12-1994

The Effects of the Proposed Larger Aircraft on Airport Capacity in the United States

Kerwin S. McKenzie

Embry-Riddle Aeronautical University - Daytona Beach

Follow this and additional works at: http://commons.erau.edu/db-theses

Part of the Management and Operations Commons

Scholarly Commons Citation

This thesis is brought to you for free and open access by Embry-Riddle Aeronautical University – Daytona Beach at ERAU Scholarly Commons. It has been accepted for inclusion in the Theses - Daytona Beach collection by an authorized administrator of ERAU Scholarly Commons. For more information, please contact commons@erau.edu.
UMI Number: EP31960

INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

UMI®

UMI Microform EP31960
Copyright 2011 by ProQuest LLC
All rights reserved. This microform edition is protected against unauthorized copying under Title 17, United States Code.

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346
THE EFFECTS OF THE PROPOSED LARGER AIRCRAFT ON AIRPORT CAPACITY IN THE UNITED STATES

by

Kerwin Saint Aubyn McKenzie

This thesis was prepared under the direction of the candidate's thesis advisor, Dr. Hank Lehrer, Department of Aeronautical Science, and has been approved by the Project Review Committee. It was submitted to the Department of Aeronautical Science and was accepted in partial fulfillment of the requirements for the degree of Master of Aeronautical Science.

PROJECT REVIEW COMMITTEE:

Dr. Hank Lehrer
Project Advisor

Dr. John Wise
Project Reader

Dr. Frank Richey
Project Reader

Charles Richardson
Program Coordinator, Aeronautical Science

Shannon Trabue
Department Chair, Aeronautical Science

Date: Apr 6 1995
ACKNOWLEDGMENTS

The author wishes to express special thanks to the Thesis Chairman, Dr. Henry Lehrer, whose constant encouragement, helpful counsel, and practical suggestions were critical to the successful outcome of this thesis. Dr. Lehrer's extensive knowledge of the air transportation system was invaluable in completing this work. Appreciation is also due to Dr. John Wise, Thesis Committee Member, for his assistance in preparing this manuscript. His guidance, tips, and suggestions proved to be very effective in this project. Also, thanks to Dr. Frank Richey, Thesis Committee Member, for his help and guidance in reading my work. A special thanks to Alix Puech for initial copy editing of this work. Mention must be made of the help given by members of the Avion;Embry-Riddle's school newspaper. Special mention to Garrett Taylor and Rob Reichenbach for field testing the questionnaire in its infancy. The staff of the Mathematics Space Lab must also be thanked. Without your assistance, this would never have been possible. Thanks to Aung Tun for the use of his computer to make the final changes to this paper. Thanks to Jan Collins for printing the slides when it seemed as if I could not get it done on time. If I forgot to mention anyone it was not intentional. Thanks.

This statement of acknowledgment would be incomplete without a formal expression of sincere appreciation and gratitude to my friends and family for providing the assistance and encouragement needed to complete the task. Special thanks to my high school math teacher, Mrs. Regna Brown for being such an inspiration, and putting up with my antics. I almost forgot the help so generously given by Catherine McClellan in organizing the questionnaire and fine tuning the title of this work. Thank you Cathy.

Thanks to the airport managers and aircraft manufacturers who took the time out of their busy schedules to answer the questionnaire and send me information requested.
Special thanks to Josephine and Curtis McKenzie for always being there whenever I needed them. These are the best parents anyone could have. Thanks a million.

This volume is dedicated to the memory of Christopher O’Neil Savory and Ava Wright, both, “gone too soon.”
The problem of airport capacity is one that has been around for some time. With air travel projected to increase into the year 2000, Airbus Industrie, Boeing Corporation and McDonnell Douglas are making plans or are in the process of building large transports. Airbus has built the A340/A330 and is planning the now named A3XX, a 600 plus seater. Boeing is currently flying the 747-400 which holds up to 570 passengers. In addition, Boeing rolled out the 777 in June 1994, which holds up to 550 passengers. Douglas is planning the MD-12 with a 700 plus passenger load. The purpose of this study is to investigate the effects of these large transports on airport capacity within the United States. The study will try to show a relationship, if any, between airport capacity and the introduction of these large transports. Data was acquired by surveying airport managers at sample U.S. airports.
# TABLE OF CONTENTS

ACKNOWLEDGMENTS iv
ABSTRACT vi
LIST OF TABLES ix

Chapter

1 INTRODUCTION 1
   Statement of the Problem 1
   Review of the Related Literature 2
      The Need for Large Transports 2
   American Large Transports 3
      The 777 Twinjet 3
      The 747 3
      The MD-12 4
   European Large Transports 5
      The A330 5
      The A340 5
      The Super Jumbo 6
   Inherent Large Transports Problems 6
   Airport Congestion 7
   Types of Capacity Problems 8
   The Size Factor 9
   Airport Design 9
   Statement of the Hypothesis 10

2 METHOD 11
   Subject/Samples 11
   Instruments 12
   Design 12
# TABLE OF CONTENTS

Procedure ........................................................................................................... 13

3. ANALYSIS ....................................................................................................... 14

Summary ........................................................................................................... 35

4. CONCLUSION ................................................................................................ 37

5. RECOMMENDATIONS .................................................................................. 41

REFERENCES .................................................................................................... 44

APPENDIX A ....................................................................................................... 47
LIST OF TABLES

Table 1  Capacity of Ramp Parking Facilities 14
Table 2  Arrival Queue(s) 15
Table 3  Departure Queue(s) 16
Table 4  Baggage Capacity 16
Table 5  Customs Area(s) Capacity 17
Table 6  Staffing Requirements Security 18
Table 7  Staffing Requirements Customs 18
Table 8  Staffing Requirements Maintenance (Airplane Cleaning, etc) 19
Table 9  Staffing Requirements Baggage Claim 20
Table 10  Staffing Requirements Tarmac 20
Table 11  Staffing Requirements Emergency team 21
Table 12  Number of Airport Busses Required 22
Table 13  Number of Taxicabs Required 22
Table 14  Airport Revenue 23
Table 15  Lavatory Capacity 24
Table 16  Time Required for Passenger Boarding 24
Table 17  Capacity of Restaurant Facilities 25
Table 18  Average Service Time of Aircraft at the Gate 26
Table 19  Airport Employees' Parking Capacity 26
Table 20  Airport Visitors' Parking Capacity 27
Table 21  Immigration Area Capacity 28
Table 22  Gate Capacity/Size 28
Table 23  Road Traffic Approaching Airport 29
Table 24  Time Required for Deplaning 30
Table 25  Runway Length 30
Table 26  Baggage Area(s) Capacity <10,000,000 Enplanements 32
LIST OF TABLES

Table 27. Baggage Area(s) Capacity >10,000,000 Enplanements ...............32
Table 28. Capacity of Restaurant Facilities <10,000,000 Enplanements ......33
Table 29. Capacity of Restaurant Facilities >10,000,000 Enplanements ......34
Chapter 1

Introduction

Most major airports suffer the same congestion problems at different times of the day. For the New York area it is the 4 to 8 p.m. time slot; this is the time when the international flights arrive into John F. Kennedy (JFK) airport. For the west coast, at Los Angeles (LAX) it is the 9 a.m. to 12:30 p.m. time slot; international and Hawaii departures as well as arrivals from the east coast. The excess air traffic is caused due to the arrival of many flights at the same time, and the airport's inability to handle such traffic.

Congestion in the world's airports is expected to worsen as one and a quarter million passengers board commercial flights each day. The increase coincided with deregulation in 1978 (Ausrotas & Simpson, 1992). Sinha (1988) also agreed, adding that the creation of the hub-and-spoke airline networks has also contributed to congestion attributed to capacity problems.

Airport authorities around the world have been battling with this problem since the 1970s (Airport Associations Coordinating Council & International Air Transport Association [AACC & IATA], 1990), and aircraft builders such as Airbus Industrie (Airbus), Boeing Corporation (Boeing) and McDonnell Douglas (Douglas) are building larger airplanes that will eventually carry more passengers into these airports, thus further compounding this problem. The capacity problem is not only felt on the airside (air traffic control (ATC)) of the airport but also on the landside in areas such as parking, ramp space, customs, and immigration areas to name a few.

Statement of the Problem

Already, airports are faced with passenger capacity problems. That is to say, more passengers are using the airports than the airports were originally designed to accommodate. With the proposed building of larger aircraft, by Airbus (A330/340; both already flying, A3XX; expected in the year 2002), Boeing (747-400; already flying, 777;
rolled out in June 1994), and Douglas (MD-12; being developed), airport capacity in the U.S. is diminishing. The purpose of this paper is to investigate the effects of these larger airplanes on airport capacity within the United States. The focus is on the airports that will be providing service to these airplanes.

Review of the Related Literature

A traveler's aim is to get from one place to the next in as short a time as possible. The Douglas Aircraft Company reports that passenger traffic is expected to rise at a rate of 6.4% in 1993, as a result of the world's economy picking up. Douglas also forecasts a 6.7% world total increase over the next eight year period. These figures are based on market trends (Douglas Aircraft Company [DAC], 1991b).

The Need for Large Transports

Donoghue (1992) agrees with Douglas' forecasts and sees the need for the MD-12 with its projected 700-plus passenger capacity. The unloading time would increase considerably over an airplane of say, the capacity of a Boeing 747. Smaller derivatives of the MD-12 will seat about 430-511 passengers, this is still a stretch above the conventional 300 or so passengers the DC-10 and the 747 carries.

Douglas' defense for building larger transports stems from their data for the period 1970 to 1990. The data showed that passenger jetliners in service grew 6% annually, approaching 8,000 aircraft by 1990. Substantial fleet growth will be needed to handle the projected twenty years ahead into 2010, where Douglas foresee at least 17,000 aircraft in operation. The MD-12, and the 747-400 are foreseen as long range 400 passenger substitutes, while the MD-12MR, Boeing 777-200 and Airbus' A330 are seen as the medium range 400 passenger solutions (DAC, 1991a). Douglas also sees the 600-seat class expanding twenty fold, while the 400-seat class fivefold. With these forecasts in mind, there will definitely be a need for airplanes such as the Airbus A330/340, the Douglas MD-12, and the Boeing 747-400 and the 777.
Sinha (1988) says that the growing size of aircraft are likely to result in about a 30-50% capacity increase caused by wide bodies during peak hours, thus shifting the problem to the apron, gate, parking, and main terminal handling.

The Boeing Commercial Airplane Group looks at the situation of passenger transport differently from Douglas. According to Boeing, the average age of the world fleet is nearly 12 years. Almost 2,000 of about 9,200 airplanes are over 20 years old, 65% of these are in the U.S. These airplanes need to be replaced. The Asian and the European fleets are considerably younger at 8 and 9 years respectively (Boeing Commercial Airplane Group [BCAG], 1992).

**American Large Transports**

**The 777 Twinjet.** In light of this, Boeing has developed an all new airplane, the 777 twinjet. The 777 which is designed to carry 305 - 440 passengers flew without major problems for the first time on June 12, 1994, from Boeing’s Paine Field in Washington (Proctor, 1994b). Delivery of the first airplane to United Airlines is scheduled for May 1995, certification is scheduled for April 1995 (Proctor, 1994c).

The 777-200, the first model to be made available, will seat up to 305 passengers for the long range “B” market. The short range “A” market will seat up to 375 passengers, with 7-abreast. These are both 3-class configurations, with 24 in first, 54 in business, and 227 in economy class. The -200 model will seat 440 in a single class configuration with 10-abreast. The 777-200 is 209 ft. 1 in. in length with a 199 ft. 11 in. wingspan. The soon to be developed derivative, the 777 Stretch will be 242 ft. 4 in. long and seating 550 passenger in a single class, high density configuration. The 777 can have 12 lavatories and up to nine galleys, depending on customer specifications. The 777 is only 10 in. narrower (19 ft. 3 in.) than the 747 at the seat level (Proctor, 1994b).

**The 747.** The Boeing 747-400 holds 350-450 in a typical 3-class configuration while a denser single economy class will yield 570 passengers. The 747-400 has a wingspan of 211 ft., 2 ft. longer than that of the 777 (Smith, 1992b). Boeing is also
considering developing derivatives of its 747 line; a stretch version of the 747-400 series or a double decker version, the second deck would run the entire length of the fuselage (Woolsey, 1992). The project is dubbed the 747X and will compete directly with Airbus' A3XX (Mecham, 1994). The airplane will be capable of carrying 550 to 800 passengers, with the average being at least 625 in a typical three-class configuration. The idea, says Boeing, is to have one flight leaving say New York's JFK to London's Heathrow instead of having three flights a day. Boeing sees consolidation of flights as a way of opening more slots at the airports and also saving the airlines money.

The MD-12. Douglas is developing the MD-12, a four-engined double decker airplane. The MD-12X design will seat up to 377 passenger in a 3-class configuration; 24 in first, 69 in business, and 284 in economy class. The single class configuration will seat more than 400 passengers. The design calls for a 242 ft. fuselage, 10 ft. longer than the Boeing 747. Ramp space at major airports halted any further attempt to stretch the fuselage farther. The original design was patterned after the MD-11 trijet and would be a derivative (Smith, 1992a).

This original concept has been redesigned. The current concept will be 203 ft. long with a 213 ft. wingspan. This will make the wingspan only 3 ft. longer that the MD-11 and 4 ft. longer than the 777. The upper deck would seat passengers the entire length of the fuselage. The width at seat level would be 293 in. This new design would carry 499 passengers in a 3-class configuration. The design calls for 6-abreast on the upper deck and eleven-abreast on the lower deck. The configuration would have 27 first, 95 business and 377 economy class passengers. Douglas is also thinking of another possible design; a partial upper deck with a maximum passenger load of 425 in a 3-class configuration. A super stretch version is also being considered with a 600 passenger capacity (Smith, 1992b).

Data from Douglas now sports a 210 ft. length, 229 ft. wingspan. Other derivatives are also under study with an aim to produce the industry's first 700-seat airplane. A
typical configuration has 3 aisles in economy with ten-abreast on the lower deck and 2 aisles on the upper deck with 8-abreast. Business class will also use the 3-aisle configuration with 8-abreast on the lower deck, while the upper deck will have two aisles with 6-abreast. Design concepts will be used from that of the MD-11 program. First customer delivery is targeted at 1999.

**European Large Transports**

The **A330**. Airbus Industrie is also engaged in the large transport market with their A340/A330 project, which will compete directly with the 777 and the MD-12. The A330 will be available in three models. The high-density short/medium range model will carry up to 440 passengers, 9-abreast. An 8-abreast configuration will yield 398 passengers. These configuration are both single-class. A typical two-class medium-range configuration will carry a total of 335 passengers. Thirty in first class and 305 in economy with 8-abreast. The three-class long-range model will carry a total of 295 passengers. There are 18 sleeperettes, 49 business class and 228 seat in economy class with 8-abreast (Airbus Industrie [AI], 1994a).

The European-based Air Inter, Air Lingus and Thai Airways are all flying the A330. Air Inter took delivery in November 1993, and Thai Airways in mid-1994. Cathay Pacific is expected to start in early 1995. The U.S. gateways used for both the A340 and the A330 are JFK, Miami, and Washington D.C.'s Dulles airports.

The **A340**. The A340 is available in two models, the -200 and the -300. The A340-200, the long range model (the longest of any airliner today) seats 260 passengers, while the A340-300, short-range high capacity, seat 295 to 350 depending on class configuration. Both models are configured in three classes; first, business and economy (AI, 1994b).

Lufthansa has been flying the A340-200 since February 2, 1993. The French airline Groupe Air France took delivery of their first A340-300 on March 29, 1993. This
airplane marks the 1,000th Airbus aircraft to be delivered (AI, 1994b). Lufthansa flies the A340 into Kennedy airport regularly.

**The Super Jumbo.** Airbus is also planning to develop a super jumbo airplane which will provide 530 to 850 seats. The airplane, set for introduction in 2003, will compete directly with Boeing’s 747X program. The current specifications for the airplane is, a wingspan of 253 ft. (A330/340, 747 is 212 ft.), a length of 228 ft. 8 in. (the 747-400 is 3 ft. 4 in. longer), and the maximum takeoff weight will be 471 metric tons, 76 more metric tons heavier than the 747-400. The current design configuration calls for 530-570 in a three-class seating on two decks or 850 in a single class. There would be 9-10 abreast on the lower deck and 7-8 on the upper. This configuration would conform to today’s wide bodied jets. Access to the upper deck would be from stairs at the rear and the front of the airplane not from jetways. The airplane, currently dubbed the A3XX, will undergo feasibility studies with twelve air carriers to determine whether or not it will be necessary (Mecham, 1994).

**Inherent Large Transport Problems**

The larger the airplanes, the more difficult it will be to park, service, board and offload passengers. Boarding passengers is one of the major issues facing the airlines and airport managers says Mecham, 1994. It would seem that the benchmark being used for boarding time is the Boeing 747. Any airplane that takes longer than that is purely unacceptable says Airbus-China’s president Rolf Rue.

From the stand point of airport gates that are able to accept the double deckers, there are none currently. Dedicated airbridges would have to be created for the upper decks. The airport designers sees that as a major concern. This may require adding a new level to current terminals (Mecham, 1994). Within the U.S. many airports have made modifications or will be making modifications soon. Upper deck additions is not one those planned modifications, however.
Catering would also pose a problem. Current data shows that it takes a two-person crew, about 45 minutes to fully stock the three galleys of a Boeing 757 which holds 182 passengers. The larger transports will have larger galleys and considerably more than three galleys, requiring far more supplies. It would be necessary to either increase the cabin service crew size or allot more time for stocking the galleys. The latter would prove more expensive for the airlines, as it would increase "time at the gate." Airbus has one solution to the problem; semi-automate the process, possibly extending this automation to serving food and beverages (Mecham, 1994).

Passenger evacuation is also seen as another source of problem. This problem has the Airbus designers worried. It may not be possible to evacuate the airplane in the required 90 seconds. One designer was quoted as saying "it would be like jumping down from a 7-story house. You could burn yourself badly on the slides." The studies being conducted however, could be used as the basis for other designs (Woolsey, Donoghue, Flint, Moorman, Reed, Crumley, & Nelms, 1993).

**Airport Congestion**

Although there are approximately 17,000 airports in the U.S. only about 400 provide commercial service. The only other country to match this capacity is Australia (Ausrotas & Simpson, 1992). As you drive by airports such as La Guardia in New York or New York's JFK you cannot help but notice the long line of airplanes waiting to take off. The same is true for other busy airports around the country.

Studies by the National Technical Information Service at La Guardia in 1982 and 1987 showed that the usage of wide bodied aircraft's decreased delays by saving annually 3,900 minutes in 1982 and 6,500 minutes in 1987. This time saving was due to the reduction of the number of airplanes as one airplane could hold more passengers. The study did not mention how the landside was affected by this experiment. The recommendations at La Guardia to ease congestion was primarily on the airside and runway facilities, rather than increase wide body traffic into the area. (Federal Aviation
La Guardia’s main problem is its close proximity to JFK’s and Newark’s airspace. The problems experienced at these three airports reciprocate however.

James (1987) says congestion is by no means new to the air transportation system. Delays reached its peak in the 1960’s forcing airports in the north eastern corridor to regulate departures so as not to overcrowd the skies, this is referred to as flow control.

Type of Capacity Problems

The AACC & IATA (1990) report talks about different types of capacity problems. The airside, ATC, runway system, and apron system are all affected. A limitation on any of these elements will adversely affect the over-all capacity. The fact that the three major aircraft manufacturers are pitting against each other, suggests that all three airplanes will probably end up in the same airport at the same peak time. In 1985, terminal and center volume accounted for 23.4% of the causes for delays. The only other factor ahead of this group was weather with 67.7% (James, 1987).

Boeing sees the capacity problem being relieved by the airlines using better schedules, more mini-hubs, higher load factors, overflights, price adjustments and of course larger airplanes. The company sees solutions to runway capacity as modifying current layouts, installing improved landing aids, and radars, and changing operating procedures. As for terminal capacities, Boeing sees the need for more master plans, apron parking space being very easy to provide, and the addition of mass transit to enhance public access. They however fail to see what the cause of all these changes really are; larger transports.

Another factor that affects larger airplanes is wake turbulence. Larger transports are classified as Heavy, i.e. over 300,000 pounds gross take-off weight (Vickers, 1987). This causes the separation between airplanes to increase. This means the airplanes will take longer to land, thus causing delays on the ATC and runway system. Despite this, John Graham of Douglas speaking at the Airfield and Airspace Capacity Delay Committee
conference, denies that technology is frequently the problem. He blames the delays on airline operations, airport operation, and ATC (Graham, 1988).

The Size Factor

Larger airplanes also means larger gate access. With the wingspan of the Boeing 777 being 199 ft. 11 in., this is longer than the widely used Douglas DC-10-10, Lockheed L-1011-1 and the 156-ft. Boeing 767. This means that the 777 may not be able to use the same ramp space as these airplanes. The passenger capacity of course is not the same, the capacity of the DC-10 is only 304 compared to that of the 777 with 305-440 passengers. Special accommodations will also have to be made for the A330-300 which has a wingspan of 198-ft. and carries 356 passengers (Swindells, 1992). What may happen is that the larger transports will sit at the end gates of the concourse or overlap other gates, thus displacing one or maybe two airplanes. This factor will undoubtedly increase capacity problems at that airport.

Airport Design

Ward (1984) tends to agree with Graham's group, adding that airport delays are caused by a mismatch between airside and the landside capacity. He continues to say that airport capacity problems are local to that airport. The airport design is also responsible for delays, if the passengers have no easy access to, through, and from the airport, then congestion results. Airports such as JFK, LAX and Denver Stapleton have approximately 0.9 vehicles entering and 1.3 exiting the airport for each passenger arriving or leaving the airport per day (Brothers, 1981). If we take a look at LAX with 33 million passenger per year, this amounts to 100,000 vehicles.

The new Denver airport would perhaps be one that would be able to adequately handle an aircraft of such dimensions. This new airport was designed with techniques that should reduce air traffic delays at the airport (General Accounting Office [GAO 91], 1991). Studies done by the Federal Aviation Administration (FAA) using computer
simulation, however, does not give any concrete data on delay reduction due to the
Denver airport. Only a 5% reduction is estimated.

The reviewed literature shows that currently our airports are congested on both the
airside and landside. The addition of larger airplanes into the traffic pattern would seem
to increase this congestion.

**Statement of the Hypothesis**

The hypothesis is based on information provided by U.S. gateway airport
management personnel. This paper will attempt to determine if larger aircraft such as the
Airbus A330/340/3XX, Boeing 747-400 and 777, and Douglas MD-12 will cause
increased airport congestion on the landside. The increased congestion will be caused
due to the size of these airplanes and by the additional passengers that will be deposited at
the airport.

This research will also attempt to determine that there is no significant difference
between the response of those airports classified by this study as “large” (enplanements
>=10,000,000 during 1991) and those labeled as “small” (enplanements <10,000,000).
Subject/Samples

The population used for this research, is all airports in the U.S. In making this selection, care must be taken not to introduce any bias. In this scenario, there could be other existing factors such as the airports not equipped to handle transports larger than a two hundred seater. Thus the airports chosen must be able to handle aircraft that are at least the size of a Boeing 747. An appropriate sample seems to be the main U.S. gateways.

The airports were chosen from the Federal Aviation Administration [FAA] (1993) report on the aviation system capacity plan. The report contained a list of 23 airports in the U.S. with annual (1991) aircraft delay in excess of 20,000 hours. Washington Dulles International airport was added to the list of chosen airports as it is a major gateway accepting the A340 and the Boeing 747-400. The airports are (a) Atlanta Hartsfield (ATL), (b) Boston (BOS), (c) Charlotte (CLT), (d) Chicago O'Hare (ORD), (e) Denver Stapleton (DEN), (f) Detroit (DTW), (g) Honolulu (HNL), (h) Houston (IAH), (i) Los Angeles (LAX), (j) Miami (MIA), (k) Minneapolis (MSP), (l) New York John F. Kennedy (JFK), (m) New York La Guardia (LGA), (n) Newark (EWR), (o) Orlando (MCO), (p) Philadelphia (PHL), (q) Phoenix (PHX), (r) Pittsburgh (PIT), (s) San Francisco (SFO), (t) Seattle-Tacoma (SEA), (u) St. Louis (STL), (v) Washington National (DCA), and (w) Washington Dulles (IAD). These airports are also located in large cities and/or are major gateways to other major cities around the world.

Although LGA was a part of the list, their runway length does not facilitate larger transports and cannot be lengthened to facilitate such. Thus, they were not asked to participate. Information was solicited from twenty-two airports. Of the twenty-two airports surveyed, eighteen responded.
Instruments

A two-page questionnaire (see Appendix A) was sent to the airport managers of the selected airports. The questionnaire highlighted 26 items that are common capacity problem areas. The managers were also able to add any additional areas that were unique to their airports. Initially, an introductory letter was sent to all managers asking for their participation. On receipt of their intent to participate, the questionnaire was mailed out to them. All correspondence included a self-addressed stamped envelope, fax number and email address. This provided the users with multiple ways of responding. The only method used for responding to the questionnaires was U.S. mail. Three airports faxed their participatory responses. One airport manager’s aid called for clarification of one question.

A letter was faxed and mailed to the three airplane manufacturers to acquire up-to-date information on their airplanes. Airbus Industrie was the first to respond, then the Boeing Corporation. At the time of writing no response was received from McDonnell Douglas. See Appendix A for the introductory letter, response form, cover letter requesting information, questionnaire, re-request for response, and letter to airplane manufacturers.

Design

The arrival of the larger transports will increase airport capacity problems, by overloading the airways, loading gates and the passenger terminals. It is also hypothesized that the cause will be the size of the airplanes, especially the wingspan, and their passenger and cargo capacity. The largest transport, the 747, already causes spacing problems (Vickers, 1987). It is hypothesized that the new larger transports will undoubtedly continue this trend.

Alternatively, the new larger transports may not affect capacity at all. If the airlines balance the introduction of say, the 777 with the removal of flights that would have
carried the same overall amount of passengers, then the effect may be nullified as far terminal capacity. The airway capacity problem may still be there however.

A Chi Squared test will be performed to determine if the larger airports (airport with more than 10,000,000 enplanements annually) responded differently than the others.

**Procedure**

Once the airports were selected, a letter of “intent to participate” was sent to the airport managers. As their responses were received, a questionnaire was sent out to each manager requesting information. The managers responding in the negative, were sent letters indicating the airports that have pledged to participate or have already participated, along with a copy of the questionnaire. This method turned two negative responses in positive ones. Reminder letters were sent a week after all deadlines. This gave the questionnaires time to arrive, if they were mailed on the deadline dates.
Chapter 3

Analysis

The airport managers showed some degree of enthusiasm when responding to the questionnaire. Although some responses were received later than the deadline, apologies were accompanied with the responses explaining the delays. One reason cited was that the mail had been forwarded to a different department than the one that it was mailed. Some managers sent in lengthy explanations about their concerns and what they were doing to address those concerns. Of the 22 airports solicited, 18 responded. The results of those questionnaire has been tabulated and presented in the tables that follow. Please refer to Appendix A, page 47 for the complete format of the questionnaire.

Table 1

As Larger Airplanes Begin to Arrive at your Airport. Please State the Effect you Think these Airplanes will Necessitate on the Capacity of Ramp Parking Facilities

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>(66.7)</td>
<td>2</td>
<td>(11.0)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>(16.7)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(5.6)</td>
</tr>
</tbody>
</table>

Note. The data is for U.S. airports, N = 18 for Tables 1 - 25.

The data in Table 1 shows that 66.7% (12) of the airport managers think they will need to increase the current capacity of their ramp parking facilities to accommodate the larger airplanes when they arrive. Only 11% (2) of the respondents suggested that no change would be necessary. The two airports are Honolulu and Denver Internationals.
The managers of these two airports states that they are both already equipped to handle large transports. The Denver airport is set to open later this year. The three (16.7%) responses for a decrease suggests that the respondents mis-read the question. This seem to be the same reason for the one (5.6%) respondent who did not indicate a response to this question.

Table 2

| As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Arrival Queue(s) |
|---|---|---|---|---|---|
| Increase | No Change | Decrease | Don't Know | No Response |
| n | % | n | % | n | % | n | % | n | % |
| Responses | 11 | (66.1) | 7 | (38.9) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) |

Table 2 shows that the majority of the respondents, 11 (61.1%) thought that their arrival queue(s) would increase with the arrival of larger airplanes. This is expected as the airplanes are bigger and thus there would have to be "increased spacing for heavy jets," says one manager. The arrival queue is defined as the line formed by the airplanes as they approach the airport. Each runway has its own arrival queue. Seven respondents representing 38.9% of the total thought that there would be no change.
Table 3

**As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Departure Queue(s)**

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>10 (55.6)</td>
<td>8 (44.4)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

The data for the departure queues in Table 3 shows that ten (55.6%) of the respondents thought that their queue would increase, the other eight (44.4%) respondents thought there would be no change. One manager indicated that there would have to be "increased spacing for heavy jets." This is the same manager who indicated that spacing would also have to be increased for the arrival queue. The departure queue is the line formed by the airplanes as they head towards the runway for departure. This line starts from the push back at the gates. There could be several feeder lines (lines from the gates), feeding into the main departure queue for the particular runway. Each runway would have a departure queue of its own.

Table 4

**As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Baggage Area(s) Capacity**

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>11 (61.1)</td>
<td>5 (27.7)</td>
<td>1 (5.6)</td>
<td>1 (5.6)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>
Table 4 shows that eleven (61.1%) of the managers thought that they would have to increase the capacity of their baggage area. Five (27.7%) thought that their current capacity was adequate. One (5.6%) manager thought that they would have to decrease their baggage area capacity. The respondent may have mis-read the question. One (5.6%) manager did not know if larger airplanes would affect their baggage area capacity.

Table 5

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Customs Area(s) Capacity

<table>
<thead>
<tr>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Responses</td>
<td>7 (38.8)</td>
<td>10 (55.6)</td>
<td>0 (0.0)</td>
<td>1 (5.6)</td>
</tr>
</tbody>
</table>

Table 5 shows that ten (55.6%) of the respondents thought that there would be no change in their customs area capacity. Seven (38.8%) of the respondents thought that their capacity would increase. One respondent representing 5.6% did not know if their customs area capacity would change. The customs area is considered to be the area immediately after the baggage claim area, usually found in international terminals only.
Table 6

**As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Staffing Requirements: Security**

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responses</strong></td>
<td>8 (44.4)</td>
<td>10 (55.6)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

The majority of the respondents in Table 6, 10 (55.6%) thought that they would not have to change their security staffing requirements. Eight (44.4%) thought that they would have to increase their security staffing. Security staffing applies to all areas of the airport, primarily the baggage check areas. There are also security personnel needed at the baggage claim areas and throughout the terminals. International terminals would have security personnel in the customs and immigration areas.

Table 7

**As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Staffing Requirements: Customs**

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responses</strong></td>
<td>11 (61.1)</td>
<td>5 (27.8)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>2 (11.1)</td>
</tr>
</tbody>
</table>
Table 7 shows that eleven managers which represent 61.1%, thought that they would have to increase their customs staffing requirements. Five (27.8%) thought that they would not have to change their current staffing. Two managers, representing 11.1%, did not respond to the question.

Table 8

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Staffing Requirements: Maintenance (Airplane Cleaning etc.)

<table>
<thead>
<tr>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Responses</td>
<td>6 (33.3)</td>
<td>7 (38.8)</td>
<td>1 (5.6)</td>
<td>3 (16.7)</td>
</tr>
</tbody>
</table>

In Table 8, six managers representing 33.3% thought that they would have to increase their maintenance staffing. 38.8% which represent seven managers reported that their staffing was adequate for this area. One (5.6%) manager thought that they would have to decrease their staffing. This suggests that they may have misinterpreted the question. Three managers did not know how the larger airplanes would affect staffing in this area. They accounted for 16.7% of the population. One (5.6%) respondent had no response to this category.
Table 9

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Staffing Requirements: Baggage Claim

<table>
<thead>
<tr>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Responses</td>
<td>12 (66.7)</td>
<td>5 (27.7)</td>
<td>0 (0.0)</td>
<td>1 (5.6)</td>
</tr>
</tbody>
</table>

Table 9 shows that twelve managers representing 66.7% thought that their staffing requirements for the baggage claim area would have to be increased. Five managers representing 27.7% thought that there would be no change necessary. 5.6% (1) reported that they did not know what kind of effect the larger airplanes would have on this area. Staffing in the baggage claim area is provided by the airlines serving the airport.

Table 10

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Staffing Requirements: Tarmac

<table>
<thead>
<tr>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Responses</td>
<td>6 (33.3)</td>
<td>9 (50.0)</td>
<td>2 (11.1)</td>
<td>1 (5.6)</td>
</tr>
</tbody>
</table>

Six (33.3%) airport managers in Table 10 reported that they think it would be necessary to increase their current staff on the tarmac. Nine (50%) managers reported
that there would be no change necessary. Two managers, representing 11.1% thought that there would be a decrease in their staffing requirements. One (5.6%) reported that they did not know what effects the larger airplanes would have on staffing requirements on the tarmac. The tarmac is the area where the airplanes park after landing.

Table 11

As Larger Airplanes Begin to Arrive at your Airport. Please State the Effect you Think these Airplanes will Necessitate on the Staffing Requirements: Emergency Team

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>7 (38.9)</td>
<td>11 (61.1)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 11 shows seven respondents representing 38.9% reported that they would have to increase the staffing level of their emergency team. Eleven (61.1%) reported that they would not have to change their current staffing. One airport manager added that the larger airplanes "may increase the CFR indices." The CFR index is determined by the FAA for each airport. This index determines the level of required preparedness for that airfield’s emergency crew in case of a disaster. The larger the airplanes using the airport the more equipment and staffing the airport will be required to provide, thus increasing the CFR index. Level of preparedness also involves the airport’s proximity to area hospitals and local trauma centers.
Table 12

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Number of Airport Busses Required

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>8 (44.4)</td>
<td>5 (27.8)</td>
<td>0 (0.0)</td>
<td>2 (11.1)</td>
<td>3 (16.7)</td>
</tr>
</tbody>
</table>

Eight (44.4%) of the respondents reported in Table 12 that they would need to add more airport busses to their current fleet. 27.8% which represents five airports reported that their busses were adequate. Two (11.1%) managers reported that they did not know what kind of effect the larger airplanes would have on their busses. 16.7% (3) of the managers had no response. Two of this three managers noted that airport busses were not applicable to their airports. One airport manager thought that this question was not specific enough. It would seem that he needed a distinction between the busses outside the terminal and the ones on the ramp.

Table 13

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Number of Taxicabs Required

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>6 (33.3)</td>
<td>9 (50.0)</td>
<td>0 (0.0)</td>
<td>3 (16.7)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>
Table 13 shows six (33.3%) of the managers reporting that the number of taxicabs required will increase. Nine (50%) reported that the number of taxicabs are adequate. Three (16.7%) reported that they did not know what effects larger airplanes would have on the number of taxicabs required. Taxicab dispatchers at the airports regulate the number of taxicabs available to match the airline flight schedules. As the number of flights decrease, so does the number of taxicabs.

Table 14
As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Airport Revenue

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>13 (72.2)</td>
<td>4 (22.2)</td>
<td>1 (5.6)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

In Table 14, thirteen (72.2%) airport managers reported that their revenue would increase due to the arrival of the larger airplanes. Four (22.2%) reported that there would be no change in the revenue generated. One (5.6%) manager reported that their revenue would decrease, this may have been an error. Another airport manager was specific and cited landing fees as a direct source of revenue that would be increased. All airport users are required to pay landing fees on arrival. These fees increase as the size of the airplane increases. Other areas of revenue includes parking fees, and passenger facilities charge (PFC, this charge is paid by passengers to use certain airports. Usually, the charge is $3.00).
Table 15

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Lavatory Capacity

<table>
<thead>
<tr>
<th>Effect</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td>12</td>
<td>(66.7)</td>
<td>5</td>
<td>(27.7)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
<tr>
<td>No Change</td>
<td>5</td>
<td>(27.7)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
<tr>
<td>Decrease</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
<tr>
<td>Don’t Know</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
<tr>
<td>No Response</td>
<td>1</td>
<td>(5.6)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
</tbody>
</table>

In Table 15, twelve (66.7%) of the eighteen airport managers who responded, reported that they would need to increase the current capacity of their lavatories. Five (27.7%) airports reported that they would need to make no changes in this area. Only one manager noted that they did not know what kind of effect large airplanes would have on their lavatories. Usually the lavatories are located in close proximity to the gates.

Table 16

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Time Required for Passenger Boarding

<table>
<thead>
<tr>
<th>Effect</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td>11</td>
<td>(61.1)</td>
<td>4</td>
<td>(22.2)</td>
<td>0</td>
<td>(0.0)</td>
<td>1</td>
<td>(5.6)</td>
</tr>
<tr>
<td>No Change</td>
<td>4</td>
<td>(22.2)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>1</td>
<td>(5.6)</td>
</tr>
<tr>
<td>Decrease</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
<tr>
<td>Don’t Know</td>
<td>1</td>
<td>(5.6)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
<tr>
<td>No Response</td>
<td>2</td>
<td>(11.1)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
<td>0</td>
<td>(0.0)</td>
</tr>
</tbody>
</table>

In Table 16, eleven (61.1%) of the managers reported that there would be an increase in the time required for passenger boarding. Four (22.2%) managers reported
there would be no change in the current time it takes to achieve this process. One (5.6%) manager reported that he did not know what effect the large airplanes would have on this category. The remaining two (11.1%) managers did not respond to this question.

Passenger boarding time usually starts twenty minutes before departure. This time is changed depending on the size of the airplane. The acceptance of stand-by passengers tend to delay this process at times. Also the airlines are allowed to overbook the flights to some extent.

Table 17

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Capacity of Restaurant Facilities

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>12 (66.7)</td>
<td>6 (33.3)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

Table 17 indicates twelve (66.7%) of the managers reporting that their restaurant facilities capacity would have to be increased. The remaining six (33.3%) reported that there would be no change necessary. Airport concessions are leased from the airport authority. Locations are usually acquired through a bidding process.
Table 18

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Average Service Time of Aircraft at the Gate

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>8</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>%</strong></td>
<td>(44.4%)</td>
<td>(38.9%)</td>
<td>(0.0%)</td>
<td>(5.6%)</td>
<td>(11.1%)</td>
</tr>
</tbody>
</table>

In Table 18, eight (44.4%) of the airport managers thought that the average service time of the aircraft at the gate would increase. Seven (38.9%) of the managers thought that there would be no change in the current service time at the gates. One (5.6%) of the managers reported that he did not know what effect the large airplanes would have in this category. The remaining two (11.1%) managers had no response for this category. This function is managed by the airlines.

Table 19

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Airport Employees' Parking Capacity

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>6</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>%</strong></td>
<td>(33.3%)</td>
<td>(61.1%)</td>
<td>(0.0%)</td>
<td>(0.0%)</td>
<td>(5.6%)</td>
</tr>
</tbody>
</table>

Responses 6 (33.3%) 11 (61.1%) 0 (0.0%) 0 (0.0%) 1 (5.6%)
In Table 19, eleven (61.1%) airport managers reported that their airport parking was adequate for their employees. Only one (5.6%) airport declined to answer this question. Six (33.3%) respondents thought that it would be necessary to increase their current parking facilities.

Table 20

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Airport Visitor's Parking Capacity

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>7 (38.9)</td>
<td>11 (61.1)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

In Table 20, the response for this category was consistent with the numbers reported for employee parking capacity. Eleven (61.1%) respondents reported that they would not need to change their current facilities. Seven (38.9%) managers reported that they would need to increase their visitors' parking facility.
Table 21

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Immigration Area Capacity

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>7 (38.9)</td>
<td>9 (50.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>2 (11.1)</td>
</tr>
</tbody>
</table>

Table 21 shows fifty percent (9) of the questionnaires received reported that their immigration area was already adequate to receive larger airplanes. Two (11.1%) airports had no response. While 38.9% (7) thought that there would need to increase their current capacity. The immigration areas are restricted to airports with international facilities. These are usually the U.S. gateways.

Table 22

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Gate Capacity/Size

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>15 (83.3)</td>
<td>2 (11.1)</td>
<td>0 (0.0)</td>
<td>1 (5.6)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

In Table 22, fifteen (83.3%) of the airports stated that they would need to increase the passenger capacity at the gates that will be serving the larger airplanes. One of these
airports reported that their capacity may increase depending on gate demand. One (5.6)
airport reported that there would be a decrease, the manager may not have understood the
question. Two airports which represents 11.1% of the population reported no change in
their gate capacity/size.

Table 23

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think
these Airplanes will Necessitate on the Road Traffic Approaching Airport

<table>
<thead>
<tr>
<th>Effect</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td>10</td>
<td>(55.6)</td>
<td>7</td>
<td>(38.8)</td>
<td>0</td>
<td>(0.0)</td>
<td>1</td>
<td>(5.6)</td>
</tr>
<tr>
<td>No Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don't Know</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Response</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Table 23 ten (55.6%) of the managers reported that there would be an increase in
the road traffic approaching the airport. Seven (38.8%) said there would be no change at
all. One (5.6%) manager thought that there would be a decrease. This manager may have
mis- interpreted the question.
Table 24

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Time Required for Deplaning

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Responses</td>
<td>10 (55.6)</td>
<td>5 (27.7)</td>
<td>0 (0.0)</td>
<td>2 (11.1)</td>
<td>1 (5.6)</td>
</tr>
</tbody>
</table>

Table 24 shows ten (55.6%) managers responded that the time required for boarding would increase. Five (27.7%) thought that there would be no change at all. Two (11.1%) managers did not know if the required time will increase or not. One manager failed to respond to this question.

Table 25

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Runway Length

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Responses</td>
<td>1 (5.6)</td>
<td>17 (94.4)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

One airport manager in Table 25, representing 5.6% of the respondents thought that their runway would need to be increased. The remaining seventeen (94.4%) would not
have to change the current length of their runways. The one airport that requires lengthening is the Seattle-Tacoma International in Washington state.

In order to perform a complete analysis on the data, the airports were broken down into two categories; enplanements over 10,000,000 and under 10,000,000 per year. The airports in the over 10,000,000 category are (a) Chicago O'Hare (ORD), (b) Los Angeles (LAX), (c) Atlanta Hartsfield (ATL), (d) San Francisco (SFO), (e) Denver Stapleton, (DEN), and (f) Phoenix Sky Harbor (PHX). The airports in the under 10,000,000 enplanements category are (a) Newark (EWR), (b) Detroit Metro Wayne (DTW), (c) St. Louis Lambert Field (STL), (d) Miami (MIA), Minneapolis-St. Paul (MSP), (e) Honolulu (HNL), (f) New York John F. Kennedy (JFK), (g) Pittsburgh (PIT), (h) Seattle-Tacoma (SEA), (i) Charlotte Douglas (CLT), (j) Orlando (MCO), (k) Washington National (DCA), and (l) Washington Dulles (IAD).

A chi-square test was performed on the data, it showed that there exists a significant difference between the data gathered from the two categories in the areas of baggage area and restaurant facilities capacity only, $\chi^2 (4, N = 18) = 9.49, p < .05$. However, since the sample is so small (18), and the $\chi^2$ value for baggage area capacity was 10.31 (0.82 more than the critical value) and that of the restaurant facilities capacity was 10.13 (0.64 more than the critical value), the data will be treated as one group. The data for the affected areas is displayed in Tables 26 - 29.
Table 26

**As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Baggage Area(s) Capacity**

(U.S. Airports; < 10,000,000 enplanements, N = 12)

<table>
<thead>
<tr>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Responses</td>
<td>10 (83.4)</td>
<td>1 (8.3)</td>
<td>0 (0.0)</td>
<td>1 (8.3)</td>
</tr>
</tbody>
</table>

Table 26 shows that ten (83.4%) airport managers thought that their airports would have to increase the capacity of the baggage areas. One (8.3%) airport manager reported no change necessary and another reported that they were unsure if any changes would be necessary.

Table 27

**As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Baggage Area(s) Capacity**

(U.S. Airports; > 10,000,000 enplanements, N = 6)

<table>
<thead>
<tr>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don’t Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Responses</td>
<td>1 (16.7)</td>
<td>5 (83.3)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>
Table 27 shows that one (16.7%) of the respondents reported that they would need to increase the capacity of their baggage areas. Five (83.3%) airport managers reported that there would be no change necessary.

Table 28

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Capacity of Restaurant Facilities

(U.S. Airports; < 10,000,000 enplanements, N = 12)

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>%</td>
<td>(91.7)</td>
<td>(8.3)</td>
<td>(0.0)</td>
<td>(0.0)</td>
<td>(0.0)</td>
</tr>
</tbody>
</table>

Table 28 reveals that 11 (91.7%) airport managers reported that they think their restaurant facilities were inadequate. One (8.3%) manager reported that there would be no change necessary at their airports.
Table 29

As Larger Airplanes Begin to Arrive at your Airport, Please State the Effect you Think these Airplanes will Necessitate on the Capacity of Restaurant Facilities

(U.S. Airports; > 10,000,000 enplanements, N = 6)

<table>
<thead>
<tr>
<th></th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>2 (33.3)</td>
<td>3 (50.0)</td>
<td>0 (0.0)</td>
<td>1 (16.7)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

Table 29 shows that two (33.3%) airport managers would have to increase the capacity of their restaurant facilities. Three (50%) managers report no change necessary, and one (16.7%) manager reported that they did not know what effect large airplanes would have on restaurant facilities capacity.

The airport managers were given an opportunity on the questionnaire to include other areas that would be affected when the large transports use their airports. Three airports made use of this category. The capacity of the following areas were selected as would need to be increased (a) loading bridges/evacuation at DEN, (b) taxiway fillets (fillets for the turn angle between taxiways) at DEN, (c) movement area at IAD, (d) clear zone (zones marked on the taxiways and ramp to denote aircraft clearance areas, the areas are defined around the perimeter of the airplane), (e) cargo handling facilities at HNL, and (f) load bearing factors at IAD. In addition, one airport, HNL, cited that they would need a rapid transit link to Honolulu. This rapid transit would be able to handle the volume of passengers and other airport users. One airport manager mentioned that fuel facilities capacity would decrease. However it is thought that he meant there would be need to increase the fuel facility capacity as the large transports would use more fuel.
One airport noted that the functions of maintenance (airplane cleaning, etc.), and airplane deplaning are functions which are handled by the airlines. As such, he gave no response to the question. This question was answered by all the other managers except for two who responded that they did not know what kind of effect would take place. Another airport manager who answered “Don’t Know” to a number of questions, annotated his responses by saying that the “questions are better answered by individual airlines and/or the agency directly affected (i.e. U.S. Customs).”

Summary

As the data was reviewed certain trends were apparent. A closer look revealed that the data for both Tables 2 and 3 are similar as the respondents responded in the same manner. This validates the data for this category, as if the arrival queue increases, then the departure queue should increase proportionally.

The results of Table 5 seems suspect. One would think that the customs areas are already overloaded. Visits to major airports such as JFK and MIA shows that these areas are overloaded during peak times. There are usually long lines as customs agents search through passengers’ baggage. If larger transports deposit passenger loads upwards of 400, one would think that the customs area capacity would be overloaded.

The staffing requirements category, Tables 8 & 10, would be answered more correctly by the airlines operating the airplanes at each airport. It would however seem that there should be a higher percentage of responses needing to increase staffing. Consider this: a MD-88 with 124 passengers on board takes about 10 minutes to deplane and 8 minutes to clean between flights with a three-man crew. The same crew will take 15 minutes to clean a Boeing 757 with 182 passengers on board. The 777 holds over 400 passengers. It would stand to reason that staffing would have to be increased if the same turn around time is needed. The same is also true for the galleys, about 40 minutes is required to clean the aft galley of a MD-88, 20 minutes for the forward, only one person is required to clean each galley. The 777 will have up to 9 galleys, therefore more
personnel will be required or it will take considerably more time to fully clean the airplanes.

Security staffing is an area where the results are also surprising. One would think that more airports would need to increase security personnel. Perhaps the vigilance of the current personnel will be increased and not necessarily the number of personnel.

The customs staffing requirements results were to be expected. As more baggage will be carried on the airplanes, it would be expected that the customs areas would need more staffing. It is interesting to note that the customs areas are adequate for the most part, see Table 5.

With the increased passenger levels from these large transports it makes sense that there would be more staff required at the baggage claim areas. The staff would be needed to police the area, making sure that passengers leave with their correct baggage.

The area of staffing on the tarmac is one area where the airlines would paint a better picture than the airport managers. It was expected that the ground support tarmac crew would have to be increased so that the larger airplanes can be serviced more efficiently. However, if these airports are already servicing 747-400s or the A340/330, then they would already be adequately staffed.

Airport busses: It would seem that more busses would be required during the peak times at the airports. The airports may already have adequate busses. Of course, if more busses are needed, it follows that more drivers will also be necessary.
Chapter 4
Conclusions

In performing this research, the airport managers who responded were thorough. It is clear that airport capacity problems are on their minds. Since the airports are already overcrowded, the arrival of the larger transports needs attention. The data gathered from the questionnaires based on the airport managers’ opinion indicates that large transports will overload the capacity at the airports that they will use but only in certain categories. Several conclusions can be drawn from the data received:

1. Ramp space is inadequate, only DEN and HNL are adequately prepared. DEN is new and as such the arrival of large transports was a factor used when designing the airport. HNL has been accepting the 747-400 for sometime now.

2. Runway length is adequate at all airports in question except for the Seattle-Tacoma International airport in Washington state. This area is one key factor that will reduce the cost of the conversion for large transports.

3. Some airport managers are aware of the capacity problems that the large transports will bring with them. As such they are planning for it. The following comment was received from Sunil Harman, airport planner at MIA: “As you may have already heard, MIA is scheduled for a large scale development effort to meet the rapidly escalating demands on the airport. To this end, a substantial amount of planning effort has gone into evaluating the effects of large aircraft on airport capacity. The design aircraft for MIA is the Boeing 747-400. Currently 3% of our fleet mix consists of aircraft of this size.” In addition, Ben Schlapak, head planning engineer at HNL reports the following: “We have had 747-400s for some time now. The 777 will be about the same as the 747. The type of aircraft will not drive our capital improvement plan as much as frequency. We just added three gates this past year.” Schlapak is correct in identifying the fact that frequency will be the deciding factor in the implementation. Also, one must bear in mind the replacement factor, i.e. how many flights will the new larger transport
replace. In addition, Michael Conway, airport manager at Detroit Metro Wayne pointed out that "we are planning a massive terminal expansion already - new generation of aircraft are being taken into consideration." Jim Seurill, manager of technical services at the Seattle-Tacoma airport had this to say: "It is difficult to separate the affects of larger aircraft from increased passenger traffic [It is safe to assume that if larger airplanes are used, passenger traffic would increase]. Larger aircraft in and of themselves is of minor impact assuming total passenger levels remain nearly the same. However, increased aircraft size and the increased passenger traffic drive increased terminal facility requirements. The history of the 747 introduction and affects could be used as an indicator of future requirements." It is clear that these managers are concerned about the future capacity of their airports.

4. Delays will increase at the airports in question. This was evident as the majority of the airports reported that their arrival and departure queues will increase.

5. The effect on customer processing facilities will be varied. The customs and immigration areas will remain the same. Currently they are overcrowded. On the other hand the baggage area capacity will decrease. It would appear that since the larger airplanes can carry more baggage, the managers are thinking that passengers will carry more bags. There will also be more passengers waiting for their bags.

6. The effects on staffing requirements will also change depending on the areas affected. It would seem that ramp support personnel and customs officers will need to be increased. The data for emergency crew staffing suggests that the airports are ready for emergencies with the larger airplanes.

7. In the area of ground transportation some problems will exists. Access to the airport will diminish unless current access improves. Some airports such as JFK recently improved access roads and are currently in the process of a plan headlined JFK 2000. This plan will improve airport access as well as other amenities. There will be need for more airport busses where appropriate. Interestingly enough, employees' and visitors'
Parking is adequate. This is not true at some airports such as DCA. However, DCA is currently in the process of building a new 35 gate terminal. New parking facilities will also be added. Taxicabs are adequate and will only need change in a few airports. At Washington National airport there are usually a full battery of cabs during peak hours, this number is depleted to a mere handful during the off times (11 p.m. - 1 a.m.). The same is true for other airports such as JFK and La Guardia. Oftentimes one can wait upwards of 30 minutes for a taxicab during peak times at New York area airports.

8. Passenger facilities such as lavatories and restaurants will be overloaded. Again, this will be due to the increase in volume of the passengers and the number of people meeting and greeting passengers.

9. Airport revenue will increase due to the income that will be received from PFCs and landing fees.

10. Airplane access appears to be an area that will create some problems. Passenger boarding and deplaning times will increase. In addition, the time required to service the airplane at the gate will increase as well as there will be a need to increase the size of the gates. Also, new airplane access methods will need to be devised.

11. Some airports such as DEN ready to accept (except for their baggage problems) and HNL are already accepting larger airplanes.

One important point to note is that the airplanes will carry more mail and cargo on each flight. This will cause the ground support crew to take a longer time to offload the airplane. They will also need more cargo, mail and baggage carts in order to efficiently handle delivery of the same. This additional baggage transfers to the baggage area in terms of capacity and wait time for the passengers.

The 777 and the new derivatives of the 747-400 are not yet in service and already Boeing is planning to build an even bigger airplane. One thing that is apparent is that the current dimensions of the 747-400 seems to be the deciding factor as far as building large transports. The only dimension that seems will change is the width and height of the
fuselage, in order to accommodate one or two more abreast or one more complete floor of seats.

Airport managers across the country and indeed around the world will be faced with additional problems. They will have to come up with creative methods of dealing with the problems that these large transports will bring. Currently, the majority of flights are centered around the early a.m. or the late afternoon periods. This factor in itself helps to create delays.

It would seem that more effort is being concentrated on building the airplanes than building or modifying the airports to better accommodate them. The latter seems to be the major concern of the airport managers interviewed. The big question seems to be, "How do I get passengers in and out of my airport safely and expeditiously." The data suggests that this question is still not completely answered.

The data supports the hypothesis that from the airport managers' point of view, large transports will reduce capacity at U.S. gateways due to the large amount of passenger traffic. The research also pointed out other areas that need to be considered as more of these airplanes are built and put into service.
Chapter 5

Recommendations

The reader must be aware that the study is based on the opinions of the airport managers. The results may have been different if the airlines were solicited for information. All recommendations and conclusions are based solely on the results of the questionnaire, which is based on the opinions of the airport managers.

As a society we are resistive to changes. The addition of larger transports to our gateways will be no different than any other change. In order to make it work effectively, the airplane manufacturers, the airlines, the air traffic controllers, and the airport managers and planners must work together. Already they are all doing their part to make this transition a success. The following recommendations will help to alleviate the capacity problems the airplanes may face:

1. The airlines will need to rework their schedules so that the large airplanes will replace two or more staggered flights to the same destination. This may inconvenience some travelers, but it will ease the capacity problems at the airports. The capacity problem already exists and measures to help correct that problem are slow to be incorporated. Until then, the airlines must play their part.

2. Manufacturers must provide more passenger legroom as well as room next to each other. This will make the passenger’s flight a little more comfortable. Note that the 777 has the widest seat width in the industry. The manufacturers must also remember that placing 440 or more passengers into an airplane will become somewhat claustrophobic. Sitting very close to someone for more than eight hours on transoceanic flights is already quite taxing. Packing more passengers in will not help any. In conversations with some flight attendants who work transoceanic flights, they talk of the stress involved in catering to so many passengers all at once. In addition, a recent walk down the aisle of a Boeing 757 on a Cincinnati to Las Vegas flight, did not look appealing. The passengers were closely packed and had trouble using the utensils for
their meals. The same was true of a L-1011 from San Francisco to Dallas/Ft. Worth. It would seem the passenger’s comfort is considered as a low priority when computing the seating configurations. One often gets leg cramps as the seat are so closely spaced. These factors are of utmost importance.

3. More lavatories must be built at the airports in question.

4. Start making changes to the airports to accept the larger transports. The airplanes are already here. Changes such as double jetways will have to be made at the affected airports. An additional level will have to be added to the current arrival areas to accommodate the double decker transports. Some airports have special areas for commuter airlines, as this expedite passenger boarding and deplaning. The same must be done for the large transports.

5. Other areas of further study.

This study has opened up other areas of capacity problems which demands further investigation. Capacity problems has been around for sometime and will not dissipate any time soon. Some possible areas might be:

a. Effects on ATC sequencing.

b. The Effects on customs and immigration areas.

c. The Effects of large transports on international airports.

d. The Effects of large transports on flight attendants attitudes, morale and effectiveness.

e. Other studies can focus on the airlines’ point of view. Questions such as their plans for these new transports can be investigated. United Airlines will be the first to fly the 777, while Lufthansa and Air Inter are already flying the A330 and the A340. Cathay Pacific will follow suit on the 777.

f. Another interesting avenue would be to compare and contrast the effects of the introduction of the 747 as against that of the 777. This was suggested by Jim Seurill of
the Seattle-Tacoma international airport. Questions such as “Were we ready for the 747 then and are we ready for the 777 now” may be investigated.

g. The Human Factors issues associated with seating so many passengers together on long flight can also be investigated.

h. In addition, the financial aspect of using the larger transports can also be investigated. Areas to be investigated may include, how many seats must be filled for the airplanes to be worthwhile on a transoceanic trip?

i. “The Effects of Larger Transports on Airport Security” is also another area that can be investigated.

j. A dialectic study of the airlines and/or the airport managers may also be undertaken.

This study is by no means a definitive study. The study chose the airport managers point of view, however, it could just as well had been the airlines’ or the ATCs’. These are only some of the areas that research can be done. The large transports are already here and their effects will be around for a long time. The success of the implementation is in the hands of the airport managers/planners and the airlines.
References


APPENDIX A

LETTERS SOLICITING INFORMATION FROM AIRPORT MANAGERS AND AIRCRAFT MANUFACTURERS
Initial letter of contact asking for participation

June 10, 1994

Emory-Riddle Aeronautical University
Box 145171
600 S. Clyde Morris Boulevard
Daytona Beach, FL 32114

Airport Name (Airport ID)
Address
City, State Zip

Dear Airport Manager’s name:

My name is Kerwin McKenzie, and I am a graduate student pursuing a Masters in
Aeronautical Science at Emory-Riddle Aeronautical University. Currently, I am working
on my thesis entitled "The Effects of the Proposed Larger Aircraft by Airbus; A330/340,
Boeing; 747-400, 777, and McDonnell Douglas; MD-12 on Airport Capacity in the
United States."

Your airport has been selected on the basis of being one of the 23 airports with more than
20,000 hours of delays during 1991. In order to gather the necessary information to
complete this thesis, I wish to know if you would participate in a survey with carefully
selected question on the subject of airport capacity. I have enclosed a self-addressed
stamped envelope along with an information sheet for your convenience. Please supply
me with the name of the individual and/or department on your staff where I should direct
my questionnaire. I would appreciate your help with this study.

This study is significant as our airports are becoming increasingly congested both on the
land and airside. Research performed by T. K. Vickers in 1987 shows that larger
airplanes cause the controllers to increase spacing between the airplanes landing and
taking off, this in turn causes delays at the terminal. The results of this thesis will be
submitted to the Federal Aviation Administration, who may act on the information if the
results are significant. This means that you could be making an invaluable contribution
to congestion at your own airport and other airports throughout the United States.

If you have any additional questions or comments, please feel free to add them on a
separate sheet of paper. I can be reached at (904) 226-6742. Please return all material in
the enclosed self-address stamped envelope by June 24, 1994. Your cooperation is
greatly appreciated. Thank you for participating.

Sincerely,

Kerwin McKenzie
INQUIRY RESPONSE FORM

ATTN: Kerwin McKenzie  
email: kerwinm@db.erau.edu  
Fax #: (904) 226-6621  
mckenzik@cts.db.erau.edu  
Tel #: (904) 226-6742  
71261,2634 on CompuServe

I WISH TO PARTICIPATE. PLEASE DIRECT YOUR QUESTIONNAIRE TO:

Name:

Title:

Airport Name:

Address1:

Address2:

City:

State:

Zip:

Tel:

I DO NOT WISH TO PARTICIPATE.
July 11, 1994

Embry-Riddle Aeronautical University
Box 145171
600 S. Clyde Morris Boulevard
Daytona Beach, FL 32114

Airport Name (Airport ID)
Address
City, State Zip

Dear Airport Manager’s name:

My name is Kerwin McKenzie, and I am a graduate student pursuing a Masters in Aeronautical Science at Embry-Riddle Aeronautical University. Enclosed is the questionnaire that was mentioned in my first letter dated June 10, 1994 with regards to my thesis, "The Effects of the Proposed Larger Aircraft by Airbus (A330/340/A3XX), Boeing (747-400, 777), and McDonnell Douglas (MD-12) on Airport Capacity in the United States."

Please return all material in the enclosed self-address stamped envelope by July 24, 1994. If you have any additional questions or comments, please feel free to add them on a separate sheet of paper. My telephone number is (904) 226-6742. Your cooperation is greatly appreciated. Thank you for participating.

Sincerely,

Kerwin McKenzie
Airport Manager’s Questionnaire

Airport Name: ______________________ Nearest City: ______________________

Is the airport a hub? ______

As larger airplanes begin to arrive at your airport, please state the effect you think these airplanes will necessitate in each area listed:

<table>
<thead>
<tr>
<th>Area</th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Capacity of ramp parking facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Arrival Queue(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Departure Queue(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Baggage area(s) capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Customs area(s) capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Staffing requirements:

<table>
<thead>
<tr>
<th>Role</th>
<th>Increase</th>
<th>No Change</th>
<th>Decrease</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Security</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Customs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Maintenance (Airplane Cleaning etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Baggage Claim</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Tarmac</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Emergency team</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Number of airport busses required</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Number of taxicabs required</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Airport revenue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Lavatory capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Time required for passenger boarding</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
17. Capacity of restaurant facilities ........................................ ........................................
18. Average service time of aircraft at the gate ............................ ........................................
19. Airport employees’ parking capacity ..................................... ........................................
20. Airport visitors’ parking capacity ......................................... ........................................
21. Immigration area capacity .................................................. ........................................
22. Gate Capacity/size ............................................................... ........................................
23. Road traffic approaching airport ........................................... ........................................
24. Time required for deplaning .................................................. ........................................
25 Runway length .................................................................. ........................................
26. Other areas (please feel free to list)
   a. ................................................................................. ........................................
   b. ................................................................................. ........................................
   c. ................................................................................. ........................................

State the time(s) of day that your airport is the busiest

State the time(s) of day that your airport is the least busy

State the time(s) of day that your airport has no traffic

If you have more comments, please submit them on a separate sheet of paper. Please return the questionnaire and comments, if any, in the enclosed self-addressed envelope by July 27, 1994, and again Thank You for participating.
First Reminder Letter

July 13, 1994

Embry-Riddle Aeronautical University
Box 145171
600 S. Clyde Morris Boulevard
Daytona Beach, FL 32114

Airport Name (Airport ID)
Address
City, State Zip

Dear Airport Manager's name:

My name is Kerwin McKenzie, and I am a graduate student pursuing a Masters in Aeronautical Science at Embry-Riddle Aeronautical University. Enclosed is the questionnaire that relates to my thesis, "The Effects of the Proposed Larger Aircraft by Airbus (A330/340/3XX), Boeing (747-400, 777), and McDonnell Douglas (MD-12) on Airport Capacity in the United States."

A letter dated June 10, 1994 was sent to you or your assistant asking for your participation. To date, no response has been received. I know that your daily tasks keep you quite busy. However, this questionnaire takes less than ten minutes to complete and is only two pages long. You may be interested to know that the following airports have already responded favorably: {Airport names are listed here}.

The information is vital in completing my thesis requirement of my degree program. Your help is greatly appreciated.

If you have any additional questions or comments, please feel free to add them on a separate sheet of paper. Please return the questionnaire and any additional material in the enclosed self-address stamped envelope by July 27, 1994. My telephone number is (904) 226-6742. Your cooperation is greatly appreciated. Thank you for participating.

Sincerely,

Kerwin McKenzie
Letter To Aircraft Manufacturer

August 3, 1994

Embry-Riddle Aeronautical University
Box 145171
600 S. Clyde Morris Boulevard
Daytona Beach, FL 32114

Aircraft Manufacturer’s Name
Address
City, State Zip
Attn: Marketing Director’s Name

Dear Sir/Madam,

My name is Kerwin McKenzie, and I am a graduate student pursuing a Masters in Aeronautical Science at Embry-Riddle Aeronautical University. Currently, I am working on my thesis entitled "The Effects of the Proposed Larger Aircraft by Airbus (A330/340/3XX), Boeing (747-400, 777), and McDonnell Douglas (MD-12) on Airport Capacity in the United States."

In order to gather the necessary information to complete this thesis, I would like to receive a media kit with all the information on your particular airplane(s). Please feel free to include any other information that you think would be helpful.

If you have any additional questions or comments, please feel free to contact me at: Telephone: (904) 226-6742,
Fax: (904) 226-6621, or
email: kerwinm@db.erau.edu.

Sincerely,

Kerwin McKenzie

Please Note: This letter was faxed to you on Wednesday August 3, 1994. If the request have been filled, please disregard. Thank You.
Second Reminder Letter

Date

Embry-Riddle Aeronautical University
Box 145171
600 S. Clyde Morris Boulevard
Daytona Beach, FL 32114

Airport Name (Airport ID)
Address
City, State Zip

Dear Airport Manager's name:

My name is Kerwin McKenzie, and I am a graduate student pursuing a Masters in Aeronautical Science at Embry-Riddle Aeronautical University. Enclosed is the questionnaire that relates to my thesis, "The Effects of the Proposed Larger Aircraft by Airbus (A330/340/A3XX), Boeing (747-400, 777), and McDonnell Douglas (MD-12) on Airport Capacity in the United States."

A letter dated June 10, 1994 was sent to you or your assistant asking for your participation. To date, no response has been received. I know that your daily tasks keep you quite busy. However, this questionnaire takes less than ten minutes to complete and is only two pages long. You may be interested to know that the following airports have already returned their questionnaire: {airports who have responded were listed here}

The information is vital in completing my thesis requirement of my degree program. Your help is greatly appreciated.

If you have any additional questions or comments, please feel free to add them on a separate sheet of paper. Please return the questionnaire and any additional material in the enclosed self-address stamped envelope by July 27, 1994. My telephone number is (904) 226-6742. You may also fax the information at (904) 226-6621. Your cooperation is greatly appreciated. Thank you for participating.

Sincerely,

Kerwin McKenzie