

Activity I: Flight Delays

Introduction

The **Aviation Research** activity begins by investigating one of the main problems with the commercial aviation industry today: delay frequency. **Part A - Picking A Route to Take** introduces the concept in a warm-up fashion, involving students building on their own knowledge bases. As soon as it is realized that delay is a major factor contributing to the perception of a commercial airline, the second activity, **Part B - Delays and Airport Usage, Time of Year, Time of Day**, addresses delay. In this activity, delay data is accumulated from an internet database and is used to paint a graphical and mathematical picture of how delay is related to the frequency of airport use, time of year, and time of day. Extensions can also be made to compare delay with weather. **Part C - Delays and Time of Day and Airlines**, is an alternate activity to Part B. In Part C, commercial airlines are investigated on a local level across a short period of time. Data is collected by the students, and is analyzed in similar ways to Part B. However, the different nature of the sample types and sizes in B and C should lead students to very different methods of statistical analysis, if the extension to statistics were made. **Part D - Delay and Fuel Use** provides a glimpse into how delays influence the airline industry itself, in terms of cost to operate airplanes and increased fuel use.



Activity I: Flight Delays

Part A - Picking a Route to Take

Pilots like to be able to choose their own routes of travel. Years ago, when flying was still relatively new, this was an option, but now that skies are packed with airplanes, pilots have little choice in the route they may take to get from one place to another. Despite the fact that a flight might take more time and use more fuel, controllers will force pilots to follow standardized routes of travel. If we watched airplanes for long enough (or better yet, recorded a day's worth of flights coming and going from an airport, and played it back at high speed), it would be easy to see the limited numbers of paths an airplane can take within a certain region.

Commercial airlines know their routes so well that they can print maps in the backs of airline magazines showing the anticipated routes for most flights. Maps are also published showing these standard routes of travel, which pilots use for planning.

Still, controllers may need to change these routes slightly, based on ground and weather conditions and traffic in any particular region.

1. As a consumer, what are the major factors to consider, when picking a route to take or an airline for travel?

2. Most often, the top influencing factor in picking an airline is past experience (positive or negative) with the airline. What positive or negative experiences have you had with airlines? Discuss and create a list of pros and cons. Are there people in your class who can recount good experiences with an airline that far outweigh the bad experiences someone else might have had?
3. The one thing that makes trips hard, time and time again, are delays. Delays can be due to a variety of factors. What do you think could cause a delay?



Activity I: Flight Delays

Part B - Delays and airport usage, time of year, time of day

It is easy to get a sense of frequency of use of a specific region, based on the top ten commercial airlines (which account for about 90 percent of the commercial airline revenues) and most frequently used airports in the US. You will be obtaining data to fill in the following chart. Before you start, make some hypotheses about the information you obtain.

Hypothesis:

- ✧ The frequency of flights coming into an airport IS / IS NOT proportional to the frequency of delays.
 - ✧ The airport with the highest percentage of delays will be _____.
 - ✧ The airport with the highest number of delays will be _____.
 - ✧ The month with the highest number of delays will be _____. (for comparison with other groups' data)
 - ✧ The time of day with the highest number of delays will be _____.
1. Visit www.dot.gov/airconsumer/atcr99.htm to obtain information a monthly Air Travel Consumer Report from 1999. Fill in the following chart to help you determine which airports have the highest frequency of flights arriving / departing and the highest frequency of delays, and furthermore if the frequency of delays is related to the frequency of flights.





Aviation Research

Activity I: Flight Delays

Activity I: Flight Delays

Name: _____

Date: _____

Airport Delays Worksheet				
Air Travel Consumer Report used: _____ (month), _____ (year)				
Airport	Number of Arrivals	% Delayed	Number Delayed	Hour of the Day with most Delays (mil. time)
Atlanta				
Boston				
Baltimore				
Cleveland				
Cincinnati				
Washington DC				
Denver				
Dallas Fort Worth				
Detroit				
EWB				
Houston				
John F Kennedy				
Las Vegas				
Los Angeles				
Laguardia				



Aviation Research

Activity I: Flight Delays

Name: _____

Date: _____

Airport Delays Worksheet

Air Travel Consumer Report used: _____ (month), _____ (year)

Airport	Number of Arrivals	% Delayed	Number Delayed	Hour of the Day with most Delays (mil. time)
Orlando				
Miami				
MSP				
ORL				
Portland				
Philadelphia				
Phoenix				
Pittsburgh				
San Diego				
Seattle				
San Francisco				
Salt Lake City				
St. Louis				
TPA				

2. Now graph your information as a bar graph, with airports along the x axis, and one of the four column headings along the y-axis.
3. Calculate means, standard deviations, and medians for the data.



Activity I: Flight Delays

Part C - Delays and Time of Day and Airlines

Delays typically become more common as the day goes on. This is why people often consider the time of day when making reservations.

1. Using data from airlines (each group should get their own), fill in the following table for at least 2 flights per hour for one 24-hour day.

Use the following definitions for variables a through d:

a = Scheduled departure

c = Scheduled Arrival

b = Actual departure

d = Actual Arrival

Determine $a - b$ and $c - d$ in minutes. The difference should be negative if the flight was late or positive if the flight was early.



Activity I: Flight Delays

Off Schedule Times

Name:

Date:

Airline:					Data for Date:			
Hour	a - b	c - d	Hour	a - b	c - d	Hour	a - b	c - d
0			8			16		
0			8			16		
1			9			17		
1			9			17		
2			10			18		
2			10			18		
3			11			19		
3			11			19		
4			12			20		
4			12			20		
5			13			21		
5			13			21		
6			14			22		
6			14			22		
7			15			23		
7			15			23		
Other Time	a - b	c - d			Other Time	a - b	c - d	



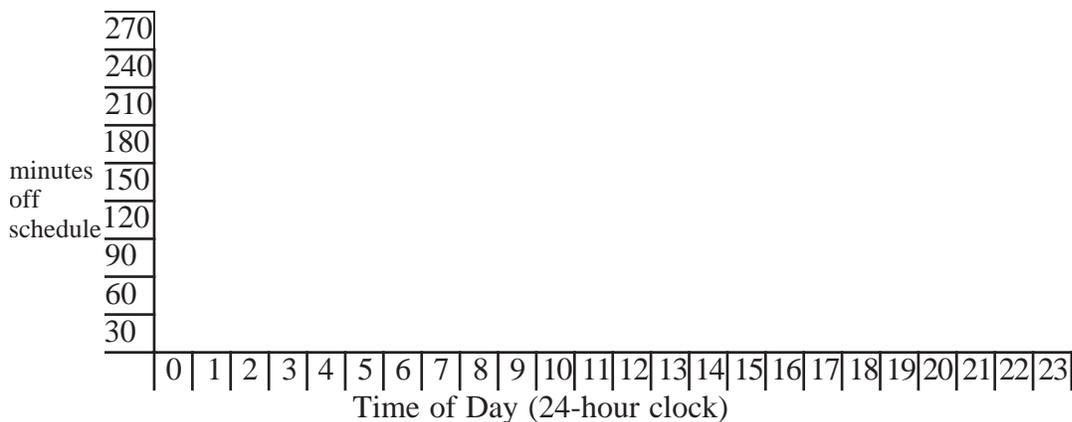
Activity I: Flight Delays

2. Now plot “off schedule” times versus time of day on the following line graph. Have all other groups do the same.

Draw a line (it doesn't have to be straight) for each set of data, to show the trends.

You could build the trend line a number of ways. You could build it so that:

- ✎ the same number of points are above and below the line.
- ✎ the line passes through the average of the two values for any hour.
- ✎ other (ask your teacher): _____



If there appears to be a trend for all airlines, draw a summative graph on another piece of paper. Be sure to document calculation of average values, which you use for constructing your graph.

3. Can you approximate an equation for measuring delay with respect to the time of day?
- a) using a line
 - b) using a parabola
 - c) using a trigonometric function
 - d) using a logarithmic function
 - e) using regression (linear or not)
4. What is the probability that a delay (any delay) will occur at each of the hours of operation (typically 6 am - 11 pm)?



Activity I: Flight Delays

5. Which airline is the most delayed? Based on what you see about delays, decide how you can rank the commercial airlines.
 - a) Describe how you could rank the airlines, so that results are misleading.

 - b) Describe how you could rank them so results are not as misleading, and defend the validity of your data. Rank them and make a conclusion for the question: which commercial airline is most delayed?

6. Do #5 again for the following question: Which airline has the highest probability of being delayed?



Activity I: Flight Delays

Part D - Delay and Fuel Use

The cost of a flight is related to the time the airplane is in use and the fuel consumed. Passengers often have a choice between flight options:

- a) a direct flight between A and B, and
- b) a connecting flight between A, C, and B.

The following problems use delay time information from the previous activity. If you do not have this information, talk to your teacher about getting a printout of the information. This information is available on the teacher's pages. The numbers in the following problems are not based on actual operational costs, as these vary widely in different circumstances. These numbers are provided for illustration only.

For the following points A, B, and C, and following flight times, what is the actual time of the airplane in air and hence the cost to operate it, if the airplane travels 500 miles / hour and costs \$5000/ hour to operate?

1. Situation 1:

$$A = (3, 2) \qquad B = (25, 14) \qquad C = (25, 5)$$

Distance travelled:

Direct Flight: _____

Connection Flight: _____

Departure Time	Flight Duration	Extra Time for Average Delay	TOTAL Time in Air	Cost
7:00 am				
12:00 noon				
2:00 pm				
5:00 pm				
8:00 pm				



Activity I: Flight Delays

2. Situation 2:

$A = (-2, 5)$

$B = (12, 14)$

$C = (7, 7)$

Distance travelled:

Direct Flight: _____

Connection Flight: _____

Departure Time	Flight Duration	Extra Time for Average Delay	TOTAL Time in Air	Cost
7:00 am				
12:00 noon				
2:00 pm				
5:00 pm				
8:00 pm				

3. Situation 3:

$A = (3, 1)$

$B = (15, -4)$

$C = (10, -6)$

Distance travelled:

Direct Flight: _____

Connection Flight: _____

Departure Time	Flight Duration	Extra Time for Average Delay	TOTAL Time in Air	Cost
7:00 am				
12:00 noon				
2:00 pm				
5:00 pm				
8:00 pm				



Activity I: Flight Delays

4. In general, when would you consider taking a connecting flight rather than a direct flight, in order to have the quickest flight possible?

5. Is there a commercial airline that appears to have less of a problem with delay? If so, explain which one and some factors that might contribute to this.

