusses future conditions with the airlines regarding aircraft acquisitions and their plans for the part the airport is to play in their route network. This could include the possibility that an airline would be likely to increase its operations at the airport in view of pending improvements.

From information gained through data collection and contact with airlines, the analyst then formulates a mathematical model to describe the influence of each different variable on the traffic pattern at the airport. He then uses this model to predict future traffic at the airport.

Economist

The Economist's responsibility in the master planning process is two-fold. First, he works closely with the statistician in developing the model to predict future airport traffic. Air transportation demand is highly dependent on economic climate. When the economy is healthy, air travel increases because people have more disposable income; in an unhealthy economy, air travel decreases. Other economic factors can influence air travel as well: the Arab Oil Embargo in 1973-1974 decreased the availability of jet fuel and raised the

price of that which was available. Airlines had to pass on the added fuel costs to passengers through increased ticket prices; fewer people were willing to pay the higher price for fares, resulting in a decrease in air traffic. Tourist-oriented travel is more sensitive to ticket price increases than is business travel.

Booming economic growth in a community can also cause an increase in air travel demand. First, it pumps money into the community, creating more disposable income which is most often used for pleasure travel; and secondly, it encourages increases in business traffic.

The second function of the economist, while on-going throughout the planning process, really comes into play when he analyzes the community's assets and helps the sponsor formulate a plan by which to finance airport development. Monies to pay for airport construction usually come from the sale of revenue bonds and from direct Federal grants.

Airport Engineer

The airport engineer's expertise is utilized throughout the planning process. He makes an on-site inspection of existing facilities (if there are any), including surveys, pavement strength testing, and soil and topographical conditions. Knowing these, he must derive a buildable runway and taxiway configuration with which to accommodate forecast operational demand in a safe and efficient manner. He is responsible for ensuring that the airfield design meets all Federal criteria concerning among other things: maximum slope, and minimum pavement length and strength requirements for the most critical aircraft likely to use the airport.

Environmentalist

Since nearly all airports are recipients of Federal monies, sponsors are required by the National Environmental Policy Act (NEPA) to prepare and submit a report assessing environmental consequences of development of a new or at an existing airport. From the sponsor's document, the FAA prepares an Environmental Impact Statement (EIS). This documentation process is intended to ensure that enhancement of aviation capabilities will, to the greatest degree practicable, be planned and constructed so as to be in environmental harmony with the community which the airport is to serve.

Many adverse environmental consequences can result from airport development. Increased noise exposure caused by additional aircraft operations can harmfully affect the

quality of life in residential areas near an airport. Possible drainage and erosion problems caused by paving large, previously permeable areas must be realized early in the planning process and measures must be taken to minimize them through construction of water runoff collection areas, structures, and other drainage use of ground cover. Air and water quality can be adversely affected through emission of contaminants from increased numbers of ground vehicles using the airport, from aircraft engines and from fuel spills.

These are just a few of the adverse impacts which could result from airport development. It is, therefore, of utmost necessity that the expertise of a staff of environmental specialists be integrated in the planning process from its inception; it is incumbent upon them to help define areas of possible adverse impact and work alongside the planners and engineers to assess and choose the scheme which minimizes these impacts.

The Architect

Traditionally, the architect has had no real responsibility in the planning process until the airfield has been designed and the terminal scheme selected and sited. He has then had to come in to the process to “decorate” and put a facade on the building and, working with the Engineer, to produce a buildable design. This historical solution has led to a multitude of terminals that are quite beautiful but really do not function too well. There have been some fortunate exceptions. But many of the problem terminals are a direct result of three factors: There has been a lack of integration of the architect’s skills at the beginning of planning considerations. There has been a lack of source of sufficient exemplary material relating to the function of airport terminals available to the architect which he can understand and use to give valuable and innovative input to the other members of the team. There has been a reluctance to recognize the need and demand for standardized building technology specifically for airport terminal buildings which will allow for inexpensive and easy incremental expansion.

Clients

The “client” of the team faced with designing an airport can encompass several interest groups. He could be the managing organization, the user airlines, the travelling public, or the community in which the airport is located. A discussion of the nature and requirements of each of these groups follows.

The Sponsor

An air carrier airport is usually owned and operated by some form of governmental organization. These governing bodies are: Municipalities, Counties, Regional Authorities, States or Nations. The actual managing organization can be a commission, Department of Aviation, Advisory Board to a government, as well as others. There are even some airports that are privately operated such as Lafayette and Rochester. Whichever the form of government, usually the local electorate decides, through their elected officials, how they want their airport managed, i.e., whether it is to make money, break even, or be subsidized by the government.

The size of the managing agency (usually appointed by the government) and staff at the airport, of course, depends on the size of the airport. It is their primary duty to operate the airport as safely and efficiently as possible, but the job goes further than that; aside from the obvious, they must maintain good relations with the surrounding community by being responsive to needs and complaints of the airport's neighbors.

The airport collects revenues from landing fees, rents from airlines, car rental agencies and concessionaires for space they lease in the terminal and on airport property, and from parking fees. With these monies, they must pay the costs of the airport land and facilities, the salaries of airport workers, the costs of maintenance on buildings and the airfield, and for improvements and additions to these buildings. Certain Federal monies are available for improvements to the airfield itself.

It is one of the chief concerns of the airport manager to have an efficiently operated terminal that welcomes travelers to his community. The costs of building monuments is passed on to the airlines through increased landing fees. The airlines ultimately pass on this added cost to all their passengers via a network-wide increase in ticket prices.

While airport sponsor pays the design team's consulting fees, there are other groups whose needs must be addressed.

User Airlines

Of all the tenants at an airport, the airlines are of prime importance. In the United States, our economic system encourages them to be quite independent. Each airline requires separate ticketing and check-in counters, as well as its own section of the terminal for gate areas and baggage claim. Each airline also keeps a separate crew for baggage handling.

In Europe and other areas, airlines share common gate areas and baggage crews. Each system has advantages and disadvantages.

One functional folly of the American system is that different sizes of aircraft are grouped together by airline. This creates spatial and functional restrictions which are caused principally by the difficulty of maneuvering large aircraft (wide bodies) on the ground. Functional utilization of space, both on the apron and in the terminal, could be gained by assigning aircraft gate positions by size of aircraft rather than by airline. Some critics of this concept would argue that confusion and inefficiency would result, since the airlines would have to maintain several additional sets of gate-check-in personnel or else shuttle these people from one area of the terminal to another to serve enplaning passengers. The other side to this argument is that it is better to shuttle a few airline personnel than 400 passengers. In any case, the American travelling public is accustomed to identifying a particular section of the terminal with one airline and could easily become confused with a different type of organizational procedure. The proposal is worthy of consideration, however, and will be explored in more depth later in this paper.

The question of shared baggage crews, while not necessarily a design influence, is of interest nonetheless as a potential cost saver for airlines whose crews are idle part of the time. Again, this concept would be difficult to implement in the whole United States system,² since most airline employees are unionized while some, notably Delta's, are not.³

One area of concern for the designer with regard to user airlines at a particular terminal is the fleet mix - the various sizes of aircraft - with which the airline is likely to serve the airport. Each airline, due to its own route structure, has a different fleet of aircraft. Knowing the current pattern of activity - time schedules and fleet mix for each airline using the airport - is absolutely necessary to correctly allocate space for departure lounges and aircraft parking positions. Planned acquisitions by an airline of new types of aircraft should be ascertained to incorporate flexibility into the terminal for easy expansion in the future.

²Sharing of baggage crews does exist in certain markets where one airline has relatively few flights compared to other airlines. In this case, the lower-volume airline could make an arrangement with the high-volume airline to utilize the other's baggage crews. At Tampa, for example, Braniff, the low-volume carrier, uses Eastern's baggage crews.

³Aviation Daily, January 16, 1979, p. 85.

Another problem is that as traffic grows at a particular station and load factors reach unacceptably high levels, the airlines will want to substitute larger aircraft on a trip by trip basis to maintain frequency and to accommodate added demand. Thus, there is constant change internally too.

Airlines, as tenants of the airport management, are usually permitted to make improvements to their areas of the terminal, as long as the proposed improvements (construction) are first approved by the management. In this case, the airline pays for the added cost.

In the United States, it is the various airlines' responsibility to protect the safety of its passengers from hijacking and other act of terrorism. Our government requires this. One area of cooperation among airlines concerns security. It is the airlines who jointly buy and pay for personnel to operate the elaborate security equipment to which we have become accustomed at all airports. The airlines share this expense. The sponsor, on the other hand, is responsible for maintaining security of the airfield and for employing the armed guards who are stationed at each security check location.⁴

In summary, while the airline is not the paying customer of a designer, it nonetheless has various spatial requirements and yields considerable weight with management. The thorough designer therefore should be aware of, and open to the suggestions and needs of the airlines who serve and are served by the airport.

Federal Agencies

Most airports have control towers operated by Federal air traffic controllers. Their special needs and those of other governmental agencies such as Customs and Immigration (where applicable) should be an important input in designing the terminal.

The Federal agency with which airport planners have the most contact is the Federal Aviation Administration (FAA), part of the U.S. Department of Transportation (DOT). FAA's prime responsibility is with airports and aircraft. They are charged with controlling airspace and ensuring that airfields meet safety criteria. It is through this agency that Federal monies for improvements to airports are obtained and for this and other reasons the team works nearly as closely with FAA as with the sponsor.

⁴U.S., Department of Transportation, Federal Aviation Administration, Federal Aviation Regulation Part 107.

The Civil Aeronautics Board (CAB) is a separate agency, not part of the DOT. The CAB is concerned primarily with airlines routes and fares; and while the agency is not in the position to influence an airport project, the team should be familiar with CAB policies regarding carriers serving the airport. CAB policies, with regard to the entire air transportation network, can have major impacts on specific airports. This will be discussed in the next section.

The Travelling Public

In a lot of American cities, the location of the airport is the final municipal secret. A travelling salesman who starts out in his rental car toward the airport, dreading the time he will have to spend in a place purposely designed to make human beings miserable, can take some perverse comfort in the fact that he probably won't be able to find it anyway.

This quote from a 1974 *Esquire* Magazine article by Calvin Trillin entitled, "The Best Airport in America is Tampa; the Worst is O'Hare" could be the subject of a dissertation. With inimitable deftness its author has managed to convey the degree of unpleasantness air travel has become to many people. "Has become" because it didn't used to be that way. Somehow, even with all good intentions of facilitating the function of loading and unloading increasing numbers of bigger and more exotic aircraft, the passenger has been nearly forgotten. There are excuses for this, however. One is that many of the airports were built in the late 1950s and early 1960s when the first generation of jets came into use, accompanied by drastic increases in demand for air transportation services. Planners, engineers, and architects were trying desperately to meet the terminal needs of this increased demand at a time when travel by air was still somewhat a novelty for the average citizen. They did the best they could with no past experience or examples (good or bad) to emulate or disregard.

Early airport terminals had evolved from simple buildings and hangars to a string of small buildings - a "linear" terminal. These worked well for all parties concerned - the airlines, passengers, and management, so they merely enlarged linear terminals and added piers. O'Hare, a prime example of the state of the art at the time it was constructed, is a perfect example of this type terminal. An interesting point to note with regard to

O'Hare is that though it was built before anyone had conceived of Boeing 747s, the designer, C.F. Murphy & Associates,⁵ had the good fortune to have been generous with the area between piers. Luckily, they were just generous enough that a 747 has sufficient space to taxi into the area between piers. One can hardly imagine the disastrous effect on O'Hare - and, for that matter, the airlines that use it - had there not been sufficient space for these large aircraft and others such as the DC-10 and L-1011 when they came into use. The function of O'Hare as the world's busiest hub may have been transferred to another airport, had it not been for this lucky foresight. Miami was not so lucky.

Unfortunately, along with the bigger, more spread-out terminals needed to accommodate these large aircraft, came longer walking distances for passengers. Further, the public now lacks the initial excitement once enjoyed at just being in the airport environment. The glamour has disappeared. No longer are passengers content to face the noisy, narrow, endless concourses and uncomfortable waiting areas. Travellers' attitudes and expectations have changed and terminal designs should change in keeping with these attitudes.

There is no reason why the time spent in an airport terminal should not be an enjoyable part of the journey. "Enjoyable" is a subjective concept; it means different things to different people. Yet, some measures can be taken to make the terminal experience as pleasant as possible.

One area to explore in this regard is the matter of circulation - the passengers' circulation through the various functional areas of the terminal. These paths should be kept as clear and functionally intelligible to the passenger as possible. Confusion can be further minimized by effective and attractive signs. Noise can be reduced by using carpeting and acoustical wall and ceiling treatments. Imaginative seating arrangements in lobby areas and waiting lounges can lessen the "bus terminal" atmosphere now prevalent in many existing terminal situations. Air travel is so much more sophisticated than other forms, it should be presented as such at the terminal building.

Walking distances can be greatly reduced by using several different design devices such as stacking functional areas of the terminal and using vertical transporters - elevators

⁵Blankenship, *The Airport*, p. 74.

and escalators. Remaining horizontal distances can be "shortened" through the use of "people-mover" systems, many of which are in current use to be evaluated as examples for future designs. People-mover systems are costly, however.

Sufficient curbspace and access/egress roadway is most important, as well as accompanying signage systems to direct vehicles to the correct areas of the complex. Ample parking and effective means of then entering the terminal building are also specific design considerations to explore. The introduction of alternate ground access modes such as rail, when applicable, should also be studied to work together with cars and aircraft. The integration of all these elements can make the whole system operate at maximum efficiency. The mass transit (rail) mode should be investigated as a possible reliever for an overburdened and non-expandable roadway network.

Various amenities including shops, snack bars, restaurants, TV screens, phone capabilities, a bank and hotel, and others should be considered as integral in the design.

Security check points should be minimized as an impediment to traffic flow and an inconvenience for the passenger who must transfer airlines and thereby submit to a second security check.

Finally, all possible changes in function within the terminal must be anticipated and planned for in the design stage so that when a change is implemented the terminal can be expanded and/or altered with minimum disruption for passengers and airlines.

The Airport's Neighbors

An airport brings revenue to the community it serves. It brings tourists and businessmen who spend money, and it creates jobs for people in the area, both at the airport and in service-related industries located nearby. Yet, the trend is for neighbors to oppose additions to existing terminals as well as development of new airports. While not the architect's concern (his job is to design the building), this anti-airport feeling certainly influences the planner and is mentioned here as an area with which all members of the design team should be aware.

Neighbors object primarily to noise associated with jet aircraft and to a lesser degree to the safety and pollution problems an airport poses for a community. Whether or not the community imposes curfews on how late into the night airlines may operate an airport indirectly affects the design of the terminal. If such a curfew is imposed, more

terminal area will be required, since the airlines will have to schedule more flights during acceptable operating hours unless there were a reduction in the number of passengers. A curfew would necessitate more gate positions and more room in the terminal building for passengers, check-in, baggage claim and operational areas.

These last problems for existing airports could have been avoided in some, not all, cases if zoning restrictions had prevented residential building close to the airport and within principal landing/take-off patterns. In the future it is advisable for the airport to purchase enough land immediately surrounding the airfield proper to create a buffer zone between aircraft and residential areas. This buffer zone can and should be developed for uses compatible with the airport's operational areas. Existing zoning laws prohibiting residential building must be strictly enforced but experience in this type of control has been very poor: variances *are* granted despite opposition.

Lastly, the planner and architect should be aware that he will be questioned and required to defend his design scheme and the reasoning behind it at various public meetings. Since citizens' groups now play so active a role (and rightfully so) in determining the future of an airport in their community, the designer should be aware of and responsive to this, endeavor to fulfill the community's needs, and defend the reasoning behind his solution.

Airport Planning Process

The following discussion will enumerate the various tasks and variables involved in the development of an airport Master Plan.

Exhibit 2 shows a comparison of the traditional and evolving planning processes. Exhibit 3 depicts, through a flow diagram, the chronological relationships between the various tasks, design team member inputs, and client involvement.

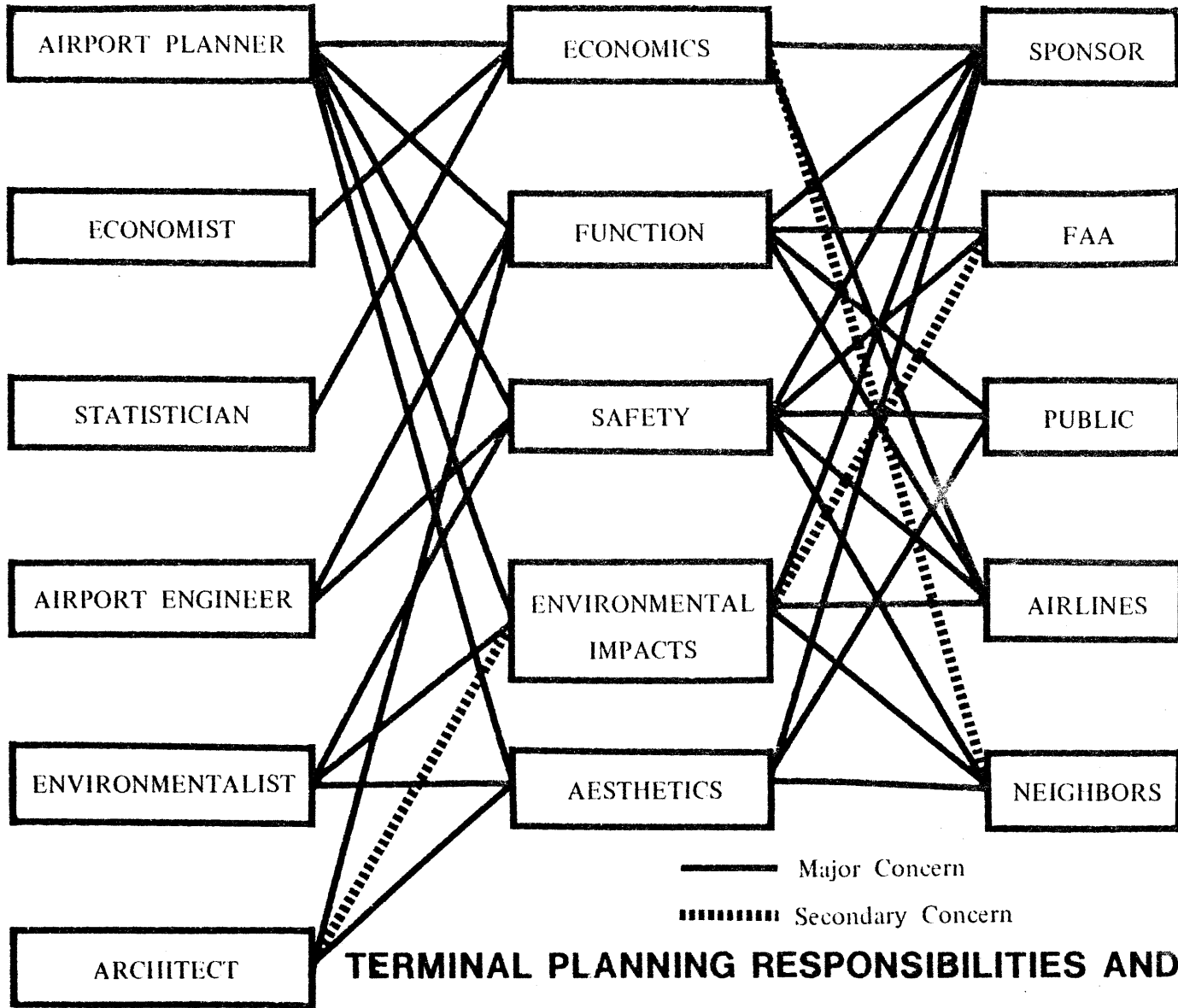
Task 1 - Statement of Objectives

Governmental agencies and the airport sponsor decide that airport development (either a new airport, or expansion to an existing airport) is required to meet the aviation needs of the community. This usually occurs after existing airport facilities have become overcrowded. It is preferable for the decision to enlarge airport facilities to be made prior to the existing facility reaching a crowded stage. This can be accomplished through close

TEAM MEMBERS

ISSUE

CLIENTS



TERMINAL PLANNING RESPONSIBILITIES AND ISSUES

EXHIBIT 3

Sponsor-FAA involvement and often leads to better airport plans because the changing facilities' requirements can be monitored and planned. Also, more time is available for assessing possible alternative expansion programs. A time frame for airport development into the future should be stated.

Task 2 - Advertise for Design Team Proposals

The airport sponsor advertises for consulting firms to form teams and prepare a brochure describing previous airport-related experience. The proposal should include a brief description of the manner in which the specific airport plan will be studied and implemented based on the sponsor's objectives.

Task 3 - Data Gathering

This task consists of compilation of recorded historical passenger traffic and aircraft operational trends for the airport, as well as demographic and economic data for the community, and discussion with user-airlines regarding their future plans for serving the community.

Task 4 - Forecast of Traffic

A forecast of passenger traffic, operations, and facility requirements is made to cover the time period defined in the statement of objectives.

The nature of forecasting is tenuous at best. It makes a "prediction" based on certain historically interrelated parameters. Forecasts of aviation activity are particularly variable in that they are derived from data which describe population, the economic base of the community for which the forecast is being prepared, the general economy of the nation, airline route structures, types of aircraft in use, promotional effort, and scheduling frequency, to name just a few. Further, the current airline industry is in a state of flux. The recent period of governmental (Civil Aeronautics Board) deregulation of airline fares (on a trial basis), and increased competition generated by dormant route awards has made it increasingly difficult to predict what the long-term effects of deregulation will be, especially on a specific airport. There is very little historical precedence on which to base judgment; one is left to make "educated guesses," clarified by a series

of assumptions which will follow shortly. Furthermore, within the next five years a new generation of wide and narrow-bodied aircraft (B757, B767, A300 series) will begin to appear in the fleets of many of the large and influential domestic carriers. These aircraft, designed for use on high-density medium-range markets, will surely make their presence felt. Just how this will affect specific airports is difficult to predict. One must wonder whether certain smaller, less efficient aircraft currently in the fleets will be sold to accommodate these new aircraft. Will the historical trend toward higher load factors continue to rise? Will it drop for several years, and resume an upturn, or will it merely reach a point of diminishing returns and remain constant? The current political unrest in Iran and the resultant cessation of oil production activities will surely affect the airline industry. The degree to which these factors (industry deregulation, the introduction of large aircraft into the fleet, and a possible fuel shortage) will affect the industry differs with each airline and its ability to absorb change and added costs.

Task 5 - Peak Conditions Determined

Data from the forecast is applied to industry-wide analysis which yields likely peak hour conditions which the ultimate scheme must be designed to accommodate.

Task 6 - Forecast of Facility Requirements

From peak hour forecasts, facility requirements are determined based on historically recognized formulae and an understanding of the nature of traffic at the airport (transfer or origin/destination, business, tourist).

Task 7 - Inventory of Facilities

An on-site examination of existing airport facilities, including bearing strengths of existing pavement on aprons, runways and taxiways is performed. Determination of possible areas of expansion is made; and a survey of these areas and preliminary soil report is accomplished. Condition and area of existing terminal facilities is studied and recorded.

Task 8 - Demand/Capacity Analysis

Future facilities requirements (runways, taxiways, aprons, and terminal areas) are examined in relation to existing facilities and expansion capabilities.

Task 9 - Consideration of new Technologies and Vastly Different Conditions

Review of technological advances in navigation systems and new aircraft are studied and an assessment is made as to possible impacts of these advances on the operation of the airport. Future navigation systems, for instance, could make operations feasible in poor weather conditions. Larger aircraft would enable greater numbers of passengers to be served by less aircraft. This would cause a reduction in projected runway capacity requirements but necessitate enlargement of terminal building areas. Gates in the terminal would be spaced further apart because of the increased size of aircraft.

Task 10 - Explore Alternate Future Strategies

This process includes a review of alternatives to expansion of an existing airport or construction of a new airport. For example, the planner could examine the consequence of not building new facilities but rather serving air transportation needs via improvements to another airport in the area. Regulations restricting general aviation operations at a large air carrier airport experiencing runway congestion problems may be more desirable and economical than construction of new air carrier runways at the large airport. In this case, the option could be made to improve facilities at a nearby general aviation airport.

Task 11 - Alternate Projects Studied

This study procedure examines the various construction alternatives: terminal schemes and runway/taxiway configurations which can best suit future traffic conditions. It could include discussion of whether to expand existing facilities or develop a new site.

Task 12 - Environmental Study

A study of the possible environmental impacts the various alternatives would cause an assessment of net value of benefits of each project alternative when compared to the environmental costs.

Task 13 - Land Use Planning

This step consists of studying alternative schemes for land use at the airport, including the relationships of terminal area to runways, ground access, and support facilities.

Task 14 - Preliminary Selection

From all the land-use alternatives, that which exhibits the most functional benefits at the least environmental cost is chosen to be refined and further examined.

Task 15 - Terminal Concepts Studied

Assuming that satisfactory airfield requirements are met, the next step is to evaluate the various possible terminal concepts which fit in the designated area and the one which will best serve the forecasted traffic activity on a functional basis.

Task 16 - Terminal Concept Selection

Choose the best of the terminal alternatives and refine.

Task 17 - Staging Plan

Refine the ultimate airfield and terminal plans to reflect staged construction over the planning period.

Task 18 - Economic Feasibility Study

A review of the probable land procurement and construction costs is weighed against the sponsor's ability to finance the project and his ability to collect rents, landing fees, concession fees, etc., to pay for it. In some cases, modifications may need to be made to the plan reflecting financial realities.

Task 19 - Financing Plan

Economists devise a plan to pay for the project. This is most likely accomplished through procurement of some Federal monies from the Airport and Airway Trust Fund under the Airport and Airway Development

and Planning Act of 1970. This Federal support only covers part of the cost of airport construction, and the rest must be paid for by the sponsor. Usually, the sponsor sells revenue bonds to pay for his share of the cost. This depends on the sponsor's ability to forecast and get adequate landing fees, rents, concessions, etc., to support bond payments as well as all other operating and maintenance costs.

Task 20 - Public Review

As part of the Environmental Impact Assessment process, and for the sake of maintaining open communication with the community served by the airport, Public Hearings and Citizen Information Meetings are held to keep the public sector informed of facts relating to airport development and how this development is likely to affect them. Open avenues of communication between the design team, the sponsor, and the public can, in many cases, help lead to public understanding and acceptance of the decisions made by these two former groups.

Task 21 - Revision of Plans

Through information sessions, public concerns are made known to the planner; and he must address and try to answer these concerns. Plans, in many cases, must be altered to meet public acceptance.

Task 22 - Political Decision

The sponsor, usually a political entity, must weigh the results of the team's study and recommendations, capabilities of financing the plan, and public comment - and then make the decision to proceed with construction.

Task 23 - Final Design

Final detailed designs of airfield, ground access, and terminal facilities are prepared.

Task 24 - Bids Let

Specifications and working drawings are sold to prospective contractors who review this material and submit bids.

AIRPORT TERMINAL DESIGN

Airport terminals serve different functions, depending on the nature of the traffic they serve. Atlanta, for example, is mainly a transfer terminal; fully 73% of the passengers who use Atlanta change aircraft for the continuation of their journey.⁶ Traffic at Tampa, on the other hand, is mostly either originating or terminating. This fact necessarily influences the relative sizes of certain areas within the terminal. A comparison of two such terminals handling equal numbers of passengers will show that the curb space, check-in and baggage claim area will be much smaller in the "transfer" terminal than in the other. Parking space and roadway capacity are similarly affected. Gate waiting areas and amenities will be approximately equal in area, but baggage handling space may have to be larger in the transfer terminal. It is, therefore, most necessary for the designer to be aware of the nature of traffic at the terminal he is to design. Any possible change in the nature of the traffic should be considered. Other subtle influences cannot be ignored, either, since they influence the size of facilities. For instance, knowing the various percentages of business and tourist traffic is important because businessmen on the average check fewer bags than tourists.

Originating passengers arrive at the airport via some sort of ground transportation. The use of private cars leads all other forms combined. Until other modes are improved and become competitive with the automobile in terms of convenience, people will continue to use their own cars to get to the airport. Recently, much money has been spent on research, development, and advertising in an effort to make mass transit a viable alternative to the private vehicle for the trip from home or office to the airport. Relatively few cities are of sufficient size to support a mass-transit rail system, the construction cost of which is quite extensive. Several communities, however, have studied the concept of linking the airport to an existing or proposed rapid transit system. In general, the cost of creating a special rail link from a city's central business district (CBD) to the airport is considered to outweigh the benefits derived in terms of *potential* relief of the highway links. In cases where the airport is located on a line from the CBD which also contains

⁶Richard DeNeufville, Airport Systems Planning, (Cambridge, Massachusetts: The M.I.T. Press, 1976), p. 106.

substantial suburban commuter traffic, the proposal to create a link to the airport is considered justified.⁷

It seems opportune to stress the importance of planning a regional transportation system of which the airport itself is an integral part. Only through understanding the role and limitations of each element in the total design can the whole system as well as each part function at maximum efficiency. The complex relationship between each mode of transportation must be understood. An airport must be conceived as being part of a whole, dependent on, yet influencing the rail, water, and highway systems which link its region to all other regions. For example, exploration of the inclusion of rail or shipping links in the cargo areas of the airport would be advisable. In the case of a failure or strike on one mode, goods could still be transported by the other modes. Air transportation is more weather-dependent than any other mode; but with a highly reliable integrated system, an airport closing due to inclement weather would not disrupt traffic because a truly efficient rail link could allow passengers to continue their journey almost as if nothing were different; only trip time would be affected. In the foreseeable future, with the development of an efficient rapid rail system reaching speeds of 100 miles per hour, a crippling snowstorm in a particular area would not keep passengers from reaching their destination.

Several phenomena in recent years should have caused a drastic change in the passenger processing and terminal planning systems used in the past. A description of each havoc-raising development and the implications of each on the design of airport terminals follows.

New Aircraft

The late 1960s saw the addition of B747s, DC10s, and L1011s to our airlines' fleets. The novelty of seeing one of these large aircraft with capacities from 250 to nearly 400 passengers soon wore off when airport operators realized their terminals were being forced to process batches of passengers almost three times as large as the size for which they were designed. Enplaning (departing) passengers and deplaning (arriving) passengers make entirely different demands on a terminal facility. Enplaning passengers arrive at and flow

⁷ Ibid., pp. 92-39.

through the terminal in "trickles." Deplaning passengers, on the other hand, arrive in a group (from the aircraft). At most airports, with the exceptions of Atlanta, Dallas-Ft. Worth, and Chicago, the majority of passengers head straight to the baggage claim area. When the wide-bodied aircraft entered service, they caused such tremendous rushes of people through the circulation elements of the terminal and around the baggage-claim and deplaning curbs that these areas required expansion. Unfortunately, most airport terminals are not easily expandable due to lack of foresight on the part of architects and to site area constraints.

Security

The second major problem to attack the integrity of terminal planning was the wave of hijackings and other breaches of security which began in the late 1960s. After many hijackings and acts of terrorism involving aircraft succeeded, the Federal Government ordered that all passengers and hand-held baggage be checked for weapons or explosives prior to being permitted on board an aircraft. This procedure is the responsibility of the airlines.

Security checking operations changed over a period of several years. Early methods consisted of a check at the entrance to the loading bridge. The procedure has evolved to a system whereby a passenger and his carry-on baggage are examined at a minimum number of locations within the terminal - for example, at the entrances to piers or satellites. This newer system is more economical than the "at gate" check, since the latter requires duplication of equipment and security personnel for every gate at the airport.⁸ With centralized checking, airlines share the expense of purchasing and operating equipment. Large numbers of gates can be kept "sterile" by this method, allowing free passage of passengers between gates in the same "sterile" area.

There are many problems brought on by the necessity and method of security checks, however. One is that often the design of the terminal precludes use of a central security check system. Linear terminals present a particularly difficult layout to make secure. The airlines are almost forced to perform the checking procedure at each gate. Transporter-type terminals have the same problem, but pier and satellite systems are easier and less costly

⁸ Dallas-Ft. Worth Regional Airport and Tampa International Airport were both opened at nearly the same time. One, Tampa, was "lucky." Designed as a satellite terminal, it has only four places, the entrances to the satellites, where the security check occurs. Dallas-Ft. Worth, on the other hand, is a linear scheme and must have security checks at each gate.

to secure. Ease in securing large areas of terminals is influenced to a great degree by the floor plan of the terminal. Some offer greater ease than others.

The second major problem in security is that arriving passengers transferring to another airline in most cases must submit to two security checks, one at his airport of origin and one at the transfer station. This second security procedure is a waste of his time and, at a busy transfer hub, a waste of the other passengers' time as well. It is inefficient and costly, since at transfer hubs much more money in terms of equipment and operators is spent for security than is necessary. An added cost is the inconvenience to all passengers. If some system were developed whereby passengers could be able to move to all gate areas, or better, all areas of the terminal freely, terminals could operate more efficiently, just as they did fifteen years ago when no security check was required.

The need for a method of inhibiting terrorist acts at airports is unquestioned. The safety and integrity of the commercial air transportation system is at stake. Security checkpoints at airport terminals are a fact of life and as such should be integrated into the design of the terminal. Unfortunately for the public, nearsighted planning has resulted in existing airports, unable to expand to accommodate the check station, having to "make do" by erecting these stations - even banks of stations - in the middle of what the architect intended to be primary circulation areas. The effect is to add to congestion in the terminal and inconvenience to passengers.

Deregulation

The third occurrence to hit the aviation industry like a storm was experimental fare deregulation in 1978. More passengers than ever have been utilizing air transportation. Overcrowding is the result.

Route deregulation has brought with it still another problem at terminals. As new airlines are awarded rights to an airport, each requires ticketing, baggage, office, and gate space. Often, especially at crowded large airports, no additional space is to be had. Sometimes space can be leased from other airlines already established at the terminal. Expansion, when possible, is so costly that the airport manager must have a commitment from the new airlines to underwrite the expense of enlarging terminal and apron areas. Most airlines are unwilling to make such commitments, since they need to ascertain the

economics of new routes with which they are experimenting. A problem with the "shared space" idea is that each airline wants its own "logo."

Route and fare deregulation are still in their early stages and must be given several years for the effects they cause to become determined. Perhaps stability will never come about; rather, there may be a situation in which airlines and routes are constantly changing at a particular hub. Even recognizing this, however, is valuable. Still, the problems caused by route and fare deregulation point to the need for developing an inexpensive and easy method to enlarge or in other ways change airport terminal buildings when new disruptions to the existing system are encountered.

Another factor that will influence terminal design is the proposed regulation by the Department of Transportation to make airports accessible to the handicapped. These regulations would require all airports currently receiving Airport Development Aid Program (ADAP) funds to install ramps and lift devices to enable handicapped access to aircraft, volume-controlled telephones for the hearing-impaired, and information-dispersing systems for the blind. These terminal facilities will have to be altered at the sponsor's expense. Total cost of altering the nation's existing terminals is estimated to be \$38.5 million. Airports failing to comply with the regulation once it has been enacted could be denied Federal funds in the future.⁹

Changes in aircraft technology, sociopolitical climate,¹⁰ and governmental regulations make new demands on the function of terminal buildings. We cannot allow building technology to limit our ability to provide safe, convenient, and straightforward air service to the travelling public.

⁹"DOT Proposes Handicapped Access Regulations," Aviation Daily, April 11, 1979, vol. 242, no. 30, p. 239.

¹⁰This point is pertinent when considering terminals in foreign countries. For instance, what will become of the new airport terminals which were planned and designed for Iran during the Shah's regime now that there has been a revolution? How will security be administered under the new government?

PASSENGER TERMINAL CONCEPTS

The passenger terminal consists of a curbside, auto parking areas, check-in for passengers and their baggage, a system of moving checked baggage to, from, and between aircraft, departure lounges and various amenities such as snack bars, shops, and the like. Exhibit 4 shows desired adjacency of various elements in the terminal. Basically, the terminal consists of a circulation system linking the various elements. The variations in this circulation system constitute the differences in terminal configuration.

There are four main layout concepts in the design of airport terminals. Each has distinct functional advantages and disadvantages and is better suited to one predominating traffic situation, i.e., transfer, terminus.

The following discussion examines the four various concepts - linear, pier, transporter, and satellite - and is presented in the order in which each evolved:

Linear Concept

The linear terminal configuration was the earliest. Developed in the period from 1930 to 1950, it presented a simple, direct interface between the aircraft and ground transportation. See Exhibits 5 and 6. Still built today on a larger scale, it is most applicable for an airport which experiences a very high degree of originating and terminating traffic, since it provides the most convenient means (shortest distance from aircraft to auto) of obtaining ground transportation. Kansas City's new airport even boasts a "Drive to Gate" plan which is really a curved linear concept. The disadvantages of the linear configuration are that many services are duplicated in this scheme which are not in others. Security is a problem; and when built on a very large scale, it even loses the advantage of easy ground access which is, after all, the scheme's underlying principle. A person could park his car at one end of the airport for his departure, only to return on an airline utilizing the other end of the building. He would have a healthy walk to retrieve his car. Exhibit 7 shows a typical linear terminal - Dallas-Ft. Worth.

Pier Concept

This configuration is an offshoot of the linear scheme. It was developed with the intent of clustering more aircraft around the circulation system. See Exhibits 8 and 9. Piers are really double-loaded corridors. This saved on building cost by nearly halving the circulation required. Further, airlines could cluster all their allotted gates in one pier,

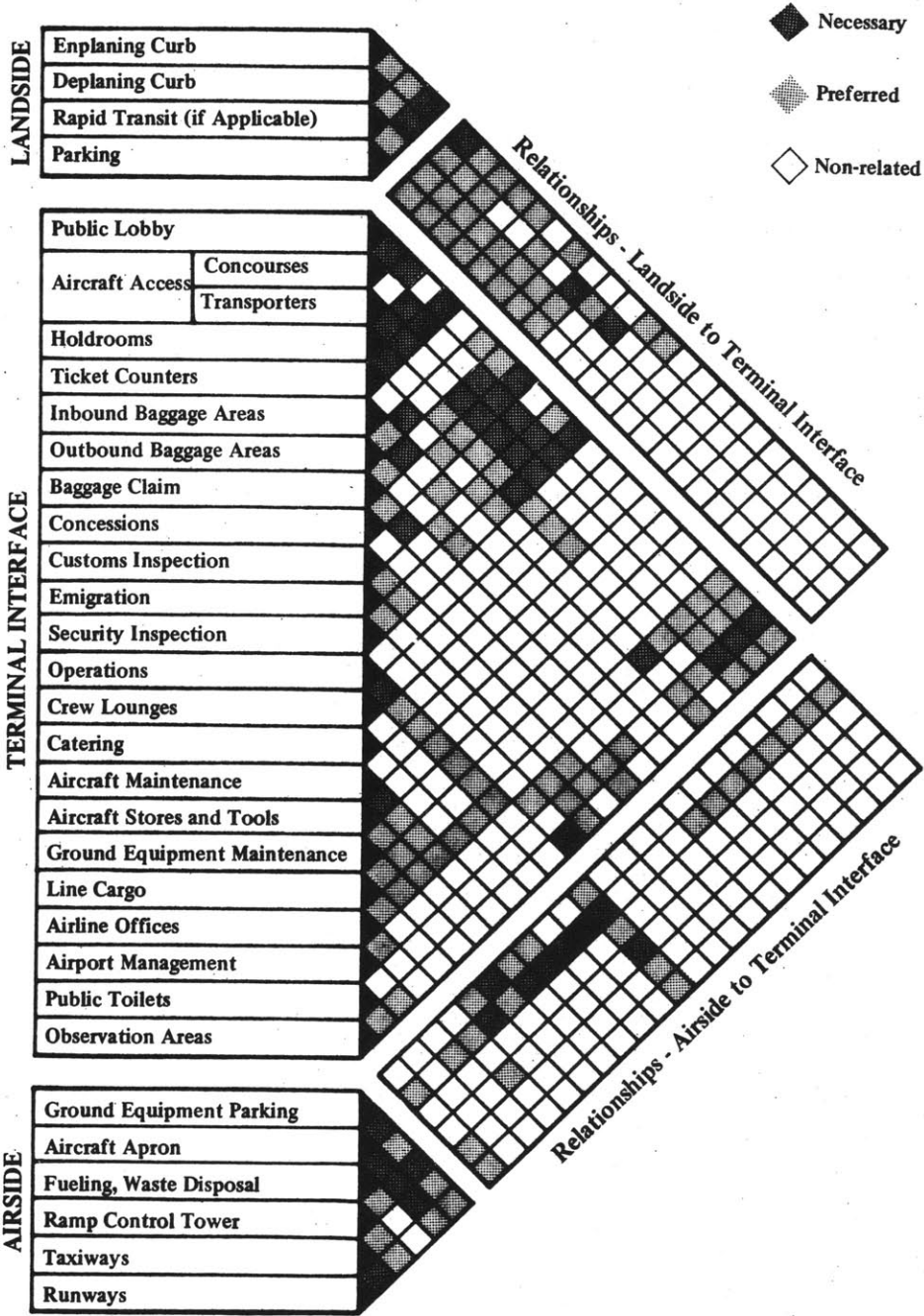


EXHIBIT 4

PASSENGER TERMINAL ADJACENCY MATRIX

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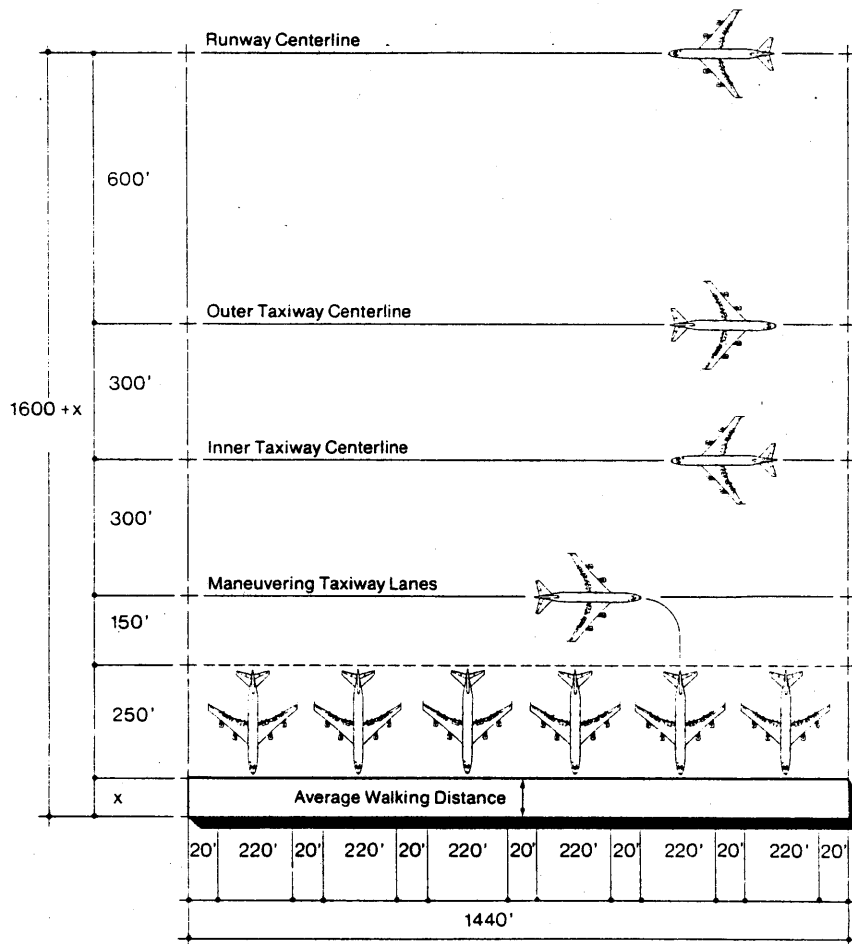
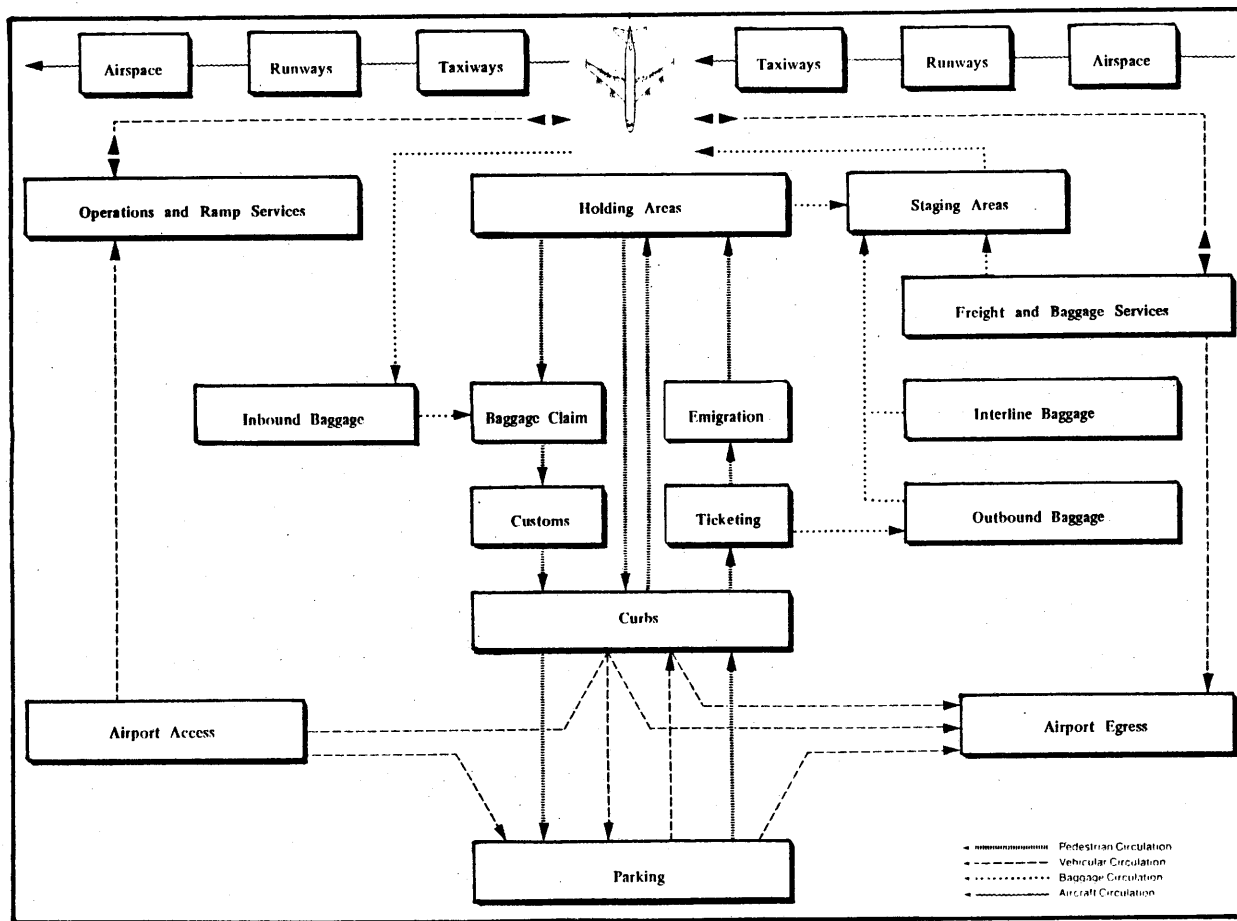


EXHIBIT 5
LINEAR CONCEPT

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LINEAR CONCEPT FUNCTIONAL RELATIONSHIPS

EXHIBIT 6

- A** TERMINAL
- B** PARKING
- C** INTRA-AIRPORT TRANSIT SYSTEM
- D** GROUND ACCESS

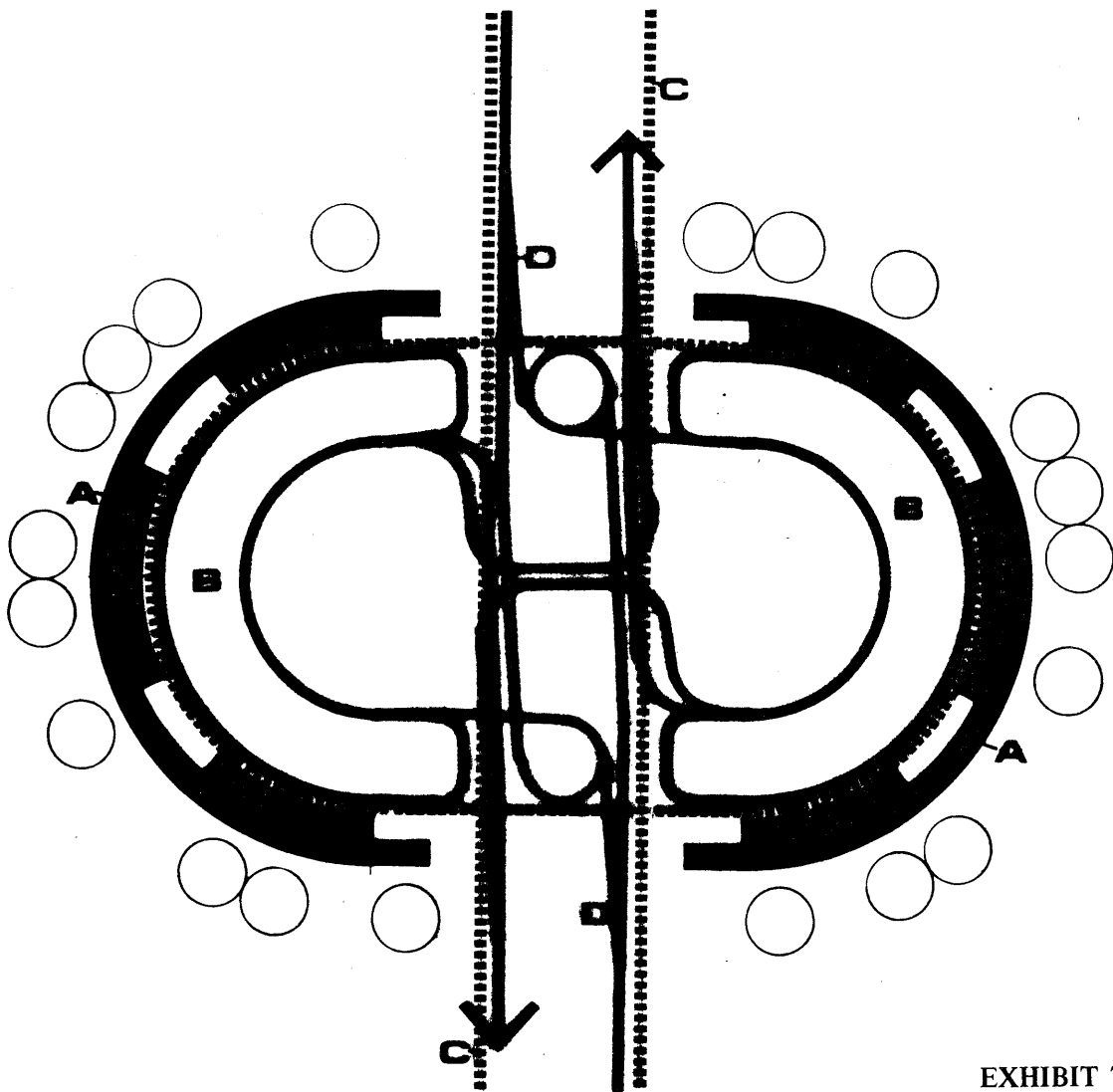


EXHIBIT 7
DALLAS-FT. WORTH REGIONAL AIRPORT

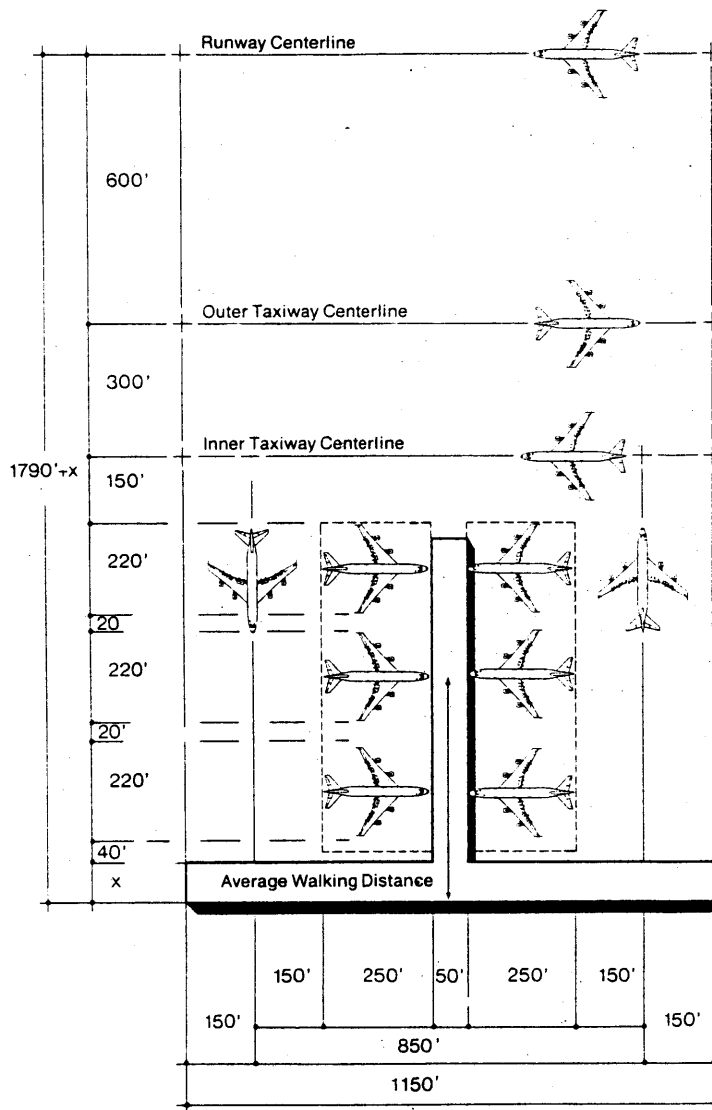
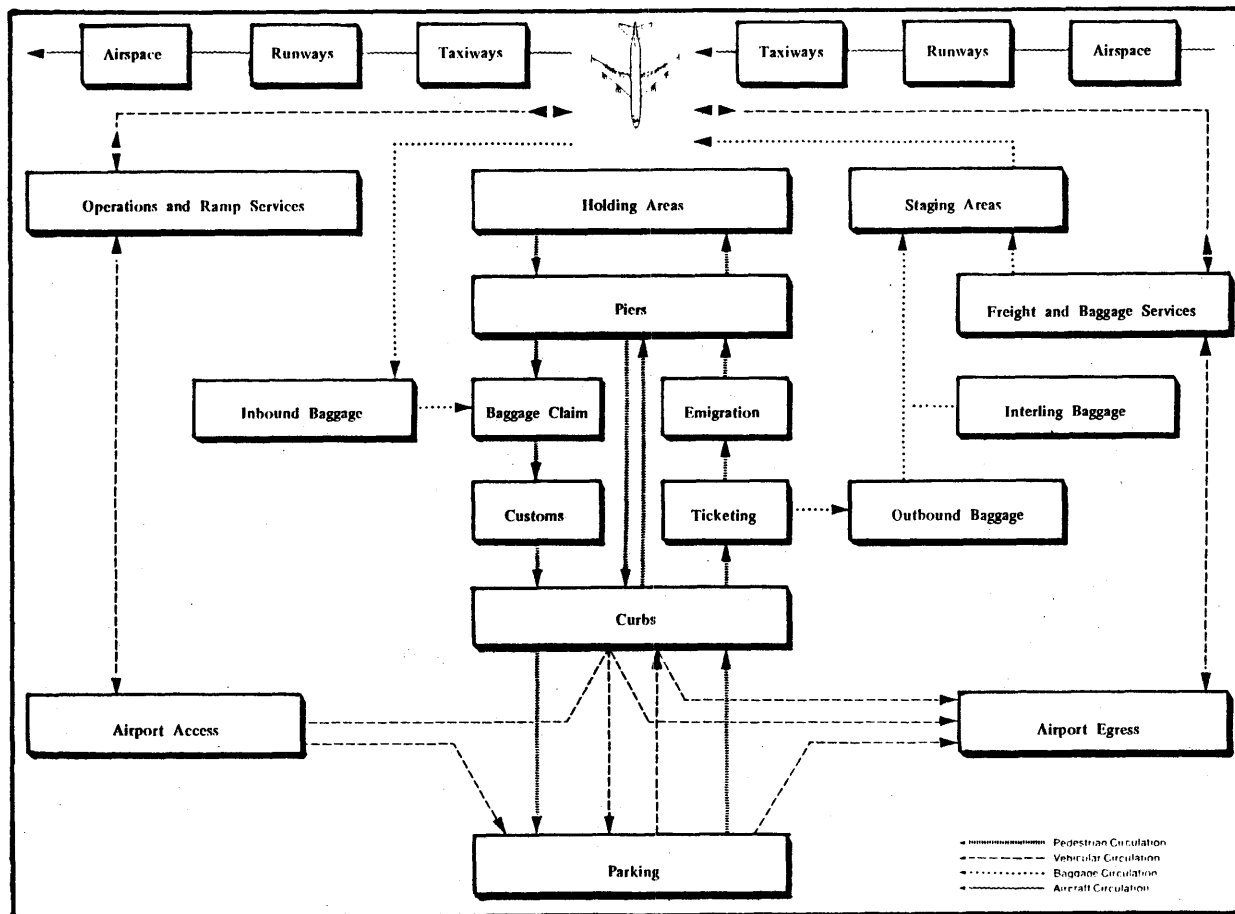


EXHIBIT 8
PIER CONCEPT

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PIER CONCEPT FUNCTIONAL RELATIONSHIPS

EXHIBIT 9

making on-line transfers easier for the traveller. Walking distances became longer from ground transportation to the aircraft and for inter-airline transfers. Another disadvantage is that in most cases it is difficult to maneuver a large aircraft (wide-body) to the gate position nearest the main body of the terminal. These aircraft, for ease of maneuverability, are often parked at the furthest gate. This creates a situation whereby the aircraft taking on or discharging the greatest number of passengers is at the furthest gate from ticketing and baggage claim facilities. It seems ironic that that aircraft which is most efficient in the air is, because of building constraints, least efficient on the ground.

The advantage gained in clustering activities in the pier concept is compromised when a pier scheme is designed to accommodate wide-bodied aircraft; the piers, of necessity, must be further apart to permit easy maneuverability of these large aircraft. This produces very long walking distances.

Like the linear concept, this scheme is best suited for an airport which experiences a very small amount of transfer traffic, since inter-airline transfers often require the passenger to traverse very long distances. When expansions to the terminal are made (via the construction of additional piers), this problem is compounded.¹¹ Exhibit 10 shows a typical pier terminal - Chicago's O'Hare airport.

Transporter Concept

While not the result of the evolution of any previously tried terminal scheme, this concept emerged concurrently with the pier concept. The underlying idea was that expensive terminal building construction could be eliminated through the use of vehicles to move the passenger to and from the aircraft. See Exhibits 11 and 12. This scheme allows the easiest mobility of aircraft on the apron area and does reduce building construction costs enormously. However, the introduction of a third vehicle, the "mobile lounge," into the flow from ground access mode to the aircraft does have its problems. First, these transporter vehicles cost upwards of \$400,000 each¹² and require an operator to drive the vehicle between the terminal and the aircraft. This human factor can cause

¹¹With multiple piers, the number and width of taxiway access/egress to "cul-de-sacs" between piers is critical.

¹²De Neufville, Airport Systems Planning, p. 118.

- A** ENPLANING ROADWAY
- B** DEPLANING ROADWAY
- C** STRUCTURAL PARKING
- D** INTERNATIONAL TERMINAL
- E** DOMESTIC TERMINAL
- F** RESTAURANT

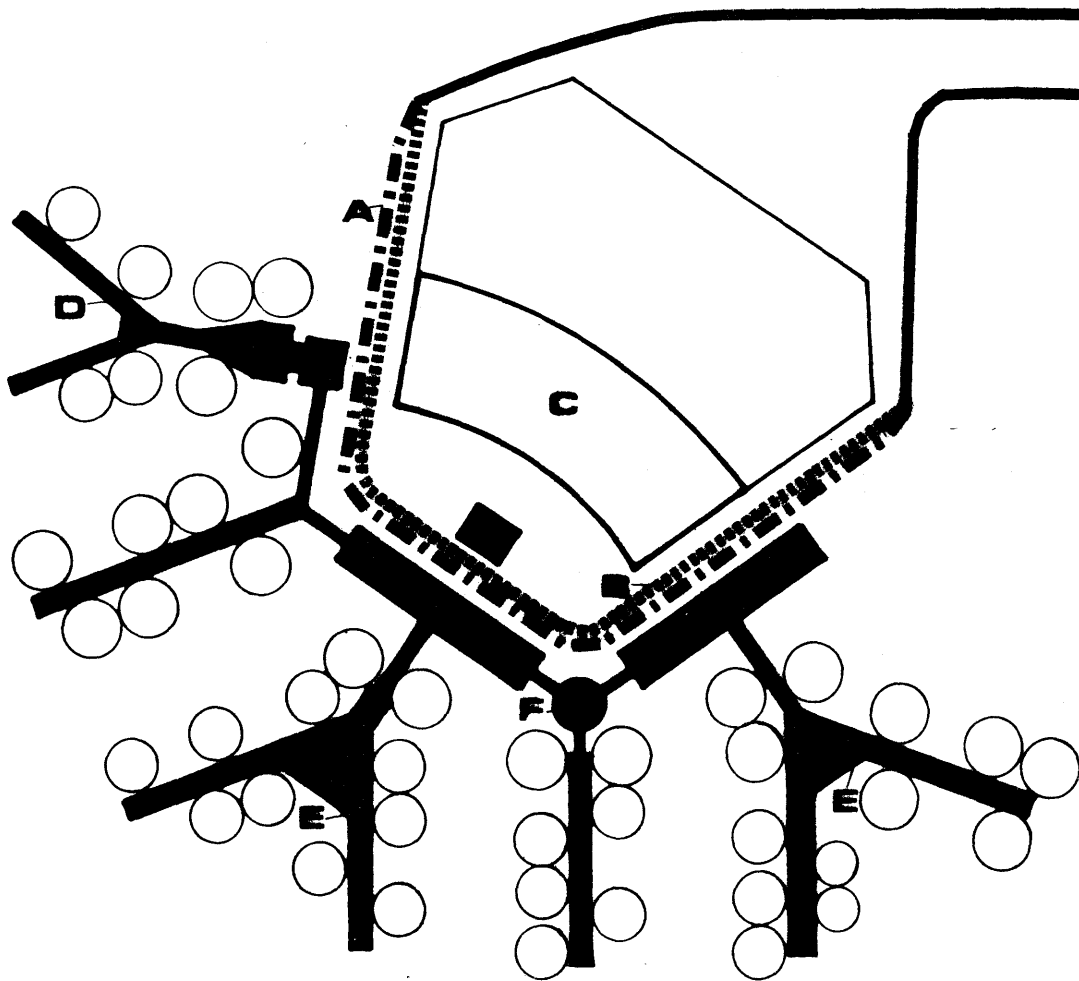
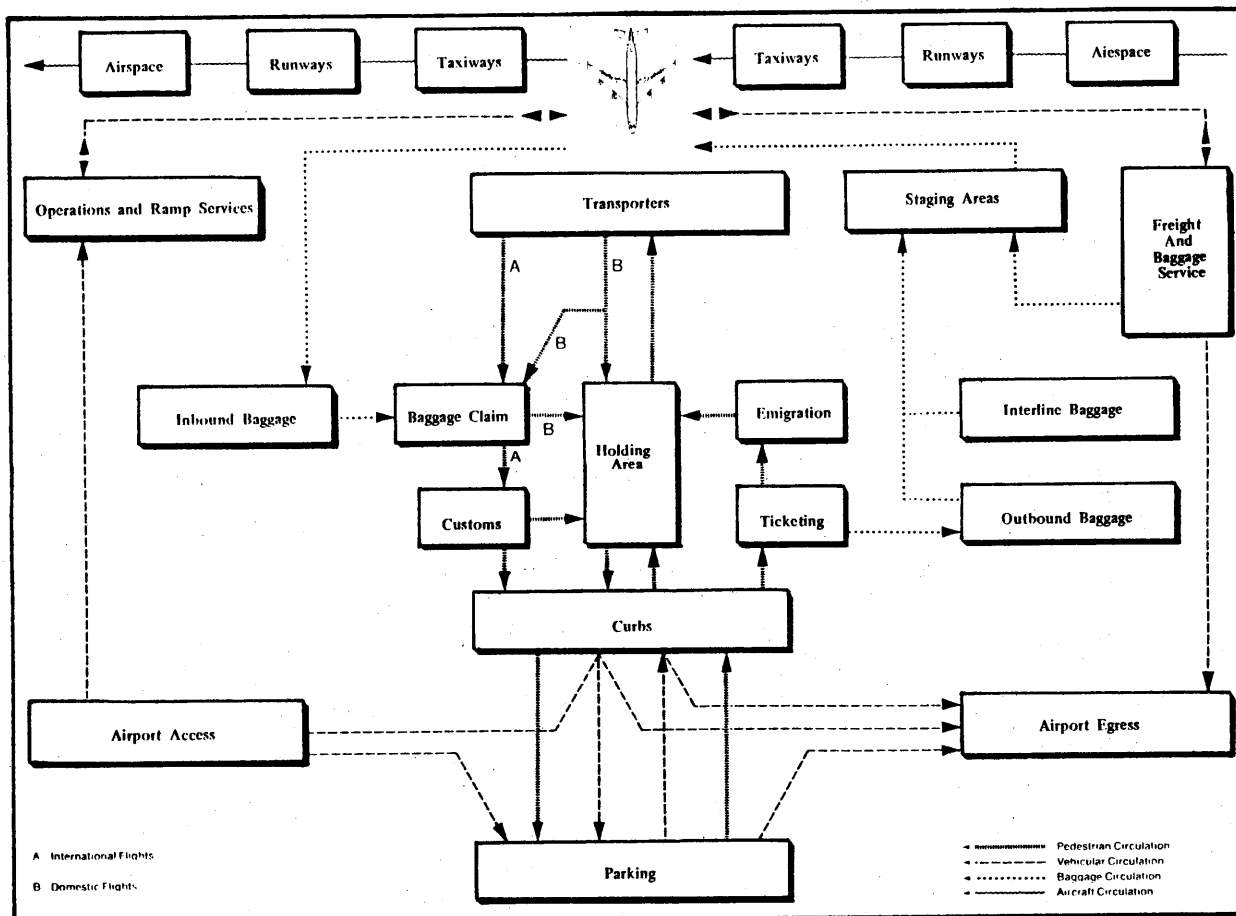


EXHIBIT 10
O'HARE INTERNATIONAL AIRPORT



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TRANSPORTER CONCEPT FUNCTIONAL RELATIONSHIPS

EXHIBIT 12

problems when transporter operators, who are unionized, go on strike. How, then, does one move the passengers to the aircraft?¹³ Further, the vehicles require periodic maintenance: an added expense.

Another disadvantage is to the late-arriving passenger who cannot simply dash down a concourse to the closing doors of his aircraft. After the final transporter has left the terminal, he misses his plane. Airlines do not particularly relish this, since they often lose revenues to other airlines when this occurs, and it is a problem for the passenger who must sit around the airport hoping to obtain a seat on the next available flight to his destination.

It must be stated, though, that transporters are particularly well suited to an airport which experiences wide fluctuations in the volume of traffic it receives. This variation is often due to seasonal peaks and is especially prevalent at vacation centers.

The inclusion of the provisional use of transporters during peak periods is a valuable consideration. It would enable an airport with highly variable traffic patterns which is unconstrained by runway capacity to process more aircraft than could be parked at conventional gate positions adjacent to the terminal building without overbuilding costly terminal building space. Exhibit 13 shows a transporter terminal: Washington - Dulles. Satellite Concept

The evolution of the Satellite concept finally defined the two primary functional areas of the passenger terminal complex: the *landside* and the *airside*. See Exhibits 14 and 15.

The satellite concept removes the aircraft gate positions from the confines of the ticketing and baggage claim areas of the terminal, allowing increased ease of maneuverability of airplanes around the airfield. Passengers are moved to the aircraft via a fixed-track vehicle. This "vehicle" in some cases is a moving sidewalk and in others, an electric bus. Some sort of alternate method (walking) of enabling passengers to reach the aircraft should be provided in case of mechanical failure which is, however, rare.

¹³ In this case, airline executives would operate the transporters. The argument that transporters are inefficient simply because in the event of a strike among operators, the system fails to perform has been voiced many times. In actuality, a strike of any unionized labor organization connected with the air transportation industry will do the same. However, since most labor complaints are aimed at one particular airline, the other airlines will continue to operate and provide service. In a terminal which relies entirely on transporters to get passengers to the aircraft, when a strike of transporter operators occurs, all airlines (and passengers) suffer.

- A** TERMINAL
- B** CONTROL TOWER
- C** TRANSPORTERS
- D** GROUND ACCESS

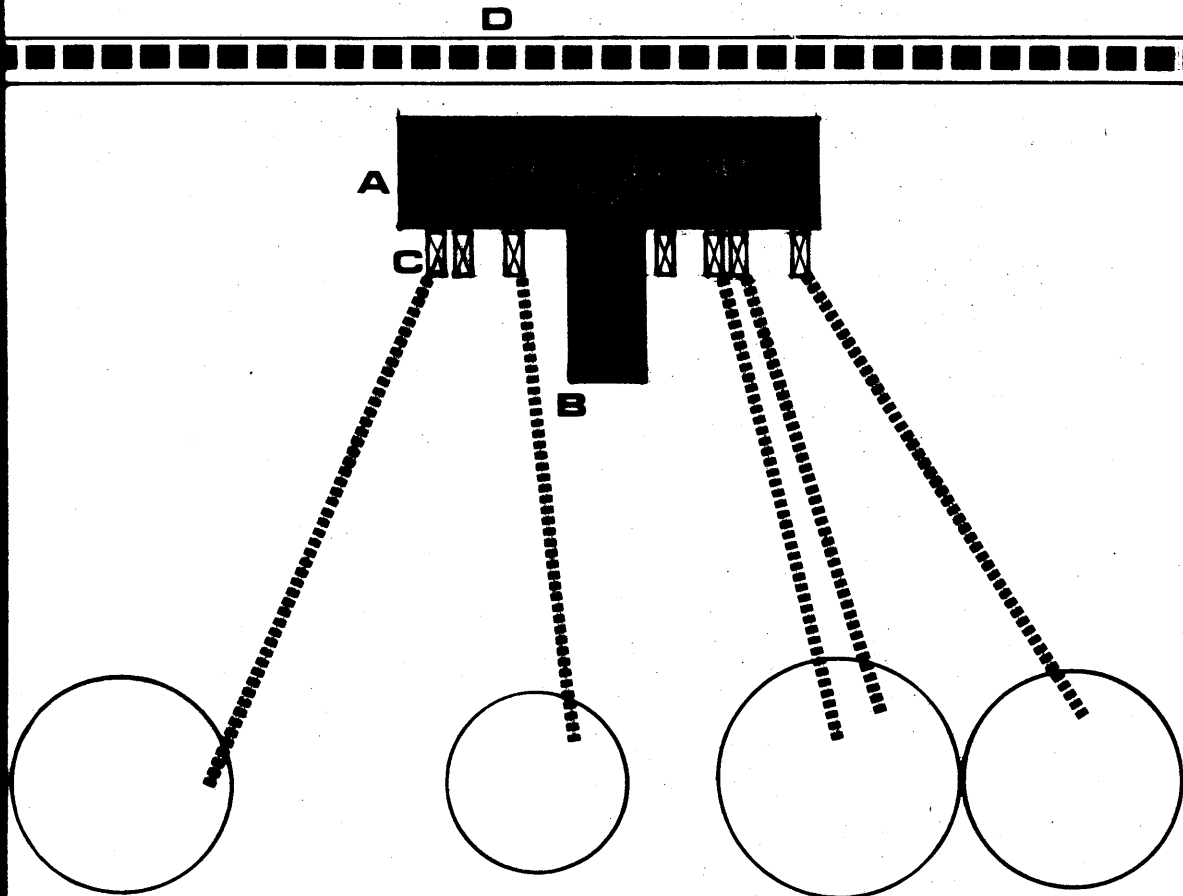


EXHIBIT 13
DULLES INTERNATIONAL AIRPORT

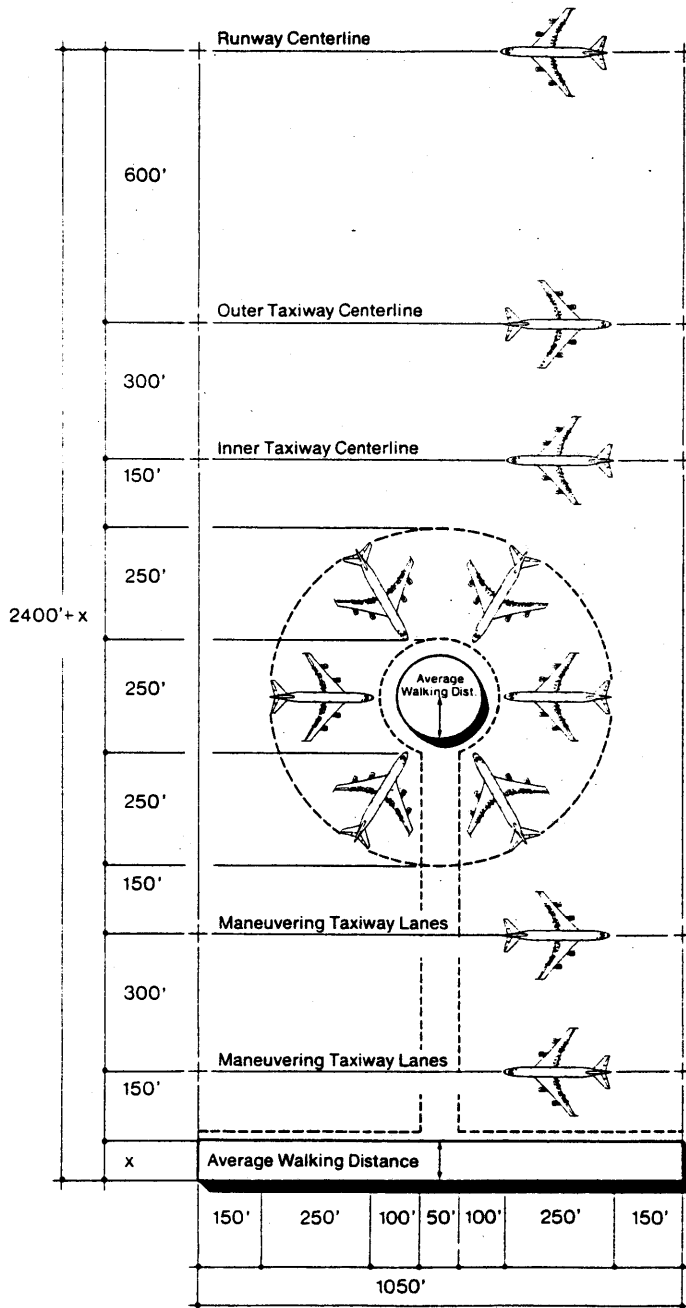
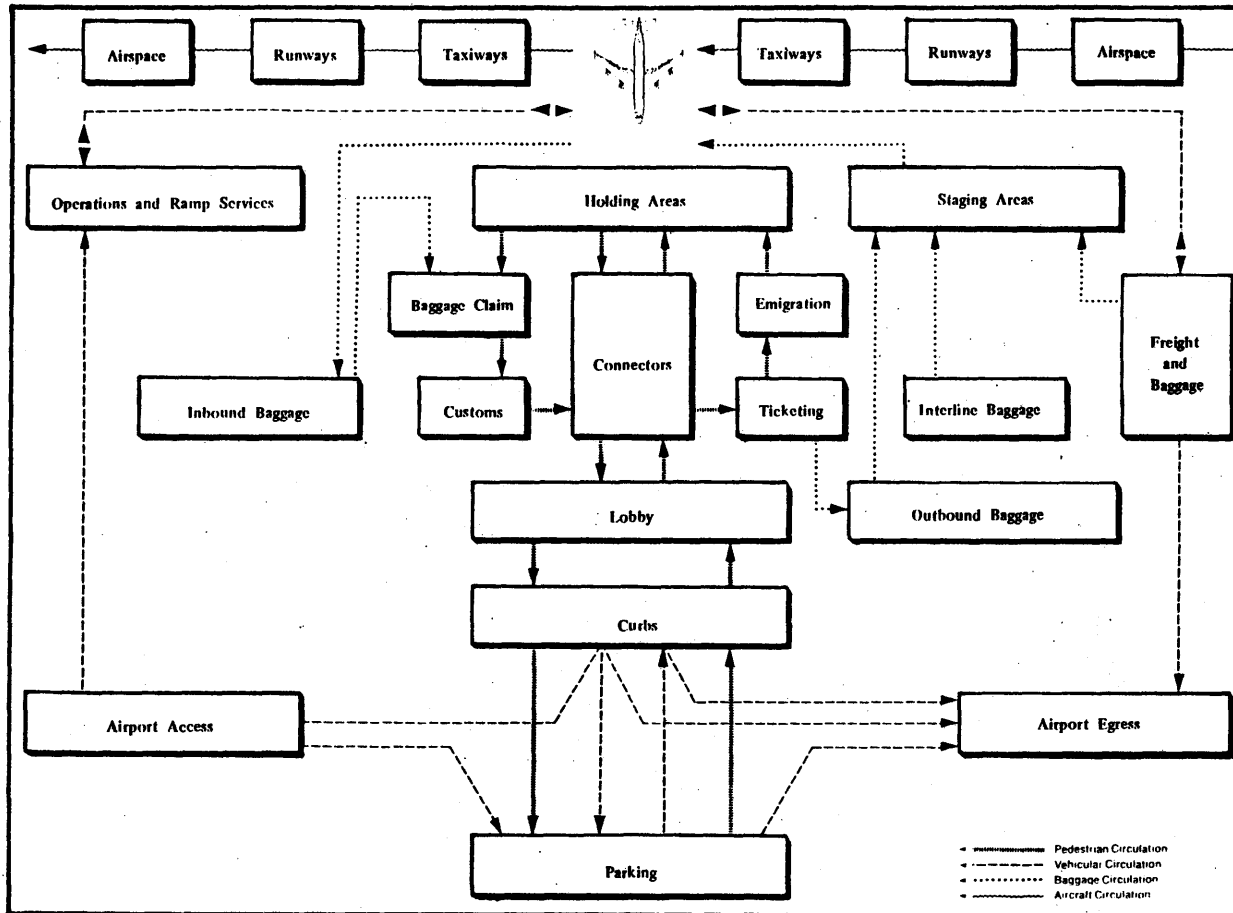


EXHIBIT 14
SATELLITE CONCEPT

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EXHIBIT 15

SATELLITE CONCEPT FUNCTIONAL RELATIONSHIPS

Satellite concepts can be enlarged when the need arises through planned expansion capabilities such as the construction of additional "airside" buildings. Satellite schemes such as the one at Tampa International Airport incorporate easy access from parked cars to the operational areas of the terminal by stacking parking levels on top of other functional areas of the terminal. Parking expansion can be accomplished by simply adding more levels to the terminal building. The structure has been designed to support this additional loading.

The two major disadvantages of the satellite configuration are: 1) unless a people-mover system is introduced, walking distances can be very long; 2) apron areas tend to be large, and these apron pavements are quite expensive to construct. Both considerations, however, can be evaluated in the planning process. Exhibit 16 shows a satellite terminal - Tampa International.

There are other schemes that have been utilized at various airports. These "hybrids" combine two or more of the "pure" concepts. It has been said that most probably some hybrid of two or more pure elements is probably better able to serve a given airport's needs than any pure concept. This is especially true of hybrids utilizing transporters to accommodate the extra traffic experienced during peak seasons and hours.

Other terminal concepts which have been used or proposed are:

Unit Terminal Concept

This scheme, epitomized at New York's John F. Kennedy International Airport, involves allowing each airline to construct and operate separate terminals on the airfield. It requires much more acreage than other schemes and is not easily expandable. It is very costly, since so much land is required and individual airlines tend to try to outdo each other in unnecessary "splendor." Expensive and prestigious architectural firms are retained to "make a statement" expressing the airline's image. In the early days of this development some of these firms had never designed airport terminals before; and from a functional standpoint, the results of their efforts, while attractive, do not really operate well. Further, pity the passenger who must change airlines. For this reason unit terminal configurations are only found at airports which experience very low transfer traffic. At Kennedy, for example, only about 6%¹⁴ of the passengers transfer airlines. The roadway network connecting the various terminals is elaborate and expensive, and parking is fit

¹⁴ DeNeufville, Airport Systems Planning, p. 106.

- A** TERMINAL
- B** HOTEL
- C** SATELLITE
- D** TRANSIT SYSTEM
- E** GROUND ACCESS

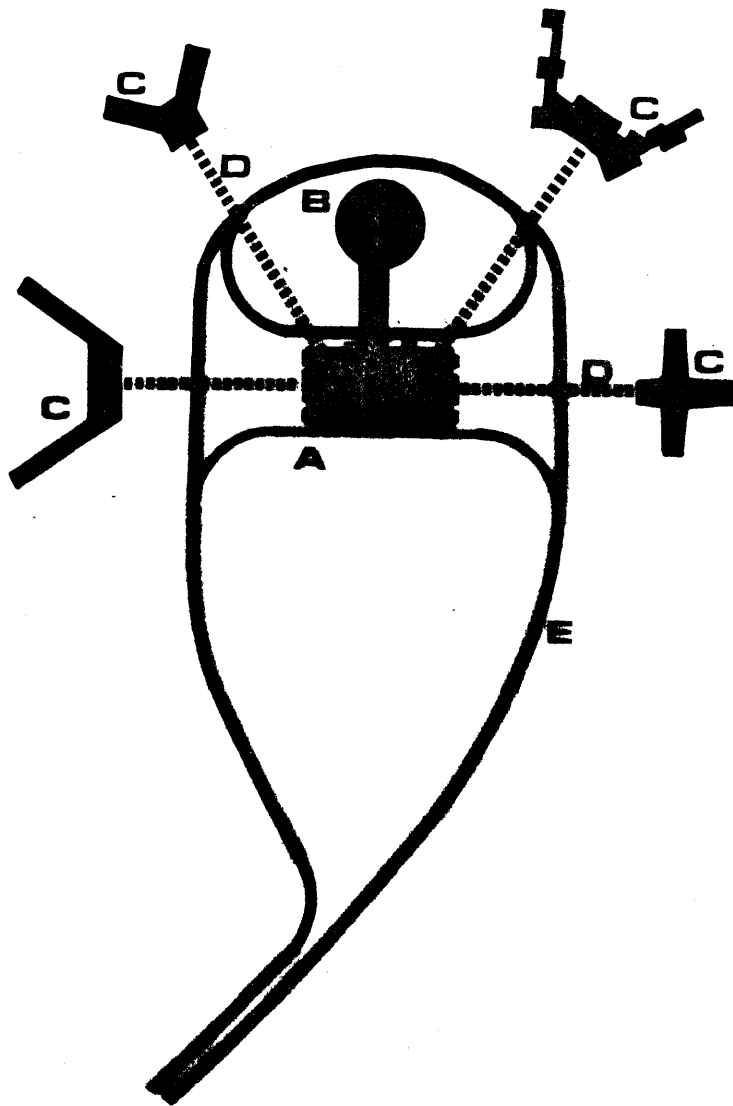


EXHIBIT 16
TAMPA INTERNATIONAL AIRPORT

in wherever possible. This is the most costly and least efficient terminal concept. Exhibit 17 shows Kennedy Airport.

Pipe Airport System

In 1975, Alitalia Airlines introduced a new concept in airport terminal design which was "...intended to stimulate thinking of an airport in terms of a living organism, sustained by a well-articulated stream flowing through a single artery, the PIPE." Supposedly applicable to new airports as well as to those needing remodeling, the system stresses:

- * simplicity
- * increased service standards
- * flexibility
- * staff amenities
- * safety
- * cost reductions
- * joint management

In essence, it consists of a building for passenger processing which is connected to the aircraft loading positions by a closed loop. This loop is traversed ideally by an electric vehicle but also is capable of being served by busses in the event that the fixed-track vehicles break down. The interior portion of the loop contains air freight and cargo activities and provides them with easy access to the aircraft.

The Pipe System is similar to the satellite concept in that it is another means of separating the airside/landside functions of the terminal. Nowhere has the system actually been implemented; therefore, no data with regard to its ability to meet its promises are available to estimate operational capabilities. One would question, however, what would happen to the system when a labor strike or other occurrence precluded operability of the vehicles on the "PIPE." Exhibit 18 shows a hypothetical "Pipe" application.

- A** EASTERN AIRLINES
- B** UNITED AIRLINES
- C** PAN AMERICAN WORLD AIRWAYS
- D** INTERNATIONAL ARRIVALS BUILDING
- E** TRANS WORLD AIRLINES
- F** NATIONAL AIRLINES
- G** BRITISH AIRWAYS
- H** AMERICAN AIRLINES
- I** UNITED AIRLINES

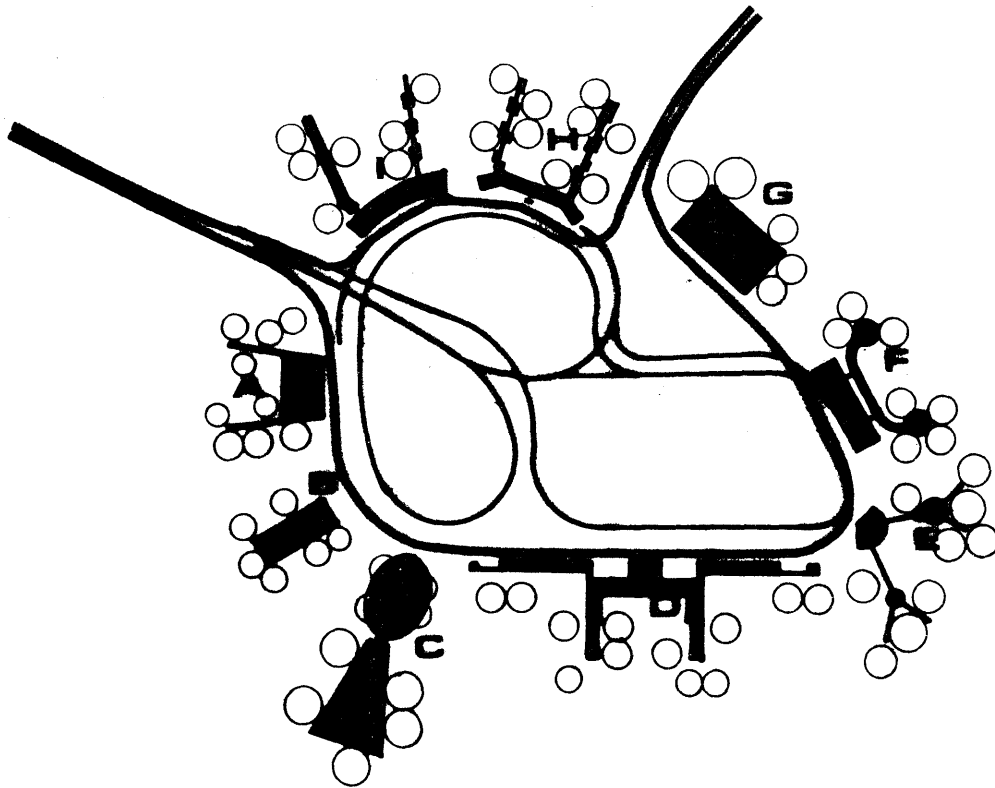
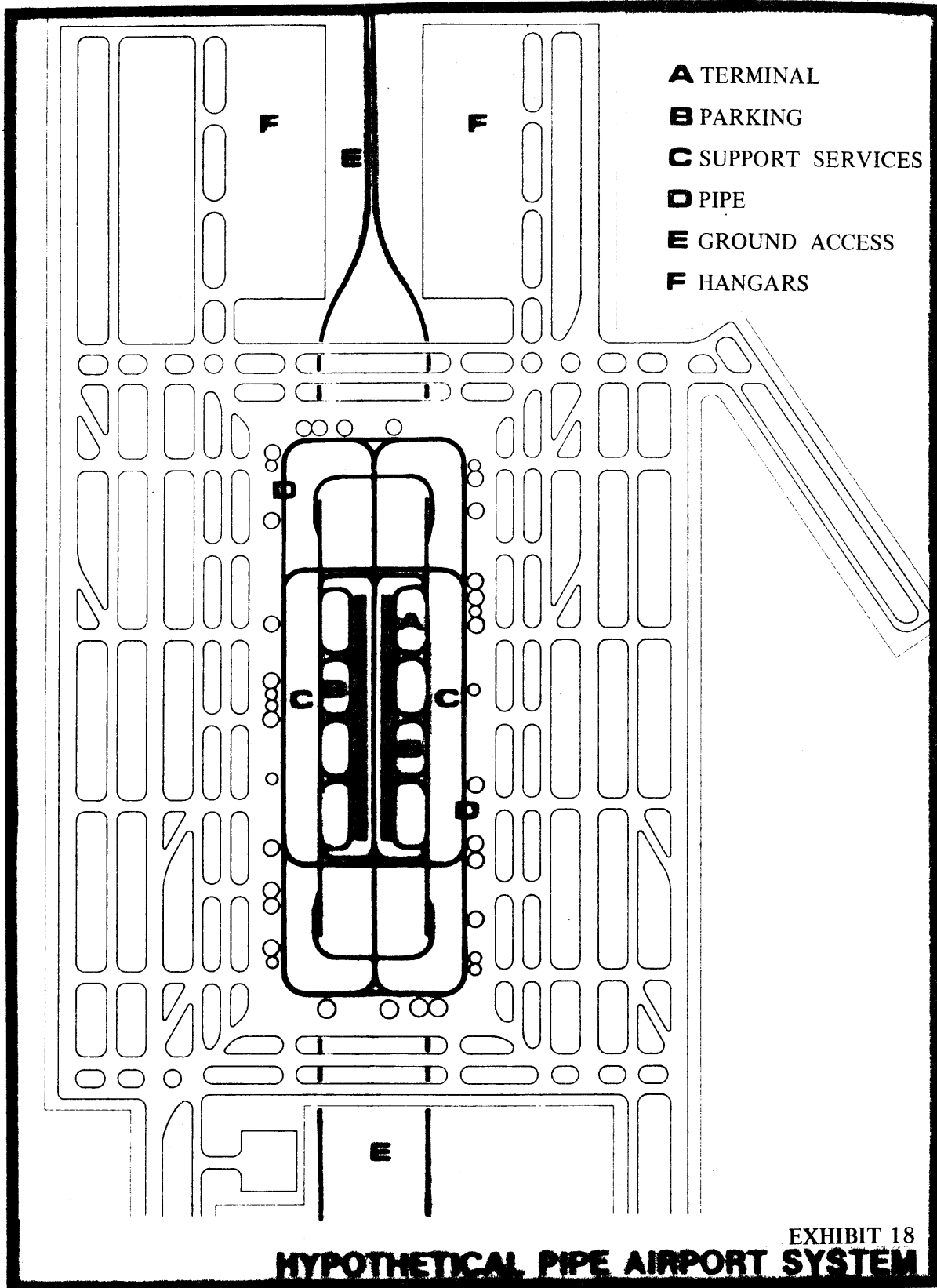


EXHIBIT 17

UNIT TERMINAL SCHEME - KENNEDY AIRPORT



2 AIR TRANSPORTATION AT ATLANTA

BACKGROUND

History of City and SMSA

Atlanta's importance in the transportation system of the Southeast goes back many years - to the time when railroads provided the most modern and efficient means of moving people and goods. The City was late to develop compared with the South's coastal cities of Savannah, Charleston, and New Orleans which grew and developed when water was the major mode of transit. In earlier times most products were imported from Europe, as little manufacturing had begun in the New World.

Like most cities, Atlanta began as a commercial center in 1837. Farmers from the surrounding countryside brought their cotton and livestock to Atlanta for market. The growth of manufacturing in the North and increased agricultural (cotton) production in the South required some means of connecting these two economic centers. Transporting commodities from one region to the other by water posed several problems. While most northern manufacturing centers were directly accessible by water, often this was a long, hazardous and costly undertaking. Many of the areas in the South which supplied cotton to the northern mills were totally landlocked. Some other overland means had to be found to economically serve this basic transportation need. Railroads provided the answer and Atlanta, to use a cliché, was in the right place at the right time. Its location near the southernmost end of the Blue Ridge Mountains made for easy passage and soon it flourished as a terminal point for east and west rail lines. From the additional trade generated by the railroad, the city grew rapidly into an influential manufacturing center in its own right. Its strategic importance as a transportation center during the Civil War was dramatically illustrated by the persistent effort that General Sherman made to capture the City, destroy its railroads, and thereby cut the South's vital supply lines. Atlanta's defeat broke the back of the Confederacy.

Favorable geographic location has enabled it to be one of only two cities in the United States where three primary Interstate Highways converge. See Exhibit 19. This fact has led to the development in the Atlanta region of many service-related and transportation industries. These industries in turn have supported growth in banking and

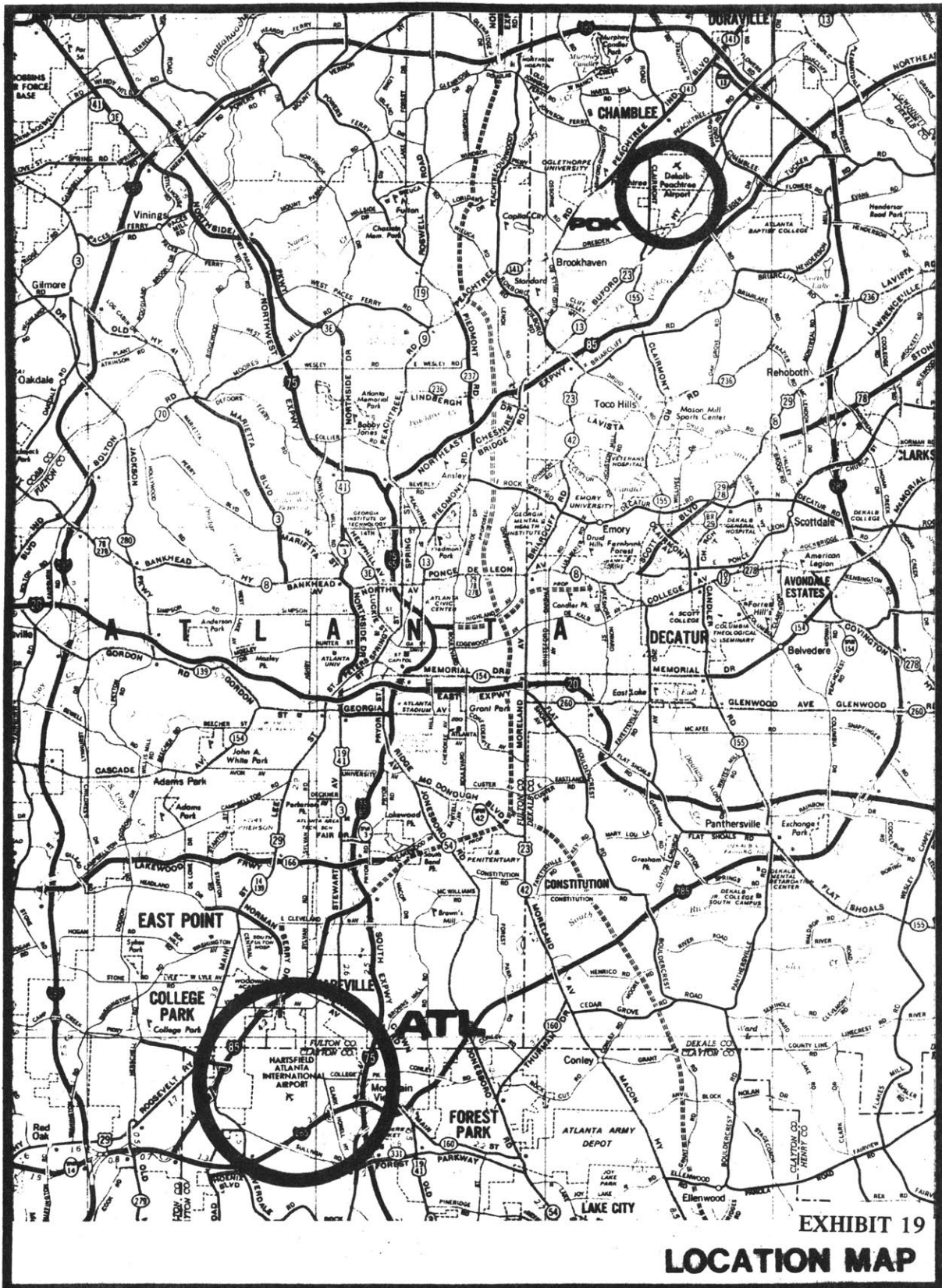


EXHIBIT 19

LOCATION MAP

finance. The South's agrarian economy required nearby processing centers for the goods they produced and from this came the establishment of textile and wood-processing industries near Atlanta, the transportation center. Atlanta is the South's major warehouse center; many retail chains, J. C. Penney, for example, have enormous warehouses near Atlanta.

Other cities in the South are not nearly as large nor as important. They are mainly coastal port cities like Savannah and Charleston or manufacturing centers like Birmingham, Alabama. The exception is Miami which, due to a favorable climate, became a tourist center and retirement community.

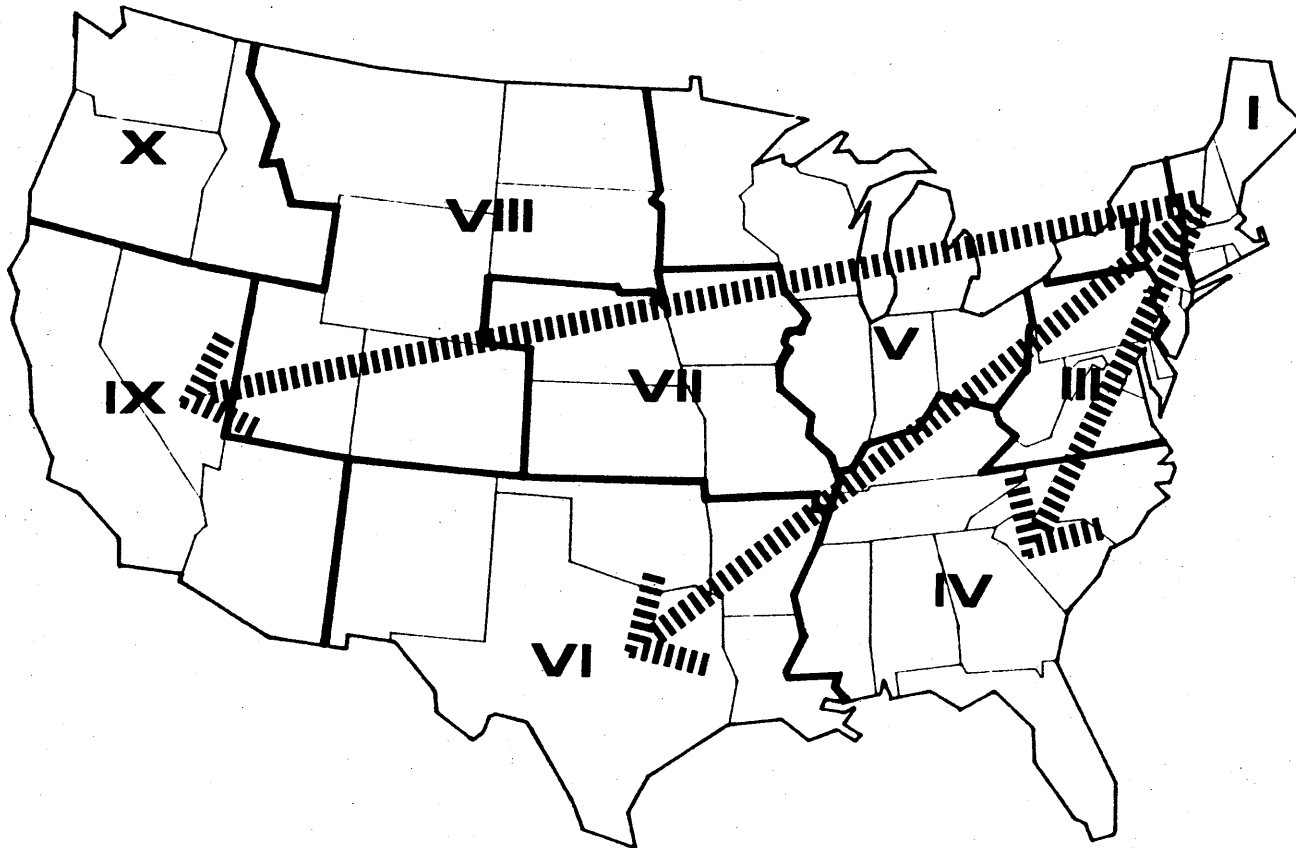
Today, Atlanta continues as an important financial and manufacturing center. Automobiles, textiles, aircraft, and iron and steel products are just a handful of the some 3500 different goods manufactured by the nearly 1,800 industrial plants located in the Atlanta Standard Metropolitan Statistical Area (SMSA). Cultural facilities have grown over the past decade to include art museums, a theater, and the Atlanta Symphony Orchestra. It is a district bank headquarters under the Federal Reserve System, as well as headquarters for the Southeastern Region of the U.S. Public Health Service and national headquarters for the Center for Disease Control, and FAA's Southern Region.

Economics and Population

The United States Census Bureau divides the country into ten Standard Federal Administrative Regions. Data such as population, income, retail sales, housing and employment are then collected every ten years and compared by region and state to the national average.

It is not particularly surprising that two regions, the Southeast and the West, have experienced economic and population growth far exceeding that of the nation as a whole. This growth is in some part at the "expense" of other areas of the United States, most particularly the Northeast. See Exhibit 20.

Recent socioeconomic developments have contributed to a very vigorous growth picture in the Southeast. Favorable climate, coupled with such economic incentives as low land prices, lack of unions, low wage scales, and low taxes, make the South a very



POPULATION MIRGRATION PATTERNS

attractive area for businesses and industries to relocate. Also, the cities of Atlanta, Houston, and Dallas are "hot spots" where recent college graduates entering the business market most want to be. The whole region, however, is benefiting from established industries leaving the Northeast. Along with industries, many people are relocating. But factories are not the only businesses to relocate; many office parks and research and development firms have been built along the Interstate Highways radiating from Atlanta.

Population in the United States increased by 34 percent in the twenty years from 1950 to 1970, from 151.2 million to 203.7 million. It was only in the 1950s that Houston, Dallas, and Atlanta passed the 1,000,000 threshold in population. Atlanta's increase was 84 percent in the same twenty-year period - from 864,462 to 1.5 million - and this rate is expected to continue to exceed the national average, though not by so great a margin. See Table 1 and Exhibit 21. The Atlanta SMSA population is expected to be greater than 2.6 million by 1990, an increase of 73 percent, while the national population is expected to grow by 20 percent - to 246 million.¹⁵

Growth in employment and personal income have increased in a manner quite similar to that of population. The 1950 employment figure was 254,900 and grew 144 percent by 1970, to 621,400. This is expected to double by 1990.¹⁶ Manufacturing and retail trade industries currently employ the largest percentage of Atlanta's labor force; and this is expected to continue with no major shift envisioned, though significant growth is projected for finance, and insurance and real estate businesses.

Atlanta has a diversified economic base, encompassing manufacturing, transportation, distribution, merchandising, finance, and government.

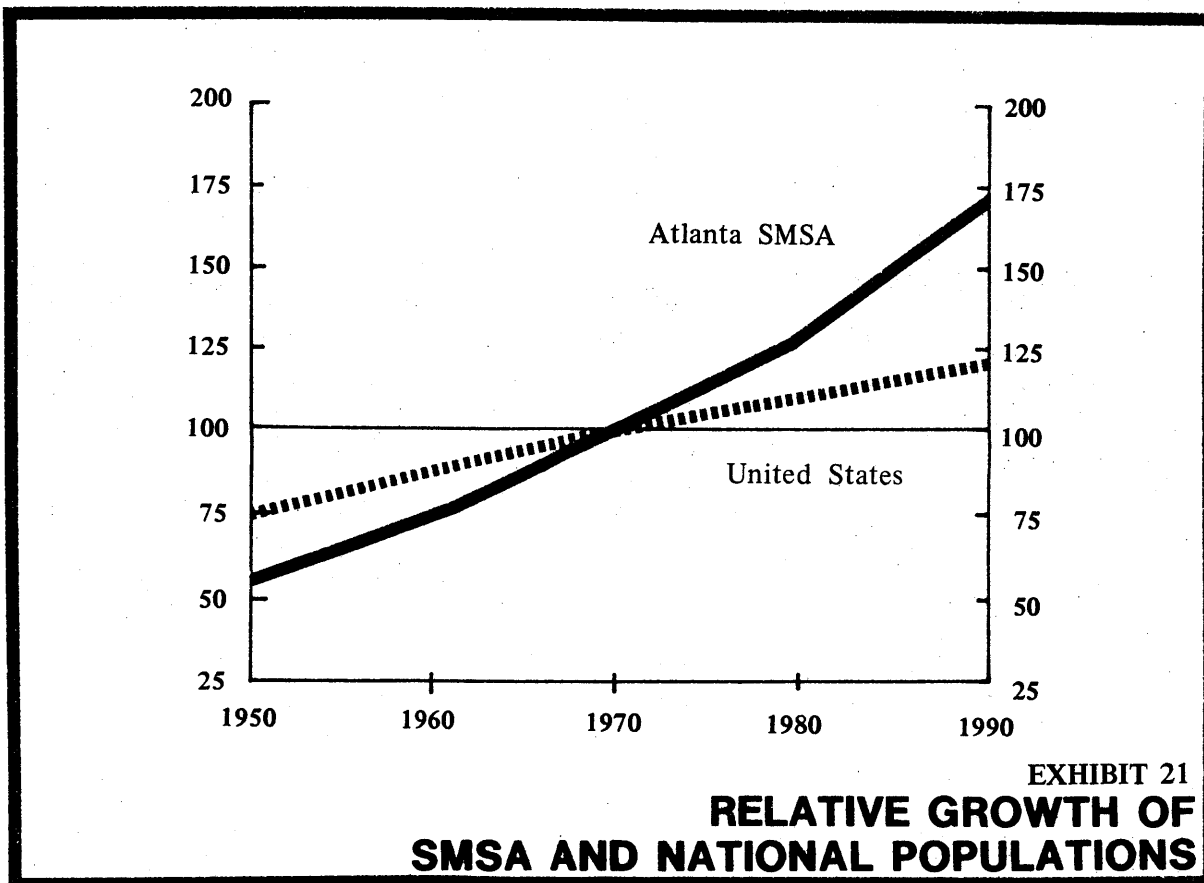
Retail sales in 1975 amounting to \$5.8 billion ranked metropolitan Atlanta 15th nationally. Employment in the retail industry for that year was some 125,000 people. This high figure is in part due to the fact that over one-half of the nation's retailers have branch offices in the Atlanta area. Wholesaling establishments are equally well

¹⁵ FAA Aviation Forecasts: Atlanta, Prepared by Verve Research Corporation, August, 1978, p. 15.

¹⁶ Ibid., p. 13.

TABLE 1
DECENNIAL CENSUS POPULATION TOTALS
Hub and National

	Atlanta SMSA	United States
1950	864,462	151,237,000
1960	1,168,867	179,937,000
1970	1,595,517	203,794,000
1980	2,028,000	223,532,000
1990	2,687,200	246,039,000



Source: U. S. Department of Transportation, Federal Aviation Administration, FAA Aviation Forecasts: Atlanta, by Verve Research Corporation, August, 1978, p. 15.

represented with \$14.8 billion in annual sales by the area's 4,367 wholesalers. This accounts for one-sixth of the entire wholesale trade for the Southeast.¹⁷

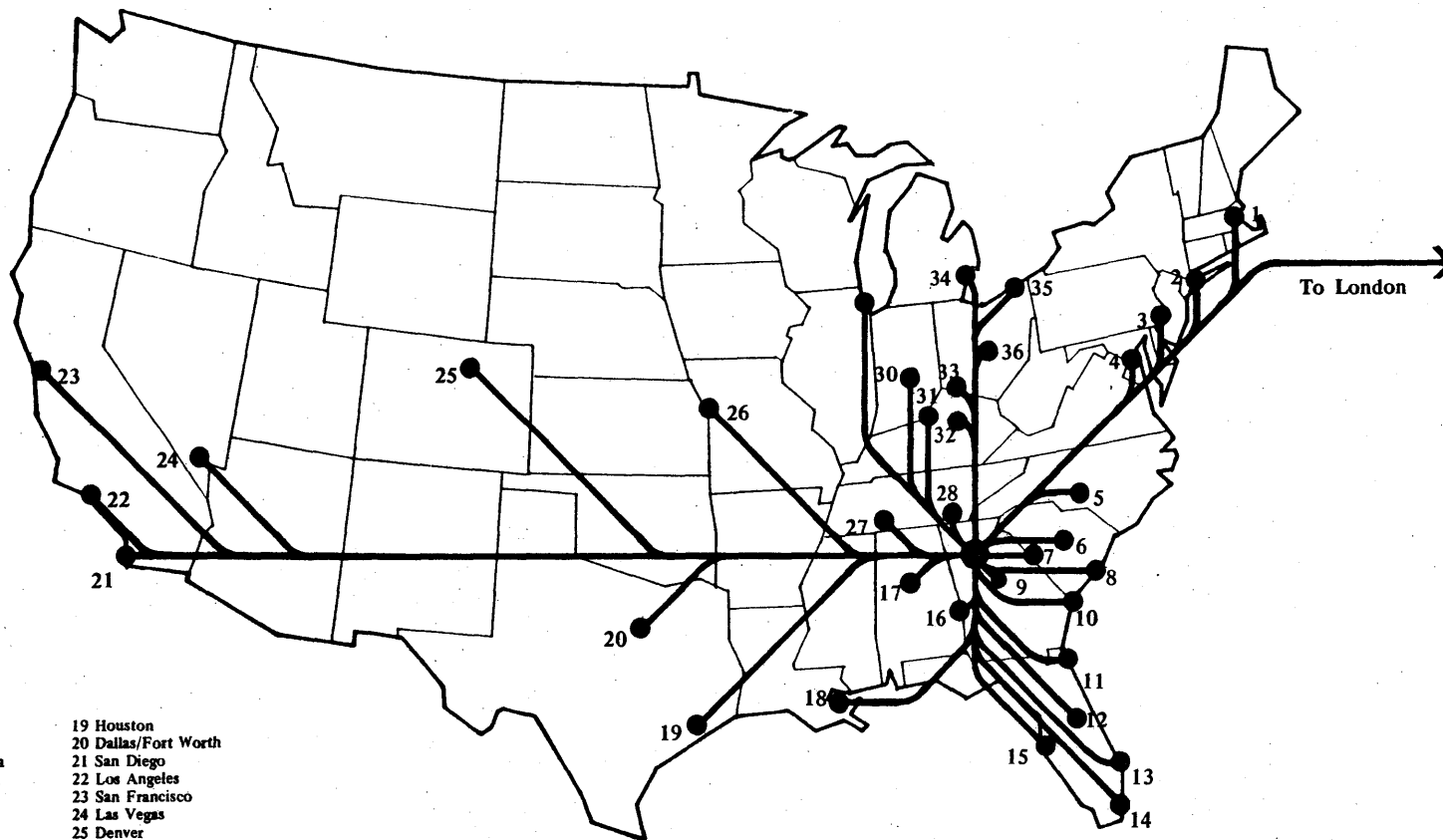
¹⁷ Ibid., p. 16.

DEVELOPMENT OF AIR TRANSPORTATION

The development of air travel served to connect various population centers. Since the North was so densely populated and had so many large cities, air transportation and airlines developed quite differently there than in the South. Early southern airlines offered service connecting the many small cities with each other. Travellers wishing to reach a city outside the region could only be served by a large carrier or were forced to make many frequent stops and aircraft changes en route to their destination. The volume of traffic wishing to go from Montgomery, Alabama or Raleigh, North Carolina to New York was simply not large enough for an airline to justify daily non-stop service on each route, but the many small cities together did produce enough demand to support this type of service. The nature of travel in this region has developed on the "Hub and spoke" principle: many small groups of passengers from all over the region are served via a transfer point -- Atlanta.

The beginning of the City's dominance began many years earlier. In 1927, Atlanta received its first airmail service to Miami; and in 1928, airmail service was inaugurated to New York. The designation of Atlanta as the refueling stop on the New York-to-Miami route was a major factor in establishing the City as the major hub in the region. This situation is now so painfully evident that to go from anywhere in the Southeast to anywhere else (including Hell), one must transfer at Atlanta. In the latter case, one often wonders which is worse, the destination, or the transfer stop - a special case of Dante's *Inferno*.

The rapid rise in population and associated increases in travel have contributed, along with the nature of air service in the region, to making Atlanta so important to air transportation in the Southeast. The airlines serving the region have structured their routes to support this "hub and spoke" operation. Exhibits 22 and 23 show, respectively, the nonstop routes for Delta Air Lines and Eastern Airlines from Atlanta. These two airlines together account for nearly 90% of the traffic (passengers) through Atlanta. Transfer traffic comprises 73% of the total. This is the highest percentage of transfer traffic anywhere in the world. One consequence is that the existing airport at Atlanta has become horribly overcrowded. The existing terminal was designed for on-line transfers, and when a passenger must change airlines, he is in for a healthy walk. Georgia, itself, could not hope to support such a large airport; therefore, Atlanta's airport must be thought of as serving the entire Southeast Region. It is their "gateway" to the rest of the world.



- | | |
|--------------------|----------------------|
| 1 Boston | 19 Houston |
| 2 New York | 20 Dallas/Fort Worth |
| 3 Philadelphia | 21 San Diego |
| 4 Washington | 22 Los Angeles |
| 5 Charlotte | 23 San Francisco |
| 6 Columbia | 24 Las Vegas |
| 7 Augusta | 25 Denver |
| 8 Charleston | 26 Kansas City |
| 9 Macon | 27 Memphis |
| 10 Savannah | 28 Chattanooga |
| 11 Jacksonville | 29 Chicago |
| 12 Orlando | 30 Indianapolis |
| 13 West Palm Beach | 31 Louisville |
| 14 Miami | 32 Lexington |
| 15 Tampa | 33 Cincinnati |
| 16 Columbus, GA. | 34 Detroit |
| 17 Birmingham | 35 Cleveland |
| 18 New Orleans | 36 Columbus, OH. |

EXHIBIT 22
DELTA AIR LINES
NON-STOPS TO ATLANTA

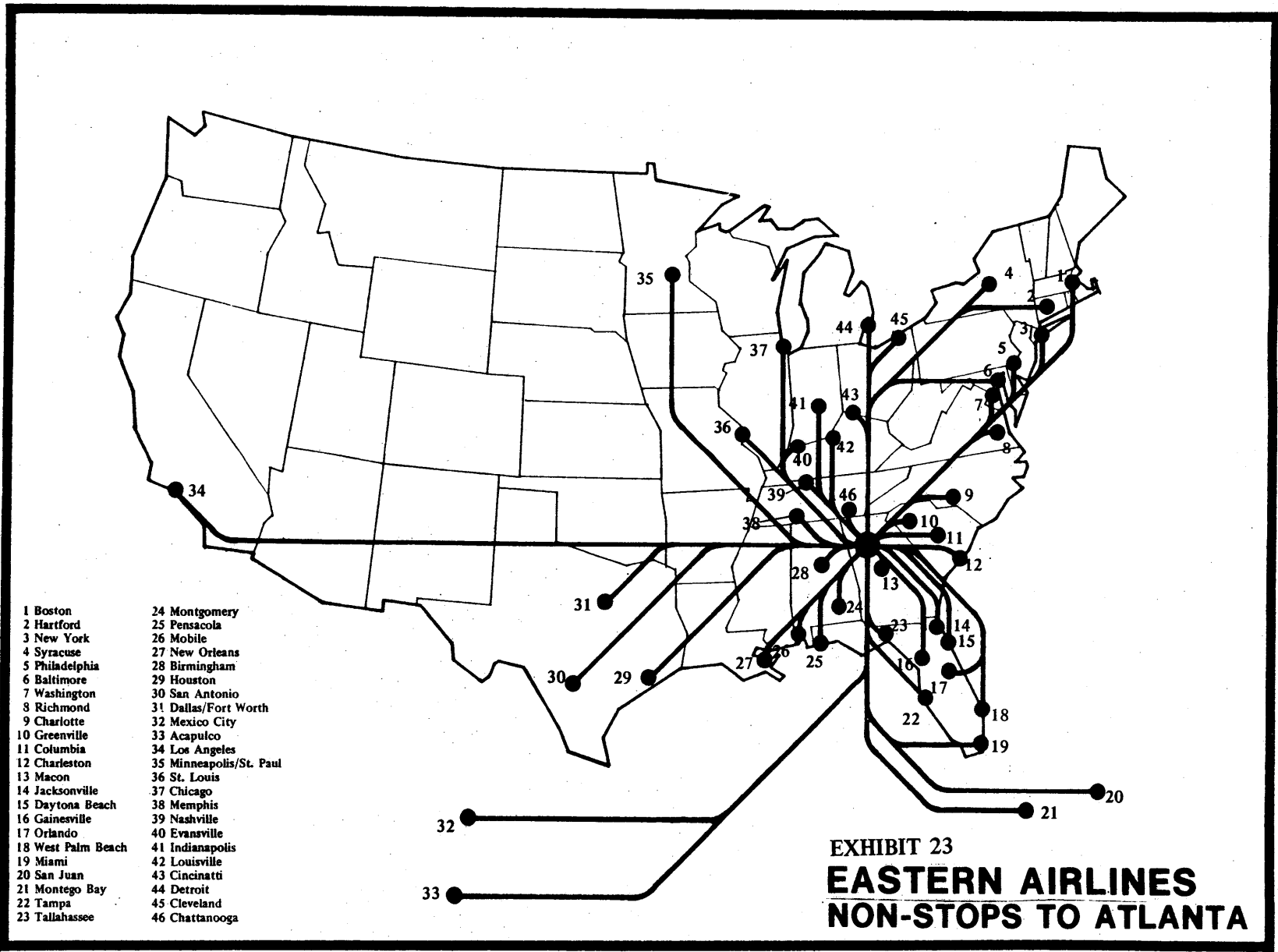


EXHIBIT 23
EASTERN AIRLINES
NON-STOPS TO ATLANTA

Airfield Development

Atlanta has constructed the Airport's boundaries to a total of 3,900 acres in a series of land acquisitions dating back to an original 1925 lease of 287 acres in South Fulton County. This land was eventually purchased from the Candler Estate¹⁸ in 1929 for \$94,600. The first terminal facilities and two 1,500-foot runways were completed in 1926 and 1927.

By 1945, the Airport had grown to one of the largest (1,230 acres) in the United States, and a new terminal was built for the then "Atlanta Municipal Airport." The terminal in use today was begun in 1958,¹⁹ and is now called "William B. Hartsfield International Airport." See Exhibit 24.

Today the airfield has three major east-west parallel 150'-wide runways which measure 10,000 feet, 9,000 feet and 8,000 feet, two crosswind runways and along with the passenger terminal many other buildings which accommodate aircraft maintenance, cargo operations, and other services.

The social and economic impact of aviation on a community is difficult to quantify. The subtleties of the question of economic benefits derived directly or indirectly from the presence of an airport are the subject of on-going controversy. One less contested measure of the benefit to a community is a survey of employment at the airport.

Hartsfield represents an employer of 23,000 citizens with an annual payroll of more than \$400 million.²⁰ These 23,000 employees are only part of the economic stimulus to the region's economy. Other businesses that supply airport or aviation-related products such as fuel, food, and equipment also contribute to the economic well-being of the area. Delta Airlines, whose corporate offices are located at the Airport, is Atlanta's single largest employer, with 12,000 employees and an annual payroll of \$280,000,000.²¹

The Airport and the excellent air service it provides are in great part responsible for Atlanta's booming convention industry. In 1976, there were more than 700 conventions.

¹⁸ City of Atlanta, "Central Passenger Terminal Complex," (pamphlet), 1977.

¹⁹ Ibid.

²⁰ Ibid.

²¹ Ibid.

Seventy percent of the some 625,000 delegates arrived by air and poured some \$125 million into the local economy.²²

The multiplier effect, \$1 in payroll pumps \$2.3 into the local economy, implies that aviation expenditures annually contribute \$1 billion to the community.²³

While the citizens of Atlanta own the airport, it receives no City, County, or State tax money. Exhibit 25 shows Atlanta's organizational structure as it applies to the Airport. Federal funds are involved to a great degree in land acquisition, runways, and related development. In the case of Atlanta, Federal monies amount to \$32,700,000 - about 10.7% of the total construction cost. Table 2 shows a summary of sources of funds currently being used to finance the terminal development. The majority of working capital, however, comes from airport revenues. These revenues are collected from rentals and utilities. Expansion is financed by the sale of revenue bonds.

**TABLE 2
SUMMARY OF PROJECT FINANCING**

SOURCES OF FUNDS	ESTIMATED PROJECT REVENUES (PER OFFICIAL STATEMENT)	ADDITIONAL REVENUES REALIZED TO DATE	TOTAL
Deposit into Construction Fund of Proceeds of 1977 Bonds	\$224,972,000	\$ -	\$224,972,000
Interest Income			
Construction Fund	20,354,000	2,043,479	22,397,479
Debt Service Account	6,533,000	-	6,533,000
Renewal & Extension Fund (a)	16,490,000	1,762,000(b)	18,252,000
ADAP Grants	32,700,000	-	32,700,000
Total Sources of Funds	\$301,049,000	\$ 3,805,479	\$304,854,479

a Excludes allocation of certain monies available for certain Airport projects

b 1977 and 1978 projected R & E Fund transfers of \$8,238,000 vs. actual of \$10,000,000.

Source: City of Atlanta, "Progress Report: The William B. Hartsfield Atlanta International Airport Central Passenger Terminal Complex," March 31, 1978, p. 14.

²² "Hartsfield Atlanta International Airport: Its Economic Impact on Atlanta," published by the Atlanta Regional Public Relations Committee, May, 1976.

²³ Ibid.

TABLE OF ORGANIZATION
CITY OF ATLANTA
WILLIAM B. HARTSFIELD ATLANTA INTERNATIONAL AIRPORT

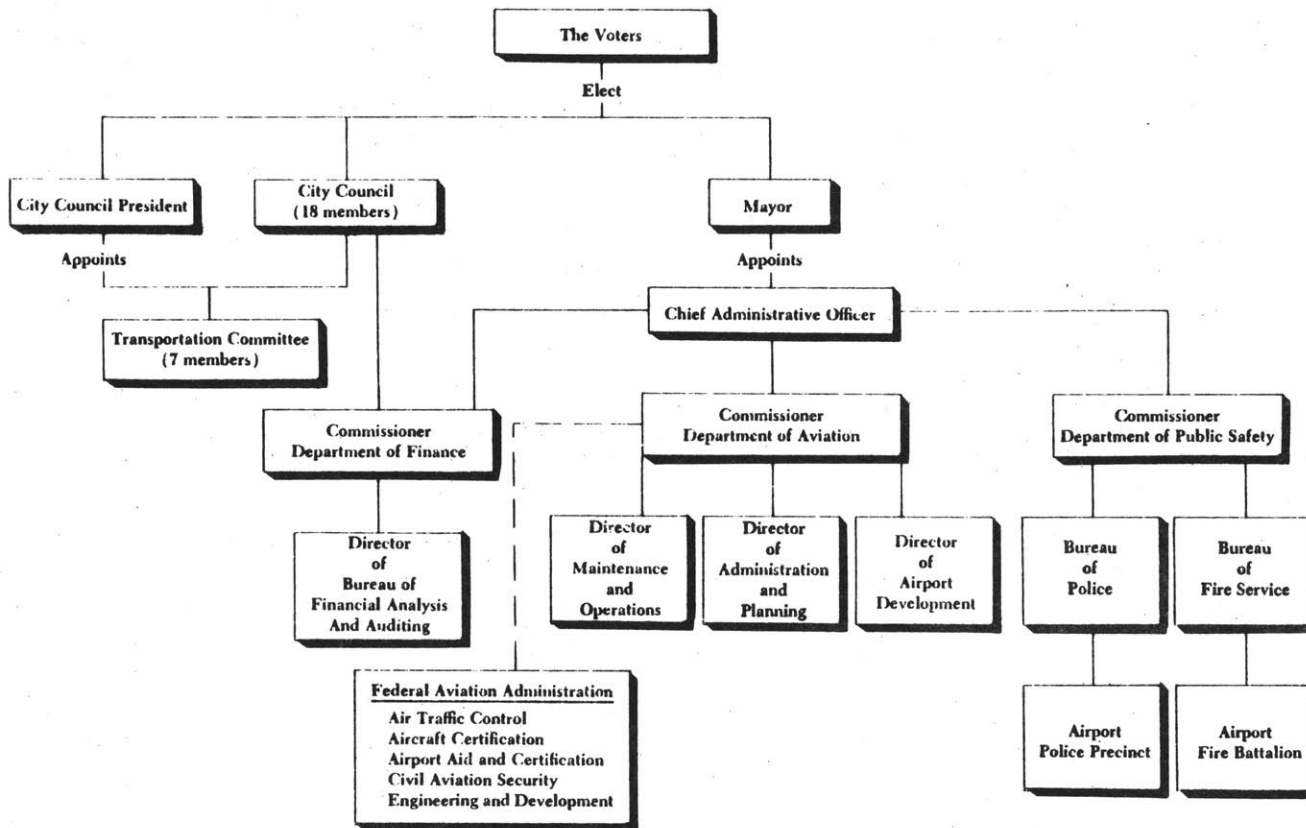


EXHIBIT 25

AIRLINES SERVING ATLANTA

Atlanta is served by twelve scheduled airlines: seven large carriers, and five regional carriers. The two categories listed in descending order by percentage of daily departures are:

	Large Trunk Airlines	% of Departures
DL	Delta Air Lines	40.3
EA	Eastern Airlines	40.2
UA	United Airlines	3.2
BI	Braniff Airways	0.9
NW	Northwest Orient Airlines	0.8
TW	Trans World Airlines	0.5
NC	North Central Airlines	0.5
	Regional Carriers	
SO	Southern Airways	8.3
PI	Piedmont Aviation	3.4
OZ	Ozark Airlines	0.5
FE	Florida Airlines & Air South	0.4
FL	Frontier Airlines	0.3

Source: Official Airline Guide, December 15-31, 1978.

Two carriers, Delta and Eastern, account for nearly 90% of the total passenger enplanements at the airport. Table 3 shows market shares for the major carriers at Atlanta in 1975.

Hartsfield's position as a major domestic passenger and cargo terminus, its favorable climate, and other factors have led to the development there of one of the primary maintenance and overhaul facilities, as well as training centers for the United States air transportation industry.

Delta maintains its corporate headquarters at Hartsfield. Long considered the most smoothly run and efficient of the major domestic airlines, Delta was named one of the nation's five best-managed companies in 1977. It set a record for a United States airline

TABLE 3
AIRLINE MARKET SHARES

Scheduled Domestic Airlines Serving
William B. Hartsfield Atlanta International Airport
1975

	ENPLANED PASSENGERS		AIRCRAFT DEPARTURES		LANDED WEIGHTS	
	NUMBER	PERCENT OF TOTAL	NUMBER	PERCENT OF TOTAL	(000LBS.)	PERCENT OF TOTAL
Delta	6,367,498	51.1%	82,497	41.8%	14,152,656	49.0%
Eastern	4,303,283	34.8	74,610	37.8	10,248,747	35.5
United	561,776	4.6	11,510	5.8	1,573,596	5.5
Southern	533,935	4.3	14,147	7.2	991,999	3.5
Piedmont	430,555	3.5	9,745	4.9	805,731	3.0
Northwest	111,023	0.9	3,587	1.8	840,922	3.0
TWA	52,988	0.4	1,427	0.7	119,282	0.5
Braniff	331	-	1	-	-	-

Source: City of Atlanta, "\$305,000,000 City of Atlanta Airport Facilities Revenue Bond Series 1977," June 12, 1977, Appendix A, p. A-7.

by earning \$92 million for the fiscal year ending June 30, 1977. Delta is well known as a good employer. This has kept labor unions from gaining much of a foothold. (Only Delta's pilots and flight dispatchers are unionized.) Being largely non-union, Delta has avoided many of the crippling strikes that have hit the industry, and has been able to keep labor costs low even though in many cases it pays above union scale.²⁴

Along with its corporate headquarters, Delta's principal maintenance and overhaul facilities are located at Hartsfield in a recently completed 197,000 square foot hangar and maintenance buildings. Delta provides direct air service to 64 cities from Atlanta, with 300 jet departures daily.²⁵ Total Delta employees in Atlanta number nearly 12,000, with an estimated annual payroll of over \$240 million.²⁶

Eastern Airlines, headquartered at Miami International Airport, maintains facilities for flight operations, customer services, marketing, and maintenance at Atlanta. Several years ago, the airline was in dire financial straits but the vigorous leadership of its new president, former astronaut Frank Borman, have brought better financial times and the Airline is now making a profit. Eastern is currently (as of January 1979) embroiled in a battle with Pan American World Airways and Texas International Airways for ownership of National Air Lines. Eastern has offered to purchase National for \$50 per share, \$9 per share better than the figure offered by Pan Am, which desperately needs National's lucrative and extensive domestic markets and flight equipment to offset losses suffered on its international routes. The Civil Aeronautics Board (CAB) has recently recommended that neither Pan Am nor Texas International be allowed to purchase National. National's Board of Directors, however, has appealed to the Airline's stockholders that they accept the offer from Pan Am instead of from Eastern. The issue is still to be decided.

Eastern, too, uses its base at Atlanta as a hub, serving 69 cities with 299 departures each day. The airline employs 5,000 people in the Atlanta area, with an annual payroll of \$109 million. Eastern's average stage length of 608 miles is the shortest among large trunk carriers. See Table 20 in Appendix B for more detailed information. Its route structure, which relies heavily on the hub and spoke type operation with Atlanta as the

²⁴"Flying High at Delta Air Lines," Dun's Review, December, 1977, p. 60.

²⁵This and following figures for airline employment are taken from the Bond Proposal document.

²⁶This and following figures for aircraft departures are taken from the Official Airline Guide, December 15, 1978.

principal collection and dispersion point, is largely responsible for this unusually short stage length.

Southern Airways is a regional carrier, currently representing 8.3% of the daily departures from Atlanta. Corporate headquarters, flight training center, and maintenance facilities are all located at Hartsfield. The Airline employs over 1,400 people at the airport with an annual payroll of over \$27.8 million. Serving 31 cities directly from Atlanta, Southern is currently third behind Delta and Eastern with 62 daily departures.

Recent talks of a merger between North Central and Southern (the new carrier is to be named Republic Airlines) have created a heated debate with Ozark Airlines. Ozark has appealed to the CAB to deny approval of the merger plans, claiming that the merger will be bad for competition and that service on some less lucrative routes to smaller communities will be eliminated.

United maintains flight operations, ticketing facilities, and cargo-handling operations at the Airport. The Airline's relatively small operation employs 325 people, with a payroll of \$7 million. United serves 14 cities directly from Atlanta with 24 departures daily.

Piedmont's Atlanta operation is similar in size to that of United. Its 29 daily flights service 22 cities directly. The airline uses B737s and YS1s on its Atlanta routes.

TWA has a city ticket office and a district sales office in addition to operational facilities at the airport, and employs approximately 42 people. The Airline has direct service to 2 cities via 4 departures daily.

Braniff, a newcomer (1977) to Atlanta, operates 7 daily direct flights from Atlanta to serve 4 cities.

Ozark, Florida Airlines/Air South, and Frontier Airlines each maintains very small operations, having four, three and two daily departures respectively from Atlanta.

Northwest Airlines uses Atlanta as a transfer point to serve its midwest-to-Florida routes and operates 6 departures each day.

National intermittently schedules flights to and from Atlanta. In September, 1978, National suspended its Atlanta operations.

Sabina, the Belgian carrier, is the only foreign Airline serving Atlanta. Specific information regarding international carriers and routes will be discussed later.

Domestic Routes

All the large trunk airlines which serve Atlanta have trans-continental and, in most cases, inter-continental route networks. The degree of importance their Atlanta flights plays in each airline's route structure varies, however. The following discussion seeks to describe this factor for each airline, concentrating on domestic markets.

Delta: Not only is Delta Airlines the largest single carrier at Atlanta, Atlanta is also the single most important city for Delta. The airline operates a "hub-and-spoke" route system, with the "hub" at Atlanta.

Delta is a southern airline. Until the August 1, 1972 merger between Delta and Northeast, Delta's routes extended only as far north as Chicago - but they covered the entire southern portion of the United States. Northeast primarily served the East coast - with flights between the Northeast and Florida. The merger added these lucrative vacation routes to Delta's schedules and helped the airline grow and mature.²⁷

Eastern: Eastern's domestic route structure is quite similar to Delta's. It is more extensive to the Northeast and Northwest, but has fewer transcontinental routes across the southern part of the country. Like Delta, Eastern uses Atlanta as the major "hub" in its system, with many of its flights connecting through this city.

United: United Airlines is America's largest carrier. It serves cities across the entire United States. Many of its routes, however, are concentrated in the Northeast and the West coast. Chicago and Cleveland are United's major "hubs." Service to the South only extends to the southeast, even here, it is not nearly as extensive as the service that either Delta or Eastern provides.

Of the other carriers serving Atlanta, only Southern has what can be called an extensive hub-and-spoke with Atlanta as the hub. Most of the other airlines are attracted to Atlanta because of the volume of traffic the airport experiences. They use Hartsfield as a point from which to pick up off-line transfer passengers, and it truly can be said that you can get nearly anywhere from Hartsfield.

Cities receiving direct service from Hartsfield number 144. (This includes non-stop, up to four stops, without changing aircraft.) A complete listing of these cities is found

²⁷ Delta Air Lines, "This is Delta," (pamphlet), 1978, p. 11.

in Table 17, Appendix A. Origin/Destination patterns of specificities are shown in Table 4. With many airlines applying for dormant routes to the Civil Aeronautics Board this number could become even larger. Already, evidence of airlines gaining new route awards to destinations they have never before served is quite apparent. Airports have had to "make room" for these new airlines which, in some cases, is a problem as noted earlier.

International Routes

At present, Delta and Eastern are the only two scheduled United States flag carriers supplying international service to and from Atlanta.

Scheduled international service from and to Atlanta is really only just beginning. Table 5 and a more complete survey in Table 18, Appendix A, show international arrivals and scheduled flights from 1969 to the present. Table 6 shows percent international traffic at Hartsfield as compared to that at other large hubs. At Atlanta in 1975, the volume of international traffic was only 0.8% of total passengers. This figure appears low when, knowing the high volumes of traffic annually processed through Hartsfield, it seems strange that along with being the South's "gateway" to the United States north of the Mason-Dixon Line, the Airport is not a "gateway" to Europe or South America. While the Southeast is different from the Northeast in ethnic makeup, a quality that to a great degree influences demand for international service, surely Atlanta's airport should generate enough demand to be able to support non-stops to Europe. In fact, this is true, though not readily apparent by reading the *Official Airline Guide*. Four charter airlines have for some time operated non-stop service from Atlanta to Europe. These airlines are: Overseas National Airways, Trans International, World Airways, and Capital International.

Until recently, Eastern Airlines was the only air carrier operating scheduled international service from the airport. Even their routes, however, were only routes within the Western Hemisphere. In June, 1978, both Delta and Sabena (the Belgian national carrier) inaugurated trans-Atlantic service to Atlanta. Exhibit 26 shows international routes from Atlanta in September 1978.

Delta uses daily L1011 flights to London's Gatwick Airport. The route has been so profitable that the Airline is actively seeking to expand its international network via a route to Frankfurt. Delta has also been awarded a route to San Juan via Miami. While this route is not yet in operation, Delta intends to forego the stop in Miami and supply non-stop service from Atlanta to San Juan. This seems reasonable, since existing service

TABLE 4
ORIGIN-DESTINATION PATTERNS OF
DOMESTIC AIRLINE PASSENGER TRAFFIC
William B. Hartsfield Atlanta International Airport
1976

CITY OF ORIGIN/ DESTINATION	ANNUAL PASSENGERS		DAILY AIRCRAFT ARRIVALS	
	NUMBER	PERCENT OF TOTAL	NUMBER	PERCENT OF TOTAL
New York	561,830	9.1%	29	5.0%
Chicago	250,380	4.1	17	2.9
Washington, D.C.....	251,130	4.1	26	4.5
Miami	244,450	4.0	16	2.7
Tampa	178,630	2.9	18	3.1
Philadelphia	155,490	2.5	14	2.4
Dallas/Fort Worth	154,780	2.5	13	2.2
Jacksonville	137,600	2.2	15	2.6
Memphis	128,870	2.2	13	2.2
Los Angeles	128,100	2.1	7	1.2
Orlando	123,270	2.0	14	2.4
New Orleans	116,570	1.9	12	2.1
Detroit	116,560	1.9	3	0.5
Charlotte	109,490	1.8	14	2.4
Fort Lauderdale	107,460	1.7	14	2.4
Houston	107,200	1.7	13	2.2
Boston	104,230	1.7	5	0.9
Birmingham	94,060	1.5	17	2.9
San Francisco	89,030	1.4	6	1.0
Savannah	89,020	1.4	3	0.5
Baltimore	83,848	1.4	9	1.5
Cleveland	78,560	1.3	7	1.2
Raleigh/Durham	78,080	1.3	5	0.9
St. Louis	75,350	1.2	9	1.5
Pittsburgh	73,230	1.2	8	1.4
Columbia, S.C.	68,230	1.1	7	1.2
Louisville	67,440	1.1	6	1.0
Subtotal	3,772,880	61.2	320	54.8
Other Cities	2,396,940	38.8	264	45.2
Total	6,169,820	100.0%	584	100.0%

Source: City of Atlanta, "\$305,000,000 City of Atlanta Airport Facilities Revenue Bond Series 1977," June 12, 1977, Appendix A, p. A-8.

TABLE 5
SCHEDULED INTERNATIONAL
FLIGHTS TO ATLANTA

YEAR	FLIGHTS			AVAILABLE SEATS		
	TOTAL	PER MONTH	DAILY	TOTAL	PER MONTH	DAILY
1969	2	-	-	280	140	-
1970	3	-	-	390	195	-
1971	62	15.5	-	8,480	2,827	94
1972	209	52	1.7	28,410	7,102	237
1973	307	77	2.6	40,600	10,150	338
1974*	194	65	2.2	25,340	8,447	282
1975	272	68	2.3	35,200	8,805	294
1976	2,228	557	18.6	294,610	73,653	2,445
1977	1,370	342	11.4	258,430	64,607	2,154
1978**	1,245	415	13.8	221,270	73,757	2,459

* Statistics for September Missing

** Statistics through September

TABLE 6
COMPARISON OF NUMBERS OF ENPLANED
PASSENGERS AND AIRCRAFT OPERATIONS AT
SELECTED UNITED STATES LARGE HUB AIRPORTS*

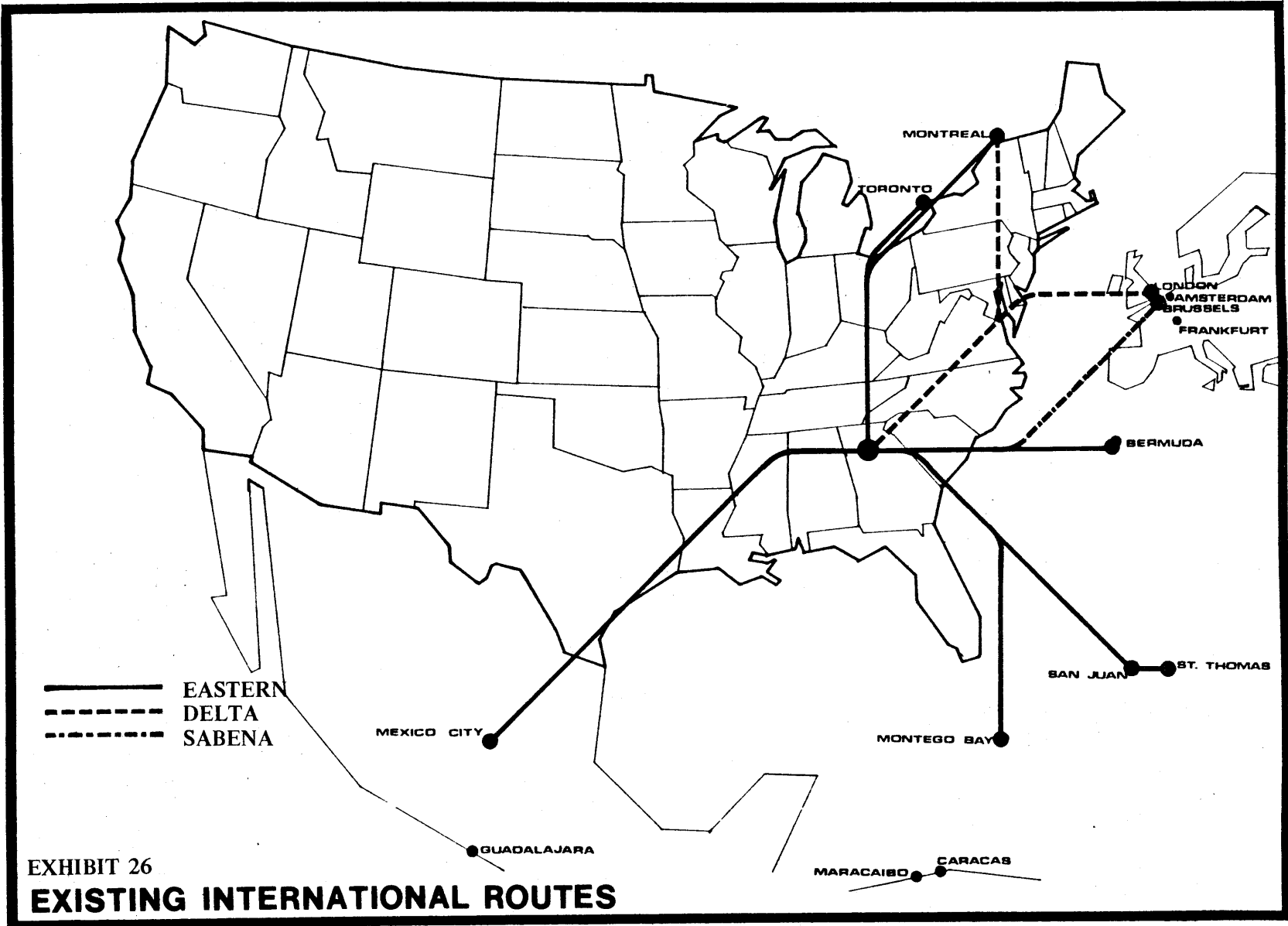
AIRPORT/CITY	ENPLANED PASSENGERS			OPERATIONS
	TOTAL	INTERNATIONAL	% INTERNATIONAL	
ORD** Chicago	18,963,000	1,000,000	5.3	686,000
ATL Atlanta	12,568,000	105,600	0.8	467,200
LAX Los Angeles	11,867,000	1,246,000	10.5	453,000
JFK** New York	10,118,000	5,166,000	51.1	309,500
DFW Dallas-Ft. Worth	7,341,000	143,000	2.0	345,000
DCA Washington, D.C.	5,642,000	0	0.0	309,800
BOS* Boston	5,237,000	682,000	13.0	327,000

* Based on 1972 Data.

**Based on 1974 Data.

All others based on 1975 Data.

Source: U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Report on Airport Capacity, Large HUB Airports in the United States, May, 1977, by Daniel E. Gentry, Jack D. Howell, Nawal K. Taneja, (Washington, D.C.: U.S. Government Printing Office, 1977), pp. 4-4, 4-31, 4-77, 4-134, 4-281, 4-448, 4-696.



by Eastern and American, the only two United States carriers presently serving Puerto Rico from Miami and New York to San Juan are very over-crowded. Delta's entrance into the San-Juan Atlanta market would almost certainly be lucrative, since the Airline could expect to pick up considerable connecting traffic through the Atlanta hub.

Sabena currently flies a B707 four times each week from Atlanta to Brussels and will change gauge of their aircraft to a B747 on April 1, 1979. Sabena eventually intends to supply service to Mexico through Atlanta.

Two other European carriers are soon to be flying to Atlanta. KLM will start service April 1, 1979 from Amsterdam, and Lufthansa is seeking a Frankfurt-to-Atlanta route award to begin service in 1980.

Two Mexican carriers, Aeromexico and Mexicana, have been awarded routes to Atlanta. Aeromexico seems not to be interested in supplying a service but Mexicana intends to initiate service in April or June of 1979 to Mexico City and Guadalajara. In addition, many South American carriers have found the congestion at Miami to be too great; and one, Aerocondor, currently using Miami, is actively seeking rights to Atlanta.²⁸ If all these above routes are awarded, the international carriers serving Atlanta will be: KLM, Sabena, Lufthansa, Aerocondor, and Mexicana. See Table 7.

The airport management at Atlanta is quite pleased with the new international service at their airport and are encouraging foreign carriers to seek rights. Exhibit 27 depicts the various international destinations described in Table 7.

Existing international arrivals and departures occur at three different places at the airport, as can be seen in Exhibit 24. Eastern has its own international arrivals area in its section of the terminal building. Delta has recently constructed an addition to Rotunda "E" which serves both Delta's and Sabena's international operations. The charter carriers are currently served by the Lockheed Air Terminal.

²⁸ Telephone conversation between author and Mr. John Braden, Public Relations Representative, Hartsfield, November 16, 1978.

**TABLE 7
PRESENT AND FUTURE
INTERNATIONAL CARRIERS AT ATLANTA**

CARRIER	DESTINATION	START SERVICE
Eastern	Mexico	1970
	Canada	1969
	Caribbean	1972
Delta	London	1978
	Frankfurt	-
	San Juan	-
Sabena	Brussels	1978
	Mexico	-
KLM	Amsterdam	1979
Lufthansa	Frankfurt	1980
Aerocondor	Caracas	-
Mexicana	Mexico City	1979
	Guadalajara	1979

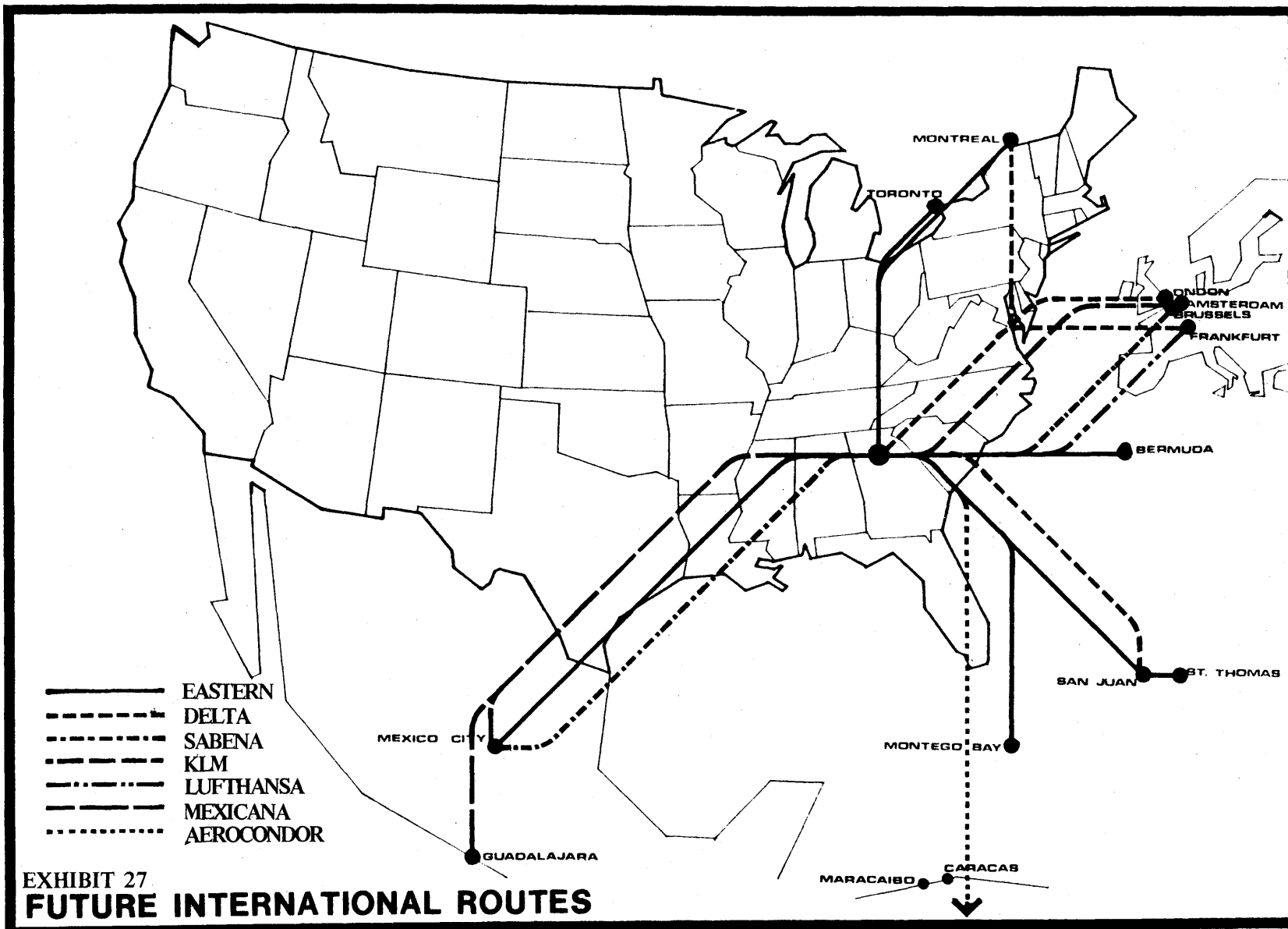


EXHIBIT 27
FUTURE INTERNATIONAL ROUTES

AIRCRAFT

Current

The fleet makeup of the various airlines using an airport is determined by each airline's route structure, demand between city-pair markets, and stage length. Most large airlines own four or even more types of aircraft to accommodate the different traffic patterns which their networks demand. An efficiently run airline continually upgrades its fleet, buying new aircraft and selling old aircraft or those it finds unsuitable for its ever-changing requirements. Fare deregulation by the Civil Aeronautics Board (CAB) is its new policy to encourage more competition among airlines by awarding routes to airlines not previously authorized to serve the route. Some routes are called "dormant." Sole authority to use them had been given to a particular airline which, for its own reasons, had decided the route was not economical, and therefore did not serve that particular city-pair market. Until recently, the CAB had been rather conservative in granting authority to competitors to enter markets. A re-thinking of these conservative policies has occurred, however, in the being of Alfred Kahn and his successor, Mr. Cohen, two appointees of President Carter who also shares their ideas. With fare deregulation, many more people are utilizing air transportation to reach their destinations.

Since deregulation, the mode that has suffered most in giving up patrons to aviation is the automobile. For environmental and energy-conscious reasons, this is really quite good. Private vehicles pollute more and use more fuel per passenger-mile than do jet aircraft. Air travel is also safer.

A certain degree of chaos has been injected in the aviation industry, however; the wide variety of discount fares offered by the different airlines serving a market is extremely difficult for a prospective passenger to understand. Furthermore, airlines like to try to operate at a network-wide load factor (LF) of 65%. This desire leads airlines to put available aircraft into the hubs where they can get these high load factors. By doing this, they forsake the lower-volume cities which formerly may have been given non-stop city-to-city service. This action also accentuates the hub growth syndrome which means that traffic grows at a greater annual percentage at the hub than anywhere else. Further, the greater the percentage of transfer passengers, the greater the ratio of annual traffic growth.²⁹

²⁹ DeNeufville, Airport Systems Planning, p. 78.

With more demand on their markets brought on by the new economic feasibility of air travel to a wider section of the public, load factors, especially on routes to vacation centers, have continued to climb. See Tables 21 and 22 and Exhibits 43 and 44 in Appendix B. The arrival of new aircraft to serve these bulging passenger lists has been slow. Again, an unforeseen change (deregulation) has caused problems of overcrowding at airports.

The award of previously dormant routes is envisioned as a means of bringing new vitality into the airline industry. Two problems have arisen, however, which have become a detriment to the system. The problem of overcrowding in the terminal was discussed earlier. An outcropping of this problem is the fact that many airports have no more gate space available for the new airlines which have started service to their airport.

Airports must double up on gate usage (two airlines must use the same gate). In theory, this situation should be of minor consequence but some airlines in their exuberance to enter a new market have scheduled their arrival times to suit their own convenience, not taking into account the scheduling procedure of the already-established airline with which they must share the gate. The result often is that the two aircraft arrive at very nearly the same time and one must wait, fully loaded, with passengers anxious to disembark, on the ramp while the other aircraft unloads its passengers, receives servicing, and takes on a new load. This lack of forethought is inconvenient for everyone - passengers and airlines alike. The situation could be remedied if "newcomer" airlines were required by the airport manager to adjust their schedules around those of the "established" airline until more space is made available.

The second problem brought on by these "dormant" route awards has been that many airlines which receive the new route awards must pull aircraft off some of their other, less profitable routes to serve the new market. Often, they are the sole operator serving these markets, and when service is discontinued, passengers are faced either with finding an alternate mode of reaching their destination or taking a "round-about" route by air, involving transfers when there had once been non-stop service. No final conclusions about the effects of deregulation can be made at this time, since the situation is still in a state of flux. Several years will be necessary for things to settle down and for airlines, planners, passengers, and government agencies to gain a better perspective and hopefully, better service.

Already, the deregulation blush of the low fare bonanza for the public bragged about by Kahn is beginning to vanish under the excuse of rising fuel costs which is, of course, true enough. But if the fuel problem continues, it will bring poorer service at a higher price.

Atlanta, because of its position as the nation's greatest transfer hub and because of the tremendous daily volume of passengers processed, is quite attractive to airlines which, if allowed in, are virtually guaranteed a lucrative market.

Airline fleets are in a nearly constant state of change, never more so than at present. Coinciding with the various CAB deregulatory procedures comes a new generation of aircraft that manufacturers are touting as being more energy-efficient than those in the current fleet. These are the two-hundred-passenger, wide-bodied, medium-range aircraft, most notably the B767 and A300B. These aircraft could replace many of the smaller (DC-9 and B737) jet aircraft in certain high-density medium-distance routes. At Atlanta, these routes could include: Atlanta - Chicago, Atlanta - New York, Atlanta - Boston, Atlanta - Miami. Current B727 service to these markets could also be affected by these newer aircraft.

Judicious use of the new aircraft could cause a decrease in the demand for gates by airlines during the current peak-hour traffic periods at the airport. Table 8 shows current gate utilization characteristics by hour and type of aircraft at Atlanta for December 15 - 31, 1978. A more complete schedule is shown in Table 19, Appendix A, which distinguishes this hourly gate utilization further by quantifying each airline's individual gate usage by aircraft type.

The most current listing of the existing fleet makeup as well as future aircraft orders for each major airline presently serving Atlanta is shown in Table 24, Appendix B. Most airlines do not use all the different types of aircraft in their fleets for their Atlanta service, however. Table 9 shows what type of aircraft they currently operate from Atlanta.

Nearly 84 percent of operations involve DC9s, B737s, and B727s, aircraft in the 88- to 137-seat capacity range. Delta and Eastern together account for 70% of the DC9s and 95.5% of the B727s which operate from Atlanta. (Delta currently uses 75 DC9s and 165 B727s each day. Eastern uses 142 DC9s and 131 B727s.)

TABLE 8
 HOURLY DEPARTURES BY
 AIRCRAFT TYPE
 DECEMBER, 1978

	PROPELLER	DC9 & 737	727	DC8	WIDE-BODIED	TOTAL
12 - 1 am		15	29	3	9	56
1 - 2						
2 - 3						
3 - 4						
4 - 5						
5 - 6		4	2			6
6 - 7	5	14	21	3	7	50
7 - 8		3	1			4
8 - 9	2	4	3			9
9 - 10		20	13		2	35
10 - 11	2	28	36	2	11	79
11 - 12	6	10	6		2	24
12 - 1 pm	1	30	22	2	5	60
1 - 2		14	12			26
2 - 3	3	20	25	1	4	53
3 - 4		26	7			33
4 - 5	4	12	19	4	7	46
5 - 6		28	8		4	40
6 - 7	3	24	38	3	4	72
7 - 8	1	7	4			12
8 - 9	4	23	39	4	11	81
9 - 10		9	5			14
10 - 11		14	11		1	26
11 - 12		10	8			18
TOTAL	31	314	310	22	67	744
PERCENT	4.2	42.2	41.2	3.0	9.0	100

SOURCE: Official Airline Guide, December 15, 1978.

**TABLE 9
AIRCRAFT USED IN
ATLANTA MARKETS**

	Delta	Eastern	Southern	Piedmont	Northwest	Braniff	Ozark	TWA	United	North Central	Frontier	Florida Airlines/ Air South
DC3	X											X
DC8	X											
DC9	X	X	X			X	X	X		X		
DC10					X							
727	X	X		X	X	X						
737				X					X		X	
L1011	X	X										
A300		X										
MR4												X
SWM			X									
YS1				X								

Source: Official Airline Guide, December 15, 1978.

Both Airlines have recently placed orders for the 200-seat size wide-bodied aircraft. Delta ordered 20 B767-300 aircraft on November 15, 1978 and optioned on 22 more. Deliveries are expected to begin in late 1982.³⁰

Eastern became the first United States carrier to purchase A300Bs with an order for 19 placed in late 1977 to join the four it currently operates. Eastern was thinking of trading some of the L1011s it has on order in favor of the "Airbus" purchase. The airline has been known to have too many small airplanes and too many large airplanes for its routes. Eastern has also placed orders (late 1978) for 21 B757s and taken options on 24 more.³¹ Boeing's newest, the 757, is a narrow-bodied aircraft. It is a stretched version of the B727 but its two Rolls Royce engines will allow the new aircraft to move 180 people at 40% less fuel per seat than the B727. Deliveries are expected to begin in 1982.

The possible effects the purchase of these aircraft by Atlanta's two major carriers will have on the airport are positive. The use by the carriers of wide-bodied aircraft and the B757 will mean that more passengers can be moved with the same number (or fewer) operations. This will delay the time when the airfield runway/taxiway configuration reaches capacity and will also diminish the number of gates needed during any particular hour to move a given number of passengers. This is, of course, assuming that the airline involved will continue to plan their flight schedules (arrival and departure times) in a manner similar to that which currently exists - where operations are more or less spread out during the course of the day. Exhibit 28 shows arrival/departure distributions at Hartsfield for recent years. It can be seen that the number of arrivals and departures has increased over the years. Exhibit 29 compares Hartsfield's distribution pattern to that of three other airports. Gate lounge areas will have to be enlarged, however, to meet the "batching" conditions of larger numbers of passengers enplaning/deplaning at the same time.

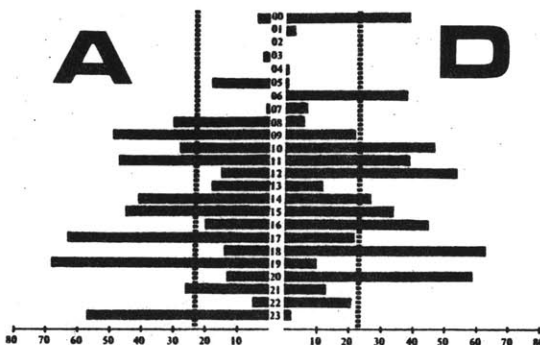
To some extent, the timely arrival of this new generation of wide-bodied aircraft may be the savior of the air transportation industry. They come at a time of increased concern over the shortage of operational capacity (runways) in the National Air Transportation System. Use of the newer aircraft to move the same (or greater) number of passengers with a decrease in the number of operations is much more economical than

³⁰ Aviation Daily, November 16, 1978, p. 82.

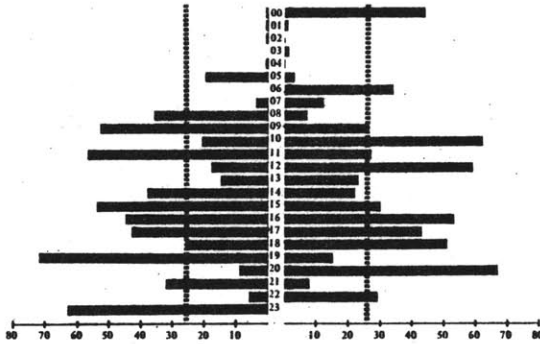
³¹ "Boeing Launches 757," Air Transport World, September, 1978, p. 8.

A I D

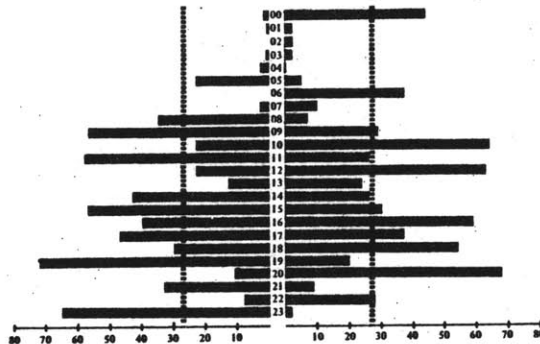
1974



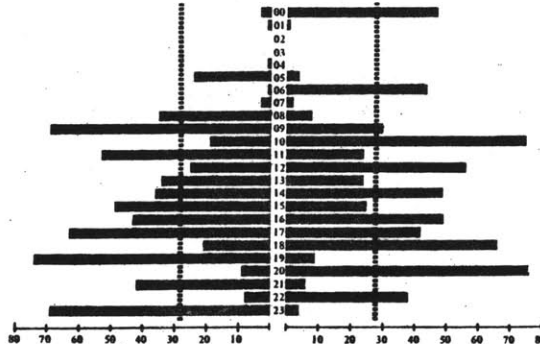
1976



1977



1978

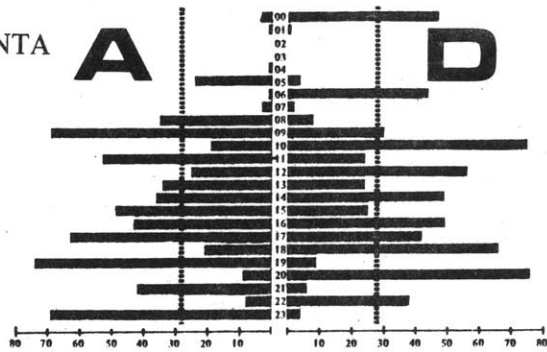


ATLANTA ARRIVAL/DEPARTURE DISTRIBUTIONS

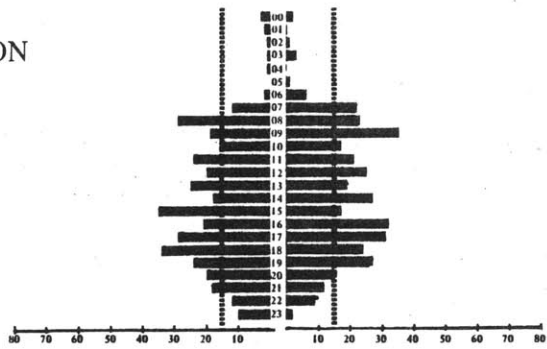
EXHIBIT 28

Source: U.S. Department of Transportation, Federal Aviation Administration, Profiles of Scheduled Air Carrier Departure and Arrival Operations for Top 100 U.S. Airports, November 1974, 1976, 1977, 1978.

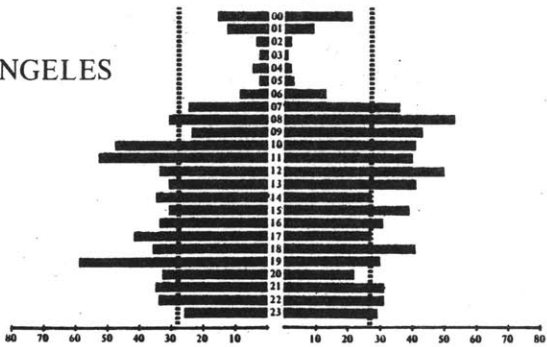
ATLANTA



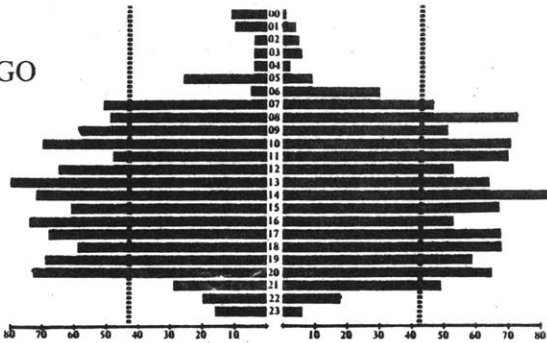
BOSTON



LOS ANGELES



CHICAGO



**COMPARISON OF
ARRIVAL/DEPARTURE DISTRIBUTIONS**

EXHIBIT 29

Source: U.S. Department of Transportation, Federal Aviation Administration, Profiles of Scheduled Air Carrier Passenger Traffic for Top 100 U.S. Airports, August, 1977.

building new airports to meet the added demand. An extra bonus is energy savings and lower direct operating costs to the airlines.

Still, though, planners must allow for flexibility in their terminal designs. Advances in aircraft technology must be able to be easily assimilated into the airport terminal scheme. New, more efficient aircraft are too important to the future of the industry and the nation's transportation system to preclude their use through nearsighted planning.

HISTORICAL AND FORECASTED TRAFFIC

Earlier in this thesis, a description of prerequisites and methods of forecasting was made. To reiterate: a reliable forecast of future aviation demand must be available from which to determine future facility requirements.

In the case of Atlanta, no less than four aviation forecasts have been made within the past eight years. All are mentioned here to show how forecasts can differ one from the other and to emphasize the necessity of using the most recent and accurate data available. Advances in computer technology and statistical modeling techniques enable forecasters to make much more reliable projections than those performed several years ago.

The four forecasts for Atlanta were evaluated and additional pertinent data was derived from them by the author given the following assumptions:

General Assumptions

Given all the above criteria, the following general assumptions were made as a basis for forecasting air traffic activity as it applies to Atlanta:

- Forecast period is 1980 through 1990. Variables associated with consideration of a long-range forecast are not definable at this time and could be too unreliable.
- The airlines serving Atlanta will continue to provide capacity to meet increases in market demand for passenger traffic.
- No governmental entities will impose restrictions which would constrain air carrier traffic growth at the airport.
- General Aviation operations at Hartsfield will remain constant or decline as a result of governmental policies and attempts to use available runway capacity for air carrier aircraft.
- The relationship between consumer prices and air fares will remain fairly constant during the forecast period.
- Availability of aircraft fuel will not be a significantly limiting factor in the ability of the airlines to provide adequate levels of service at the Airport.³²

³² Even with the present fuel shortage, it is assumed that if airlines decide to discontinue service for lack of fuel, they will do so on their less lucrative routes, not on those routes involving Atlanta.

Enplaned Passengers

- Population trends for the Southeast show that population growth (one of the prime determinates for predicting airline-passenger traffic) in the Atlanta Region is increasing at a faster rate than the national average. This implies that passenger enplanements at Hartsfield will grow at a greater rate than the national average.
- Hartsfield's role as the prime transfer hub of the Southeast will continue to an increasing extent in the future.

Scheduled Aircraft Departures

- The fleet makeup of the various airlines serving Atlanta will change over the forecast period. See Appendix B. It is assumed that by 1985 one-half of Delta's DC8s will either be sold or used solely for charter service and that one-half of the new-generation large aircraft currently on order will be available for the various airlines fleets. For 1990, it is assumed that all aircraft presently on order will be delivered.
- The average number of enplaned passengers per departure would gradually increase over the forecast period.

The forecasts used here are:

R. Dixon Speas Associates for the *Airport Layout Plan Report*, 1971.

FAA *Terminal Area Forecast 1977-1987*.

FAA *Terminal Area Forecast 1978-1988*.

FAA *Special Forecast for Atlanta*, August, 1978.

Air Carrier

Enplaned Passengers

Table 10 and Exhibit 30 show historic annual enplanements and those predicted for various future years for Atlanta by the above forecasts. There is a considerable range in the numbers quoted in these different reports. The FAA *Special Forecast, 1978* will be utilized in this thesis as the basis for determining terminal area requirements. Reasons for this decision are that it offers the most current data available. This data follows quite closely to the previous FAA Forecast (1977). It is presumed that the additional effort

TABLE 10
ANNUAL ENPLANED
PASSENGER FORECAST

1965 3,786,127
 1966 4,660,871
 1967 5,801,589
 1968 6,728,319
 1969 7,670,293
 1970 8,131,489
 1971 9,045,167
 1972 10,560,970
 1973 11,602,604
 1974 12,699,179
 1975 12,568,689
 1976
 1977
 1978
 1979
 1980
 1981
 1982
 1983
 1984
 1985
 1986
 1987
 1988
 1989
 1990
 1991
 1992
 1993
 1994
 1995
 1996
 1997
 1998
 1999
 2000

1. *Airport Layout Plan Report, 1971*
2. *FAA Terminal Area Forecast 1977-1987*
3. *FAA Terminal Area Forecast 1978-1988*
4. *FAA Special Forecast for Atlanta, 1978*

	1	2	3	4
1977		13,862,000		14,978,000
1978	18,000,000	14,758,000	15,176,000	
1979		15,540,000	16,549,000	
1980			17,982,000	18,574,000
1981				
1982		18,244,000		
1983	26,000,000		21,949,000	
1984				
1985				25,134,000
1986				
1987		24,776,000		
1988	35,600,000		29,136,000	
1989				
1990				33,403,000
1991				
1992				
1993	48,000,000			
1994				
1995				
1996				
1997				
1998				
1999				
2000	68,000,000			

which FAA took in the preparation of this *Special Forecast* document is expressed in increased accuracy.

Air Carrier Operations

Historical and projected annual aircraft operations for Hartsfield are shown in Table 11 and Exhibit 31. Again, a range in the data is apparent. The importance of data is more directly applicable to the layout and number of runways required at the airport than it is to the design of the terminal building. Of interest here, however, is a graph showing the historical ratio of enplaned passengers per departure compared to those same ratios obtained from the FAA *Special Forecast*. Exhibit 32 shows this relationship over time and reflects the trend toward larger aircraft and higher load factors.

Peak Hour Passengers

Airport terminals are usually designed to handle peak conditions. Every airport experiences a greater passenger load during certain seasons (holidays and summer). Even during the course of a day peaks occur in the morning and in the afternoon. Interestingly, these daily peaks most nearly coincide with the beginning and end of the business day and are caused by the airlines scheduling flights based on this demand from business travelers. Another cause of peaking is the timing consideration in the scheduling of international flights. At most East Coast airports Trans-Atlantic flights arrive and depart in the late afternoon. In Europe, these flights arrive and depart in the morning. Flight duration, time zone changes and most efficient aircraft utilization require this. Until a practical descendant of the Concorde is introduced which will lessen the six- to eight-hour flight time necessary in crossing the Atlantic and be affordable for most people, the existing international peaking conditions will continue.

At Atlanta, the concern is not with peaks in international traffic because the volume of international flight is such a small percentage of the total. Also, peaks are somewhat less apparent at Hartsfield than at other large airports because Hartsfield is so busy so much of the time, peaks are not as perceptible as they are at a less busy airport. This means that at highly utilized airports, passenger volumes tend to be more spread out over the course of the flying day - they are uniformly large.

TABLE 11

AIR CARRIER OPERATIONS
FORECAST

YEAR		1	2	3	4
1965	208,802				
1966	223,074				
1967	273,904				
1968	312,912				
1969	367,496				
1970	374,453				
1971	391,870				
1972	414,717				
1973	441,613				
1974	411,365				
1975	414,023				
1976					
1977			461,000		455,300
1978		513,600	475,000	426,000	
1979			493,000	432,000	
1980				438,000	504,620
1981					
1982			551,000		
1983		591,000		465,000	
1984					
1985					572,560
1986					
1987			645,000		
1988		683,800		536,000	
1989					
1990					632,690
1991					
1992					
1993		776,000			
1994					
1995					
1996					
1997					
1998					
1999					
2000		920,000			

1. *Airport Layout Plan Report, 1971*
2. *FAA Terminal Area Forecast 1977-1987*
3. *FAA Terminal Area Forecast 1978-1988*
4. *FAA Special Forecast for Atlanta, 1978*

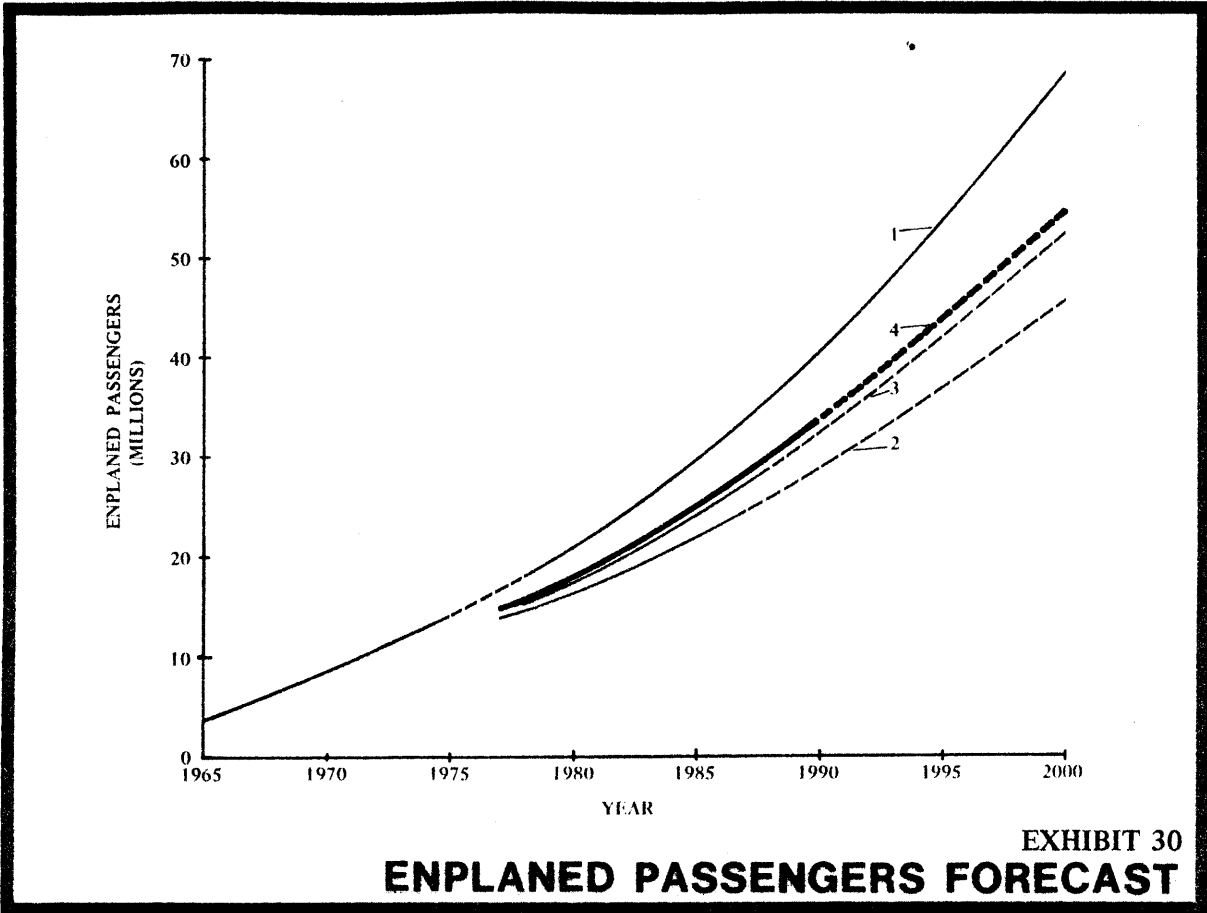


EXHIBIT 30

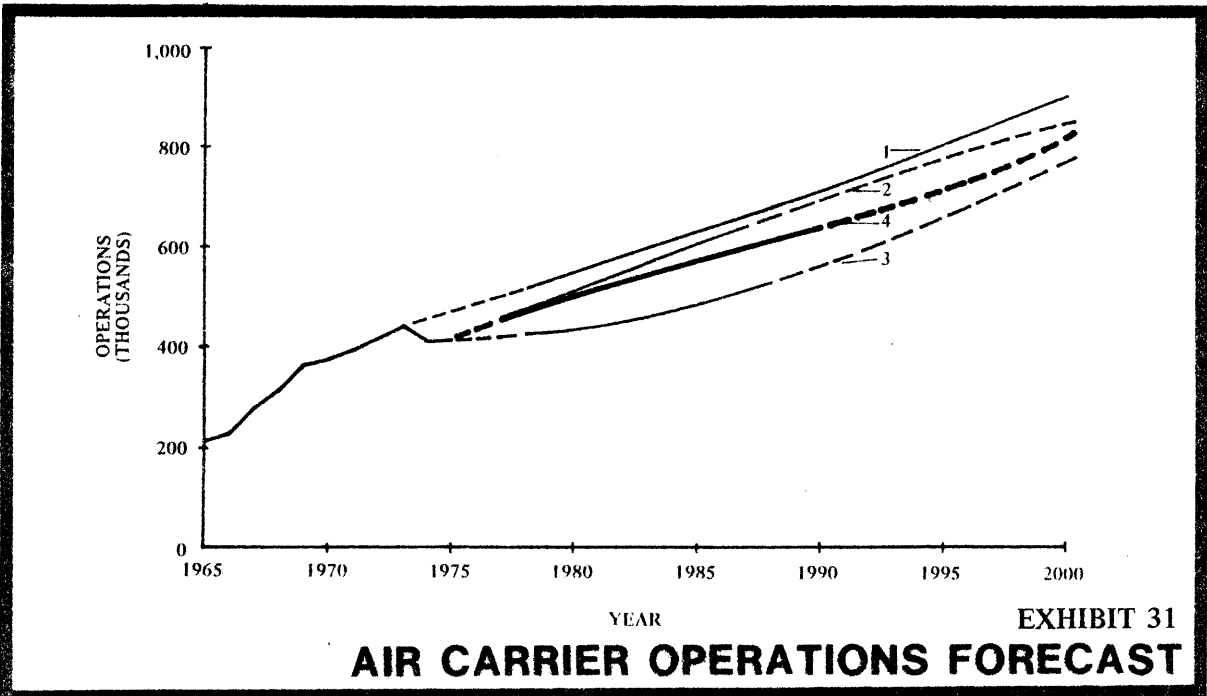


EXHIBIT 31

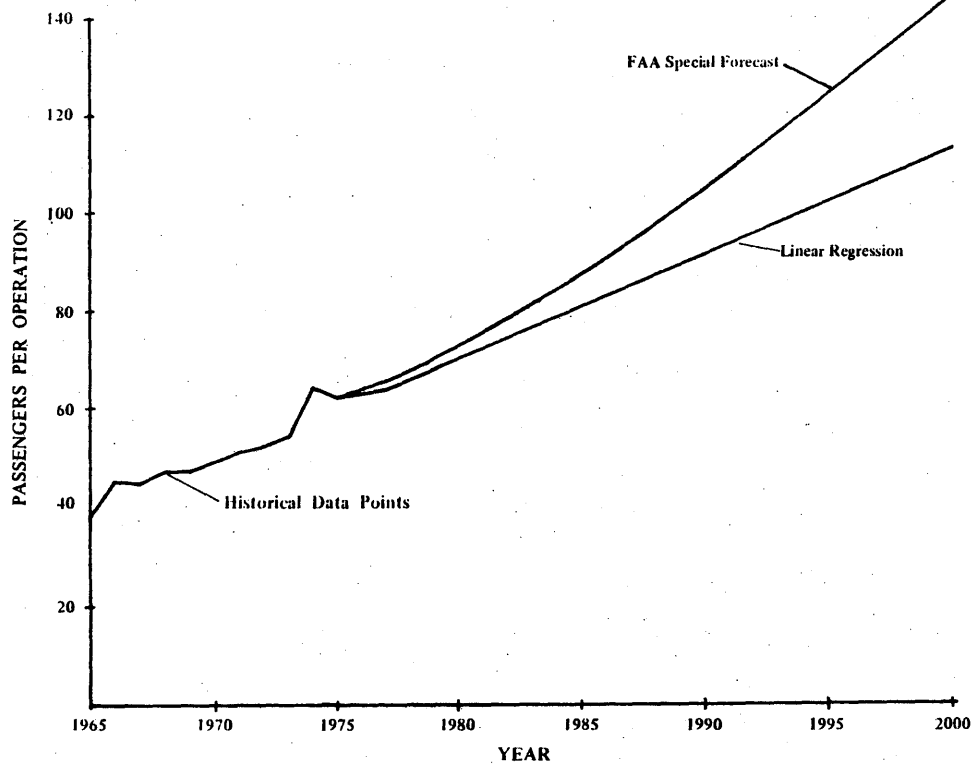


EXHIBIT 32

ENPLANED PASSENGERS PER DEPARTURE

Typical Peak Hour Passengers (TPHP) is the number of passengers expected during the “peak” (busiest) hour of an average day of the “peak month.” The “peak month” usually occurs during the summer when most people take vacation. It is the month during which the airport in question experiences the greatest amount of activity. The “peak hour” of an average day of that month is that hour during which the largest number of aircraft operations occur. The rationale behind this methodology is to design the terminal facilities to accommodate the average large volume of passengers comfortably. If the terminal were built to process the *largest expected* volume of passengers, it would be vastly under-used for a good part of the year. The conventional technique allows for seasonal peaking (summer and Christmastime) and permits greater economy of design. Surely, there may be times in which overcrowding occurs, but the duration of these times is so minor compared to the operation of the terminal during the remainder of the year that they are overlooked.

A formula has been developed from which one can predict the Typical Peak Hour Passengers (TPHP) given total annual passengers. It is contained in Table 12.

Atlanta’s annual traffic is so large that it greatly exceeds the largest value on the Table. To use the Table, it was therefore necessary to draw a curve from which to interpolate values for future years at Atlanta. The graph is semi-logarithmic, with percentages as the ordinate and the log of the number of annual enplanements as the abscissa, and is shown as Exhibit 33. When one uses the curve shown in that Exhibit and multiplies the expected annual passengers by the corresponding percentage, one gets the expected number of peak hour passengers.

TPHP Forecasts are shown in Table 13 and Exhibit 34. These results are reasonable and can be checked by the following computation:

1. Total annual passengers in 1990 = 33,403,000
2. Peak month passengers (approximately 10% of total) = 3,340,300
3. Average day, peak month passengers = $\frac{3,340,300}{30} = 111,343$
4. There are about 6 peak hours each day at Atlanta. See Exhibit 35.

therefore, $\frac{111,343}{6} = 18,557$

TABLE 12
TYPICAL PEAK HOUR PASSENGERS
AS A PERCENT OF
ANNUAL PASSENGERS

Total Annual Passengers			TPHP As a Percent of Annual
20,000,000	and	over	.030
10,000,000	to	19,999,999	.035
1,000,000	to	9,999,999	.040
500,000	to	999,999	.050
100,000	to	499,999	.065
under		100,000	.120

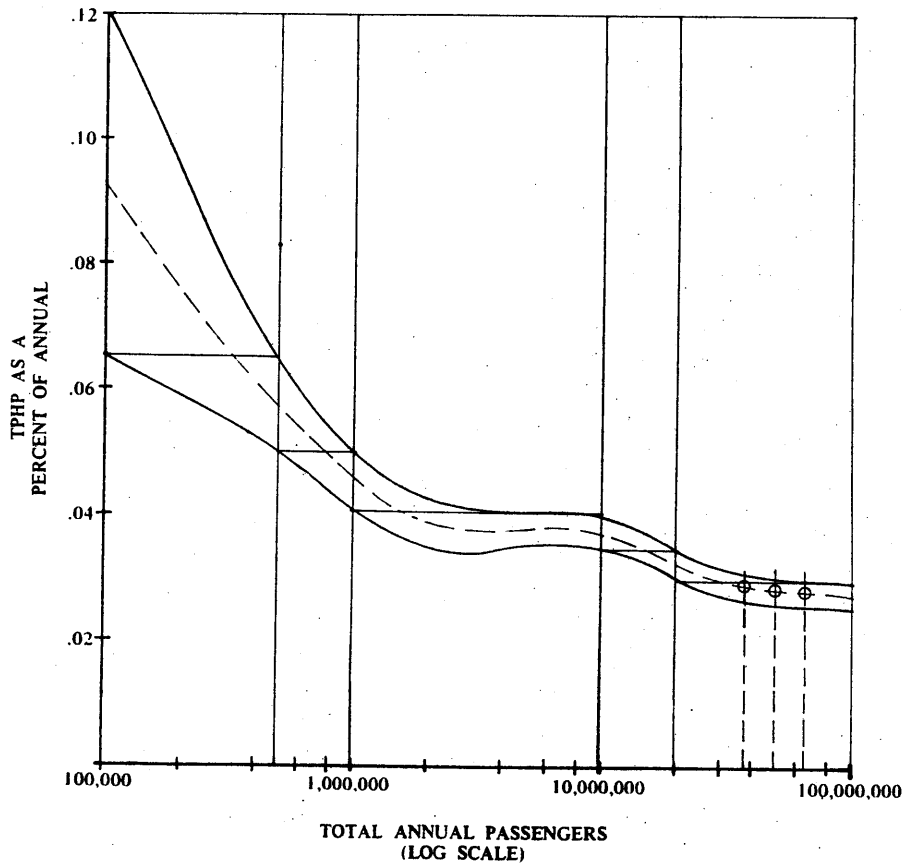


EXHIBIT 33

TPHP AS A PERCENT OF ANNUAL PASSENGERS

TABLE 13
TPHP FORECAST

Year	Annual Enplanements				Annual Passengers		Factor (%)		TPHP
1965	3,786,000	x	2	=	7,572,254	x	.0365	=	2,763
1966	4,660,871	x	2	=	9,321,742	x	.0365	=	3,402
1967	5,801,589	x	2	=	11,603,178	x	.0360	=	4,177
1968	6,728,319	x	2	=	13,456,638	x	.0355	=	4,776
1969	7,670,293	x	2	=	15,340,586	x	.0350	=	5,369
1970	8,131,489	x	2	=	16,262,978	x	.0340	=	5,529
1971	9,045,167	x	2	=	18,090,334	x	.0335	=	6,060
1972	10,560,970	x	2	=	21,121,940	x	.0320	=	6,758
1973	11,602,604	x	2	=	23,205,208	x	.0320	=	7,425
1974	12,699,179	x	2	=	25,398,358	x	.0310	=	7,874
1975	12,568,689	x	2	=	25,137,378	x	.0310	=	7,793
1976									
1977	14,978,000	x	2	=	29,956,000	x	.0305	=	9,136
1978									
1979									
1980	18,574,000	x	2	=	37,148,000	x	.0295	=	10,959
1985	25,134,000	x	2	=	50,268,000	x	.0285	=	14,326
1990	33,403,000	x	2	=	66,806,000	x	.0280	=	18,706

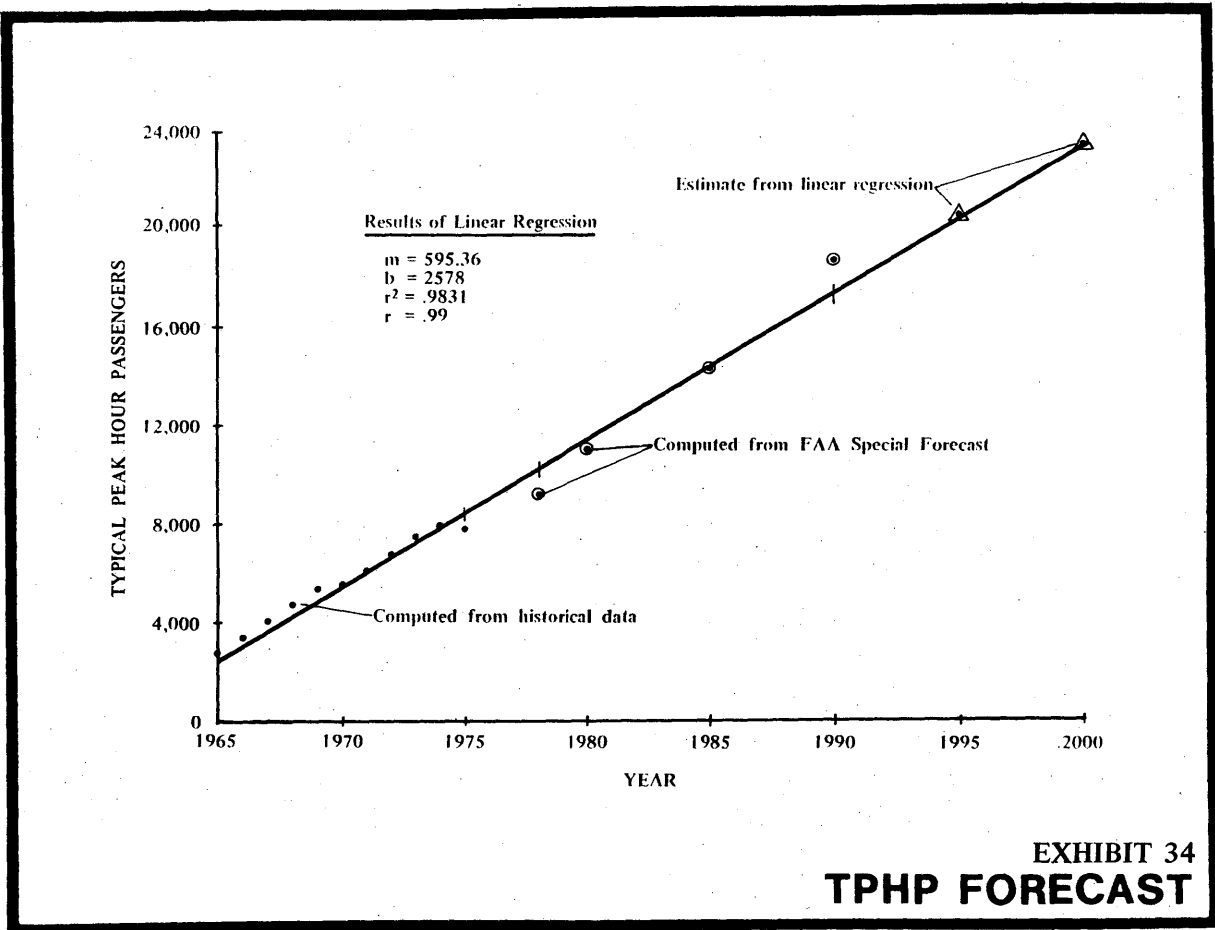


EXHIBIT 34
TPHP FORECAST

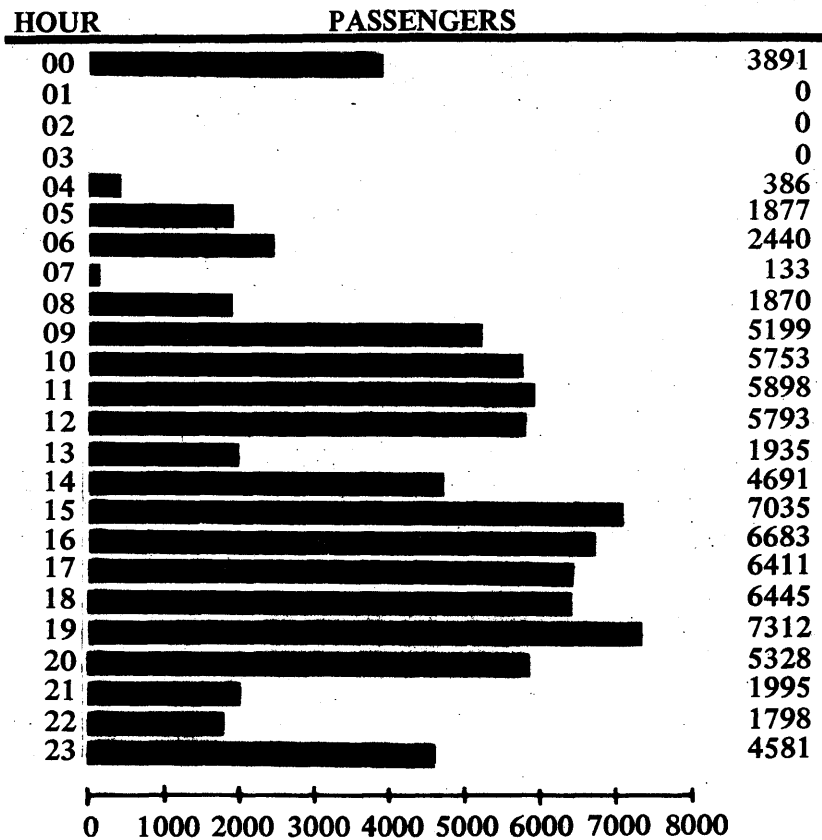


EXHIBIT 35

HOURLY PASSENGER VOLUMES

Source: U.S. Department of Transportation, FAA, Profiles of Scheduled Air Carrier Passenger Traffic for Top 100 U.S. Airports, August, 1977.

Peak Hour Operations

Future Gate Requirements

It would seem that, knowing peak hour passengers and average passengers per departure, simple arithmetic could be used to arrive at a projected value for peak hour operations; and that, from this, the required number of gates could be determined. This is not the case. The results of such computations would indicate that the number of peak hour operations would decline drastically in future years. This is obviously ridiculous and negates two of the initial assumptions that "the airlines would continue to provide adequate levels of service to the Airport"³³ and "increased reliance on Atlanta as a transfer hub will continue." Furthermore, when compared to actual data, the values obtained are not even in the same "ballpark." A more sophisticated means of determining future gate requirements is necessary. One method used for this procedure is outlined in FAA publication, FAA-RD-75-191, *The Apron and Terminal Building Planning Manual*. Another method was devised by the author to project future peak hourly demand for gate positions. Since both yield nearly the same results, the figures seem accurate. The author's method is described in Appendix C.

Gate requirements forecasts are obtained from the FAA methodology, as follows:

1. Given current (1980) annual enplanements and present available gate positions determine current annual enplanements per gate.

$$1980 \text{ annual enplanements} = 18,574,000$$

$$1980 \text{ available gate positions} = 100$$

$$\frac{18,574,000}{100} = 185,740 \text{ annual enplanements per gate.}$$

2. Given annual enplanements forecast for 1990 and current annual enplanements,

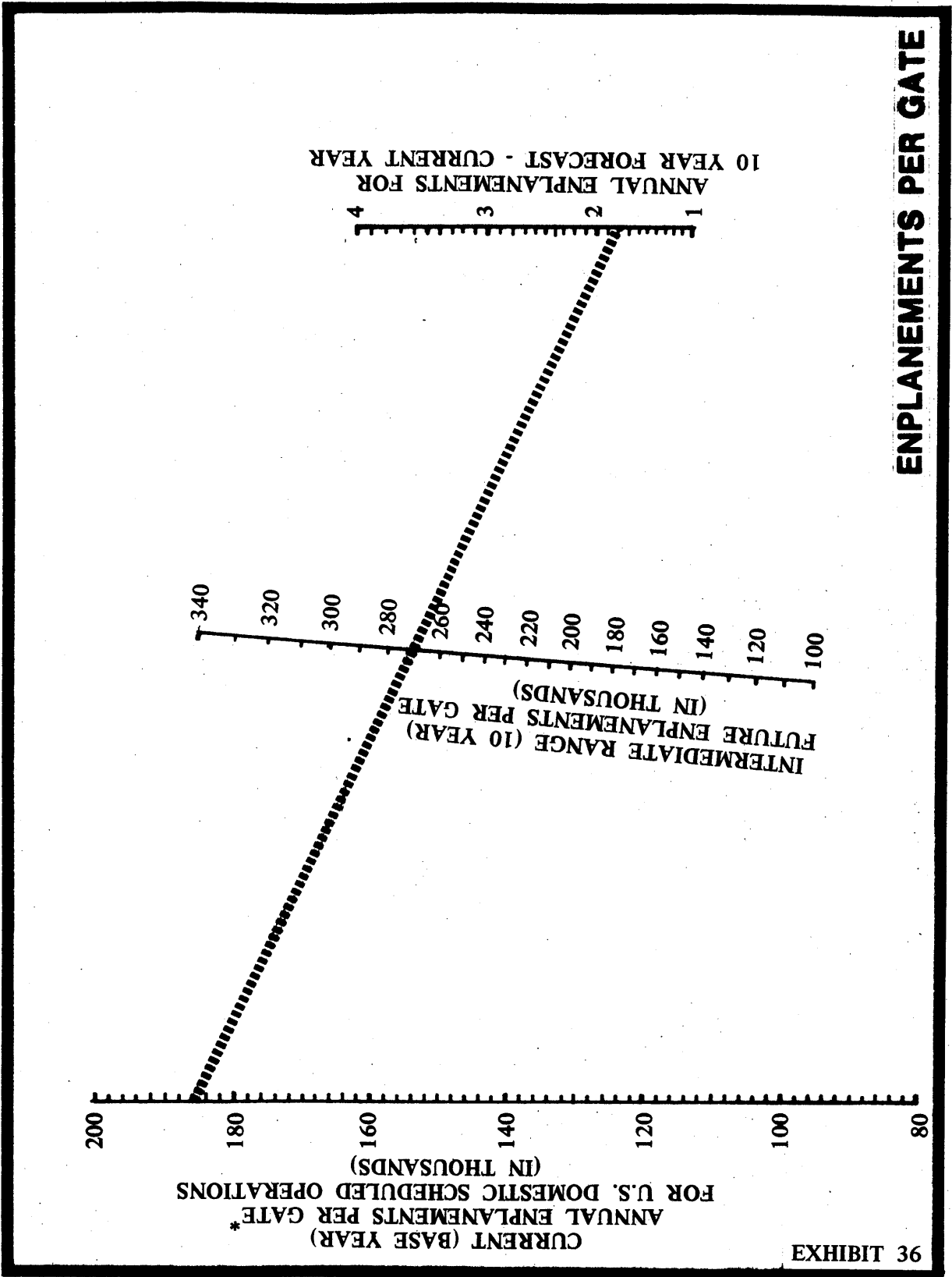
$$\text{growth factor} = \frac{33,403,000}{18,574,000} = 1.8$$

3. From these two values, go to Exhibit 36 to find 10-year enplanements per gate forecast = 270,000

4. Divide 1990 enplanements forecast by 1990 enplanements per gate forecast:

$$\frac{33,403,000}{270,000} = 123.7 \text{ gates required in 1990.}$$

³³ In theoretical terms, "Level of Service" applies to the number of daily departures from city "A" to city "B" which, of course, are spread throughout the day. It is assumed that even with the advent of larger aircraft, airlines will continue to provide excellent service from Atlanta. This implies that average daily departures will not decline.



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 6-3.

Equivalent Aircraft

When some activity statistics are unavailable, for most planning purposes approximations can be developed which include consideration of the number and size of the various aircraft serving the terminal.

This methodology yields a single number called Equivalent Aircraft (EQA) which reflects these seating capacity and sizes of the aircraft. Conversion factors are as follows:

AIRCRAFT	SEATING CAPACITY	CONVERSION FACTOR
DC3, SWM	Up to 80	0.6
B737, DC9	81 - 110	1.0
DC8, B727-200	111 - 160	1.4
B757, B767, A300, DC8-61	161 - 210	1.9
DC10, L1011	211 - 280	2.4
B747	281 - 420	3.5

Source: U.S. Department of Commerce, *The Apron and Terminal Building Planning Manual*, by Ralph M. Parsons Company, July, 1975, p. 1-10.

These figures will be used in predicting terminal area requirements.

Equivalent aircraft for 1990 based on the author's method of forecasting each airline's gate requirements are contained in Table 14.

General Aviation

A detailed discussion of all area requirements for general aviation operations (hangar and storage area) is not considered to be within the scope of this thesis. It is timely to point out, however, that a large percentage of the aircraft operations on the airfield is presently utilized by general aviation operations. In an effort to gain airfield (runway) capacity for air carrier operations, airport management is currently studying various schemes which would seek to divert general aviation traffic to other airports in the Atlanta area. Two airports, Charlie Brown-Fulton County, and DeKalb-Peachtree, receive the lion's share of general aviation traffic. A study to select a site for a new general aviation reliever airport is now under way but is being met with a considerable amount of opposition on the part of citizens' groups. Plans to divert general aviation activity at Hartsfield include the imposition of high landing fees and the limitation in the future of space on the airport for tie-down facilities and hangar space for general aviation aircraft.

TABLE 14
1990 GATE REQUIREMENTS
BASED ON
EQUIVALENT AIRCRAFT

	PRESENT	1990
DELTA		
DC9	8.3 x 1.0 = 8.3	8.3 x 1.0 = 8.3
B727-200	22.0 x 1.4 = 30.8	28.0 x 1.4 = 39.2
DC8	3.0 x 1.4 = 4.2	2.2 x 1.4 = 3.1
L1011	5.3 x 2.4 = 12.7	7.8 x 2.4 = 18.7
B767	0 x 1.9 = 0	4.6 x 1.9 = 8.7
TOTAL	38.6 56.0	50.9 78.0
EASTERN		
DC9	7.3 x 1.0 = 7.3	7.3 x 1.0 = 7.3
B727	14.3 x 1.4 = 20.0	16.1 x 1.4 = 22.5
A300B4	0.7 x 1.9 = 1.3	4.0 x 1.9 = 7.6
L1011	2.0 x 2.4 = 4.8	2.2 x 2.4 = 5.3
B757	0 x 1.9 = 0	2.4 x 1.9 = 4.6
TOTAL	24.3 33.4	32.0 47.3
SOUTHERN		
DC9	5.0 x 1.0 = 5.0	7.1 x 1.0 = 7.1
SWM	2.7 x 0.6 = 1.6	2.7 x 0.6 = 1.6
TOTAL	7.7 7.6	9.8 8.7
OTHERS	6.6 x 1.9 = 12.5	8.3 x 1.9 = 15.8
TOTAL	109.5	149.8

Cargo and Mail

Since the thrust of this thesis deals with the design of airport passenger terminals, a discussion of present and future cargo and mail activity is not considered to be within the scope of the project and, therefore, none will be included. A generalized designation of space on the airfield for mail and cargo handling operations is indicated on the Airport Layout Plan, however.

Consolidated Forecast

Presented in Table 15 are the major findings of this section. These forecasts serve as an overall framework in which planning the airfield can be accomplished.

When related to the capacity of the various terminal facilities required to meet increased demands, a realistic program of facility needs can be established.

**TABLE 15
CONSOLIDATED FORECAST**

	1980	1990
Enplanements	18,574,000	33,403,000
Operations	504,620	632,690
TPHP	10,959	18,706
Gates	100	126
EQA	108.5	137.7

3

TERMINAL AREA REQUIREMENTS

TERMINAL AREA REQUIREMENTS

Over the years many methods have been used to quantify the square footages required for the different functional areas of airport terminals. Since terminal design was still in its infancy, in most cases the "trial and error" method was implemented with varying results. Somewhat more scientific means of sizing terminals have been developed and the most recent, as described in *The Apron and Terminal Building Planning Manual*, is used in this thesis to predict area requirements. It must be emphasized, however, that much more research in perfecting the method is necessary and should be pursued by both academic and professional practitioners.

From the graph in Exhibit 37, a preliminary square footage requirement for the terminal is determined, yielding the following results:

1990 Gross Terminal Area per Gate:

Low	20,300 S.F.
Medium	21,300
High	22,300

1990 Gross Terminal Area Approximation:

Low	$20,300 \times 126 = 2,557,800$
Medium	$21,300 \times 126 = 2,683,800$
High	$22,300 \times 126 = 2,809,800$

This method predicts terminal area as a function of annual enplaned passengers and should only be used as a basis for determining the "order of magnitude" for Gross Terminal Area Requirements.

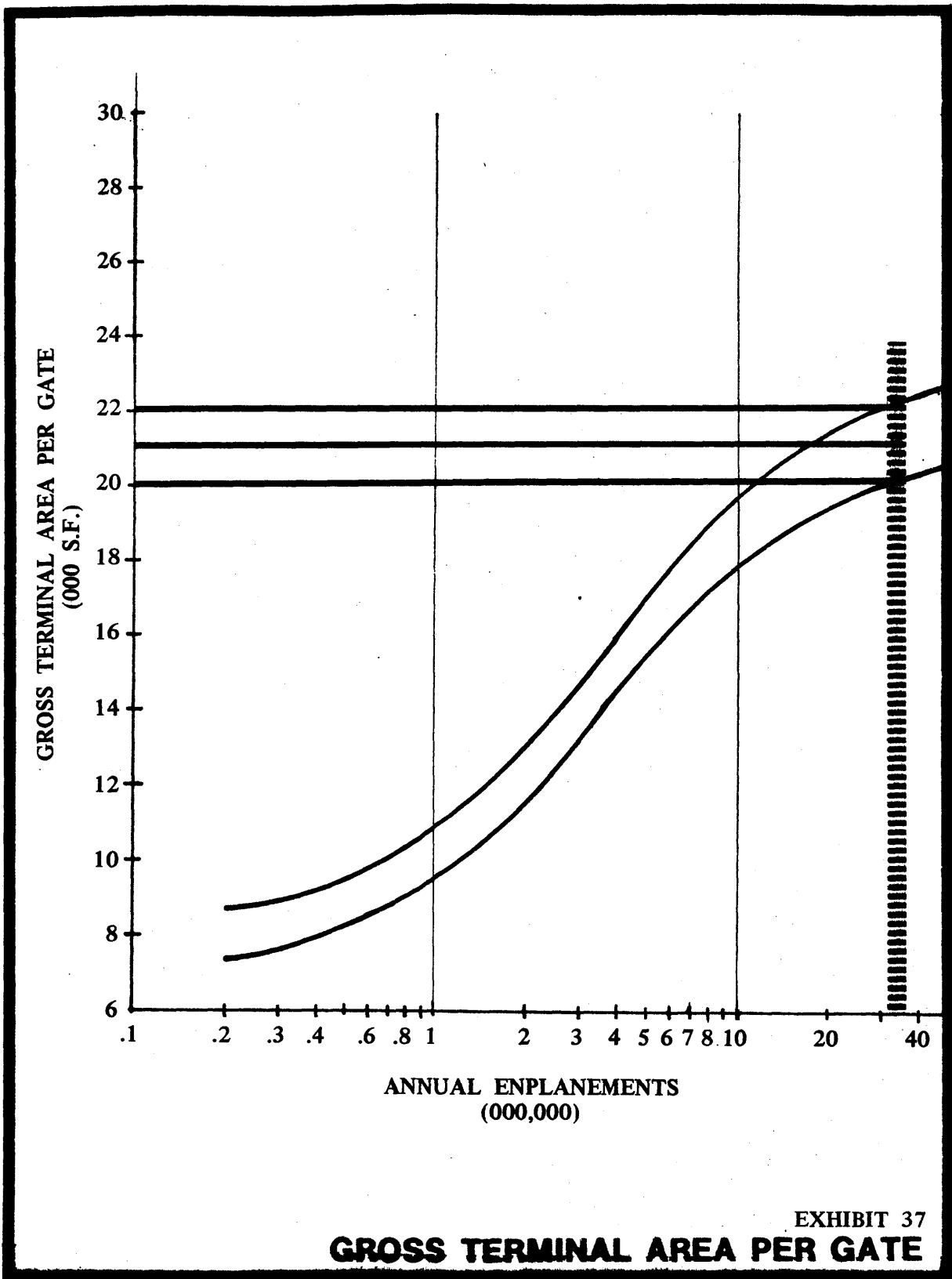


EXHIBIT 37

GROSS TERMINAL AREA PER GATE

Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 6-7.

The use of the procedure described in *The Apron and Terminal Building Planning Manual* and FAA Advisory Circular AC 150/5360-7, *Planning and Design Considerations for Airport Terminal Building Development* (October 5, 1976) to determine various facility requirements will not be studied here in detail. All terminal spaces will be determined by the method outlined in these two publications. Since specific applications are thoroughly described in the manuals themselves, a step-by-step enumeration of each procedure is considered to serve no useful purpose when such information is readily available in these manuals. Applicable charts and procedures from these two publications are outlined in Appendix D. The results of the methodology are shown in Table 16.

TABLE 16
FUTURE FACILITIES REQUIREMENTS

1. Ticket Counters

Delta	550	350
Eastern	380	280
Southern	130	90
Others	210	140
TOTAL	1,270	860

2. ATO Support

Delta	10,500	7,500
Eastern	8,200	6,000
Southern	3,000	2,500
Others	5,000	3,600
TOTAL	26,700	19,600

3. Outbound Baggage &
Baggage Handling

Delta	110,000
Eastern	65,000
Southern	11,000
Others	20,000
TOTAL	206,000

4. Baggage Claim

Claim Area

Delta	54,400	49,600
Eastern	27,200	24,800
Southern	6,800	6,200
Others	13,600	12,400
TOTAL	102,000	93,000

Input Area

Delta	20,000	15,200
Eastern	10,000	7,600
Southern	2,500	1,900
Others	5,000	3,800
TOTAL	37,500	28,500

Future Facilities Requirements
Continued

5. Airline Operations/Support		
Delta	39,000	
Eastern	23,650	
Southern	4,350	
Others	7,900	
TOTAL	74,900	
6. Departure Lounges		
Delta	156,000	93,600
Eastern	94,600	57,760
Southern	17,400	10,440
Others	31,600	18,960
TOTAL	299,600	179,760
7. Security		
Units/S.F.	25/3,000	21/2,500
A. SUBTOTAL	749,700	604,260
8 Ticket Lobby		
Delta	41,500	35,500
Eastern	31,000	26,500
Southern	7,000	4,500
Others	12,500	7,500
TOTAL	92,000	74,000
9. Waiting Lobby		
Seats	1,473	
Area	38,480	
10. Baggage Claim Lobby		
Delta	23,800	
Eastern	11,900	
Southern	2,975	
Others	5,950	
TOTAL	44,625	
11. Food & Beverage Service	183,700	
12. Building Services		
Toilets	44,522	
Offices	60,000	(estimate)
Other	10,000	(estimate)

Future Facilities Requirements
Continued

12. Building Services

Toilets	44,522
Offices	60,000
Other	10,000

13. Concessions 123,597 79,202

14. International Facilities 39,828

B. SUBTOTAL 636,752 574,357

C. SUM A + B 1,386,452 1,178,617

D. CIRCULATION = 0.7 x C 970,516 825,032

E. SUM C + D 2,356,968 2,003,649

F. MECHANICAL = 0.15 x E 353,545 300,547

G. STRUCTURAL = 0.05 x E 117,848 100,182

TOTAL E + F + G 2,828,362 2,404,379

15. Enplaning Curb 1,283 1,000

16. Deplaning Curb 3,207 2,500

17. Parking

Short - Term	8,925
Long - Term	1,575
TOTAL	10,500

4

**TERMINAL BUILDING
DESIGN
CONSIDERATIONS**

EXISTING FACILITIES

Atlanta's airport is located approximately eight miles south of the central business district (CBD) on a piece of land bounded by Interstate 85 on the west, Interstate 75 on the east, and Interstate 285 (Atlanta's "beltway") on the south. See Exhibit 38. Less than a mile north of the airport, Interstates 75 and 85 join. Ground access to the existing passenger terminal is from Interstate 85.

The existing terminal facilities consist of a two-level passenger building with five piers. See Exhibit 39. Ticket counters, waiting areas, office space and concessions are located on the upper level, with baggage claim and rent-a-car and airline operational areas on the lower level.

Five piers provide enclosed walkways between the aircraft parking positions and the main terminal area. There are presently 60 aircraft loading positions directly adjacent to the terminal, with an additional 40 remote positions on the apron area. Existing facilities were built to accommodate 12 million passengers per year, but since 1968 this volume has been exceeded. Extensive congestion occurs during certain peak hours.

As of 1976, the number of loading positions leased to the various air carriers is summarized below.

<u>CARRIER</u>	<u>NUMBER OF LOADING POSITIONS</u>
Delta	24
Eastern	22
United	6
Southern	4
TWA	2
Northwest	2

Some airlines not mentioned above lease positions from other carriers under separate lease agreements. Other use remote positions exclusively.

This terminal was begun in 1958 and opened for service in 1961. Since then there have been several additions, including improvements by Delta and Eastern to their areas. Most recent was Delta's construction of the international passenger facility in their Airside E.

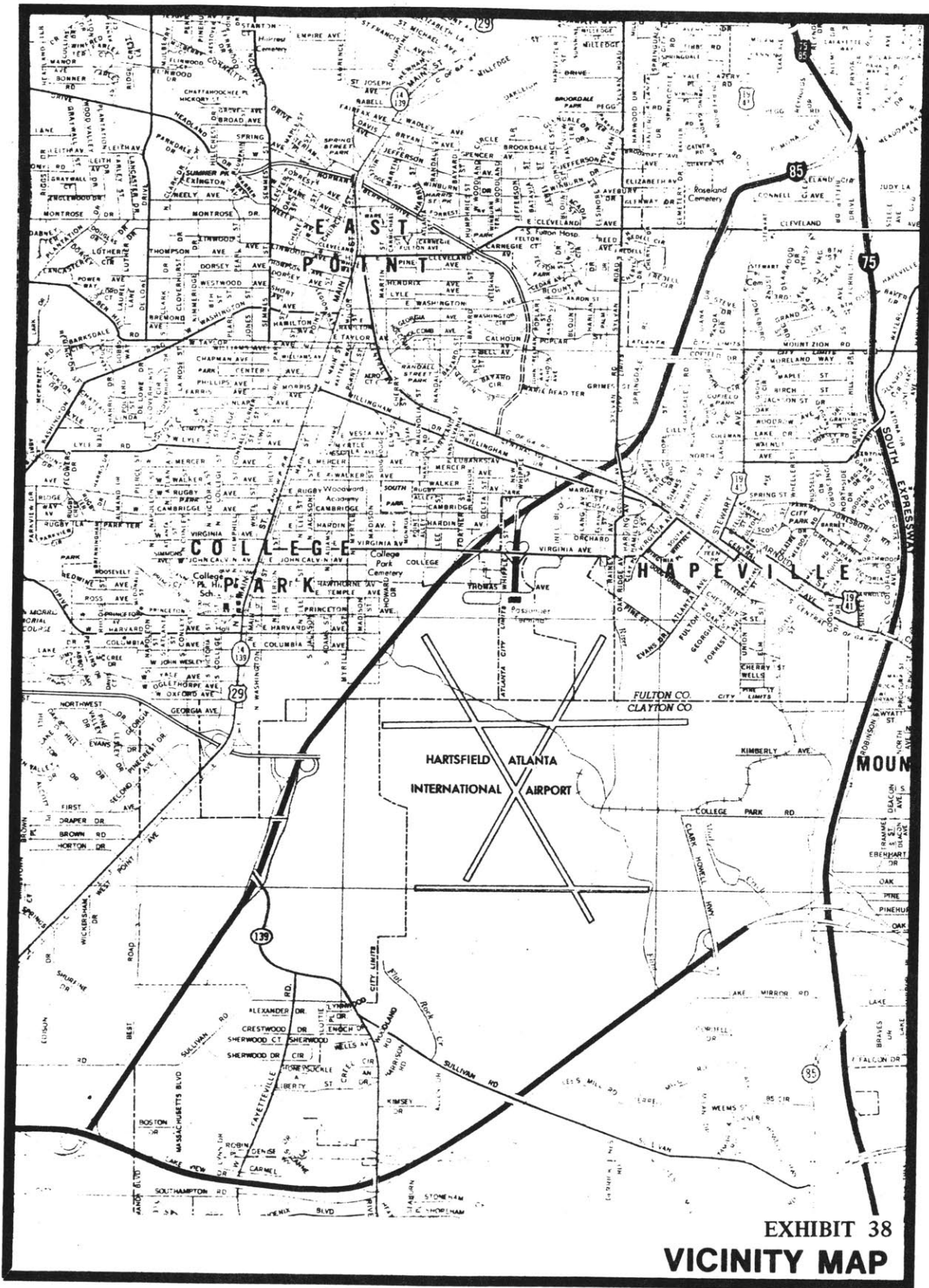
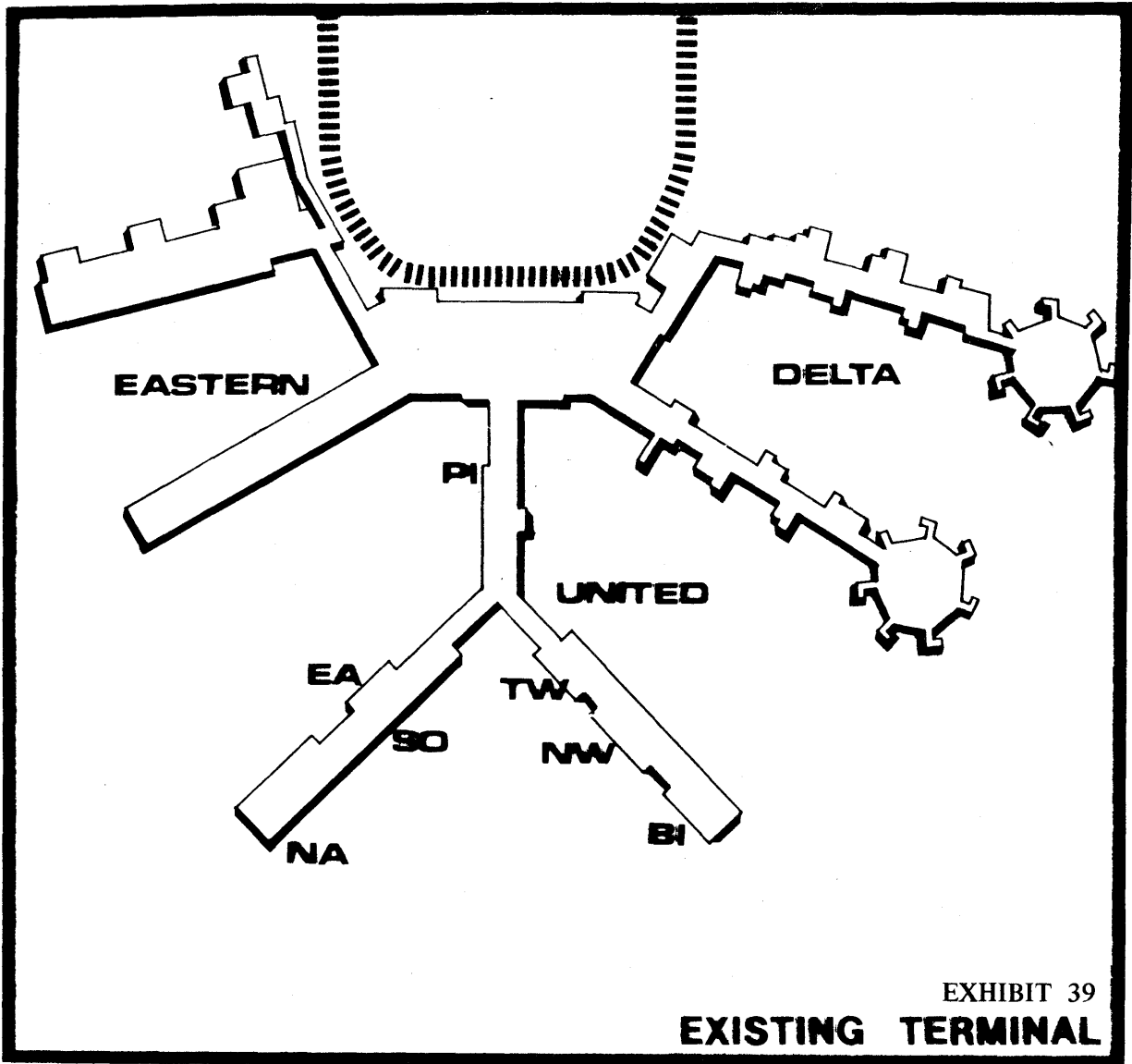


EXHIBIT 38
VICINITY MAP



The need for expansion of the terminal facilities and airfield was realized in the early 1970s. The *Airport Layout Plan Report (ALP)* of 1973 studied alternatives to gain additional operational and passenger handling capability for the Atlanta Metropolitan area. It was decided that while a new air carrier airport to serve the region would eventually need to be constructed, a new passenger terminal complex and an additional runway at the existing airport would meet the immediate air transportation needs of the community until a new site could be developed. Site selection, planning, engineering, design and construction of a new airport is a process which takes almost 10 years. New airports of the scale required by Atlanta are also quite costly; Dallas-Fort Worth Regional Airport cost an estimated \$800 million.

The city of Atlanta has purchased two tracts of land in Dawson and Paulding Counties to the north on which to begin preliminary site analysis for the eventual construction of the new air carrier airport. Meanwhile, improvements are being made to Charlie Brown-Fulton County Airport, and DeKalb-Peachtree Airport, Atlanta's two large general aviation reliever facilities. These improvements are intended to attract general aviation traffic to the two smaller airports to gain needed runway capacity for air carrier operations at Hartsfield.

Consequences of the future construction of another air carrier airport for Atlanta are many. Most likely, the new airport would become the regional transfer hub, and the existing facility would then be the "in-town" terminal for the City. By 1990, if one were to assume that the percentage of transferring passengers would remain in the same range as that experienced at present, the "in-town" terminal could expect annual enplanements over 10 million. This is still a large volume. The question then arises of how the terminal should be designed for the situation where it is predominantly a very large transfer terminal for several years and then it must accommodate primarily originations and terminations but at a greatly decreased annual volume. Certainly, many areas of the transfer terminal would be grossly oversized for a terminus facility. This consideration makes the design problem more challenging.

The remainder of this thesis will seek to study the design solution currently under construction at Hartsfield and alternative solutions proposed by the author which may have better answered the terminal needs of the airport.

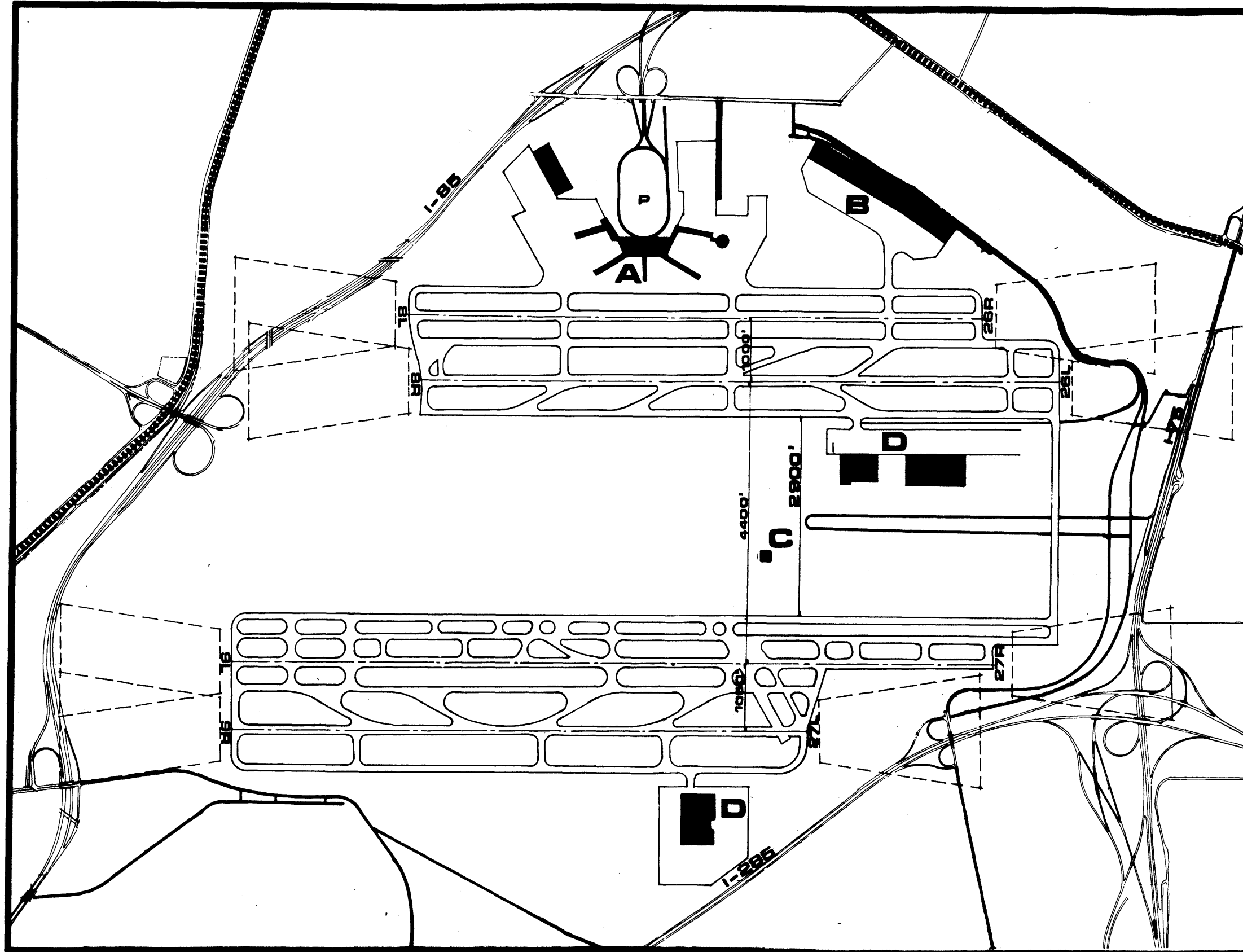
Presently Atlanta has three parallel 150-foot-wide runways, two with Instrument Flight Rule (IFR) capability and one crosswind runway. See Exhibit 40. It has been decided by the Atlanta Airport Engineers and their consultants (the team which produced the airfield and terminal plan for Atlanta currently under construction) that the crosswind runway be removed and that a fourth parallel runway be constructed. All four runways will eventually have IFR capability and give the airport a capacity of 156 aircraft operations per hour based on current aircraft mix and existing waivers of following distance required between landing aircraft. The configuration will permit four simultaneous aircraft operations, two landings and two takeoffs. The Airport Engineers have determined that the existing runways are of sufficient strength to permit the operation of the largest existing commercial aircraft. It was further determined that all existing runways are able to accommodate increased wide-body aircraft operations without requiring strengthening.

A system of high-speed exit taxiways has been constructed to enable rapid exit from the runways onto parallel taxiways.

A new FAA Air Traffic Control Tower containing the most sophisticated equipment presently available was constructed in 1976 in the center of the airfield to the east of the site selected for terminal development.

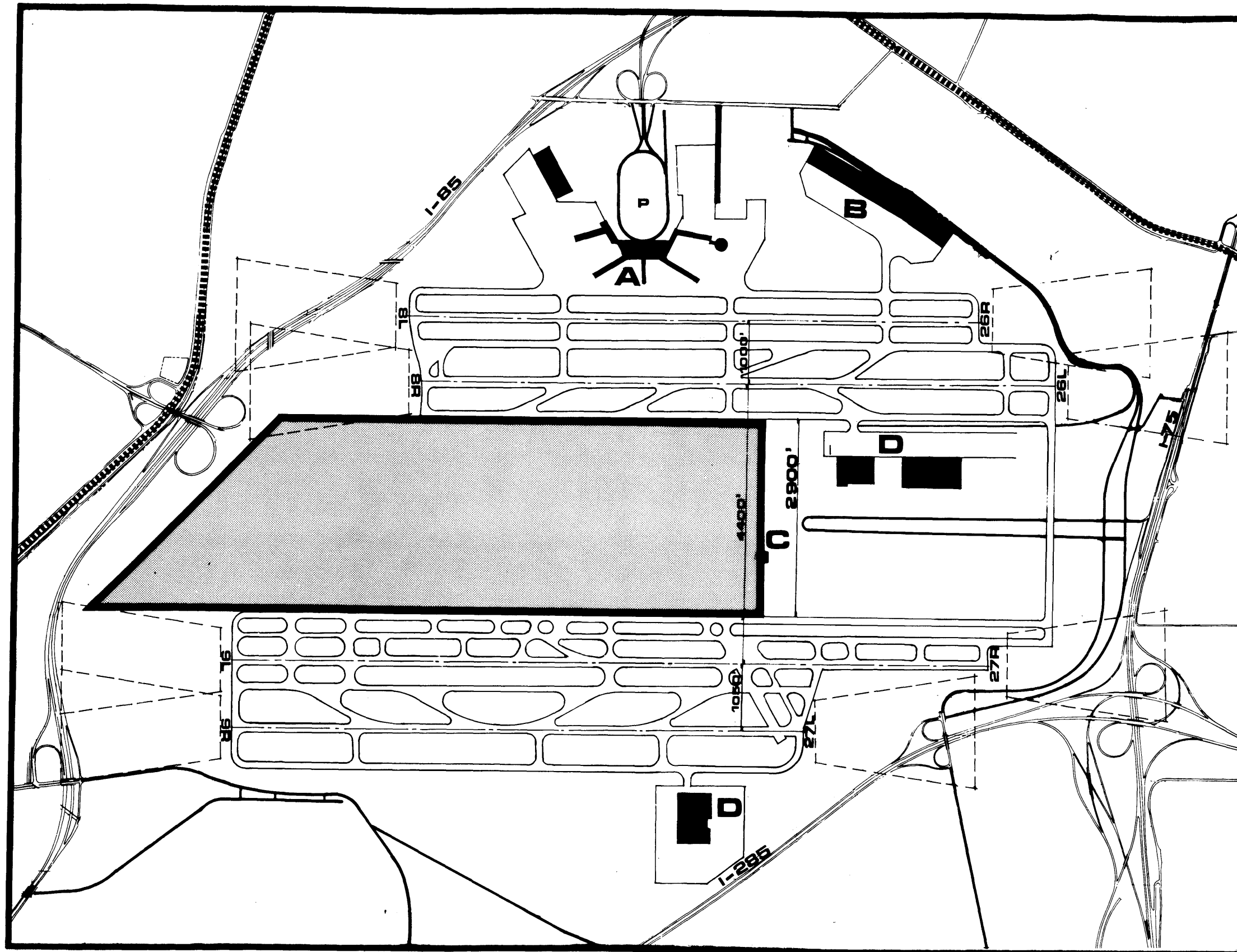
One major problem in designing and siting any terminal facility on existing airport property is severe space limitation. The two innermost runways are only separated by 4,400 feet. Most design manuals suggest a minimum separation of 5,000 feet for the innermost runways in a "dual-parallel" runway system. The availability of an extra 600 feet could be most beneficially used for terminal area. A second problem is the location of Interstate 85. It has been decided that the portion of this highway directly to the west of airport property should be relocated to provide more space for terminal development and a ground access network. The location of existing aircraft maintenance areas indicated in Exhibit 40 acts as a further barrier to terminal construction. The actual area available for terminal facilities is shown in Exhibit 41. It is constrained on the north and south by taxiways, on the east by airline maintenance areas, and on the west by Interstate 85.

The Atlanta Airport Engineers, the "Team" charged with designing the new facility, has chosen the terminal scheme indicated in Exhibit 42. This scheme consists of a central



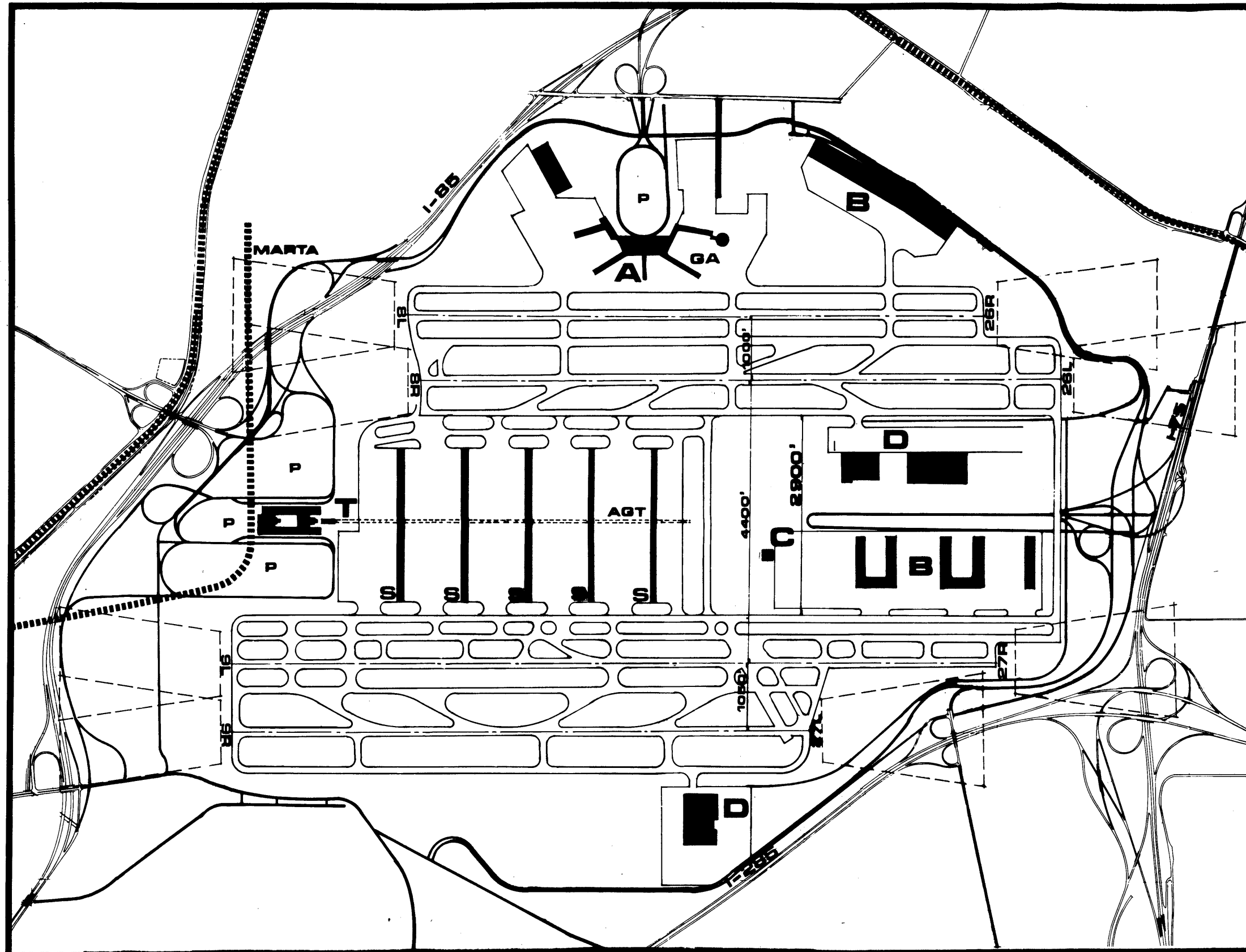
- A** EXISTING TERMINAL
- B** CARGO
- C** CONTROL TOWER
- D** MAINTENANCE
- P** PARKING

EXHIBIT 40
**FUTURE
 AIRFIELD CONFIGURATION**



- A** EXISTING TERMINAL
- B** CARGO
- C** CONTROL TOWER
- D** MAINTENANCE
- P** PARKING

EXHIBIT 41
**AREA FOR
 TERMINAL DEVELOPMENT**



- A** EXISTING TERMINAL
- B** CARGO
- C** CONTROL TOWER
- D** MANITENANCE
- P** PARKING
- S** SATELLITE
- T** NEW TERMINAL

EXHIBIT 42
**TERMINAL PLAN
 CURRENTLY
 UNDER CONSTRUCTION**

passenger terminal and five satellites (or airside buildings) which are connected to each other and the main terminal (landside) by an underground transit system. The transit system or "spine" affords passengers three alternatives of traversing the distance between satellites and the central terminal: walking, using a moving sidewalk, and using an "Activated Guideway Train" (AGT). The spine is to be an arcade filled with shops and other amenities. Escalators will take the passenger from the underground transit station at each satellite to the departure lounges two levels above. Each satellite or "concourse" is a 2,400-foot-long corridor, double-loaded with departure lounges. There are to be thirteen aircraft loading positions on each side of the concourse. Each loading position (130 in all) is designed to accommodate wide-bodied aircraft of the L1011 size range. This translates to 176 available loading positions (EQAs) for narrow-bodied aircraft.

The landside facility is a many-levelled, double-sided building which houses ticketing and baggage claim functions, as well as a terminal for the Metropolitan Atlanta Regional Transportation Authority (MARTA), Atlanta's new rapid rail system which extends from the CBD to surrounding residential areas.

There are two commendable attributes to this terminal plan. First, aircraft movements are unencumbered; this will lead to fewer delays for the aircraft on the ground which will, in turn, enable greater runway capacity. Secondly, transfer passengers will not be required to submit to a security check at Hartsfield because all security searches will be accomplished in the landside building.

There are several drawbacks to this scheme, however. The most important is that while the primary complaint about the existing terminal is that walking distances are so great for transferring passengers, in the proposed scheme these distances are even longer. A passenger transferring from an aircraft at one end of a concourse to an aircraft at the other end must walk 2,400 feet. Another drawback is that a passenger travelling between the landside building and the furthest airside must make intermediate stops at all the other airside. The transit system is similar to a city subway. A scheme that permitted a more direct connection between landside and airside would be preferable.

CONCLUSIONS

Hartsfield evolved as a hub as so many other service centers evolved: Chicago with railroads and air; New York City through finance and as a port; New Orleans as a river traffic terminus and port; and San Francisco as a port to the Orient. Since the beginning of time man has evolved usages of localities and areas on a functional basis.

In the air age evolution is more rapid and outpaces the ability to adjust and modify as technology outpaces the reality of the everyday world. Civic pride and local government concentrated growth in Atlanta and the airlines followed. Hartsfield is now probably too big and getting bigger; maybe too big as a high usage transfer airport. One cannot help but reflect on the possibility of a separate pure transfer airport in the mid South to relieve the transfer load from Atlanta. Through transfer passengers to and from locations in the mid and deep South certainly have no need to pause within the metropolitan environs of Atlanta. Initially this was the logical transfer point during the days of the propeller airplane and moderate traffic demands; but the jet age arrived before adequate foresight and planning had been assembled and traffic demand outstripped preparedness, a not uncommon situation in the history of the United States. The analogy of Hartsfield to the highway systems in many parts of the nation being found to be obsolescent prior to completion is but one other comparable example of the vigorous and almost impossible to predict character of this vibrant and energetic nation.

The critic always has the advantage of perfect vision in hindsight and undoubtedly would be subject to the same foibles and errors of those he would criticize if he were in the position of initial decision making. This notwithstanding, it should be brought out that the known acquisition of the large areas of land north of Atlanta for potential airport development, when seen in the light of present and future problems at Hartsfield, is at once a shining beacon of promise and foresight and at the same time the cold ashes of a campfire which has been extinguished for the last time.

The obvious potential of these northern land areas to function as a true transfer airport for the Southeastern United States cannot be ignored. Had this potential been realized, Atlanta would probably have had the pre-eminent air transportation complex in the United States and perhaps the world, as a remodeled and updated close-in Hartsfield would have been the obvious metropolitan airport and the specially designed and conceived

northern airport would have become a model of the transfer hub of the future. The resultant advantages to the traveling public and the airlines themselves would have been incalculable; and potential expansion of both facilities would still be possible, especially in the case of Hartsfield as the severe constraints which have so restricted the present construction would not have had such overbearing influence for decades to come.

As it is with all present heavy loads being carried by Hartsfield, and with the obvious addition of heavy short term future loads, Hartsfield faces a clouded future in terms of efficiency and the ability to satisfy the basic requirements of both operations and the public. Surely, the atmosphere of the new complex will be more pleasant and the environment more acceptable, but the serviceability and the ground time at the new Hartsfield may see very little improvement over the current condition. In spite of many technological improvements the old truism still holds: it is still very difficult to pack six pounds of flour in a five-pound bag.

Obviously, given the decision to expand and update Hartsfield within the constraints already imposed upon it, the present design from an architectural planning and service standpoint represents an acceptable solution. The most has been made out of a difficult and vexing series of imposed conditions. Expansion is limited, too, due to the same ever-present constraints which limited the design potential from the start. The essence of the art of planning and design is to provide the optimum solution within the limits imposed upon the designer. This can be said to have been done in the new Hartsfield. The only constructive comments which may be applicable and of some value to future Airport Commissions and Planning Authorities, whether of City, State or Federal representation, would be those suggested above which indicate the separation of Transfer Airport functions from Municipal Airport functions be given greater weight when making long range plans and investments in this constantly unpredictable and surprising society which is now ready to enter into the twenty-first Century.

In reality and from a practical point of view, an additional evolution will take place as Hartsfield again becomes saturated and reaches the point where no real relief can be provided. It is doubtful that economics will ever be acceptable to justify a whole new Transfer Airport on the northern lands available. Though, again, nothing is impossible

in this nation if we are able to maintain our past standards of advancement; only time and the international economics of energy availability will determine that. Given the unavailability of a pure Transfer Airport in the Atlanta area and total saturation at Hartsfield, the carriers will adjust in future years to providing more direct flights to and between points in the South, with perhaps some transfer operations at other secondary hubs such as Birmingham, Richmond or Greensborough, North Carolina. Yankee Ingenuity and ever more efficient computerized schedule programming will meet the challenge of the constantly burgeoning South. While it may be a contradiction in idiom to imply that Yankee Ingenuity will rise to solve the air travel problems of the South, the South may forgive this reference, since it realizes that it now is fast becoming the most favored area of the nation for expansion of commerce and population and in this new air age can finally with certitude claim that the century-old rallying cry has finally come to fruition - the South, indeed, shall rise again - and Hartsfield has shown the way.

APPENDIX A
ATLANTA
TRAFFIC STATISTICS

TABLE 17
DIRECT FLIGHTS FROM ATLANTA

DESTINATION	STOPS			AIRLINE(S)
	0	1	2+	
Akron, OH	2	1	0	EA, UA
Albany, GA	4	0	0	SO
Albany, NY	0	1	0	EA
Alexandria, LA	0	2	0	DL
Allentown, PA	0	3	0	EA
Anchorage, AK.....	0	0	1	NW
Anniston, AL	7	0	0	SO
Asheville, NC	6	0	0	UA, PI
Athens, GA	5	0	0	SO
Augusta, GA	11	0	0	DL, PI
Baltimore, MD	9	1	2	DL, EA, UA
Bangor, ME	0	0	3	DL
Baton Rouge, LA	4	0	0	DL
Beaumont, TX	0	1	0	DL
Beckley, WV	0	0	1	PI
Birmingham, AL	17	3	0	DL, EA, SO
Bluefield, WV	0	0	1	PI
Boston, MA	9	13	1	DL, EA
Buffalo, NY	5	2	0	EA, UA
Burlington, VT	0	1	0	DL
Cedar Rapids, IO	0	1	0	OZ
Charleston, SC	10	3	0	DL, EA
Charleston, WV	2	1	1	UA, PI
Charlotte, NC	13	3	0	DL, EA, SO
Chattanooga, TN	10	0	0	DL, EA
Chocago, IL	15	7	6	DL, EA, NW, PI, SO
Cincinnati, OH	10	2	1	DL, EA
Cleveland, OH	17	0	0	DL, EA, UA
Columbia, SC	12	0	0	DL, EA
Columbus, GA	10	0	0	DL, EA
Columbus, OH	6	4	0	DL, EA
Corpus Christi, TX	0	2	0	EA
Dallas/Ft. Worth, TX	20	1	13	DL, EA, BI, FL
Danville, VA	0	0	1	PI
Dayton, OH	7	1	0	DL
Daytona Beach, FL	7	1	0	EA
Denver, CO	7	4	0	DL, BI, FL
Des Moines, IO	1	1	0	OZ

Detroit, MI	15	6	8	DL, EA, NC
Dothan, AL	4	0	0	SO
Elgin AFB, FL	3	0	0	SO
Evansville, IN	1	0	0	EA
Fayetteville, NC,	4	1	0	PI
Flint, MI	0	2	0	NC
Florence, SC	1	2	0	PI
Ft. Lauderdale, FL	12	5	0	DL, EA
Ft. Myers, FL	9	0	0	EL
Ft. Wayne, IN	0	3	1	DL
Gadsden, AL	3	0	0	SO
Gainesville, FL	5	0	0	EA
Grand Rapids, MI	0	0	1	NC
Greenbrier, WV	1	0	0	PI
Greensboro, NC	6	1	0	DL, EA
Greenville, MS	0	1	0	SO
Greenville, SC	9	0	0	ES, SO
Gulfport, MS	1	2	0	SO
Hartford, CT	8	6	0	DL, EA
Hickory, NC	2	1	0	PI
Hilton Head Island, SC	1	0	0	FE
Houston, TX	17	1	0	DL, EA
Huntington, WV	1	0	1	PI
Huntsville, AL	5	0	0	SO
Indianapolis, IN	9	3	1	DL, EA
Jackson, MS	7	6	0	DL, SO
Jackson, TN	1	0	0	SO
Jacksonville, FL	15	0	0	DL, EA
Jacksonville, NC	0	2	1	PI
Kansas City, MO	5	2	0	DL, BI, TW
Kinston, NC	1	1	0	PI
Knoxville, TN	7	3	0	DL, SO
Lansing, MI	0	3	0	UA, NC
Las Vegas, NV	1	2	0	DL
Laurel, MS	1	1	0	SO
Lawton, OK	0	1	0	FL
Lexington, KY	4	4	0	DL, EA
Little Rock, AR	0	3	0	DL
Los Angeles, CA	6	3	0	DL, EA
Louisville, KY	12	5	0	DL, EA
Lynchburg, VA	0	0	1	PI
Macon, GA	4	0	0	DL
Melbourne, FL	5	0	0	EA

Memphis, TN	11	6	3	DL, SO
Meridian, MS	2	1	0	DL, SO
Mexico City, MEXICO	2	0	0	EA
Miami, FL	15	4	5	DL, EA, NW, SO
Milwaukee, WI	4	0	1	EA, NC
Minneapolis, MN	7	0	3	EA, NW, OZ
Mobile, AL	8	3	0	EA, SO
Moline, IL	1	0	0	OZ
Monroe, LA	1	2	0	DL
Montego Bay, JAMAICA	1	1	0	EA
Montgomery, AL	11	1	0	DL, EA
Montreal, CANADA	0	3	1	DL, EA
Moultrie, GA	2	0	0	SO
Muscle Shoals, AL	1	1	0	SO
Muskegon, MI	0	0	2	UA, NC
Myrtle Beach, SC	2	0	0	PI
Nashville, TN	10	0	0	EA, SO
Nassau, BAHAMAS	0	1	0	EA
New Bern, NC	0	1	1	PI
New Orleans, LA	15	4	1	DL, EA, SO
Newport News, VA	1	2	0	UA
New York, NY	28	11	10	DL, EA, UA, PI
Norfolk, VA	8	1	3	UA, PI
Oklahoma City, OK	3	0	0	BI
Omaha, NB	0	3	0	EA
Orlando, FL	14	1	1	DL, EA, SO
Panama City, FL	4	0	0	SO
Pensacola, FL	5	2	0	EA
Peoria, IL	1	0	0	OZ
Philadelphia, PA	15	1	0	DL, EA, UA
Phoenix, AZ	0	1	2	DL
Pittsburgh, PA	9	2	1	EA, UA
Portland, ME	0	1	2	DL
Portland, OR	0	1	3	EA
Providence, RI	2	1	0	EA
Raleigh/Durham, NC	8	2	1	DL, EA, UA
Reno, NV	0	1	0	DL
Richmond, VA	6	2	0	EA, PI
Roanoke, VA	2	5	0	PI
Rochester, MN	0	1	0	OZ
Rochester, NY	2	1	0	UA

Saginaw, MI	0	0	2	NC
St. Louis, MO	9	2	1	DL, EA, TW
St. Simons Island, GA	2	0	0	FE
Salt Lake City, UT	0	0	1	FL
San Antonio, TX	4	1	0	EA
San Diego, CA	0	3	1	DL
San Francisco, CA	4	1	0	DL, EA
San Jose, CA	0	0	1	DL
San Juan, PR	3	0	0	EA
Sarasota, FL	6	1	0	EA
Savannah, GA	13	2	0	DL, EA
Seattle, WA	0	3	2	EA, NW
Shreveport, LA	2	4	2	DL
Springfield, MO	0	0	1	DL
Syracuse, NY	3	0	0	EA
Tallahassee, FL	6	2	0	EA, SO
Tampa, FL	19	3	0	DL, EA, NW
Toledo, OH	1	4	0	DL
Toronto, CANADA	0	4	1	EA
Tri-City Airport, TN	4	2	0	PI
Tulsa, OK	4	0	0	DL
Tupelo, MS	2	0	0	SO
Tuscaloosa, AL	3	0	0	SO
Valdosta, GA	0	5	0	SO
Washington, DC	27	5	14	DL, EA, UA, PI
Waterloo, IO,	0	0	1	OZ
West Palm Beach, FL	10	3	0	DL, EA
Wichita, KS	2	0	0	FL
Wilkes-Barre/Scranton, PA	0	2	0	EA
Wilmington, NC	2	1	0	PI
Winston-Salem, NC	0	3	1	PI
Youngstown, OH	0	1	0	UA

**TABLE 18
SCHEDULED INTERNATIONAL
FLIGHTS TO ATLANTA**

YEAR	MONTH	CARRIER	ORIGIN	AIRCRAFT	NO.	AVAILABLE SEATS	
1969	March						
	June						
	September		Port-of-Spain	B707	1	150	
	December	EA	Toronto	B727	1	130	
	TOTAL 1969					280	
	MONTHLY AVERAGE					140	
1970	March						
	June						
	September	EA	Toronto	B727	1	130	130
	December	EA	Toronto	B727	1	130	
		EA	Mexico City	B727	1	130	260
	TOTAL 1970				3	390	
	MONTHLY AVERAGE					195	
1971	March		Caracas	B707	1	150	
	June						
	September	EA	Mexico City	B727	30	3,900	
	December	EA	Mexico City	DC8	20	3,000	
				B727	11	1,430	4,430
	TOTAL 1971					8,480	
	MONTHLY AVERAGE					2,827	
1972	March	EA	Mexico City	DC8	31	4,650	
	June	EA	Mexico City	DC8	27	4,050	
				B727	1	130	4,180
	September	EA	Mexico City	DC8	5	750	
				B727	25	3,250	
		EA	Montego Bay	B727	30	3,900	7,900
	December	EA	Acapulco	B727	6	780	
		EA	Mexico City	DC8	1	150	
				B727	30	3,900	
		EA	Montego Bay	B727	49	6,370	
	EA	Toronto	DC9	4	480	11,680	
	TOTAL 1972					28,410	
	MONTHLY AVERAGE					7,102	

CONTINUED:

YEAR	MONTH	CARRIER	ORIGIN	AIRCRAFT	NO.	AVAILABLE SEATE		
1973	March	EA	Acapulco	B727	8	960		
		EA	Mexico City	B727	24	3,120		
				DC8	1	150		
			EA	Montego Bay	B727	61	7,930	
			EA	Toronto	DC9	1	120	12,280
	June	EA	Mexico City	DC8	29	4,350		
		EA	Montego Bay	B727	40	5,200	9,950	
	September	EA	Mexico City	B727	30	3,900		
				DC8	4	600		
			EA	Montego Bay	B727	34	4,420	8,920
	December	EA	Acapulco	B727	9	1,170		
		EA	Mexico City	B727	31	4,030		
				L1011	1	250		
			EA	Montego Bay	B727	31	4,030	
		EA	Toronto	DC9	2	240		
			B727	1	130	9,850		
TOTAL 1973						40,600	40,600	
MONTHLY AVERAGE							10,150	
1974	March	EA	Acapulco	B727	10	1,300		
		EA	Mexico City	B727	30	3,900		
		EA	Montego Bay	B727	31	4,030		
		EA	Toronto	B727	1	130	9,360	
	June	EA	Mexico City	B720	30	3,900		
		EA	Montego Bay	B727	29	3,770	7,670	
	September	Missing						
	December	EA	Mexico City	B727	31	4,030		
				L1011	1	250		
		EA	Montego Bay	B727	31	4,030	8,310	
TOTAL 1974							25,340	
MONTHLY AVERAGE							8,447	
1975	March	EA	Acapulco	B727	9	1,170		
		EA	Mexico City	B727	30	3,900		
		EA	Montego Bay	B727	31	4,030		
		EA	Toronto	B727	2	260	9,360	
	June	EA	Acapulco	B727	14	1,820		
		EA	Mexico City	B727	30	3,900		
		EA	Montego Bay	B727	29	3,770		
				L1011	1	250	9,470	

CONTINUED:

YEAR	MONTH	CARRIER	ORIGIN	AIRCRAFT	NO.	AVAILABLE SEATS
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1975 Continued

September	EA	Acapulco	B727	1	130	
	EA	Mexico City	B727	30	3,900	
	EA	Montego Bay	B727	30	3,900	7,930
December	EA	Acapulco	B727	3	390	
	EA	Mexico City	B727	31	4,030	
	EA	Montego Bay	B727	31	4,030	8,190

TOTAL 1975						35,220
MONTHLY AVERAGE						8,805

1976	March	EA	Acapulco	B727	4	520			
		EA	Bermuda	L1011	62	15,500			
		EA	Freeport	DC9	31	3,720			
		EA	Mexico City	B727	31	4,030			
		EA	Montego Bay	B727	31	4,030			
		EA	Montreal	B727	62	8,060			
		EA	Nassau	B727	31	4,030			
		EA	San Juan	L1011	62	15,500			
		EA	Toronto	L1011	31	7,750			
						B727	93	12,090	75,230
June		EA	Acapulco	B727	8	1,040			
		EA	Bermuda	L1011	30	7,500			
				B727	30	3,900			
		EA	Freeport	B727	30	3,900			
		EA	Mexico City	B727	60	7,800			
		EA	Montego Bay	B727	30	3,900			
		EA	Montreal	DC9	30	3,600			
						B727	30	3,900	
		DL	Montreal	B727	30	3,900			
		EA	San Juan	L1011	60	15,500			
September		EA	Toronto	L1011	30	7,500			
				B727	120	15,600			
				DC9	30	3,600	81,640		
		EA	Acapulco	B727	5	650			
		EA	Bermuda	L1011	30	7,500			
				B727	7	910			
		EA	Freeport	B727	7	910			
		EA	Mexico City	B727	60	7,800			
		EA	Montego Bay	B727	30	3,900			
		EA	Montreal	B727	30	3,900			
				DC9	30	3,600			
DL	Montreal	B727	30	3,900					
EA	St. Thomas	B727	19	2,470					
EA	San Juan	L1011	60	15,000					

CONTINUED:

YEAR	MONTH	CARRIER	ORIGIN	AIRCRAFT	NO.	AVAILABLE SEATS		
1976	September	Continued						
		EA	Toronto	L1011	30	7,500		
				B727	120	15,600		
				DC9	30	3,600	77,240	
	December	EA	Acapulco	B727	4	480		
		EA	Mexico City	B727	62	8,060		
		EA	Montreal	B727	31	4,030		
				DC9	31	3,720		
		DL	Montreal	B727	31	4,030		
		EA	San Juan	L1011	62	15,500		
		EA	Toronto	L1011	38	9,500		
				B727	110	14,300		
				DC9	7	840	60,500	
	TOTAL 1976						294,610	
	MONTHLY AVERAGE						75,653	
1977	March	EA	Acapulco	B727	2	260		
		EA	Mexico City	B727	62	8,060		
		EA	Montego Bay	B727	31	4,030		
		EA	San Juan	L1011	62	15,500		
		EA	Toronto	L1011	31	7,750		
				B727	124	16,120	63,500	
	June	EA	Bermuda	L1011	30	7,500		
				B727	8	1,040		
		EA	Montego Bay	B727	4	520		
		EA	Montreal	B727	60	7,200		
				DC9	30	3,600		
		EA	San Juan	L1011	60	15,000		
		EA	Toronto	L1011	30	7,500		
				B727	60	7,800	58,560	
	September	EA	Bermuda	L1011	30	7,500		
				B727	6	780		
		EA	Mexico City	B727	60	7,800		
		EA	Montego Bay	B727	30	3,900		
		EA	Montreal	B727	84	10,920		
				DC9	6	720		
		EA	San Juan	L1011	90	22,500		
		EA	Toronto	L1011	54	13,500		
				B727	36	4,680	72,300	
	December	EA	Bermuda	L1011	11	2,750		
				B727	16	2,080		
		EA	Mexico City	B727	62	8,060		
		EA	Montego Bay	B727	7	910		

CONTINUED:

YEAR	MONTH	CARRIER	ORIGIN	AIRCRAFT	NO.	AVAILABLE SEATS	
1977	December	Continued					
		EA	Montreal	B727	62	8,060	
				DC9	12	1,440	
		DL	Montreal	B727	31	4,030	
		EA	San Juan	L1011	55	13,750	
		EA	Toronto	L1011	59	14,750	
				B727	44	5,720	
				DC9	21	2,520	64,070
TOTAL 1977							258,430
MONTHLY AVERAGE							64,607
1978	March	EA	Bermuda	L1011	12	3,000	
				B727	19	2,470	
		EA	Mexico City	B727	62	8,060	
		EA	Montego Bay	B727	8	1,040	
		EA	Montreal	B727	62	8,060	
				DC9	31	3,720	
		DL	Montreal	B727	31	4,030	
		EA	San Juan	L1011	62	15,500	
		EA	Toronto	L1011	62	15,500	
				B727	62	8,060	
				DC9	31	3,720	73,160
	June	EA	Mexico City	B727	60	7,800	
		EA	Montego Bay	B727	8	1,040	
		EA	Montreal	B727	90	11,700	
		DL	Montreal	B727	30	3,900	
		EA	San Juan	L1011	90	22,500	
		EA	Toronto	L1011	60	15,000	
				DC9	30	3,600	
		DL	London	L1011	30	7,500	
		SN	Brussels	B707	18	2,700	75,740
	September	EA	Mexico City	B727	35	4,550	
		EA	Montego Bay	B727	9	1,170	
		EA	Montreal	B727	65	8,450	
				DC9	20	2,400	
		DL	Montreal	B727	30	3,900	
		EA	San Juan	L1011	90	22,500	
		EA	Toronto	L1011	60	15,000	
				DC9	30	3,600	
		DL	London	L1011	30	7,500	
		SN	Brussels	B707	18	2,700	72,370
TOTAL 1978 TO DATE							221,270
MONTHLY AVERAGE							73,757

TABLE 19
HOURLY DEPARTURES BY
AIRCRAFT TYPE AND AIRLINE
DECEMBER, 1978

	DELTA					EASTERN					SO			PI				NW			BI			OZ		FWA		UA			FE			FL		NC		Total
	DC9	727	DC8	L1011	Total	DC9	727	A3B	L1011	Total	DC9	SWM	Total	737	727	YSU	Total	727	DC10	Total	DC9	727	Total	DC9	DC9	737	DC3	MR4	Total	737	DC9	Total						
12 - 1 am	7	23	3	4	37	8	6	2	3	19																								56				
1 - 2																																						
2 - 3																																						
3 - 4																																						
4 - 5																																						
5 - 6						4	2			6																								6				
6 - 7	6	17	3	6	32	2	2		1	5	3	3	6	1	2	2	5							2									50					
7 - 8						2	1			3																							1	4				
8 - 9		3			3	1				1	3	2	5																					9				
9 - 10	2	1			3	15	11	1	1	28				1			1				1	1										2	35					
10 - 11	8	20	2	8	38	8	16		2	26	6	2	8	3			3		1	1				1							2	79						
11 - 12						5	4		2	11		2	2		2		2	1		1	1	1	2		1		1	1	2			1	24					
12 - 1 pm	12	19	2	5	38	8	3			11	3	1	4	2			2						1										60					
1 - 2		1			1	10	11			21	2	2	1				1																1	26				
2 - 3	7	13	1	1	22	8	12	1	2	23	2	3	5	1			1																1	53				
3 - 4	3	1			4	15	5			20	2	2	2	2			2				1	1											1	33				
4 - 5	6	14	4	5	29	3	4	1		8	1	3	4	1	1		2	1	1	2													46					
5 - 6	2				2	18	7	1	3	29	5	5	5								1	1											1	40				
6 - 7	9	24	3	3	39	10	12		1	23	1	2	3	2	1	1	4	1		1		1		1									1	72				
7 - 8		1			1	2	3			5	2	2	2	1		1	2																	12				
8 - 9	8	22	4	5	39	4	15	2	3	24	8	4	12		1		1		1	1		1	1										1	81				
9 - 10		1			1	4	4			8	1		1	2			2																	14				
10 - 11	5	5		1	11	5	5			10	1		1	1		1	1					1	1										26					
11 - 12						10	8			18																								18				
TOTAL	75	165	22	38	300	142	131	8	18	229	40	22	62	18	5	6	29	3	3	6	1	6	7	4	4	24	1	2	3	2	4	744						
PERCENT					40.3					40.2			8.3				3.4			0.8			0.9	0.5	0.5	3.2			0.4	0.3	0.5	100						

SOURCE: Official Airline Guide, December 15, 1978.

APPENDIX B
AIRCRAFT AND
AIRLINE STATISTICS

TABLE 20
U.S. DOMESTIC TRUNKS
PASSENGER REVENUE AND TRAFFIC
BY
TYPE OF FARE
November, 1978

		REVENUE PASSENGER MILES (000)	%	PASSENGER REVENUE (5000)	PASSENGER YIELD (CENTS)	REVENUE PASSENGER ENPLANEMENTS	AVERAGE ON-FLIGHT TRIP LENGTH (MILES)	AVERAGE
BRANIFF	Coach Total	484,891	88.99	44,916	9.26	781,488	621	
	Full	323,671	59.40	33,941	10.49	552,582	586	
	Other	161,220	29.59	10,975	6.81	228,906	704	
	First Class Total	59,991	11.01	7,437	12.40	93,051	645	627
	Full	58,984	10.83	7,343	12.45	91,388	645	
	Other	1,007	0.18	94	9.33	1,663	606	
DELTA	Coach Total	1,723,592	92.07	148,387	8.61	2,802,290	615	
	Full	907,808	48.49	94,157	10.37	1,688,935	538	
	Other	815,784	43.58	54,230	6.65	1,113,355	733	
	First Class Total	148,541	7.93	18,649	12.55	241,337	615	629
	Full	118,835	6.35	15,772	13.27	196,040	606	
	Other	29,706	1.58	2,877	9.68	45,297	656	
EASTERN	Coach Total	1,522,271	91.96	135,652	8.91	2,571,690	592	
	Full	806,611	48.73	88,047	10.92	1,545,976	522	
	Other	715,660	43.23	47,605	6.65	1,025,714	698	
	First Class Total	133,137	8.04	16,530	12.42	207,721	641	608
	Full	108,128	6.53	14,530	13.27	171,552	630	
	Other	25,009	1.51	2,180	8.72	36,169	691	
NORTHWEST	Coach Total	331,152	92.63	31,667	9.56	534,069	620	
	Full	226,673	63.41	24,371	10.75	402,616	563	
	Other	104,479	29.22	7,296	6.98	131,453	795	
	First Class Total	26,346	7.37	3,580	13.59	42,263	623	635
	Full	25,995	7.27	3,547	13.64	41,659	624	
	Other	351	0.10	33	9.40	604	581	
TWA	Coach Total	1,174,266	90.85	96,451	8.21	1,217,800	964	
	Full	628,522	48.63	61,474	9.78	757,794	829	
	Other	545,744	42.22	34,977	6.41	460,006	1,186	
	First Class Total	118,254	9.15	13,000	10.99	104,114	1,136	1,009
	Full	104,815	8.11	11,935	11.39	95,739	1,095	
	Other	13,439	1.04	1,065	7.92	8,375	1,605	
UNITED	Coach Total	2,325,590	93.10	190,037	8.17	2,891,846	804	
	Full	1,284,031	51.40	121,857	9.49	1,763,787	728	
	Other	1,041,559	41.70	68,180	6.55	1,128,059	923	
	First Class Total	172,380	6.90	17,967	10.42	154,298	1,117	836
	Full	155,459	6.22	16,697	10.74	140,836	1,104	
	Other	16,921	0.68	1,270	7.51	13,462	1,267	

SOURCE: AVIATION DAILY, January 25, 1979.

**TABLE 21
HISTORICAL AIRCRAFT LOAD FACTORS**

	U.S. DOMESTIC TRUNKS			INTERNATIONAL			LOCAL SERVICE
	DL	EA	TOTAL	DL	EA	TOTAL	TOTAL
1970	52.3	57.0	59.2	52.5	63.0	65.4	NA
1971	51.0	54.6	55.6	63.2	63.0	61.1	NA
1972	55.6	62.9	62.3	53.1	69.0	68.4	NA
1973	53.9	57.3	58.0	55.2	57.8	61.1	51.8
1974	65.5	69.4	63.4	54.1	67.0	61.3	56.6
1975	60.1	59.2	63.3	55.6	58.7	61.0	57.8
1976	57.6	57.0	61.9	59.4	61.6	67.3	57.1
1977	59.9	57.2	62.2	63.1	59.1	65.4	57.8
1978	69.5	71.4	70.9	81.7	75.3	75.8	NA

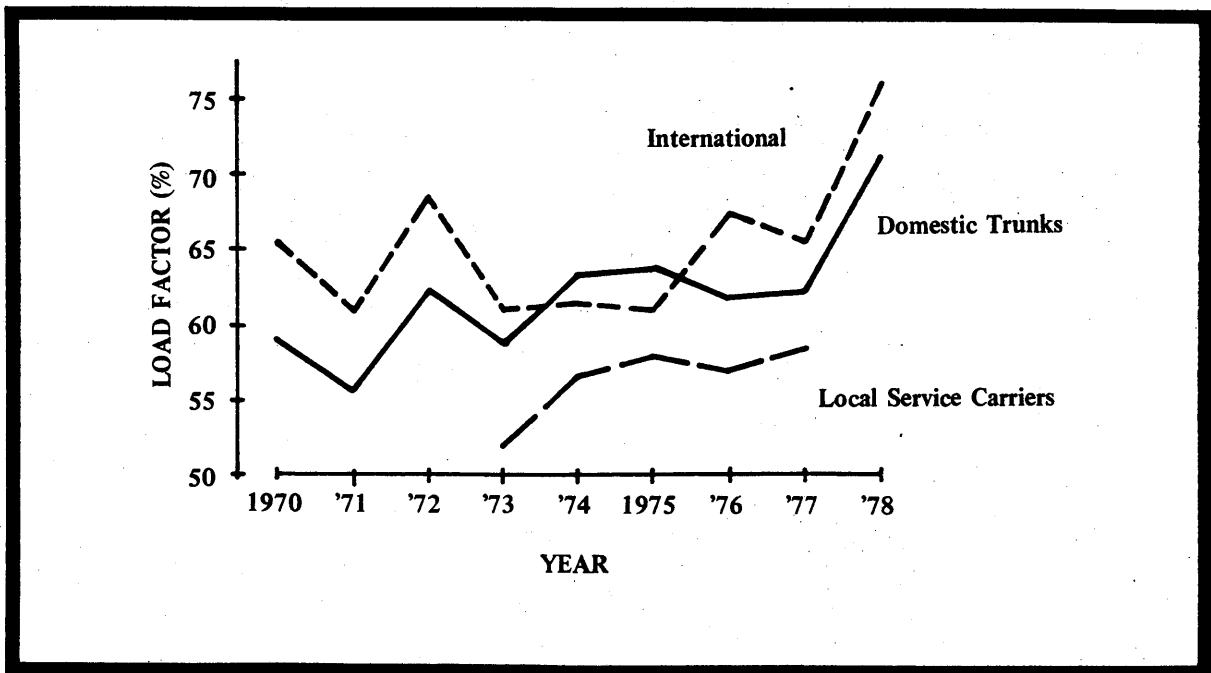


TABLE 22
COMPARISON OF LOAD FACTORS
BEFORE AND AFTER
FARE DEREGULATION

	U.S. DOMESTIC TRUNKS		INTERNATIONAL		LOCAL SERVICE	
	1977	1978	1977	1978	1977	1978
March	56.3	61.9	54.3	60.5	53.2	59.4
April	56.9	60.2	57.0	63.6	54.0	57.8
May	NA	NA	57.0	63.9	NA	NA
June	58.2	67.6	60.3	70.7	55.9	64.8
July	60.5	68.1	65.0	75.8	57.2	62.7
August	62.2	70.9	65.8	75.8	NA	NA
September	NA	NA	60.5	65.4	NA	NA
October	55.8	58.4	59.9	61.2	54.7	57.5

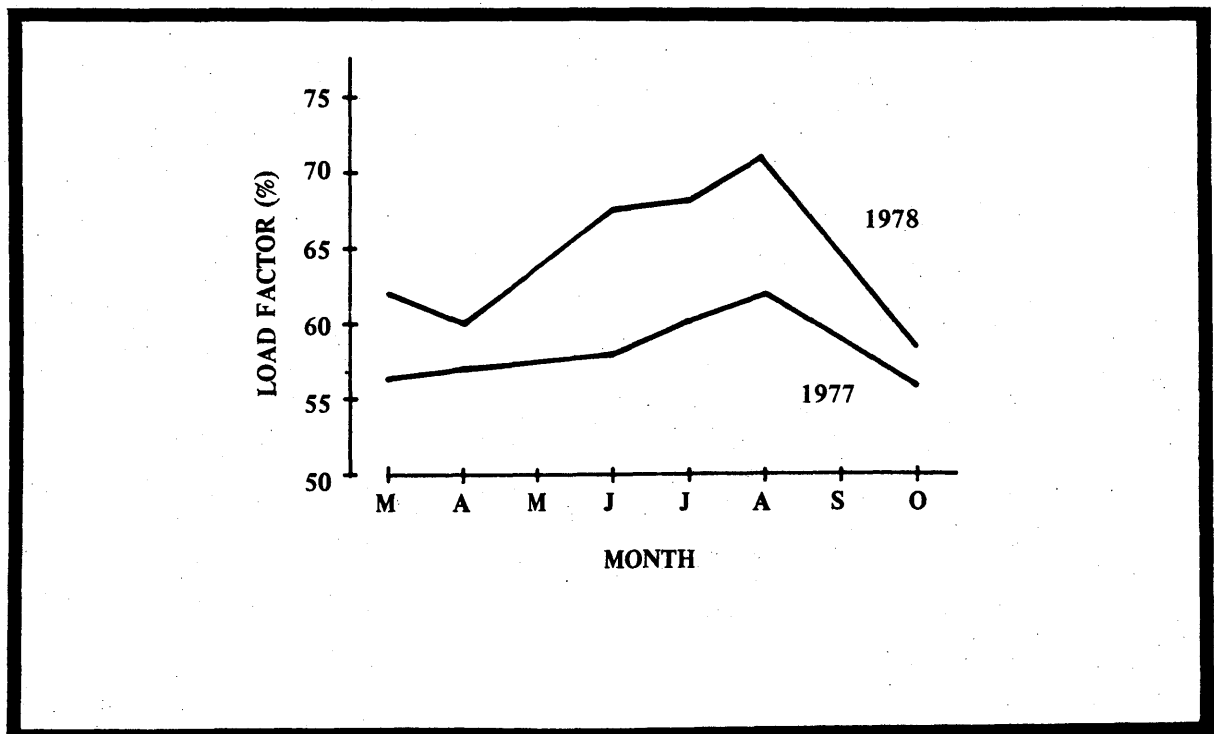


TABLE 23
RUNWAY LENGTH REQUIREMENTS
AND
MAXIMUM RANGE FOR
VARIOUS AIRCRAFT

	FAA Takeoff Field Length (Feet)	FAA Landing Field Length (Feet)	Maximum Still-air Range (Miles)
B727-100	7,950	4,800	3,000
B727-200	8,500	4,150	2,500
B737-100	5,700	4,000	1,300
B737-200	5,000	4,100	2,300
B747-100	9,000	6,200	6,900
B747-SP	7,800	5,250	8,520
DC8-50	10,000	4,920	8,720
DC8-61	10,000	6,000	7,150
DC8-62	9,800	4,820	8,500
DC9-10	6,500	4,470	2,040
DC9-30	5,530	3,900	3,000
DC9-50	7,750	4,350	2,550
DC10-10	9,000	5,140	5,900
DC10-30	10,500	5,290	7,220
DC10-40	12,250	5,430	6,710
F-27	5,600	3,660	1,530
L1011-1	7,960	5,690	3,400
L1011-100	10,640	5,800	4,400
L1011-200	8,070	5,800	4,280
L1011-5005	9,330	6,420	6,100
SWM	2,620	3,550	2,460

SOURCE: Aviation Week & Space Technology, March 21, 1977, p. 95.

TABLE 24
A SURVEY OF THE
FLEETS OF THE
AIRLINES SERVING ATLANTA

BRANIFF INTERNATIONAL AIRWAYS

Exchange Park

Dallas, Texas 75235

	Owned	Leased	On Order	On Option	Total
B727-100	17	6	0	0	23
B727-200	53	5	14	0	72
B747-100	0	1	0	0	1
B747-200	0	1	1	0	2
B747-SP	0	0	1	0	1
DC8-51	4	2	0	0	6
DC8-62	1	7	0	0	8
TOTAL	75	22	16	0	113

\$220 Million in Capital

11,500 Employees

DELTA AIR LINES

Hartsfield Atlanta International Airport

Atlanta, Georgia 30320

	Owned	Leased	On Order	On Option	Total
B727-200	96	7	28	0	131
B767-200	0	0	20	22	42
DC9-32	51	0	0	0	51
DC8-51	5	0	0	0	5
DC8-62	13	0	0	0	13
L1011-1	21	0	9	15	45
L1011-200	0	2	0	0	2
L1011-500	0	0	2	0	2
TOTAL	186	9	50	37	282

\$679.6 Million in Capital

30,316 Employees

EASTERN AIRLINES
International Airport
Miami, Florida 33148

	Owned	Leased	On Order	On Option	Total
B727-100	46	0	0	0	46
B727-225	29	21	15	0	65
B727-QC	21	3	0	0	24
B757	0	0	21	24	45
DC8-61	0	0	6	0	6
DC9-14	0	9	0	0	9
DC9-31	42	25	0	0	67
DC9-51	0	9	0	0	9
L811A	4	0	0	0	4
L1011	18	13	3	1	35
A300B4	4	0	19	0	23
TOTAL	64	71	65	25	325

\$384 Million in Capital
34,300 Employees

NORTHWEST ORIENT AIRLINES
Minneapolis-St. Paul International Airport
St. Paul, Minnesota 55111

	Owned	Leased	On Order	On Option	Total
B707-320C	2	0	0	0	2
B727-100	13	0	0	0	13
B727-200C	12	0	0	0	12
B727-200	40	0	0	0	40
B747-100	12	0	0	0	12
B747-200	0	0	4	0	4
B747-200B	5	0	6	0	11
B747-F	4	0	0	0	4
DC10-40	22	0	0	0	22
TOTAL	110	0	10	0	120

\$747.6 Million in Capital
11,445 Employees

UNITED AIRLINES
P.O. Box 66100
Chicago, Illinois 60666

	Owned	Leased	On Order	On Option	Total
B727-100	63	50	0	0	113
B727-200	40	3	31	0	74
B737-200	59	0	0	0	59
B747-122	9	9	0	0	18
B767	0	0	30	0	30
DC8-50	16	0	0	0	16
DC8-54F	14	0	0	0	14
DC8-61	25	6	0	0	31
DC8-62	4	5	0	0	9
DC10-10	29	8	5	0	42
TOTAL	259	81	66	0	406

\$897.9 Million in Capital
49,816 Employees

TRANS WORLD AIRLINES
605 Third Avenue
New York, New York 10016

	Owned	Leased	On Order	On Option	Total
B707	77	11	0	0	88
B707-Cargo	9	2	0	1	12
B727-100/100C	33	0	0	0	33
B727-100	0	2	0	0	2
B727-200	10	29	0	0	39
B727-231	0	0	7	0	7
B747	1	0	0	0	1
B747-131	0	10	0	0	10
DC9	14	0	0	0	14
L1011	20	8	0	2	30
TOTAL	164	62	7	3	236

\$532 Million in Capital
35,506 Employees

SOUTHERN AIRWAYS
Hartsfield Atlanta International Airport
Atlanta, Georgia 30320

	Owned	Leased	On Order	On Option	Total
SWM	7	0	0	0	7
DC9	29	0	0	0	29
DC9-10	0	0	8	0	8
DC9-30	0	0	4	0	4
TOTAL	36	0	12	0	48

\$21.3 Million in Capital
 2,922 Employees

FRONTIER AIRLINES

	Owned	Leased	Total
B737-200	13	11	24
CV-580	27	0	27
DH6-300	3	0	3
TOTAL	43	11	54

NORTH CENTRAL AIRLINES

	Owned	Leased	Total
DC9-30	18	9	27
DC9-50	9	0	9
CV-580	17	9	26
TOTAL	44	18	62

OZARK AIRLINES

	Owned	Leased	Total
DC9-10	7	4	11
DC9-30	21	7	28
F-27	14	0	14
TOTAL	42	11	53

PIEDMONT AVIATION

	<u>Owned</u>	<u>Leased</u>	<u>Total</u>
B727	3	0	3
B737	19	1	20
YS-11A	21	0	21
TOTAL	43	1	44

CAPITOL INTERNATIONAL

	<u>Total</u>
DC8	12

OVERSEAS NATIONAL AIRWAYS

	<u>Total</u>
DC8	7
DC10	2
TOTAL	9

TRANS INTERNATIONAL

	<u>Total</u>
DC8	8
DC10	3
L188	9
L382	12
TOTAL	32

WORLD AIRWAYS

	<u>Total</u>
B747	1
DC8	5
TOTAL	6

APPENDIX C
METHODOLOGY
FOR FORECASTING
FUTURE GATE
REQUIREMENTS

METHODOLOGY FOR FIGURING NUMBER OF GATES REQUIRED

Assumptions:

1. Take 3 highest volume hours for departures as seen in seen in Table 19.
2. Average these numbers for each aircraft and airline.
3. Figure for Delta, Eastern and Southern, since others are minor in comparison.

Total of Delta, Eastern and Southern equals approximately 91.5% of total departures.

4. Assume that peak hour departures as a percentage of the number of that particular aircraft in each airline's fleet will remain constant. Since Delta and Eastern are opting for purchase of larger aircraft (B767, B757,A-300), it is logical that they will use these aircraft on their high density markets, i.e., Atlanta, first where they can make the greatest profit.
5. From Historical experience, studying past patterns of the number of total aircraft as a percentage of total departures, and of total gate usage in the peak hour (peak hour departures and arrivals usually do not occur at the same time), one can work backwards to find the total number of aircraft likely to use the airport (and gate positions) in the peak hour.
 - a. Assume total daily departures equal total daily arrivals.
 - b. From historical trends, peak hour departures equal 11% of total departures.
 - c. From historical trends, peak hour operations equal 7.7% of total operations.
6. For 1990, assume that all aircraft on order as of 1978 will be delivered, and that Delta will have sold five DC8-51s.

**TABLE 25
EXISTING GATE REQUIREMENTS
BY AIRLINE**

	Departures in Peak Hour	Aircraft in Fleet	Pk. Hr. Departures % of Aircraft in Fleet
DELTA			
DC9	8.3	51	16.3
B727-200	22.0	103	21.4
DC8	3.0	18	16.7
L1011	5.3	23	23.0
TOTAL	38.6		
EASTERN			
DC9	7.3	85	8.6
B727	14.3	120	11.9
A300B4	0.7	4	17.5
L1011	2.0	31	6.5
TOTAL	24.3		
SOUTHERN			
DC9	5.0	29	17.2
SWM	2.7	7	38.6
TOTAL	7.7		
TOTAL	70.7		
OTHERS	6.6		
TOTAL	77.3		

**TABLE 26
FUTURE GATE REQUIREMENTS
BY AIRLINE**

	Departures in Peak Hour	Aircraft in Fleet	Pk. Hr. Departures % of Aircraft in Fleet
DELTA			
DC9	8.3	51	16.3
B727-200	28.0	131	21.4
DC8	2.2	13	21.4
L1011	7.8	34	23.0
B767	4.6	20	23.0
TOTAL	50.9		
EASTERN			
DC9	7.3	85	8.6
B727	16.1	135	11.9
A300B4	4.0	23	17.5
L1011	2.2	34	6.5
B757	2.4	21	17.5
TOTAL	32.0		
SOUTHERN			
DC9	7.1	41	17.2
SWM	2.7	7	38.6
TOTAL	9.8		
TOTAL	92.7		
OTHERS	8.3		
TOTAL	101.0		

APPENDIX D
METHODOLOGY
FOR DETERMINING
FUTURE FACILITY
REQUIREMENTS

1. Ticket Counters

Linear Feet of Frontage

This is determined for each airline based on EQA in the peak hour for that airline as applied to the curve in Exhibit 45.

2. Airline Ticket Counter/Office Support Space

Includes:

Accounting & safe-keeping of receipts

Agent supervision

Communications

Information display equipment

Personnel lounges

Supervisor office

Manager office

Storage of office and counter supplies

Use Exhibit 46 for each airline.

3. Outbound Baggage & Baggage Handling

Assume:

Bag room located on different floor from ATO counters

1.3 bags per passenger

Tilt tray sorter system used by the airlines

Use Exhibit 47.

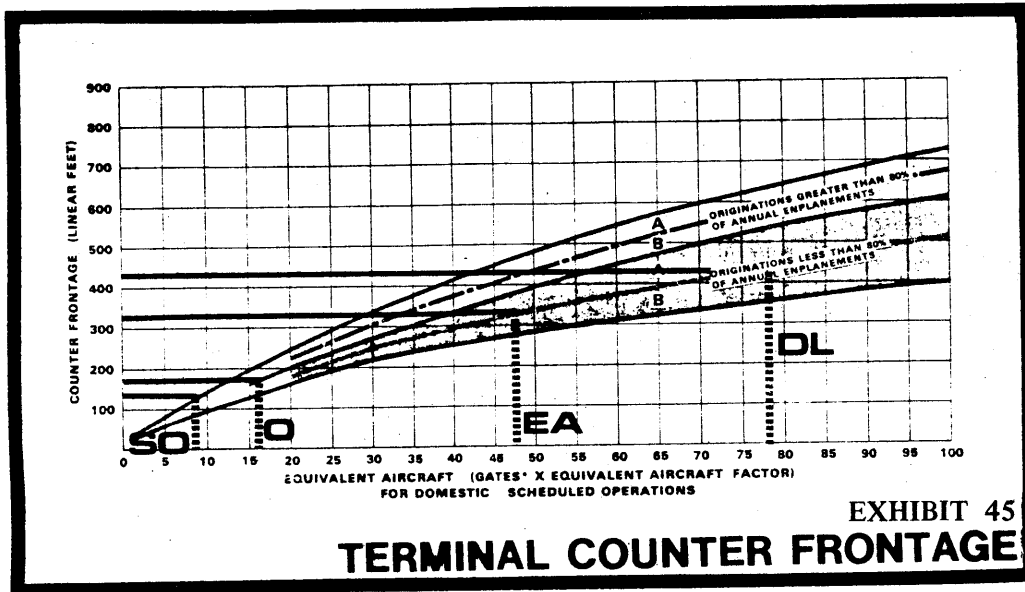
4. Baggage Claim

Use flat-bed - Direct-feed as seen in Exhibit 48.

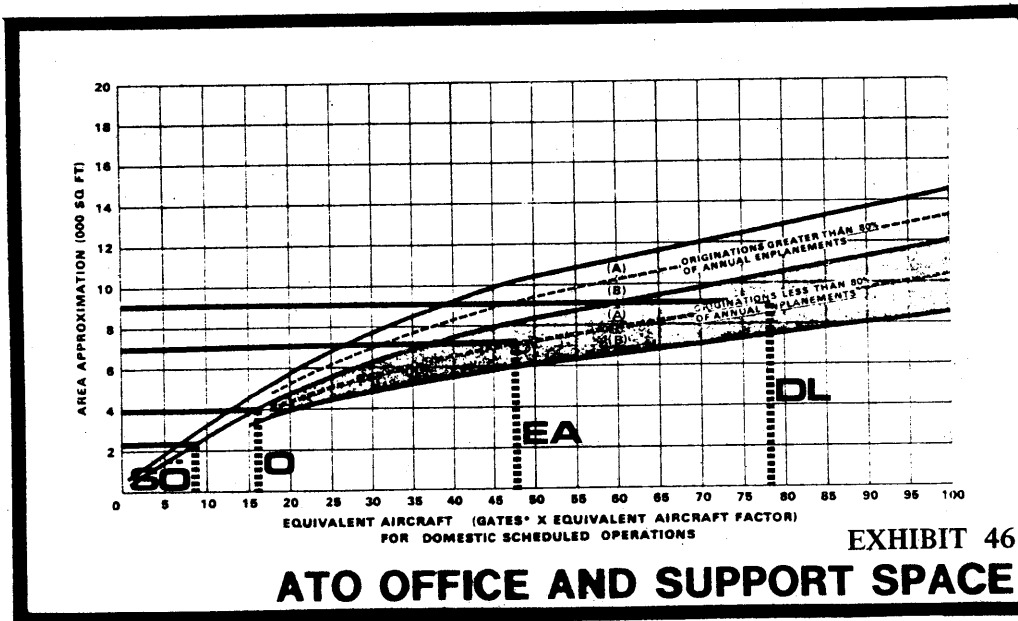
Linear feet of display for each airline is derived from Exhibits 49 & 50.

Baggage Claim Area

Use Exhibit 51 for each airline.



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-8.



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-9.

(A) TYPICAL WHERE PEAK HOUR GATE UTILIZATION HAS HIGH PERCENTAGE OF DEPARTURES (EQUAL OR GREATER THAN 80% OF EQUIVALENT AIRCRAFT).
 (B) TYPICAL WHERE PEAK HOUR GATE UTILIZATION COMBINES ARRIVALS AND DEPARTURES (DEPARTURES LESS THAN 80% OF EQUIVALENT AIRCRAFT).

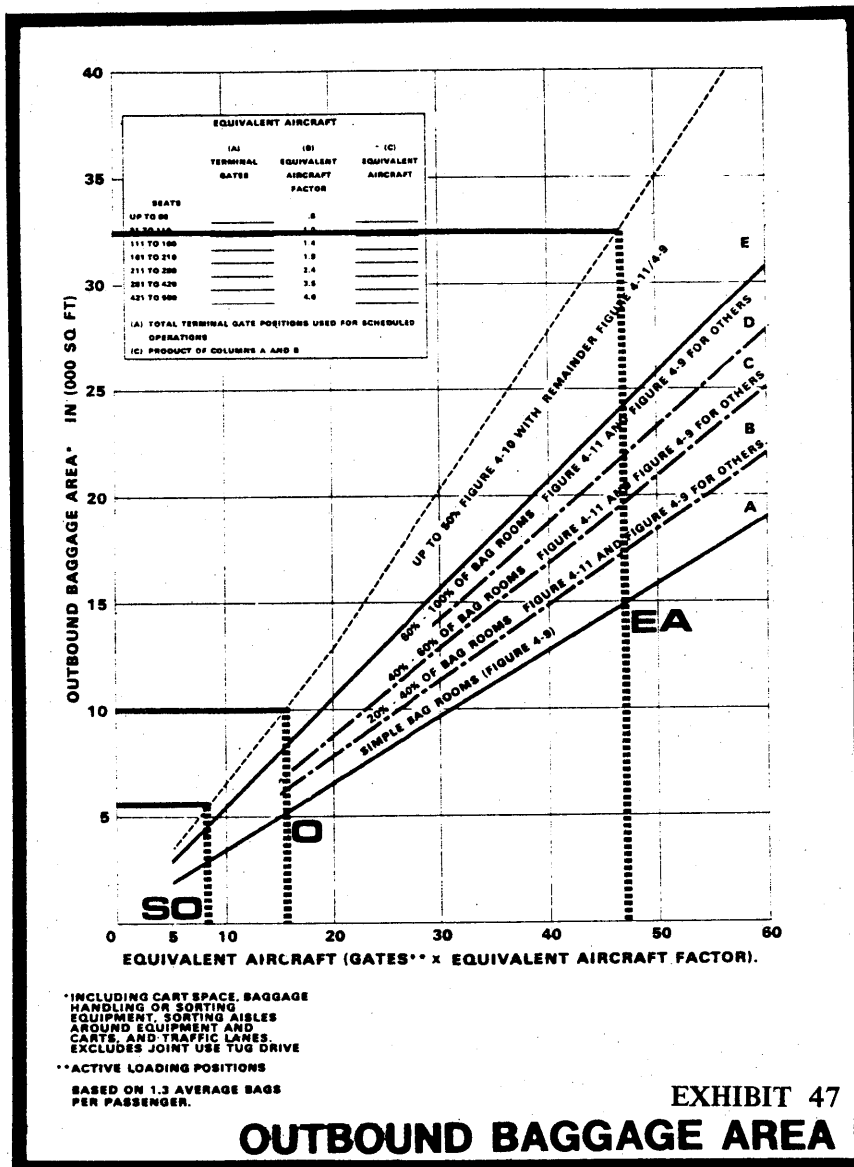
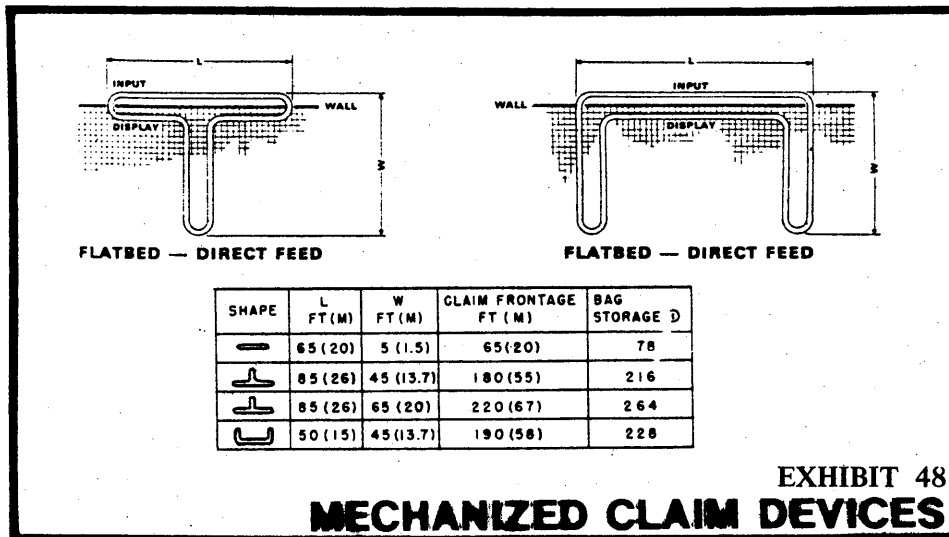


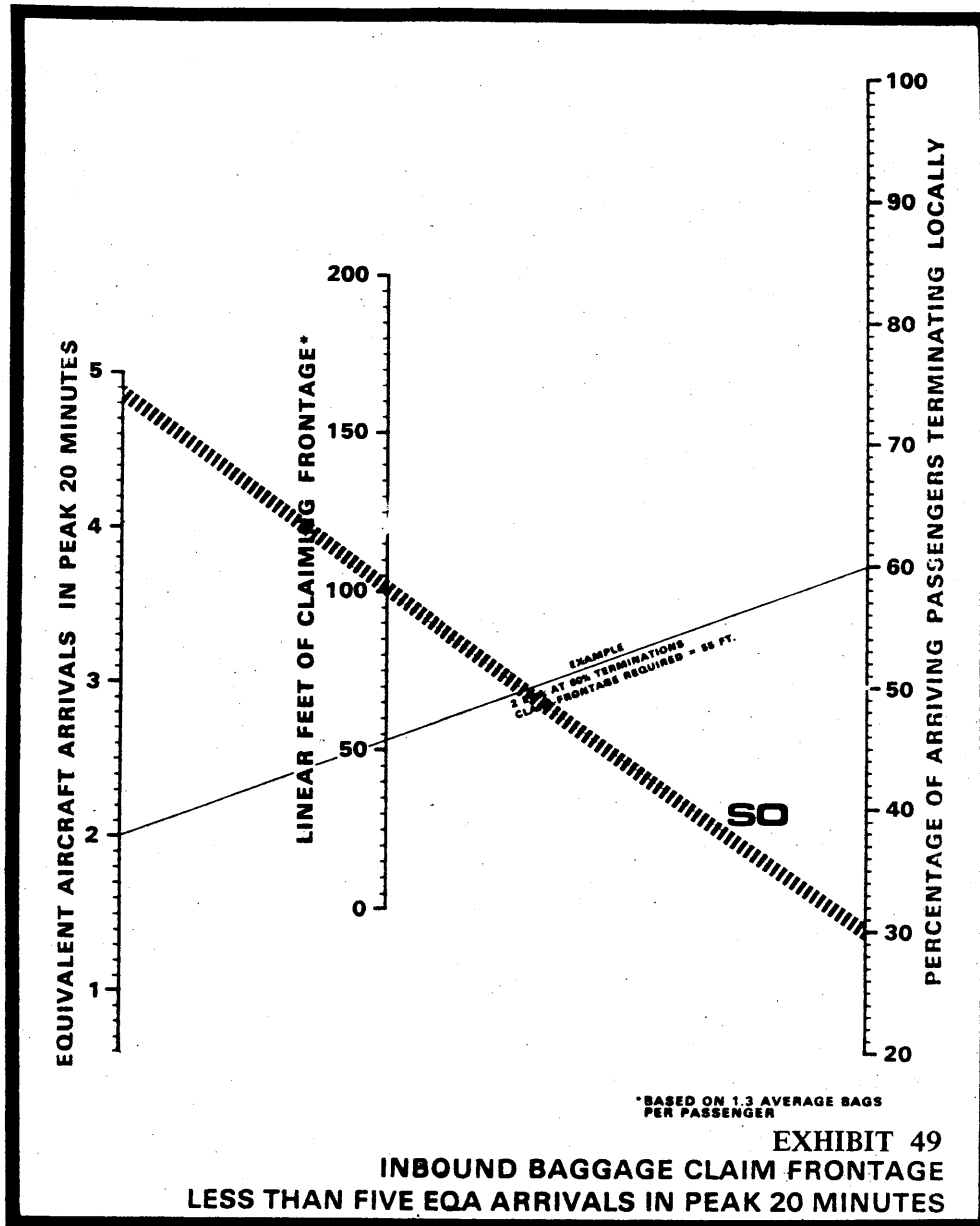
EXHIBIT 47

OUTBOUND BAGGAGE AREA

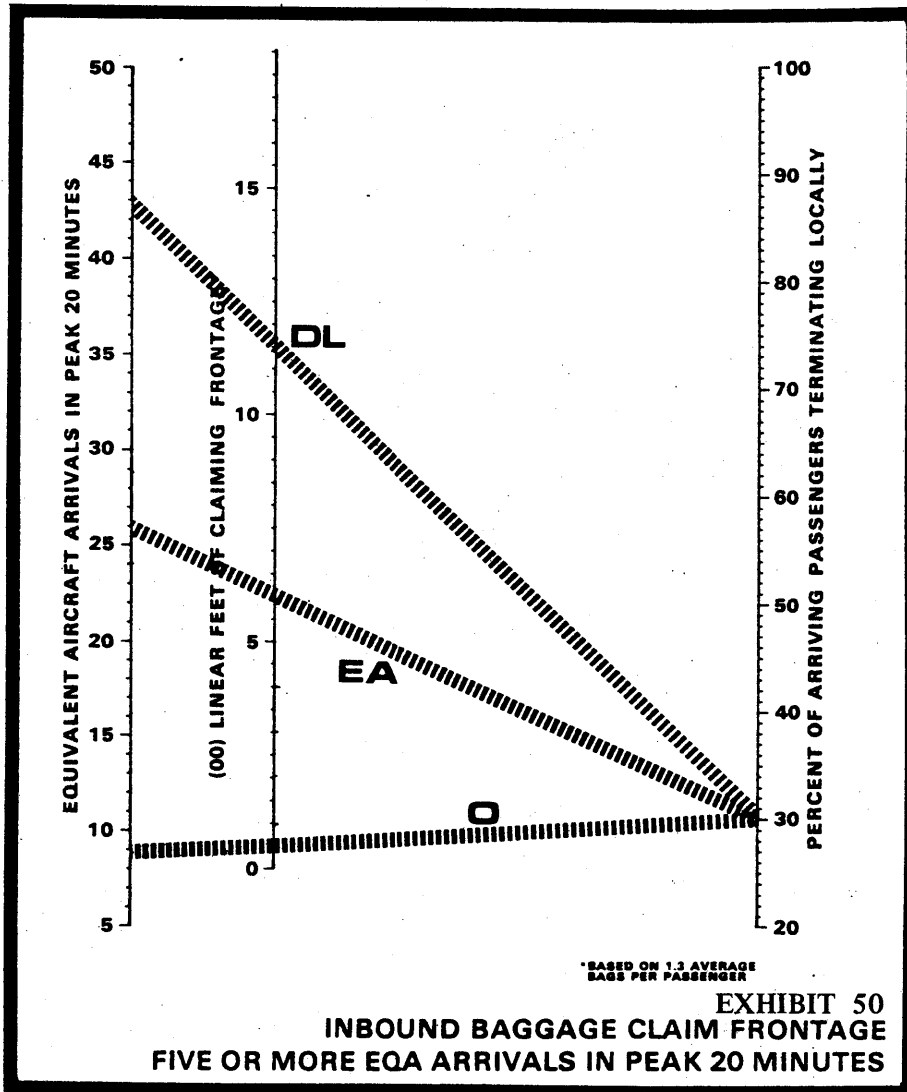
Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-22.



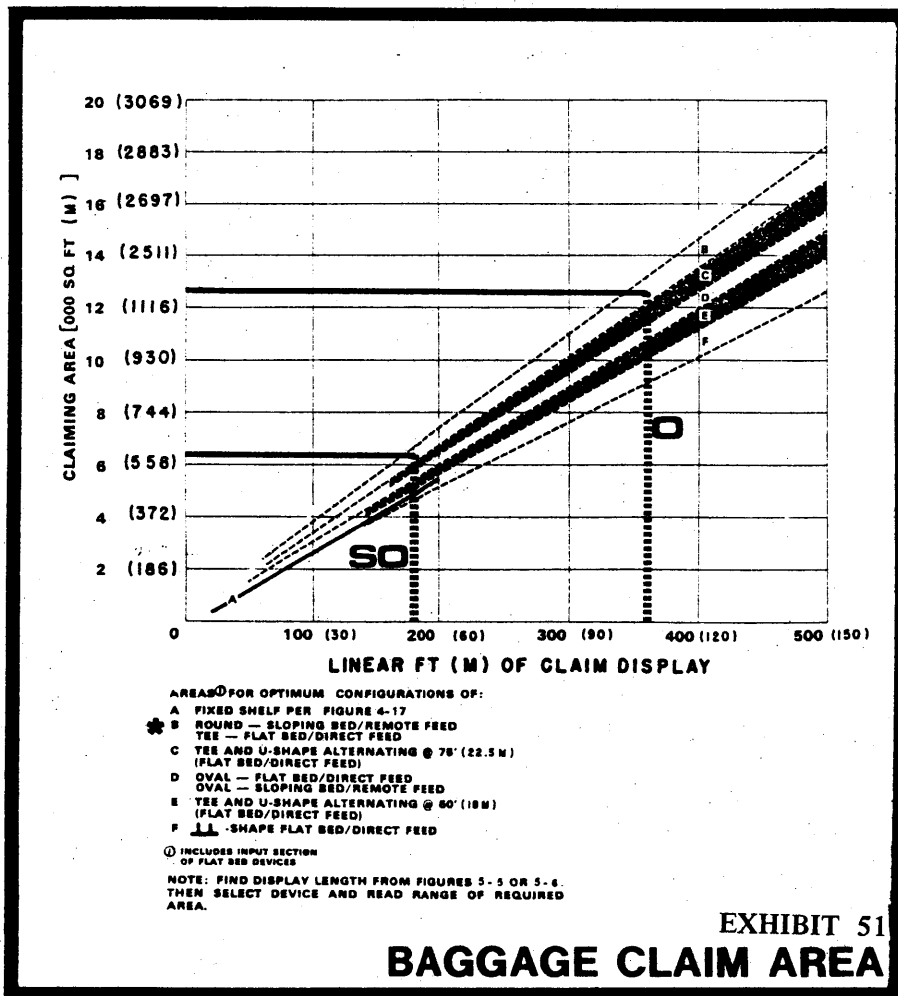
Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-25.



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-29.



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-30.



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-31.

Input Area

Use Exhibit 52 for each airline.

5. Airline Operations/Support

Use 500S.F./EQA Departure from Parsons, p. 3-25.

6. Departure Lounges

Use Parsons, p. 3-22, and Exhibit 53 for each airline.

7. Security

One security unit for 500 to 600 passengers per hour
or 165 to 198 passengers in 20 minutes.

Scenario 1: only originating passengers need security check.

Assume: 60 to 70% are departures (use 65%)

$$18,706 \times .65 = 12,159$$

30% of these are originations

$$12,159 \times .30 = 3,648$$

passengers + visitors = 1.1 x passengers

$$3,648 \times 1.1 = 4,012$$

Assume 1/2 arrive in peak 20 minutes

$$4,012 \times .5 = 2,006$$

$$\frac{2,006}{165} = 12 \qquad \frac{2,006}{198} = 10$$

@120 S.F./unit = 1200 to 1400 S.F.

Scenario 2: only arriving passengers don't need security check

Assume: 65% are departures

$$18,706 \times .65 = 12,159$$

30% of these are originating

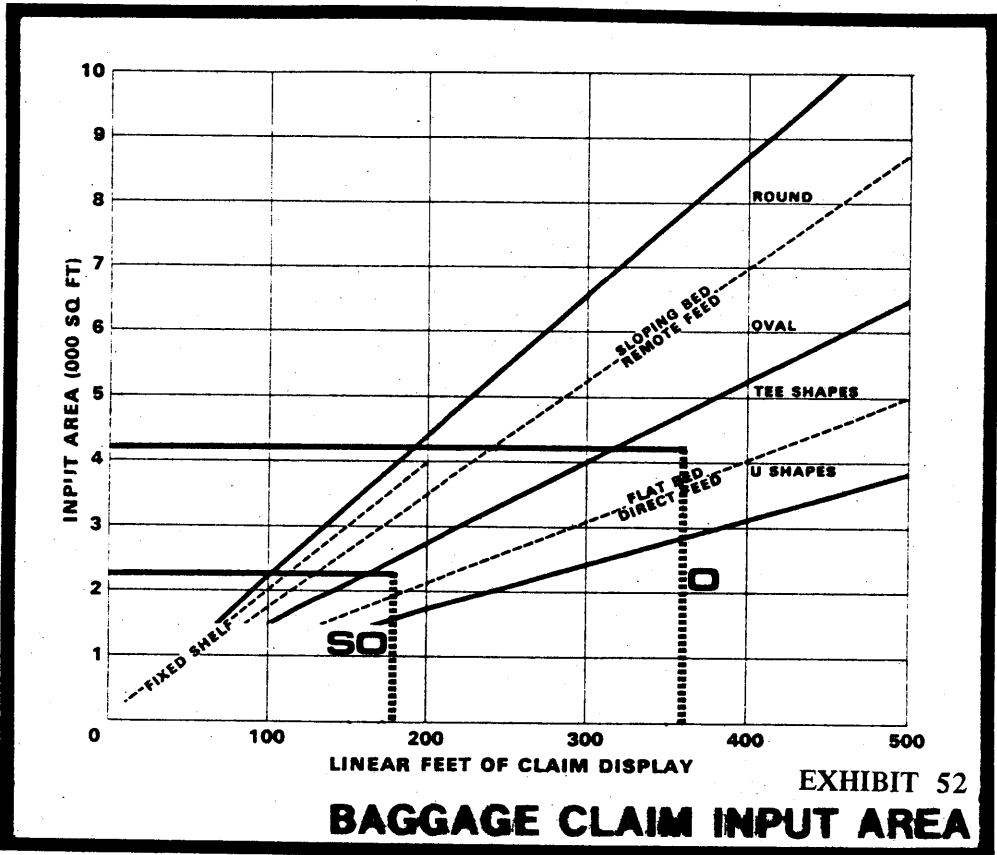
$$12,159 \times .30 = 3,648$$

passengers + visitors = 1.1 x passengers

$$3,648 \times 1.1 = 4,012$$

$$\text{Transfers} = 12,159 - 3,648 = \underline{\underline{+8,511}}$$

12,523



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-32.

AIRCRAFT TYPE MODEL	SEAT CAPACITY RANGE	TOTAL AREA (FT ²) RANGE
CV-580; DC-9 -10; BAC-111; YS-11-B; M-404; F-227B	40 TO 80 AV 60	350 TO 675
B-737; B-727 -100; DC-9 -30; CV-880	90 TO 110 AV 100	600 TO 1,100
DC-8 -50; DC-8 -62; B-727 -200; B-727 -300; B-707 (ALL); B-720	120 TO 160 AV 140	850 TO 1,500
DC-8 -61	170 TO 210 AV 190	1,200 TO 2,000
DC-10, L-1011	220 TO 280 AV 250	1,500 TO 2,500
B-747	300 TO 420 AV 360	2,200 TO 3,800

*** 40 TO 80% LOAD FACTORS**

**EXHIBIT 53
DEPARTURE LOUNGE AREA/
TYPE OF AIRCRAFT SERVED***

Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 3-22.

Assume 1/2 are in peak 20 minutes

$$12,523 \times .5 = 6,262$$

$$\frac{6,262}{165} = 38 \qquad \frac{6,262}{198} = 32$$

$$@120 \text{ S.F./ unit} = 3795 \text{ to } 4560 \text{ S.F.}$$

8. Ticket Lobby

Includes:

- Depth of counter
- Primary circulation
- Flight insurance
- Information counter
- Minimal seating

See Exhibit 54.

9. Waiting Lobby

Assume: departure lounges provided for all gates

Lobby sized to seat 15 to 20% (use 20%) of design hour enplaning passengers and visitors.

$$\text{TPHP} = 18,706$$

$$\text{Enplanements} = .65 \times 18,706 = 13,094$$

$$\text{Originations} = .30 \times 13,094 = 3,928$$

$$\text{Visitors} = .50 \times 3,928 = 1,964$$

$$3,648$$

$$\begin{array}{r} 3,648 \\ + 1,964 \\ \hline \end{array}$$

$$5,892 \times .25 = 1,473 \text{ seats}$$

Use Exhibit 55.

10. Claim Lobby

Area for claim lobby = width of Claim Device x 35'
per claim device.

In this case, use: width = 85'

$$\text{Therefore, area per device} = 85 \times 35 = 2,975 \text{ S.F.}$$

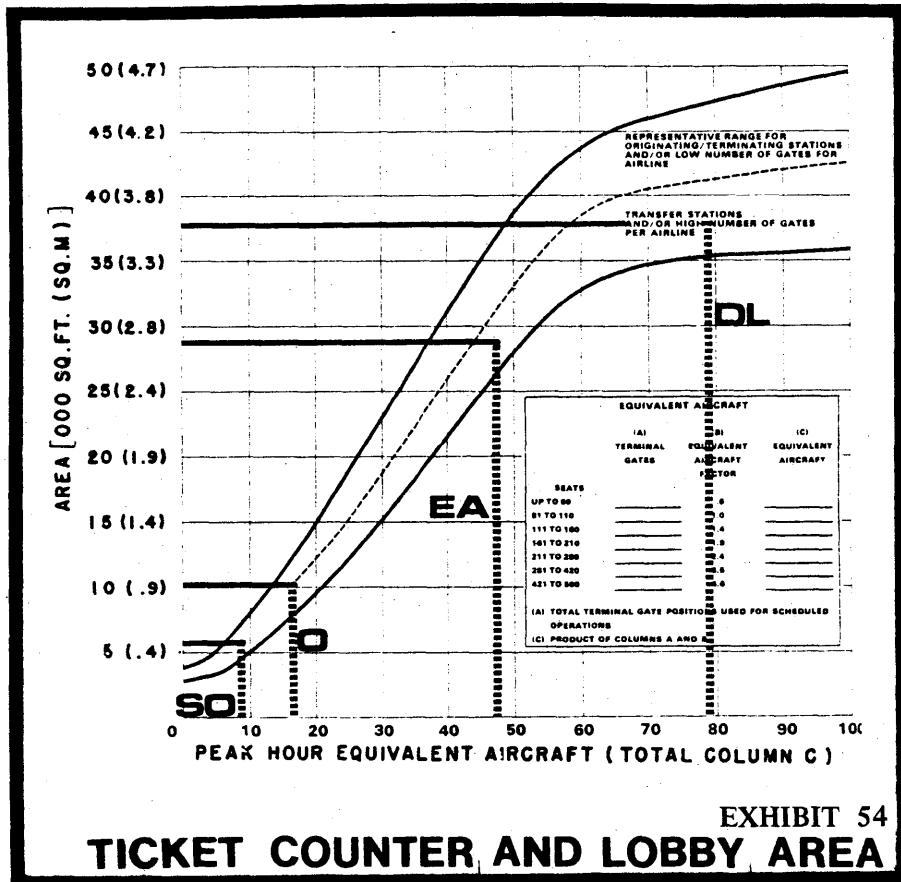
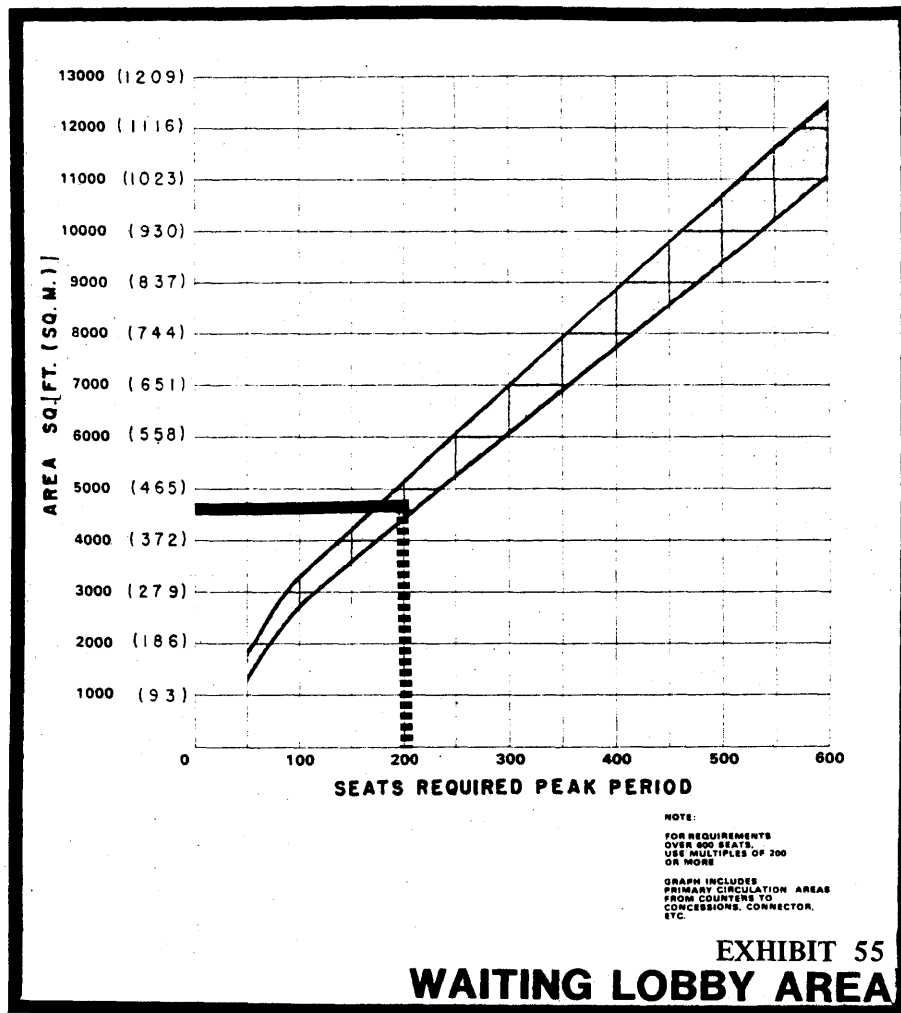


EXHIBIT 54
TICKET COUNTER AND LOBBY AREA

Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-10.



Source: U.S. Department of Commerce, The Apron and Terminal Building Planning Manual, by Ralph M. Parsons Company, July, 1975, p. 4-12.

11. Food and Beverage Service

Includes:

- Snack bars
- Coffee Shops
- Restaurants
- Bar - Lounges

Average Daily Use Factor = 20% to 40% (Parsons, p 4-34.)

A. Gross Area:

$$\begin{aligned} \text{Annual Enplanements} &= 16,700,000 @ 30\% \text{ use factor} \\ 2 & \\ &= 91,850 \text{ S.F.} \times 2 \\ &= 183,700 \text{ S.F.} \end{aligned}$$

B. Assume 6 Satellites:

$$\frac{183,700}{6} = 38,000 \text{ S.F. per satellite}$$

12. Building Services

1. Toilets

1,333 S.F. / million annual enplanements (Parsons, p. 4-37).

$$33.4 \times 1,333 = 44,522, \text{ S.F.}$$

2. Offices

Assume 60,000 S.F.

3. Other

Assume 10,000 S.F.

13. Concessions

From Parsons, p. 4-35.

14. International Facilities

From Parsons, p. 4-44

15. Enplaning Curb

TPHP in Design Hour = 18,706
 Assume Enplanements = 70% of TPHP = 13,094
 Assume 50% are in peak 20 minutes = 6,547
 30% are Originations;

Modal Choice: (Parsons, p. 5-17)

SCENARIO I - No MARTA

Private auto	84%	=	1,650
Taxi	9%	=	177
Public Bus	2%	=	39
Limo	5%	=	98
	100%		1,964

SCENARIO II - MARTA is built

MARTA	20%	=	393
private auto	66%	=	1,296
Taxi	9%	=	177
Public bus	0	=	0
Limo	5%	=	98
	100%		1,964

Assume 30% of those who drive use parking

Scenario I 1,650 x .3 = 1,155
 Scenario II 1,296 x .3 = 907 use curb

Assume a 1:1 visitor:passenger ratio at curb

Scenario I 2,310
 Scenario II 1,814 people at curb

Assume occupancy of private vehicle = 1.5 @ 2 minutes dwell time:

Enplaning curb required =

$$\frac{60 \text{ min/hr}}{2 \text{ min/ vehicle}} = 30 \text{ Vehicles per hour}$$

Scenario I:

$$\frac{2,310 \text{ passengers}}{(1.5 \text{ pax/veh}) (30 \text{ veh/hr.})} = 51 \text{ slots @ } 25' \text{/slot} = 1,283'$$

Scenario II:

$$\frac{1,814 \text{ passengers}}{(1.5 \text{ pax/veh}) (30 \text{ veh/hr})} = 40 \text{ slots @ } 25' \text{/slot} = 1,000'$$

16. Deplaning Curb

Assume same numbers as for Enplaning curb, except that dwell time
= 5 minutes.

$$\text{Scenario I: } 2.5 \times 1,283' = 3,207'$$

$$\text{Scenario II: } 2.5 \times 1,000' = 2,500'$$

17. Parking

Assume 30% passengers are enplaning.

From Fig. 5-9 in Parsons:

$$\text{Short - Term spaces req.} = 8,925$$

$$\text{Long - Term spaces req.} = 1,575$$

$$\text{TOTAL} \quad \quad \quad 10,500$$

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