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# The Effect of Airline Scheduling on Airport Delays

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THE EFFECT OF AIRLINE SCHEDULING ON AIRPORT DELAYS


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An Independent Study

Submitted to the Graduate Faculty

Of the

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in partial fulfillment of the requirements


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Master of Science


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2006

This independent study, submitted by Craig D. Carlson in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisor under whom the work has been done and is hereby approved.

_____
(Advisor)

TABLE OF CONTENTS

LIST OF TABLES

iv

LIST OF FIGURES

ABSTRACT

With the passage of the Deregulation Act of 1978 the government unknowingly hastened the arrival of the "Hub and Spoke" system of airline operations. The passage of this act along with the increasing use of smaller commuter planes has caused the airlines to over schedule many of the larger hub airports in the United States causing many delays in the nation's air traffic control system.

Of the large hub airports in the United States a convenience sample was taken to ensure the needed data was present. Schedule data for the time period of May 2004 – June 2004 was collected and analyzed to find the impact that airline scheduling had on airport delays.

Throughout the research it became clear that all the airports studied were not affected equally by airline scheduling, and that a handful of these airports operations were moderately to severely affected by airline scheduling.

INTRODUCTION


Ever since the Deregulation Act of 1978 airlines have been using the hub and spoke system. This causes enormous congestion at the "hub" airports. It also creates many en-route delays for aircraft coming into those airports and at times gridlock for the aircraft attempting to leave. (Federal Aviation Administration, (1995, Dec.)


But what is the cause of all of these delays? Is it as some suggest a problem with the air traffic control system? Is it an airline-scheduling problem? Is it because the current airports are to small to accommodate all of the planes? It may be a combination of these things and more.

PURPOSE OF THE STUDY

The purpose of the study is to determine the extent airline scheduling causes airport delays at larger hub airports. The study will also attempt to provide recommendations based upon the findings.

## STATEMENT OF THE PROBLEM

There are many reasons for the delays we now face going into "hub" airports, but for now lets just look at the scheduling aspect. If you watch traffic flow at a place like Chicago O'Hare International airport it doesn't take very long before you start to realize that the airport is only truly busy at certain times of the days while at other times they have very little going on. So the question begs to be asked, do the airlines cause a significant amount of their own problems by scheduling most of their flights at only certain times of the day?

If they do cause their own problems why do they continue? Why not just change their schedule so they don't have the delays? We can assume that in the end it all comes down to profit. That is when the people want to fly so that is when they will fly them. Is this really cost effective? How much money do the airlines lose, just because of lost fuel, when they take airborne delays going into an airport? Is that greater than the amount that they would lose if they changed their schedule? Not only is it a flawed practice to get into from a delay standpoint but it is inherently dangerous. In a business that values on-time service it seem inconceivable that the airlines will not willingly give up their current scheduling practices.

So it will be up to the government to implement any changes.

## SIGNIFICANCE OF THE STUDY

This study will attempt to determine the extent that airline scheduling has on delays at major hub airports.

## RESEARCH QUESTIONS

1.   How many hours per day have the airlines scheduled more than the maximum number of aircraft at major hub airports?

2.   How long does the system take to recover for the over scheduling of aircraft at major hub airports?

3.   How much of their total percentage are these airports using with current scheduling practices?

## CONCEPTUAL/THEORETICAL FRAMEWORK

The concept of supply and demand determines to a great extent how businesses operate, and the airline industry is no exception.  The airlines must always take into consideration when passengers would like to travel.  In some cases, however there is a limit to the supply, to be balanced against an ever increasing demand. In other words there are a lot more passengers who would like to fly out

3

of a given airport at specific time, than the airport can accommodate. The result is the airlines have a demand of more slots of aircraft than the airports can accommodate.

## DEFINITIONS

Enroute delays – Delays taken by aircraft while up in the air.

Ground delays – Delays taken by aircraft while on the ground.

Weather delays – Delays taken by aircraft while on the ground or in the air but solely due to weather.

## ASSUMPTIONS

The first assumption is that the airlines over schedule major hub airports at numerous times during the day.

The second assumption is that the airlines lose a significant amount of money due to scheduling delays caused by trying to accommodate the flying public.

## LIMITATIONS

This study has several limitations. There isn't any way to do a complete study for each airport because this problem only exists at larger hub airports, and also there are many other factors that cause delays at airports such as weather.

CHAPTER II:  REVIEW OF LITERATURE

INTRODUCTION

This chapter will review the works related to the proposed research topic, the effect of passenger attitudes on airline scheduling delays.  Some of the works deal with just scheduling delays, some with delays in general, some with the effect delays have on passengers, and some deal with airline scheduling itself.

REVIEW OF LITERATURE

The purpose of this review is to discuss the research that has already been done on aircraft delays.  This review will be divided into two sections:  Airline Delays: scheduling and otherwise, and the effect delays have on passengers.

*Airline Delays*

The airlines and the FAA clearly understand what causes the majority of delays in the national airspace. (House Committee on Transportation and Infrastructure (2001, April) Finding the delays are not the problem; it is finding the solution that causes trouble.

The effects of weather cause most delays in the enroute phase of flight causing massive rerouting of traffic. This is the largest single factor causing delays and it happens almost every day in the spring and summer.

5

(House Committee on Transportation and Infrastructure, 2001)

Another type of delay is scheduling delays. According to the Subcommittee on Transportation Appropriations, DOT Inspector General Ken Mead only 11% of all delays in the National Airspace System were due to airline scheduling. Mr. Mead also said "a set of capacity benchmarks is essential in understanding the impact of air carrier scheduling practices." (House Committee on Transportation and Infrastructure, 2001) One of the problems with the benchmarks is they are strictly capacity benchmarks for the airline schedule and nothing else, no impacts, no measurements.

It would be wrong to assume that anytime a scheduling peak is observed above the capacity benchmark that airlines are involved in some sort of scheduling abuse. In order to assess the impact of a schedule, we must know if the delay was caused by schedule. According to Jack Ryan (Acting Senior Vice President – Aviation Safety and Operations at the Air Transport Association of America) what's missing from the FAA's effort is an analysis of the delays caused by scheduling, if any. After all, some delay is accepted in all modes of transportation as a result of accommodating demand, when people are *free* to select the time when they

6

intend to travel. (House Committee on Transportation and Infrastructure, 2001)

The consulting firm of Landrum and Brown was asked by the Air Transport Association of America to conduct a study to determine the delay created by *scheduling alone* at the Atlanta airport before and after a schedule change. Delta Air Lines implemented a scheduling change at Atlanta on April 1$^{st}$ 2001. (House Committee on Transportation and Infrastructure)

The new schedule decreased the bank size from 90 to 75; it increased the number of banks from 10 to 12, and decreased the time between banks. In other words the flights used to come in, in 10 groups per day, each with as many as 90 aircraft. In April, they changed that to 70 flights, 12 times a day. (Online News Hour)

# Comparison of Maximum Waiting Times -- 8/17/00 to 4/5/01



**Atlanta Hartsfield International Airport**
**Comparison of Maximum Aircraft Waiting Times**
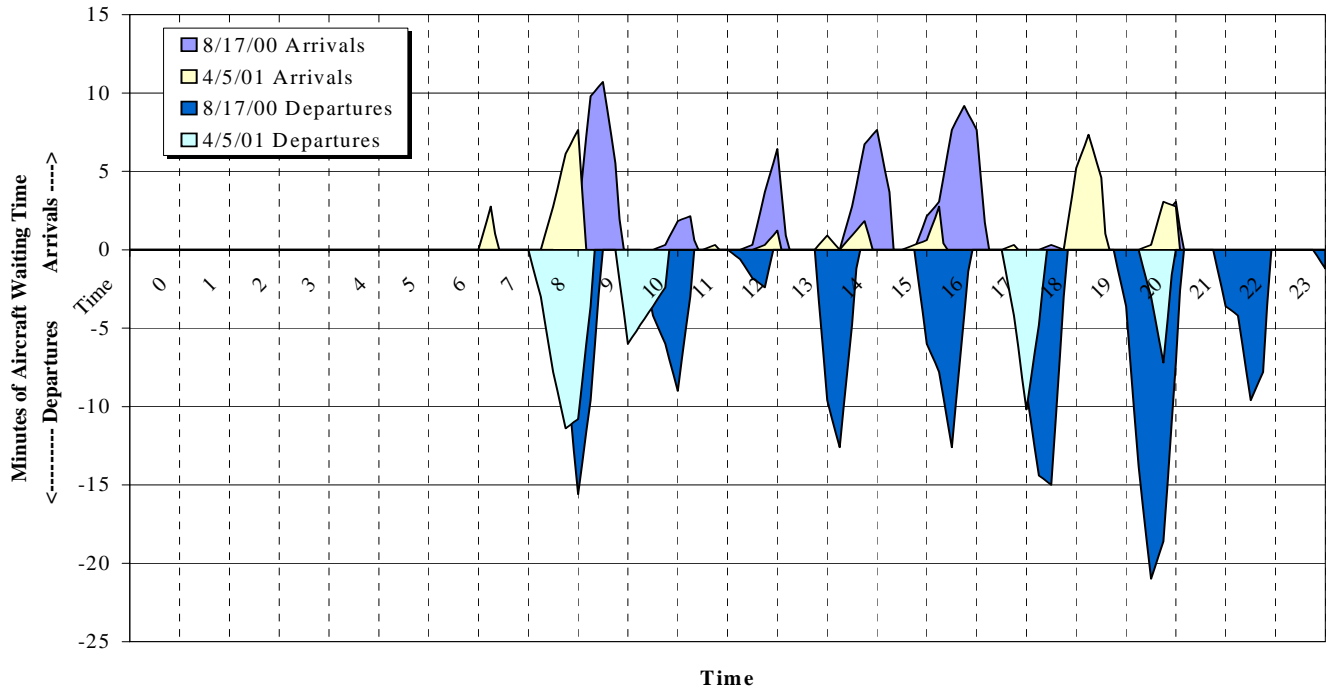
As you can see, the waiting times were substantially reduced especially in the 2000-hour where the wait time was reduced to 6-7 minutes.

**Figure 2:**

## Comparison of Flight Activity -- 8/17/00 to 4/5/01

**Atlanta Hartsfield International Airport**
**Comparison of Scheduled Aircraft Activity (15 Minute Periods)**
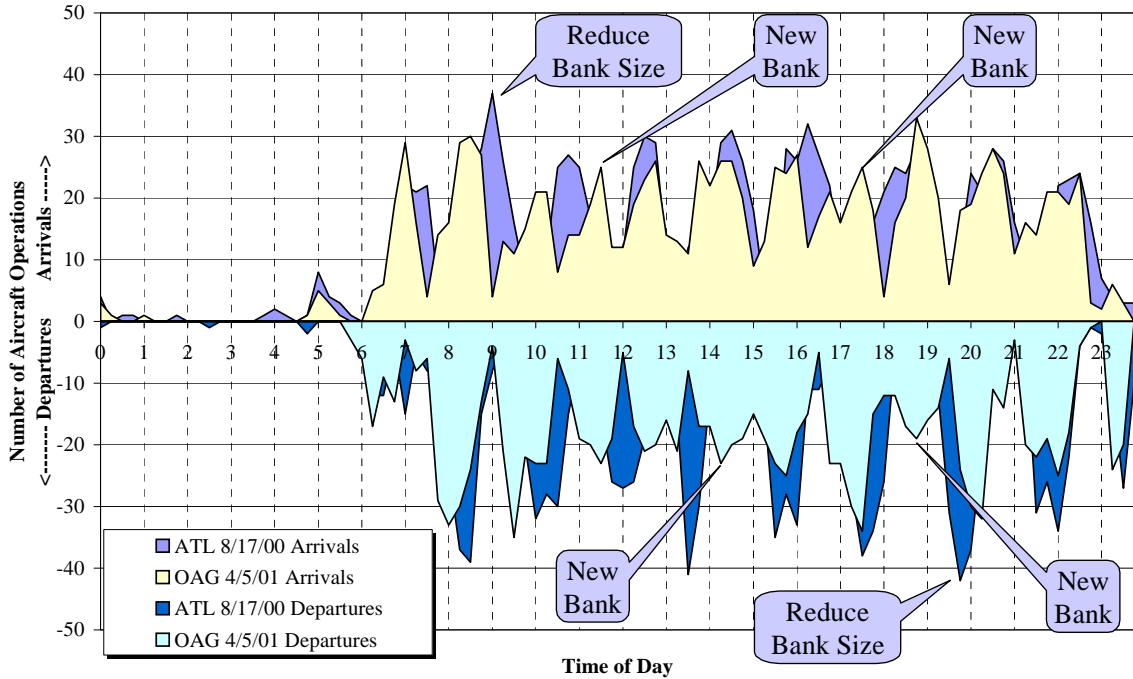


According to Mr. Ryan, each airline understands its role in serving passengers and will not impose onerous delays because of its scheduling practices. Airlines can and will make schedule changes to reduce delay. The benchmarks – by themselves – should not be used as the preeminent tool to address delay problems. The FAA and the airline industry must continue their daily cooperative effort to reduce the biggest cause of delays – those caused

by weather. (House Committee on Transportation and Infrastructure, 2001)

Another reason for delays is the airport capacities inability to meet scheduling demands. The problem is that capacity is not growing as fast as demand. In the long term, this problem has to be addressed by expansion. The Aviation Investment and Reform Act for the 21st Century (AIR 21), Public Law 106-181, became law on April 6, 2000 and provided the funding necessary for airports to build new runways and enhance existing ones. (Federal Aviation Administration, 2000, July.) Airport construction is not as easy as it seems however. One of the biggest challenges to expansion, besides just the construction, lies in the slow pace of identifying the environmental safeguards that need to be done along with the expansion.

Another often cited cause of delays is the outdated equipment that makes up the air traffic control system. When the Aviation Investment and Reform Act for the 21st Century became law it also unlocked money in the aviation trust fund for the purchase of new ATC equipment as well as the airport construction mentioned above.

With more modern equipment, there should be fewer outages. Also, modern computer equipment will provide a

platform for upgraded software that will do more to alleviate delays. The current HOST software used by the FAA ATC system was built and designed in the 1960's.

Some airlines have even suggested that they be given limited antitrust immunity, like they had in the early eighties, in order to meet and adjust their schedules to reduce the number of flights at certain hours. Others have suggested determining the capacity of each airport, which could lead to a limit on the number of flights. (Federal Aviation Administration, 2000, July.)

So as you can see there are a number of different things that can cause delays. Now we will take a look at how those delays can affect passengers.

*The effect delays have on passengers*

Airport congestion and the subsequent delays are making air travel an increasingly frustrating experience for passengers. Air travel has doubled since 1980. With this growth has come growth in delays and cancellation, and customer dissatisfaction with air carrier customer service. Delays increased 50 percent from 1995 to 1999. Cancellations increased 68 percent, from 91,905 to 154,311 flights, between the same time periods. Much of the delay time is occurring on the ground in the form of longer taxi times. The number of flights having taxi-out times of 1

11

hour or more increased 130 percent, from 17,164 flights
delayed in 1995 to 39,523 flights delayed in 1999. (U.S.
Department of Transportation, 2000 June.)

In 1999 the DOT Air Travel Consumer Report disclosed
that consumer complaints against more than doubled from
1998 to 1999.  From 7,980 to 17,381, with more than a 115
percent increase in the number of complaints relating to
flight problems (delays, cancellations and missed
connections).  (U.S. Department of Transportation, 2000
June.)

**Figure 3: Taxi out times of 1 hour or more.**
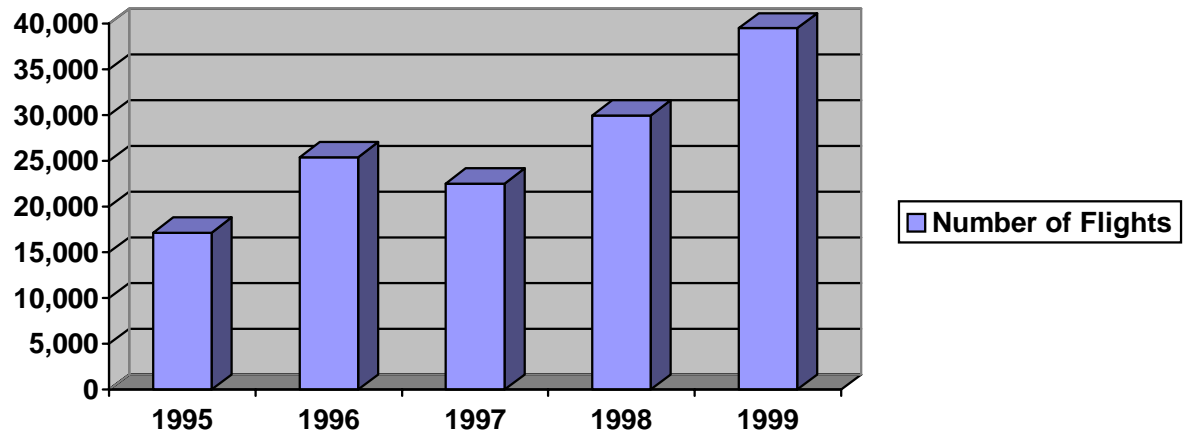


Over the last part of the 1990's the DOT has ranked
flight problems as the number one air traveler complaint,
with customer care and baggage complaints ranked as either
two or three. (U.S. Department of Transportation, 2000

June.) So as you can see the majority of complaints passengers have is with regards to delays, cancellations and missed connections.

### SUMMARY/ABSTRACT

There are many different things that can cause delays: outdated air traffic control equipment, unforeseen weather phenomenon, lack of capacity on the ground at hub airports, and scheduling problems to name a few. There are also a number of reasons that a passenger can become disenchanted with the flying process: customer care, lost baggage, refunds, reservations ticketing, & boarding, and flight problems such as delays cancellations and missed connections are also reasons for disenchanted passengers.

This study will focus on the amount of delays caused by current airline scheduling practices.

The study will involve analyzing existing FAA data on airline scheduling delays to determine the following items:

1. How many hours per day have the airlines scheduled more than the maximum number of aircraft at major hub airports?

2. How long does the system take to recover for the over scheduling of aircraft at major hub airports?

13

3. How much of their total percentage are these airports using with current scheduling practices?

CHAPTER III:  PROCEDURES

INTRODUCTION

This section will describe the procedures that will be used in the study.  The study will be composed of analysis of quantitative data on airline scheduling delays.

POPULATION

The population will be all the major hub airports in the United States.

SAMPLE

The sample will be a convenience sample based upon available scheduling data for the major hub airports.

STUDY DESIGN

The study will use scheduling data from 8 major hub airports in the United States selected by a convenience sample. The data will be analyzed to determine the number of hours a day that the airlines over schedule airports and also to determine the time that it takes for the system to recover from the over scheduling.

DATA COLLECTION METHODS/PROCEDURES

Data will be collected from existing FAA scheduling data on the airports involved. Data will be divided into 15-minute periods from 7 AM until 10 PM local time.   The schedules for each day of the week, Sunday through

Saturday, will be averaged over three months for both a peak and an off-peak season at each airport. Although traffic on weekdays is slightly higher than traffic on the weekends, using the schedule for all seven days will allow for the inclusion of the busy Sunday evening period.

## INSTRUMENT RELIABILITY AND VALIDITY

The FAA is known to be a reliable source for information on airline scheduling practices. The data for each airport can easily be compared to that of the other airports.

## PROPOSED DATA ANALYSIS

All data will be quantitative and will be compiled in an orderly manner to be analyzed. The changes over time will be converted into percentages to better be able to compare the data. The change in delays will be expressed as a percentage change. An analysis of this data will be performed to find any differences between the different airports.

## PROTECTION OF HUMAN SUBJECTS

There will be no research involving human subjects. An IRB approval will not be necessary to commence with this study.

CHAPTER IV

PRESENTATION OF THE DATA


The data used for the research was obtained from the Federal Aviation Administration.

Airports Selected for analysis

- Chicago O'Hare International Airport (ORD)
- Dallas/Fort Worth International Airport (DFW)
- Fort Lauderdale-Hollywood International Airport (FLL)
- Hartsfield-Jackson Atlanta International Airport (ATL)
- Houston George Bush Intercontinental Airport (IAH)
- Minneapolis-St. Paul International Airport (MSP)
- New York LaGuardia Airport (LGA)
- Newark Liberty International Airport (EWR)
- Philadelphia International Airport (PHL)
- Washington Dulles International Airport (IAD)


All the information was obtained and analyzed in order to answer the two research questions that this study put forth:

RESEARCH QUESTIONS

1.   How many times per day have the airlines scheduled more than the maximum number of aircraft at major hub airports?

2.   How long does the system take to recover for the over scheduling of aircraft at major hub airports?

3.    How much of their total percentage are these airports using with current scheduling practices?

The following analysis of data will fully answer these questions.

## Data Related to Research Questions

All of the delay data for this study was obtained from the Federal Aviation Administration.

Each of the following charts used show scheduled traffic (arrivals, departures, or total operations) in 15-minute periods from 7 AM until 10 PM local time. The FAA averaged the schedules for each day of the week, Sunday through Saturday over three months for both a peak and an off-peak season at each airport. Although traffic on weekdays is normally higher than traffic on the weekends, Sunday evening is generally very busy, using the schedule for all seven days allows for the inclusion of the busier Sunday evening period.

Each chart also shows the Current Optimum and IFR benchmark values, adjusted for the 15-minute period.

The arrival and departure benchmark rates indicate the number of flights that the airport could be expected to handle during an hour, given a typical operational configuration. The actual number of operations during that

period is a result of many factors such as traffic schedules, weather, and the runway configuration in use. En route airspace congestion and delays at other airports may also affect the actual number of operations, especially if programs such as ground delay are implemented. The ATC facility at the airport constantly advises the Air Traffic Control System Command Center (ATCSCC) of the number of arrivals and departures that they expect to be able to handle based on conditions at the airport, taking into account the weather and runway configuration. These airport called rates, the Airport Arrival Rate (AAR) and the Airport Departure Rate (ADR), reflect actual conditions at the airport during the given time period. The called rate may be as high as the Optimum rate or lower than the IFR rate; the average usually lies in between, depending on the weather and runway configurations in use during the charted period. (FAA, Benchmark Values and Airline Schedules 2004)

A sample chart, for arrivals at EWR during the period of May-July 2004, is shown in Figure 4.

Figure 4 – Schedule vs. Benchmarks at EWR



**AVERAGE SCHEDULED ARRIVALS, CAPACITY BENCHMARKS, AND CALLED ARRIVAL RATE AT NEWARK (EWR), May-July 2004**
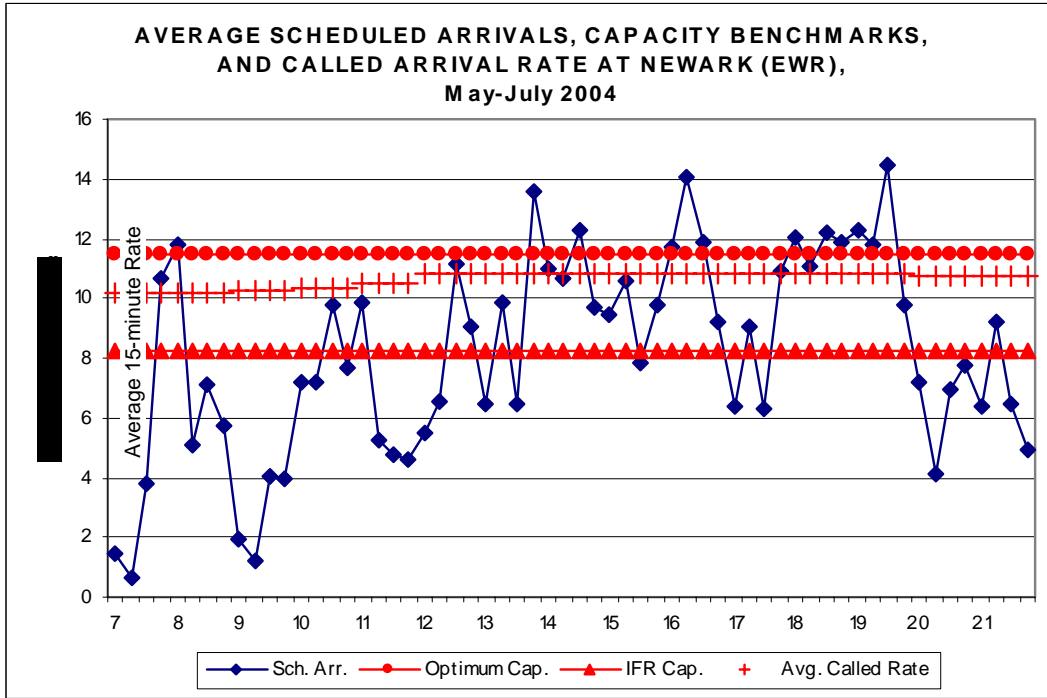
Source: FAA Benchmark Values and Airline Schedules

Scheduled carrier operations constitute a significant part, but not all, of an airport's traffic. Non-scheduled traffic includes air taxi flights, military operations, general aviation (including charter flights), and some cargo operations. Scheduled flights, including air carriers and commuter carriers, accounted for approximately 78-98 percent of the total traffic at these ten airports during 2002 and 2003, according to the FAA Terminal Area Forecast as shown in Table 1.

Table 1
Selected Airports and Percentage of Scheduled Operations

| Airport | Airport Name | Air Carrier, Commuter and Air Taxi Operations |
|---------|-------------|-----------------------------------------------|
| ATL | Hartsfield-Jackson Atlanta International Airport | 98% |
| DFW | Dallas/Fort Worth International Airport | 97% |
| EWR | Newark Liberty International Airport | 97% |
| FLL | Fort Lauderdale-Hollywood International Airport | 78% |
| IAD | Washington Dulles International Airport | 79% |
| IAH | Houston George Bush Intercontinental Airport | 95% |
| LGA | New York LaGuardia Airport | 97% |
| MSP | Minneapolis-St. Paul International Airport | 89% |
| ORD | Chicago O'Hare International Airport | 97% |
| PHL | Philadelphia International Airport Source: FAA | 86% |

Source: FAA Benchmark Values and Airline Schedules

The following charts depict airline and commuter schedules only. The effect of the non-scheduled traffic is unknown. Some of the non-scheduled flights may use a separate runway, or they may try to avoid operating during the busy periods for the air carriers. Non-scheduled flights may have some impact on delay during the busy times of the day at some airports, even though air carrier operations are the main component of operations.

Figure 5 shows the average scheduling versus the capacity benchmarks at Hartsfield-Jackson Atlanta International Airport from May – July 2004

Figure: 5
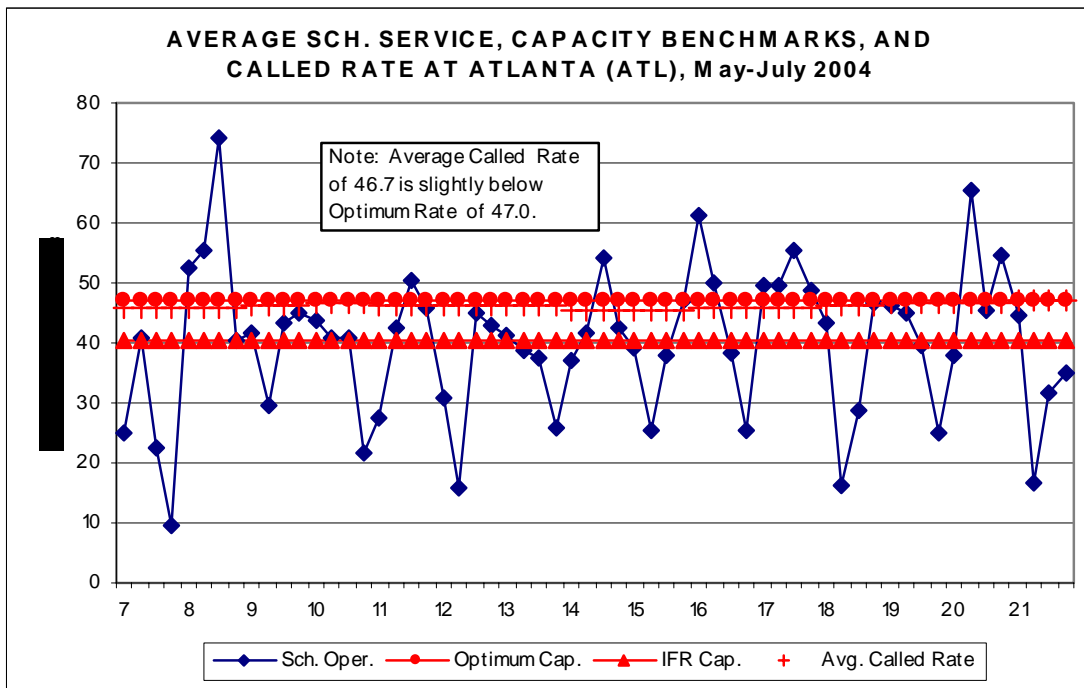


Source: FAA Benchmark Values and Airline Schedules

This figure shows that Hartsfield-Jackson Atlanta International Airports IFR capacity is 40 aircraft per 15 minutes. It also shows that the airport was scheduled, on average, at or over its IFR capacity for 35 out of the 56 fifteen minute increments shown. The airport was scheduled for an average of 39.88 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 99.7% of its IFR capacity. Assuming an average of a 2 minute separation between

aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 8:00 until 9:00 of 62 aircraft would take a minimum of 24.8 minutes to correct, assuming the airport was operating at maximum capacity and utilizing all 5 of the available runways. If only four runways were available the over scheduling would take 31 minutes to correct, assuming there is no other traffic scheduled at the airport during that time.

Figure 6 shows the average scheduling versus the capacity benchmarks at Dallas/Forth Worth International airport from May – July 2004

Figure: 6



AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND CALLED RATE AT DALLAS/FT. WORTH (DFW), May-July 2004

Source: FAA Benchmark Values and Airline Schedules

23

This figure shows that Dallas/Forth Worth Airports IFR capacity is 48 aircraft per 15 minutes. It also shows that the airport was scheduled, on average, at or over its IFR capacity for 6 out of the 56 fifteen minute increments shown. The airport was scheduled for an average of 33.97 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 70.8% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 8:00 until 9:00 of 7 aircraft would take a minimum of 2.33 minutes to correct, assuming the airport was operating at maximum capacity and utilizing all 6 of the available runways. If only five runways were available the over scheduling would take 2.8 minutes to correct, assuming there is no other traffic scheduled at the airport during that time.

Figure 7 shows the average scheduling versus the capacity benchmarks at Newark Liberty International airport from May – July 2004

Figure: 7



**AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND CALLED RATE AT NEWARK (EWR), May-July 2004**

Legend: Sch. Oper. — Optimum Cap. — IFR Cap. — Avg. Called Rate
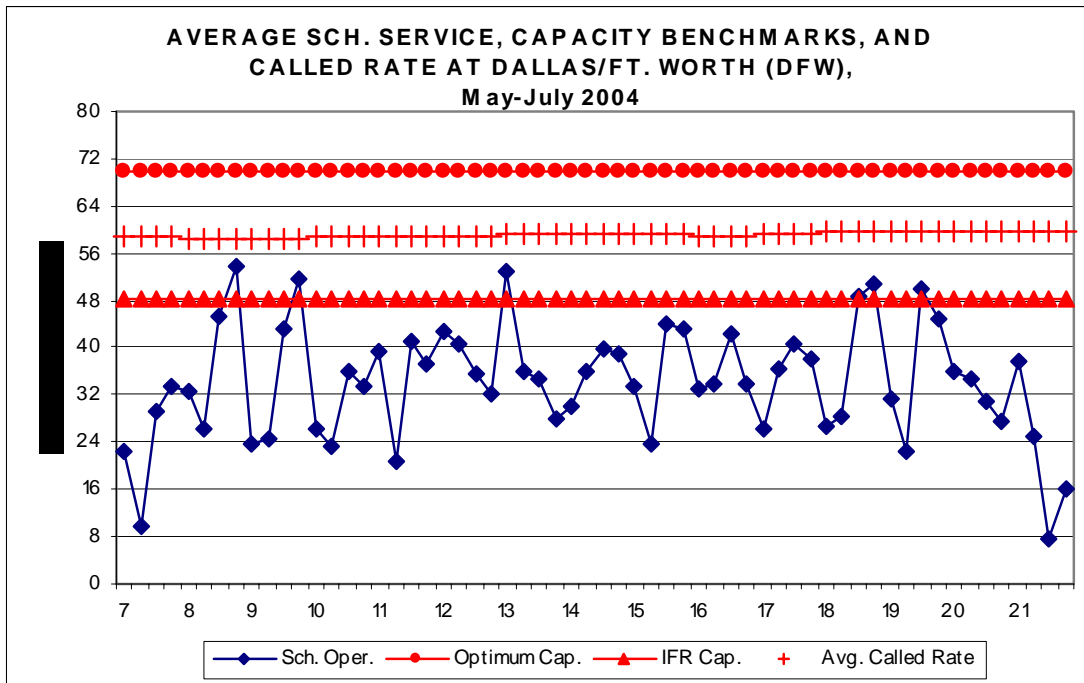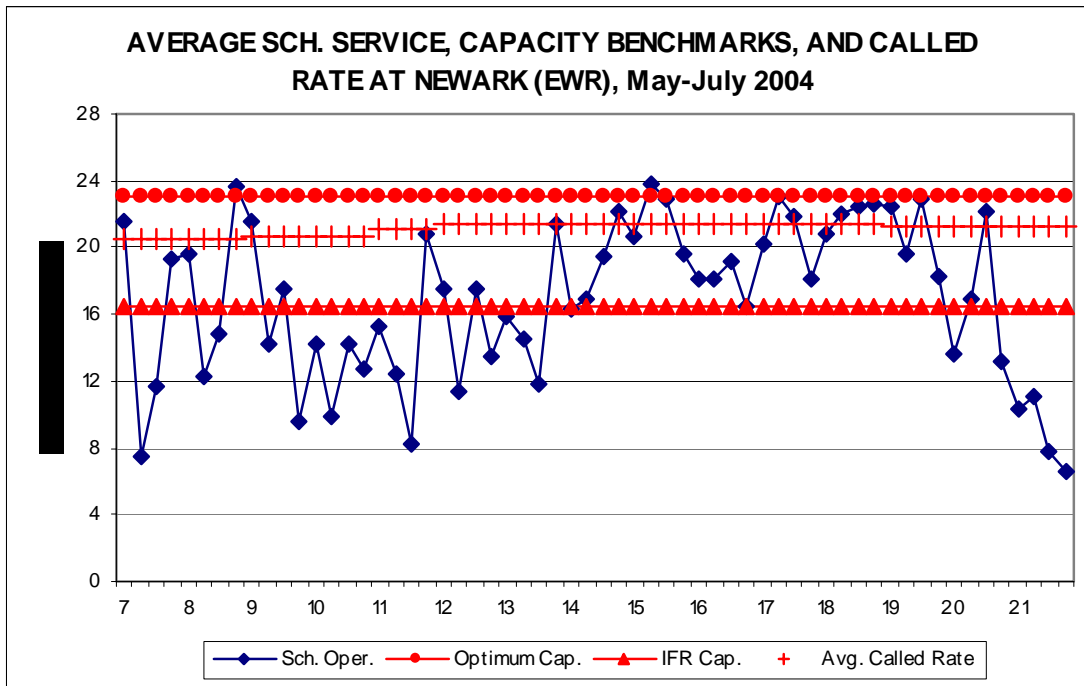
Source: FAA Benchmark Values and Airline Schedules

This figure shows that Newark Liberty International Airports IFR capacity is 16 aircraft per 15 minutes. It also shows that the airport was scheduled, on average, at or over its IFR capacity for 35 out of the 56 fifteen minute increments shown. The airport was scheduled for an average of 16.86 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 105.4% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 14:00 until 19:30 of 103 aircraft would

25

take a minimum of 68.67 minutes to correct, assuming the
airport was operating at maximum capacity and utilizing all
3 of the available runways. If only 2 runways were
available the over scheduling would take 103 minutes to
correct, assuming there is no other traffic scheduled at
the airport during that time.

Figure 8 shows the average scheduling versus the
capacity benchmarks at Ft. Lauderdale-Hollywood
International airport from May – July 2004

Figure: 8



**AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND
CALLED RATE AT FT. LAUDERDALE (FLL),
May-July 2004**

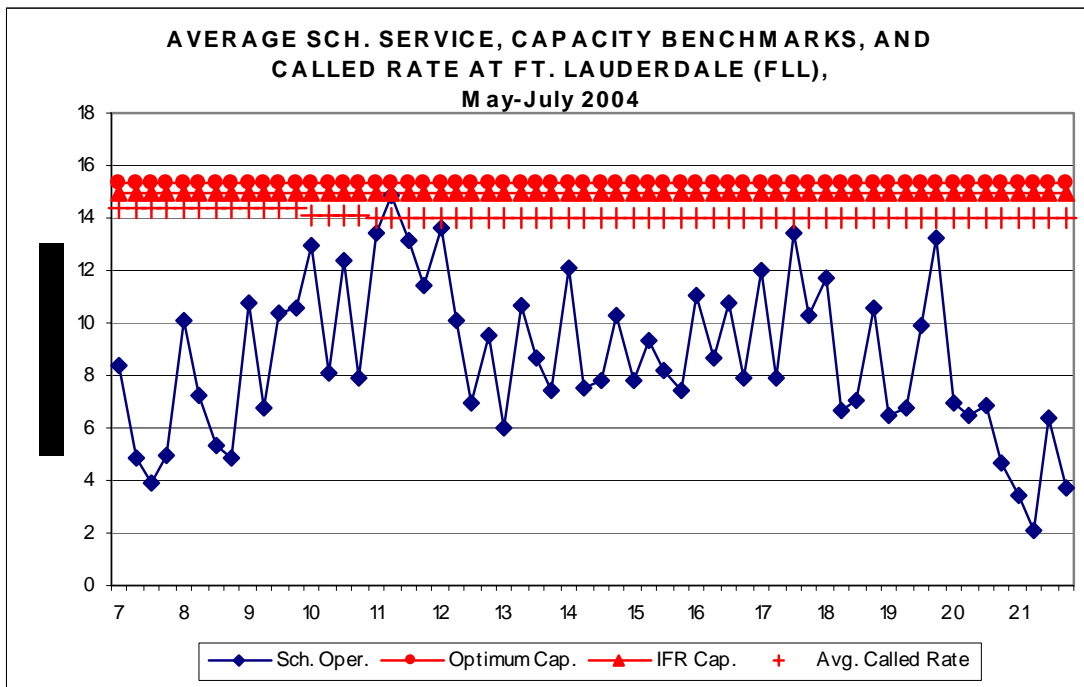Source: FAA Benchmark Values and Airline Schedules

This figure shows that Ft. Lauderdale-Hollywood
International Airports IFR capacity is 15 aircraft per 15

minutes. It also shows that the airport was scheduled, on average, at or over its IFR capacity for 1 out of the 56 fifteen minute increments shown. The airport was scheduled for an average of 8.63 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 57.5% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 11:00 until 12:00 of 1 aircraft would take a minimum of .67 minutes to correct, assuming the airport was operating at maximum capacity and utilizing all 3 of the available runways. If only 2 runways were available the over scheduling would take 1 minute to correct, assuming there is no other traffic scheduled at the airport during that time.

Figure 9 shows the average scheduling versus the capacity benchmarks at Washington Dulles International airport from May – July 2004
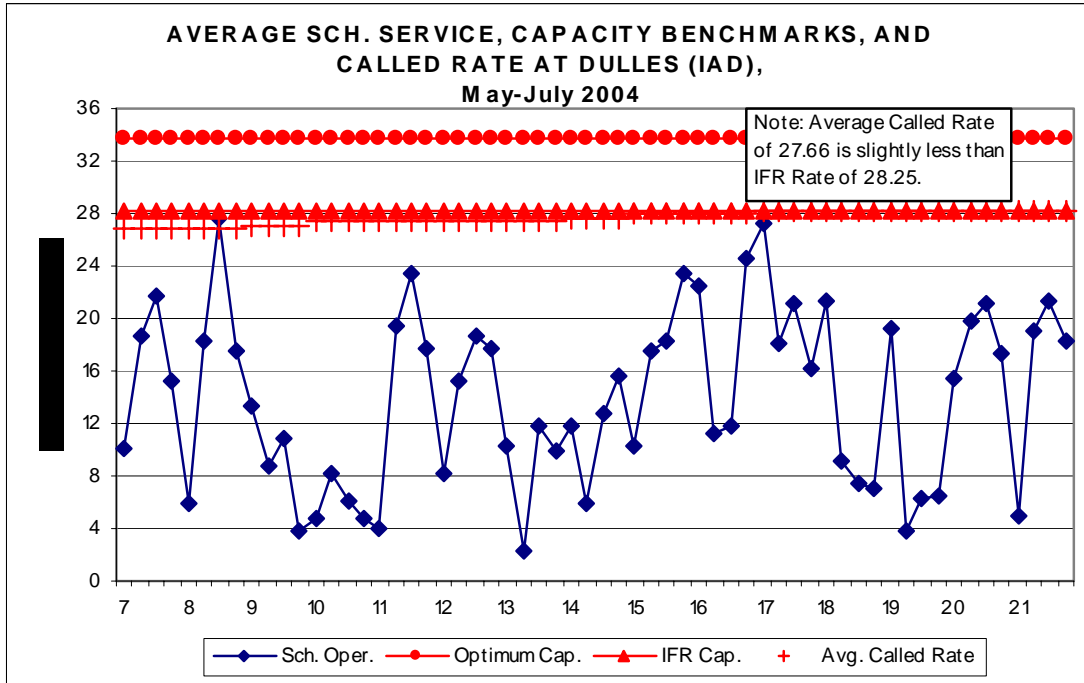
Figure: 9



Source: FAA Benchmark Values and Airline Schedules

This figure shows that Washington Dulles International Airports IFR capacity is 28 aircraft per 15 minutes. It also shows that the airport was scheduled, on average, at or over its IFR capacity for 1 out of the 56 fifteen minute increments shown.  The airport was scheduled for an average of 14.15 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 50.5% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 11:00 until 12:00 of 1 aircraft would take a minimum of .67 minutes to correct,

28

assuming the airport was operating at maximum capacity and
utilizing all 3 of the available runways. If only 2 runways
were available the over scheduling would take 1 minute to
correct, assuming there is no other traffic scheduled at
the airport during that time.

Figure 10 shows the average scheduling versus the
capacity benchmarks at Houston George Bush Intercontinental
airport from May – July 2004

Figure: 10



**AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND CALLED RATE AT HOUSTON (IAH), May-July 2004**

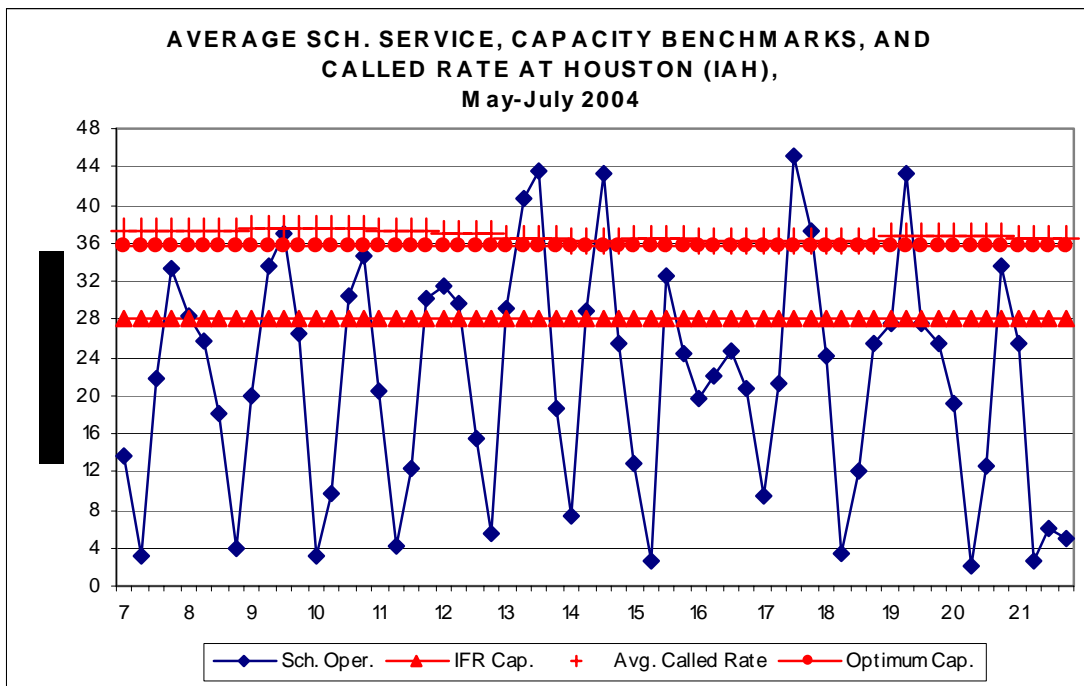Legend: Sch. Oper. | IFR Cap. | Avg. Called Rate | Optimum Cap.

Source: FAA Benchmark Values and Airline Schedules

This figure shows that Houston George bush
Intercontinental Airports IFR capacity is 28 aircraft per
15 minutes. It also shows that the airport was scheduled,

on average, at or over its IFR capacity for 21 out of the 56 fifteen minute increments shown. The airport was scheduled for an average of 21.65 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 77.32% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 13:00 until 14:00 of 30 aircraft would take a minimum of 12 minutes to correct, assuming the airport was operating at maximum capacity and utilizing all 5 of the available runways. If only 4 runways were available the over scheduling would take 15 minutes to correct, assuming there is no other traffic scheduled at the airport during that time.

Figure 11 shows the average scheduling versus the capacity benchmarks at New York La Guardia airport from May – July 2004

Figure: 11



**AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND CALLED RATE AT LAGUARDIA (LGA), May-July 2004**

Legend: Sch. Oper. — Optimum Cap. — IFR Cap. — Avg. Called Rate
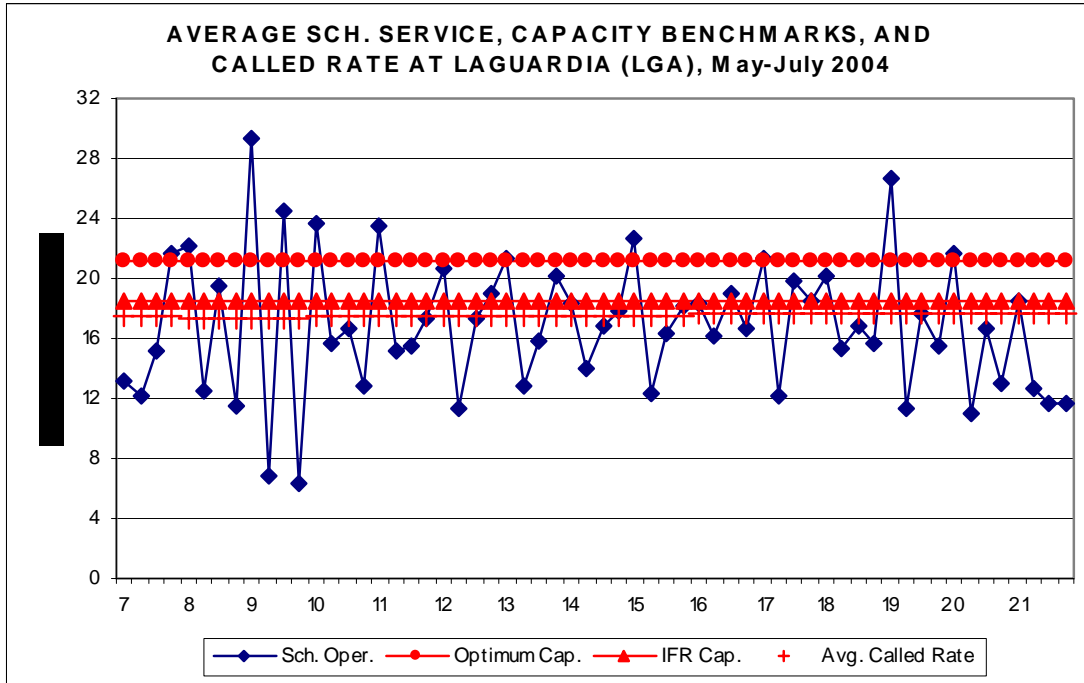
Source: FAA Benchmark Values and Airline Schedules

This figure shows that New York La Guardia Airports IFR capacity is 18 aircraft per 15 minutes. It also shows that the airport was scheduled, on average, at or over its IFR capacity for 20 out of the 56 fifteen minute increments shown. The airport was scheduled for an average of 16.98 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 94.33% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 9:00 until 9:30 of 12 aircraft would take a minimum of 12 minutes to correct,

assuming the airport was operating at maximum capacity and utilizing all 2 of the available runways. If only 1 runway were available the over scheduling would take 24 minutes to correct, assuming there is no other traffic scheduled at the airport during that time.

Figure 12 shows the average scheduling versus the capacity benchmarks at Minneapolis-St. Paul International airport from May – July 2004

Figure: 12



**AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND CALLED RATE AT MINNEAPOLIS/ST. PAUL (MSP), May-July 2004**

Note: Average Called Rate of 29.3 is slightly below Optimum Rate of 30.0.

Legend: Sch. Oper. — Optimum Cap. — IFR Cap. + Avg. Called Rate
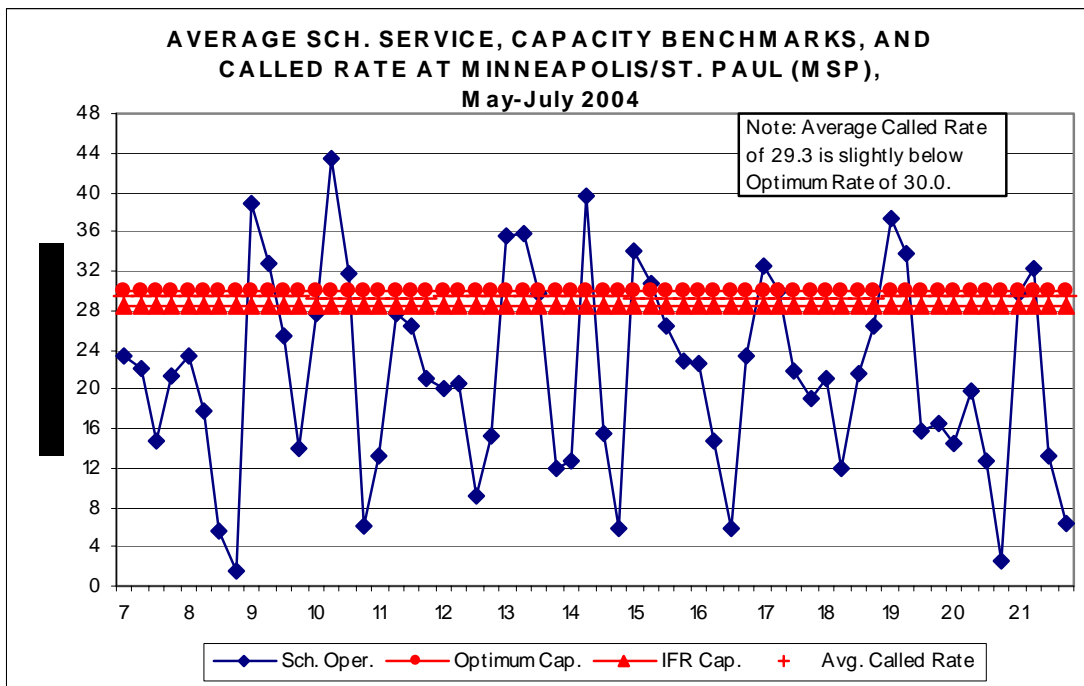
Source: FAA Benchmark Values and Airline Schedules

This figure shows that Minneapolis-St. Paul International Airports IFR capacity is 28 aircraft per 15 minutes. It also shows that the airport was scheduled, on

average, at or over its IFR capacity for 16 out of the 56 fifteen minute increments shown.  The airport was scheduled for an average of 21.34 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 76.21% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 10:00 until 10:45 of 20 aircraft would take a minimum of 10 minutes to correct, assuming the airport was operating at maximum capacity and utilizing all 4 of the available runways. If only 3 runway were available the over scheduling would take 13.33 minutes to correct, assuming there is no other traffic scheduled at the airport during that time.

Figure 13 shows the average scheduling versus the capacity benchmarks at Chicago O'Hare International airport from May – July 2004

Figure: 13



**AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND CALLED RATE AT CHICAGO (ORD), May-July 2004**
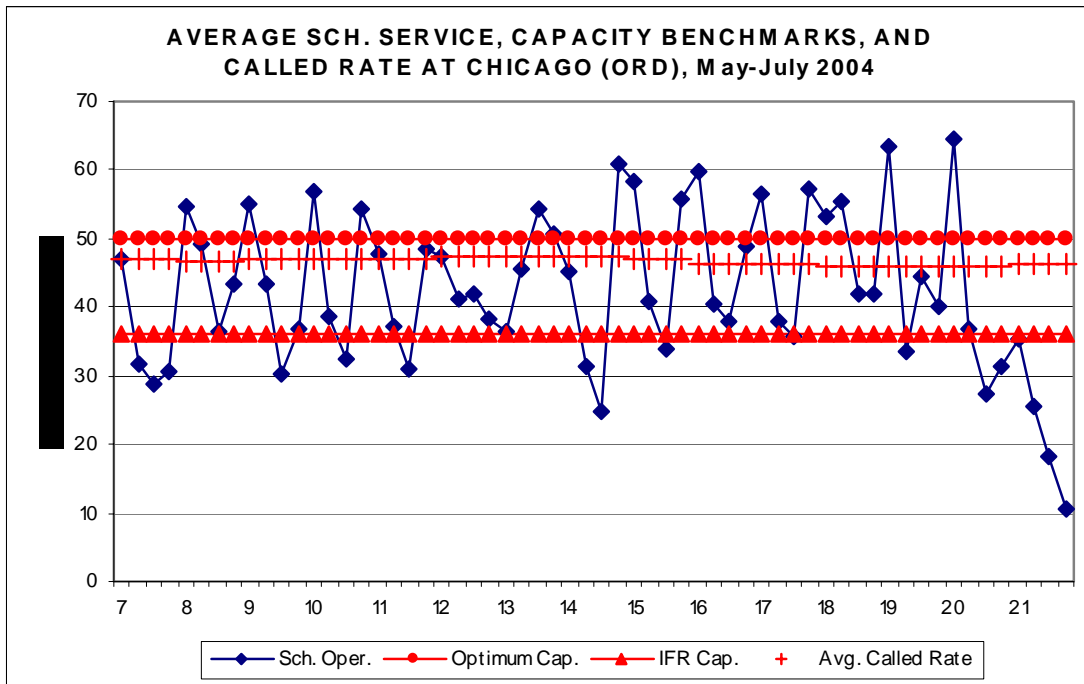
Source: FAA Benchmark Values and Airline Schedules

This figure shows that Chicago O'Hare International Airports IFR capacity is 35 aircraft per 15 minutes. It also shows that the airport was scheduled, on average, at or over its IFR capacity for 45 out of the 56 fifteen minute increments shown. The airport was scheduled for an average of 42.54 aircraft per 15 minutes for the three months. Therefore if everything went as scheduled the airport was operating at 121.54% of its IFR capacity. Assuming an average of a 2 minute separation between aircraft per runway (based upon air traffic control regulations and procedures) the over scheduling of operations from 15:30 until 19:00 of 198 aircraft would

34

take a minimum of 66 minutes to correct, assuming the airport was operating at maximum capacity and utilizing all 6 of the available runways. If only 5 runway were available the over scheduling would take 79.2 minutes to correct, assuming there is no other traffic scheduled at the airport during that time.

Figure 14 shows the average scheduling versus the capacity benchmarks at Philadelphia International airport from May – July 2004

Figure: 14



AVERAGE SCH. SERVICE, CAPACITY BENCHMARKS, AND CALLED RATE AT PHILADELPHIA (PHL), May-July 2004

Note: Average Called Rate of 24.3 is slightly above IFR Rate of 24.0.

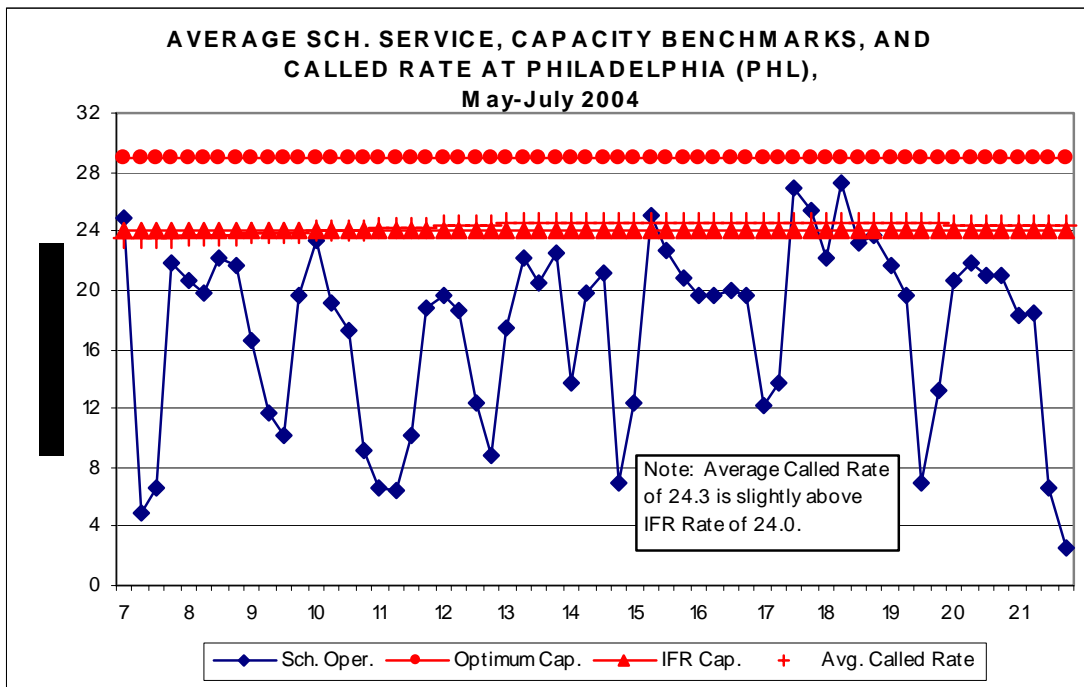Sch. Oper.    Optimum Cap.    IFR Cap.    Avg. Called Rate

Source: FAA Benchmark Values and Airline Schedules

This figure shows that Philadelphia International Airports IFR capacity is 24 aircraft per 15 minutes. It

also shows that the airport was scheduled, on average, at
or over its IFR capacity for 7 out of the 56 fifteen minute
increments shown.  The airport was scheduled for an average
of 17.37 aircraft per 15 minutes for the three months.
Therefore if everything went as scheduled the airport was
operating at 72.37% of its IFR capacity. Assuming an
average of a 2 minute separation between aircraft per
runway (based upon air traffic control regulations and
procedures) the over scheduling of operations from 17:30
until 18:00 of 5 aircraft would take a minimum of 3.33
minutes to correct, assuming the airport was operating at
maximum capacity and utilizing all 3 of the available
runways. If only 2 runway were available the over
scheduling would take 5 minutes to correct, assuming there
is no other traffic scheduled at the airport during that
time.

Table 2 ranks each airport based upon the percentage
of aircraft scheduled at each airport in relation to the
IFR capacity for each airport from May 2004-July 2004.

Table 2: Percentage of IFR capacity utilization

| Airport | Airport Name | Percentage of IFR capacity |
|---------|--------------|----------------------------|
| ORD | Chicago O'Hare International Airport | 121.54% |
| EWR | Newark Liberty International Airport | 105.4% |
| ATL | Hartsfield-Jackson Atlanta International Airport | 99.7% |
| LGA | New York LaGuardia Airport | 94.33% |
| IAH | Houston George Bush Intercontinental Airport | 77.32% |
| MSP | Minneapolis-St. Paul International Airport | 76.21% |
| PHL | Philadelphia International Airport | 72.37% |
| DFW | Dallas/Fort Worth International Airport | 70.8% |
| FLL | Fort Lauderdale-Hollywood International Airport | 57.5% |
| IAD | Washington Dulles International Airport | 50.5% |

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

The purpose of this study was to analyze the impact of airline scheduling practice on airport delays. The study was entirely quantitative using only data publicly available through the Federal Aviation Administration and submitted in accordance with federal regulations. The data was presented through use of charts, which at the same time simplified that analysis of the data.

Summary

This study attempted to answer the following research questions:

1.  How many times per day have the airlines scheduled more than the maximum number of aircraft at major hub airports?

2.  How long does the system take to recover for the over scheduling of aircraft at major hub airports?

3.  How much of their total percentage are these airports using with current scheduling practices?

This summary is based on the data presented in Chapter IV and will refer to those figures when applicable. The data was used to show delay trends at ten different airports over a three month period during 2004. Figures 5 through 14 show the delay data for each individual airport that was selected for this study.  The IFR capacity of each airport was deemed the most accurate capacity to judge the airlines schedule against based upon the fact that in almost every instance the air traffic control procedures for all the airports studied are based upon IFR procedures and separation standards.  The airports used in this study were selected by a convenience sample based upon the availability of data for major hub airports.

It was expected that all airports would be different, but throughout the analysis it was also expected that each airport was, at least, moderately affected by over scheduling by the airlines. Table 2 was compiled by using information calculated from the tables and was used as a comparison of airports based upon the airlines schedule with respect to the IFR capacity of each airport.

When comparing the airports it became clear that all the airports studied were not affected equally by airline scheduling. Chicago O'Hare International and Newark Liberty International airports immediately stand out based upon

their percentage of IFR capacity used. As depicted in table 2, each airport is scheduled over 100% of their IFR capacity. These two airports also distinguished themselves with regards to their recovery time from the largest number of planes scheduled over the IFR capacity. In each case, on a daily basis, it takes each airport at minimum 1 hour to recover from over scheduling during their busiest times, operating at full capacity, easily pushing many of the planes scheduled during that time into the next wave of overscheduled aircraft.

Hartsfield-Jackson Atlanta International and New York La Guardia airports also stood out based upon their percentage of IFR capacity utilized. As depicted in table 2, each of these airports is scheduled for 94% of their IFR capacity, with Hartsfield Jackson Atlanta International airport very close to 100% at 99.7%. At Atlanta it takes daily, on average, 24.8 minutes to recover from over scheduling during their busiest time, when operating at full capacity, pushing several of the planes scheduled at that time back into the next wave of over scheduled aircraft. Conversely, at New York La Guardia airport, when operating at full capacity, it only takes 12 minutes to recover from the largest over scheduled time period,

leaving just enough time for the system to recover before the next wave of over scheduled planes hit.

Houston George Bush Intercontinental, Minneapolis-St. Paul International, Philadelphia International, and Dallas/Forth Worth International airports were all scheduled between 70 and 80% of their IFR capacity during the three month period. None of the airports exceeded any over scheduling periods, that would take more than 12 minutes to recover from, when operating at full capacity, leaving enough time for the system to recover before the next wave of over scheduled planes hit at any of these airports.

Fort Lauderdale-Hollywood International and Washington Dulles International airport ran with virtually no over scheduling and at 57.5% and 50.5% of there IFR capacity, leaving them with ample time to recover from any over scheduling during the three months.

## Conclusions

Throughout the analysis of the study if became obvious that not all of the airports studied were in danger of having severe delay problems based upon the scheduling of the airlines. Chicago O'Hare and Newark Liberty International airports were, on average, scheduled over their IFR capacity for the entire three months. With the

amount of planes scheduled at these two airports, even operating at maximum capacity, there is no way for the airports to accept air traffic without encountering at least moderate delays. The schedule alone at these two airports is already a significant problem at these airports. Because of the number of aircraft that are overscheduled at certain times during the day there is already going to be delays no matter how well the system is working. If any other delay inducing phenomenon occurs it just adds to the delays that the aircraft are experiencing because of the over scheduling. In other words these two airports are scheduled so tightly that they cannot accept anything that might alter their schedule. When severe weather becomes a factor each of these airports may encounter delays in excess of 1-2 hours sometimes taking ½ a day or more to recover.

Hartsfield-Jackson Atlanta and New York La Guardia airports schedules are being pushed to a point that there is no room for error. If anything else that could cause delays such as weather were to occur these two airports will start to encounter moderate delays of around 1 hour. The schedule alone at these two airports plays a significant role in the overall delays experienced at these airports. Because of the number of aircraft that are

overscheduled at certain times during the day there is no way that the schedule can accept any other delay inducing phenomenon to occur. In other words these two airports are scheduled so tightly that they cannot accept anything that might alter their schedule.

Of the remaining airports Houston, Minneapolis-St. Paul, Philadelphia and Dallas/Forth Worth airports really have very few scheduling problems. They all have some periods where they are scheduled over their IFR capacity but there is enough flexibility that the schedule itself will cause only a minor role in the overall delays at these airports. The only time that scheduled delays would cause any problems would be when other larger delays such as thunderstorms occur.

Fort Lauderdale and Washington Dulles airports have no over scheduling problems to speak of. The schedule itself at these two airports should cause no delays and would play an insignificant role in overall delays at the airports.

<div align="center">Recommendations</div>

While it is certain that more research needs to be done on this topic to verify the findings of this study. It was assumed by this researcher that all of the larger airports in the United States had a large problem with over scheduling. That assumption was incorrect. However it is

obvious that at Chicago and Newark airports something has to be done to correct the massive over scheduling that is occurring. At Atlanta and La Guardia the situation is only marginally better.  For the safe and expeditious movement of air traffic an airport should never be scheduled over its IFR capacity.

There are no easy solutions to the problem of over scheduling. At most airports the government could step in and force each airport schedule to be under the IFR capacity.  This would ensure that the schedule would be flexible enough to withstand other strains on it.

At airports like Chicago and Newark the situation becomes much harder to control.  While forcing these airports to schedule under the IFR capacity would even out the schedule there isn't any way that the current number of aircraft could ever be scheduled without delay.  At these locations the options would be to cut some existing flights or build to expand the capacity of the airport. With the industry continuing to utilize smaller commuter aircraft the problem of over scheduling airports will only grow if something is not done. The onus would have to be on the government to decide to cut existing flights or build to expand the capacity of the airport.

REFERENCES

Federal Aviation Administration, (1995, Dec.) <u>Airport Capacity and Delay, Chg.2 </u>Advisory 6A). Washington, D.C. :FAA

Federal Aviation Administration (1991, Nov.). <u>Airport Technology Program Plan </u>(FAA Technical Center Publication). Atlantic City, NJ:FAA

Federal Aviation Administration, (2004, Dec.) <u>Benchmark Values and Airline Schedules</u>. Washington, D.C. :FAA

2<sup>ND</sup> USA/EUROPE AIR TRAFFIC MANAGEMENT R&D SEMINAR Orlando (1998, Dec.) <u>Airline Arrival Prioritization in Sequencing and Scheduling  </u>(NASA Ames Research Center) Moffett Field, CA

FAA/OST Task Force Study  (1999, Oct.). <u>Airport Business Practices and their Impact on Airline Competition</u> (FAA Technical Center Publication). Atlantic City, NJ:FAA

Federal Aviation Administration (2000, July.). <u>Hearing on Airline Delays </u>(FAA Technical Center Publication). Atlantic City, NJ:FAA

Online News Hour (2001, July) <u>Holding Pattern</u> (MacNeil-Lehrer Productions)

U.S. Department of Transportation (2000 June.) <u>Interim Report on Airline Customer Service Commitment</u> (Office of Inspector General) Washington, DC

House Committee on Transportation and Infrastructure (2001. April) <u>Statement of Jack Ryan</u> (Air Transport Association of America) Washington, DC

Laura Kang & John-Paul Clarke (Date unavailable) <u>Degradable Airline Scheduling</u> (International Center for Air Transportation/Operations Research Center) Massachusetts Institute of Technology

Joel Antolini (2001, Feb) <u>Aviation Gridlock Seminar</u> (Airline Planning Group)

Sergio Ortega (2001, July) <u>delays, delays…</u> (airodyssey.net)

House Committee on Transportation and Infrastructure (2001. Mar) <u>Statement of Deborah C. McElroy</u> (Regional Airline Association) Washington, DC

Jan K. Brueckner (2003, Jan) <u>Network Structure and Airline Scheduling</u> (Institute of Government and Public Affairs) Champaign, IL