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Space Administration
Langley Research Center
Hampton, VA 23681-2199

Educational Product	
Educators	Grades 5-8

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NASA CONNECT™

Measurement, Ratios, and Graphing: Safety First

A Lesson Guide with Activities in Mathematics, Science, and Technology

Measurement, Ratios, and Graphing: Safety First is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the lesson guide for NASA CONNECT can be found at the NASA CONNECT web site: **http://connect.larc.nasa.gov**

NASA CONNECT

Measurement, Ratios, and Graphing: Safety First

A Lesson Guide with Activities in Mathematics, Science, and Technology

Acknowledgments: Special thanks to Summer 2001 Educators in Residence, Jennifer Pulley, Bill Williams, and NCTM.

Program Overview

SUMMARY AND OBJECTIVES

In *Measurement, Ratios, and Graphing: Safety First*, students will learn about NASA's Aviation Safety Program and how engineers are testing aircraft at extreme angles in wind tunnels to make sure they remain a safe form of transportation for all future air travelers. They will also learn about NASA FutureFlight Central, a virtual facility that simulates our nation's airports in real time, allowing air traffic controllers, pilots, and airport personnel to interact with each other and test new technologies. Students will observe NASA engineers using mathematics to predict airplane behavior and to analyze data. By conducting hands-on and web activities, students will make connections between NASA research and the mathematics, science, and technology they learn in their classrooms.

STUDENT INVOLVEMENT

Cue Card Questions

Norbert, NASA CONNECT's animated co-host, poses questions throughout the broadcast. These questions direct the instruction and encourage students to think about the concepts being presented. When viewing a videotaped version of NASA CONNECT, educators have the option to use Norbert's Pause, which gives students an opportunity to reflect and record their answers on the Cue Cards (p. 15). Norbert appears with a remote to indicate an appropriate time to pause the videotape and discuss the answers to the questions.

Hands-On Activity

"In the Safety Zone," the hands-on activity, is teacher-created and is aligned with the National Council of Teachers of Mathematics (NCTM) standards, the National Science Education (NSE) standards, the International Technology Education Association (ITEA) standards, and the National Educational Technology (NET) standards. Students will assume the role of an air traffic controller (ATC) to safely and efficiently guide aircraft to their destinations. Through plotting, measuring, and calculating, students will experience the stressful job of an ATC.

Instructional Technology Activity

Gate to Gate, the instructional technology activity, is aligned with the National Council of Teachers of Mathematics (NCTM) standards, the National Science Education (NSE) standards, the International Technology Education Association (ITEA) standards, and the National Educational Technology (NET) standards. This multimedia CD-ROM takes students behind the scenes to meet the people who manage air traffic and highlights some of the tools they use everyday. Students will navigate through the phases of a flight from San Francisco to New York and become familiar with the air traffic management facilities that monitor their flight. *Gate to Gate* is available through NASA Central Operation of Resources for Educators, **http://core.nasa.gov**.

RESOURCES

Teacher and student resources (p. 21) support, enhance, and extend the NASA CONNECT program. Books, periodicals, pamphlets, and web sites provide teachers and students with background information and extensions. In addition to the resources listed in this lesson guide, the NASA CONNECT web site, **http://connect.larc.nasa.gov**, offers on-line resources for teachers, students, and parents. Teachers who would like to get the most from the NASA CONNECT web site can visit the "Lab Manager," located in "Dan's Domain," **http://connect.larc.nasa.gov/dansdomain.html**.

Hands-On Activity

BACKGROUND

The Air Traffic Control System is run by the Federal Aviation Administration (FAA) as an agency of the U.S. Department of Transportation. The system's primary purpose is to maintain safe separation of aricraft throughout the U.S. and to keep air traffic flowing as efficiently as possible in an orderly fashion.

Air traffic controllers coordinate the movement of aircraft to make certain that they stay a safe distance apart. Their immediate concern is safety, but controllers must direct aircraft efficiently to minimize delays.

Although air traffic controllers monitor all aircraft traveling through any airspace, their main responsibility is to organize the flow of aircraft in and out of airports. Relying on radar and visual observation, they closely monitor each plane to ensure a safe distance between all aircraft and to guide pilots to a safe landing. Controllers also keep pilots informed about changes in weather conditions such as wind shear. Wind shear is a sudden change in the velocity or direction of the wind that can cause the pilot to lose control of the aircraft.

Every minute hundreds of commercial aircraft begin flights that follow a common profile. The flight begins in preflight when weather information is obtained and a flight plan is filed. After the tower gives departure clearance, the aircraft leaves the gate, and the pilot receives instructions from the Ground Controller, who is responsible for all ground movement around the airport. The aircraft then taxis towards the takeoff runway. After "cleared for takeoff" is issued by the Local Controller, a person responsible for takeoff and landing clearance, the aircraft lifts off the runway. Shortly after takeoff, the pilot is instructed to change radio frequency and contact Departure Control or Terminal Radar Approach CONtrol (TRACON). During this phase, the aircraft is routed away from the airport by the Departure Controller, who is responsible for routing air traffic immediately upon takeoff by using an assigned heading with a climb clearance to a new altitude.

After departure, the aircraft is transferred to an en route controller. There are 21 en route control centers located around the country. In these centers, controllers work in teams of up to three members, depending on the amount of air traffic. Each team is responsible for a section of the center's airspace. These controllers are in charge of the aircraft between airports.

As an aircraft approaches a team's airspace, the radar controller accepts responsibility from the previous controlling unit. The controller also delegates responsibility for the aircraft to the next controlling unit when the aircraft leaves a team's airspace.

The radar controller observes the aircraft in the team's airspace on radar and communicates with the pilots when necessary. Radar controllers warn pilots about nearby aircraft, bad weather conditions, unusual terrain, and other potential hazards. Through team coordination, the aircraft arrives safely at its destination.

In addition to airport towers and en route centers, air traffic controllers also work in flight service centers in more than 100 locations. These flight service specialists help pilots in emergency situations and initiate and coordinate searches for missing or overdue aircraft. They also provide data about the terrain, report weather conditions in the service area, and suggest routes to improve flight safety.

NATIONAL STANDARDS

Mathematics (NCTM) Standards

- Compute fluently and make reasonable estimates.
- Understand patterns, relations, and functions.
- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Apply appropriate techniques, tools, and formulas to determine measurements.
- Develop and evaluate inferences that are based on data.
- Build new mathematical knowledge through problem solving.
- Apply and adapt a variety of appropriate strategies to solve problems.
- Recognize, use, and learn about mathematics in contexts outside of mathematics.

Science (NSE) Standards

- Unifying Concepts and Processes
  Systems, order, and organization
  Change, constancy, and measurement
- Science as Inquiry
  Understanding about scientific inquiry
- Science and Technology
  Abilities of technological design
- Science in Personal and Social Perspectives
  Personal health
  Populations, resources, and environments
  Natural hazards
  Risks and benefits
- Science and technology in society

Technology (ITEA) Standards

The Nature of Technology

- Develop an understanding of the characteristics and scope of technology.

Technology and Society

- Develop an understanding of the cultural, social, economic, and political effects of technology.
- Develop an understanding of the role of society in the development and use of technology.

Technology (NET) Standards

- Practice responsible use of technology systems.
- Develop positive attitudes toward technology uses that support lifelong learning collaboration, personal pursuits, and productivity.
- Use technology resources for solving problems and making informed decisions.
- Employ technology in the development of strategies for solving problems in the real world.

INSTRUCTIONAL OBJECTIVES

The student will

- plot initial aircraft coordinates by using a rectangular coordinate system.
- use measurement tools and techniques to determine distance.
- apply ratios to calculate the Air Safety Travel Index.
- calculate initial aircraft distance vs. actual aircraft distance traveled.
- incorporate collaborative problem-solving strategies in a real-life application.

VOCABULARY

air traffic controller (ATC) – a person who coordinates the movement of air traffic to make certain planes stay a safe distance apart and to ensure efficient use of airspace

coordinates – a pair of numbers and/or letters that shows the exact position of a point on a map or graph

flight path – the line connecting the successive positions occupied, or to be occupied, by an aircraft as it moves through air

quadrant – one-fourth section of a coordinate plane

rectangular coordinate plane – a set of lines used to locate points in a plane

runway – a long, level piece of ground with a specially prepared smooth, hard surface on which aircraft take off and land

PREPARING FOR THE ACTIVITY

Student Materials (per 4-student group)

game board
4 metric rulers
4 calculators
4 Flight Plans (p. 12)
4 Tracking Charts (p. 13)
pre-cut game pieces
4 different colored pencils
20 pushpins or sewing pins
4 Safety Rating Cards/Game Constraints (p. 14)
corrugated cardboard (44 cm x 56 cm)

Teacher Materials

stopwatch or timer
clear tape
Aircraft and Storm Game Pieces (p. 16)

Time

Discussion of the activity (reviewing constraints and parameters)..................................15 min
Playing the game ....40 min

Focus Questions

1. What is the job of an Air Traffic Controller (ATC)?
2. Why is aircraft safety important to the ATC?
3. How does an ATC keep track of multiple aircraft in a region at one time?
4. How does an ATC assign the landing order of multiple aircraft?

Advance Preparation

For each group:

1. Copy the game board and assemble using clear tape.
2. Cut out the Aircraft and Storm Game Pieces (p. 16).

THE ACTIVITY

Step 1: Introducing the Activity

A. Organize students into groups of four.

B. Distribute a game board and the necessary materials to each group.

C. Provide each group member with
- a Flight Plan (p. 12) to record the landing times.
- a Tracking Chart (p. 13) to track the progress of the assigned planes.
- a Safety Rating Card (p. 14) to keep track of the total points earned, and the Game Constraints (p. 14).

Note: Be sure to discuss each game card in detail. Remind students of the scoring procedures.

D. Announce: "We will be playing 'In the Safety Zone,' a game of strategy involving Air Traffic Controllers (students) and their ability to safely and efficiently guide aircraft to their destinations. You will be divided into groups of four, and each student or Air Traffic Controller (ATC) will be responsible for three aircraft. Your primary goal is to land each aircraft safely and on time. You will receive points for plotting planes correctly, landing on time, and landing on the correct runway."

E. Have the students plot the initial position for each aircraft on the game board by using the initial aircraft flight coordinates provided in the Flight Plan. Students will use a pushpin or sewing pin, along with the correct aircraft game piece, to mark where each aircraft is initially located.

Note: Each group should know the Flight Plan.

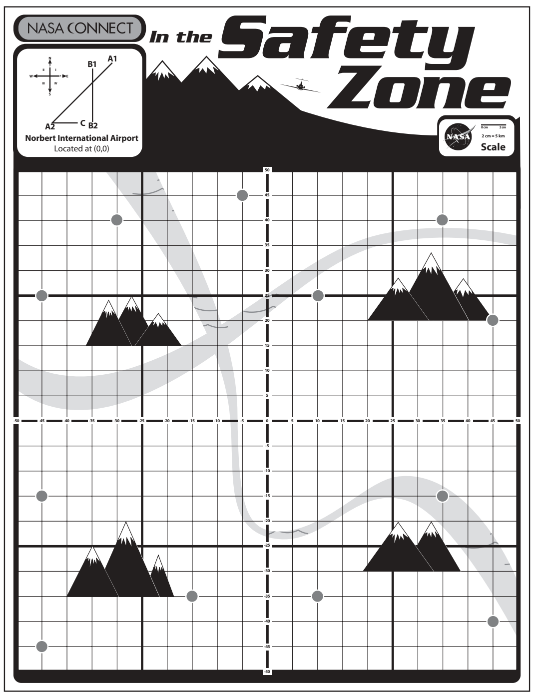

Figure 1

F. Use the answer key (figure 1) to award 1 point for each correctly plotted aircraft. Record the total point value on each group's Student Rating Card.

Note: Make sure students correct any incorrectly plotted aircraft.

G. Assign each group member a quadrant in which to oversee aircraft movement.

Suggestion: Students within each group might want to choose their own quadrant.

I. Announce: "Each ATC is responsible for three aircraft. Record Flight Number, Aircraft Type, and Runway information on the Tracking Chart."

J. Have students choose a colored pencil and color each aircraft game piece to ensure correct tracking.

K. Have each ATC measure the direct distance from each of his assigned aircraft to the airport. Next, have students calculate the direct distance in km using the scale: 2 cm : 5 km. Students round results to the nearest km and record the information on the Tracking Chart (p. 13).

Suggestion: The teacher might want to provide an example problem dealing with ratios and proportions.

L. Announce: "For each minute of play, all aircraft must make 1 move. One move corresponds to 2 cm of linear travel (5 km). Use your metric ruler to verify 2 cm of movement. Remember, an aircraft cannot move backwards on any consecutive move. (See game constraints, p. 14)

M. Announce: "During each minute of play, each ATC must keep track of his aircraft's flight paths using a colored pencil and metric ruler. In addition, after all flight paths have been updated, place a check mark on the Tracking Chart to indicate completion of your aircraft's move."

N. Have students familiarize themselves with the airport layout located at the top of the game board. The entire airport is located on the origin, (0, 0). Please see game constraints for final approach guidelines.

Note: The teacher should draw the airport layout on the chalkboard or overhead projector and explain the landing procedures.

O. Allow groups a few minutes to study the Flight Plan (p. 12), particularly arrival times and runway locations, so that each ATC can plan his landing strategy.

Step 2: Playing the game

A. Control the pace of the game by following the script. All students should work quickly, efficiently, and collaboratively during the game. Remind students they are working as a team and not playing against each other.

B. Set your stopwatch to 0:00.

C. Announce: "We are now ready to begin the game. Flight 322 is taking off from runway B1 and flying to point (-50, 50). Each group should place a pushpin, along with designated aircraft, at the origin to represent Flight 322."

D. Announce: "Minute 1. Each group now has 1 minute to move each aircraft on the game board 2 cm. Flight 322's first move must be positioned at the point (0, 5) since it is taking off from the south (runway B1)."

Suggestion: For the first several minutes, the teacher might allow an extra 30 seconds so students can complete their moves.

E. Announce: "Minute 2. You have 1 minute to move each aircraft on the game board 2 cm."

F. Announce: "Minute 3. Continue to move aircraft 2 cm."

G. Announce: "Minute 4. Continue to move aircraft 2cm."

H. After the 4th minute, stop the timer and announce: "A thunderstorm is approaching the airport traveling due east at a rate of 5 km/min. The leading edge of the storm is located at (-35, 5) and (-35, -5). Each group needs to place the thunderstorm in the correct position. Minute 5. Continue moving each aircraft 2 cm." Start the timer again.

I. Stop the timer after minute 5 has expired. Announce: "The storm continues to move east at 5 km/min. Flight 932 is taking off from runway A2, heading to the point (-50, -35). Minute 6. Continue moving each aircraft 2 cm. Flight 932's first move must be positioned at the point (-5, -5) before it can change course." Start the timer again.

J. Stop the timer after minute 6 has expired. Announce: "A 737's right engine has caught on fire and caused runway B1 to be temporarily closed to incoming aircraft. The storm continues to move east at 5 km/min. Minute 7. Continue moving each aircraft 2 cm." Start the timer again.

K. Announce: "Minute 8. The storm is still moving east at 5 km/min. Continue moving each aircraft 2 cm."

L. Announce: "Minute 9. Runway B1 has been cleared for takeoffs and landings. The storm continues to advance at 5 km/min. Continue moving each aircraft 2 cm."

M. Stop the timer after minute 9 has expired. Announce: "Flight 1130 is experiencing fuel leakage. Please clear the flight path for an emergency landing. Flight 1130 must land within 7 minutes or no points are awarded for this flight. The storm is still moving due east at 5 km/min. Minute 10. Continue moving each aircraft 2 cm." Start the timer again.

M. Announce: "Minute 11. The storm is still moving east at 5 km/min. Continue moving each aircraft 2 cm."

N. Announce: "Minute 12. The storm is crossing the airport and all takeoffs and landings are delayed until the storm clears. Continue moving each aircraft 2 cm."

O. Announce: "Minute 13. The storm continues to cross over the airport at 5 km/min, producing heavy downpours and severe lightning. Airport is still temporarily closed. Continue moving each aircraft 2 cm."

P. Announce: "Minute 14. The storm continues to cross over the airport at 5 km/min. Airport is still temporarily closed as the storm moves through the area. Continue moving each aircraft 2 cm."

Q. Announce: "Minute 15. The storm continues to cross over the airport at 5 km/min. Airport is still temporarily closed as the storm heads out of the area. Continue moving each aircraft 2 cm."

R. Announce: "Minute 16. The storm has dissipated and the airport is now clear for takeoffs and landings. Continue moving each aircraft 2 cm."

S. Announce: "Minute 17. Continue moving each aircraft 2 cm."

T. Announce: "Minute 18. Mechanical problems have caused runways B1 and B2 to be closed for the next 3 minutes. Continue moving each aircraft 2 cm."

U. Announce: "Minute 19. Continue moving each aircraft 2 cm."

V. Announce: "Minute 20. Continue moving each aircraft 2 cm."

W. Announce: "Minute 21. Runways B1 and B2 are open for takeoffs and landings. Continue moving each aircraft 2 cm."

X. Continue to announce each minute until all aircraft have landed.

Step 3: Scoring the game

A. Score 10 points for aircraft landed on time, subtract 1 point for each minute ahead or behind schedule, and subtract 5 penalty points for each aircraft coming in on the wrong runway.

B. Each ATC responsible for tracking Flight 322 or Flight 932 receives 2 bonus points if each flight reaches its destination before the game is over (4 point maximum). Have students record bonus points under Team Score on the Safety Rating Card (p. 14).

Step 4: Distance and Accuracy Calculations

A. Have students determine the Air Safety Travel Index (ASTI) by calculating the percentage using the ratio of team points divided by total possible points (132). Write the percentage on the Safety Rating Card.

B. Have students complete the Tracking Chart (p. 13) by calculating the actual linear distance traveled from the aircraft's initial coordinates to the airport by using the equation: 5 (km / min) multiplied by landing time (min).

C. Calculate the difference between the direct distance traveled and the actual distance traveled and record these values on the Tracking Chart.

Step 5: Discussion

A. Analyze the difference between the direct distance traveled and the actual distance traveled. What conclusions can you draw from this discrepancy?

B. Analyze your calculated Air Safety Travel Index (ASTI). The optimum ASTI value is 100%. If your ASTI value is not 100%, what are some variables that affected your ASTI value?

C. Why is communication vital to an Air Traffic Controller?

D. Research indicates that Air Traffic Controlling is of the most challenging and stressful jobs. After having limited experience with directing aircraft, write a paragraph or two commenting on this statement.

E. Air traffic is expected to increase in the future. What challenges will face the next generation of Air Traffic Controllers? What technological advancements will allow the ATCs to perform their job more efficiently?

F. Altitude is not a variable in this activity; however, if it were, how would your strategy change? Would your job as an ATC become easier or harder? Why?

Extensions

1. Invite an Air Traffic Controller to participate in the game with the students. After the game is played, have the ATC lead a discussion on the qualities of a successful ATC.
2. Have the students design their own script and game board for the game.
3. Incorporate advanced topics into the game such as the distance formula, the Pythagorean Theorem, and vectors.

Name: ____________________

Date: ____________________

Flight Plan

Aircraft Type	Flight No.	Airline	Departure Point	Flight Coordinates	Arrival Time	Runway	Landing Time	Difference in Times
757	125	Aspen Air	Denver	(10,25)	+7 min.	B1		
MD-80	711	Gamble Air	Las Vegas	(45,20)	+12 min.	B1		
737	625	Cub Tran	Chicago	(35, 40)	+25 min.	B2		
767	780	Green Air	Seattle	(-30, 40)	+18 min.	A1		
Cessna	615	Green Tran	San Francisco	(-45, 25)	+20 min.	C		
DC-9	1058	WWA	Portland	(-5, 45)	+10 min.	B1		
747	239	Dar-Mills Air	Hawaii	(-45, -45)	+27 min.	A2		
777	1214	Fuji	Tokyo	(-40, -15)	+11 min.	A2		
MD-80	1130	Tex-Mex	Mexico	(-15, -35)	+15 min.	B2		
737	347	Saint Airway	New Orleans	(45, -40)	+23 min.	B2		
757	432	Tri-Alpha	Atlanta	(35, -15)	+13 min.	A1		
757	222	Tex-Mex	Houston	(10, -35)	+8 min.	B2		

Tracking Chart

Flight Number			
Aircraft Type			
Runway			
Direct Distance From Airport			
Actual Distance Traveled			
Difference in Kilometers			

Use this grid to help yourself remember if you've moved all your planes! After each minute, check off each plane you have moved.

Minute	Individual Plane Check-Off		
1			
2			
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Tracking Chart

Flight Number			
Aircraft Type			
Runway			
Direct Distance From Airport			
Actual Distance Traveled			
Difference in Kilometers			

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Tracking Chart

Flight Number			
Aircraft Type			
Runway			
Direct Distance From Airport			
Actual Distance Traveled			
Difference in Kilometers			

Use this grid to help yourself remember if you've moved all your planes! After each minute, check off each plane you have moved.

Minute	Individual Plane Check-Off		
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30			

ATC: ______________________________

Quadrant: ______________________

Safety Rating Card

Individual ATC Score	ATC's Points	Max. Points
Initial Aircraft Setup 1 point for each correctly plotted aircraft	________	3
Landing Aircraft 10 points possible for each aircraft landed. Subtract 1 point for every minute early or late. Subtract 5 points for a wrong runway landing.	________	30
Total →	________	33

Team Score	Points	Max. Points
Quadrant I	_____	
Quadrant II	_____	
Quadrant III	_____	
Quadrant IV	_____	132
Bonus Points		
Flight 322	_____	
Flight 932	_____	
Total →	_____	

Air Safety Travel Index (ASTI) Formula

(A/B) * 100 = ASTI

A = Team's Total Points   B = Maxium Points

(_____/ 132) * 100 =

Game Constraints

1. For each minute of play, aircraft can move 2 cm in any direction except backwards.
2. Aircraft cannot be closer to each other than 2 cm (5 km).
3. To land on Runway C, aircraft must be on the positive x-axis.
4. Runway C is reserved strictly for the Cessna aircraft.
5. To land on Runway B1, aircraft must be on the positive y-axis, and for Runway B2, on the negative y-axis.
6. To land on Runway A1, aircraft must land from the northeast from (5,5) and on Runway A2, from the southwest from (-5, -5).
7. Landing an aircraft on the wrong runway results in a 5-point penalty.
8. No two aircraft can land on the same runway at the same time.
9. Within three minutes of landing, the ATC must announce his intention of landing an aircraft by identifying the flight number and runway.
10. Aircraft flight path must avoid mountains and storms.

Name: ______________________________
Date: ______________________________

Cue Cards

John Foster, Senior Research Engineer, NASA Langley Research Center

1. How will NASA contribute to airplane safety in the future?

____
____
____
____
____

2. How do NASA engineers use math in their wind tunnel tests?

____
____
____
____
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3. What happens to an airplane when the angle of attack becomes too great?

____
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____
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Nancy Tucker, NASA FutureFlight Central, NASA Ames Research Center

1. Why was NASA FutureFlight Central built?

____
____
____
____
____

2. How does NASA use technology to simulate airports?

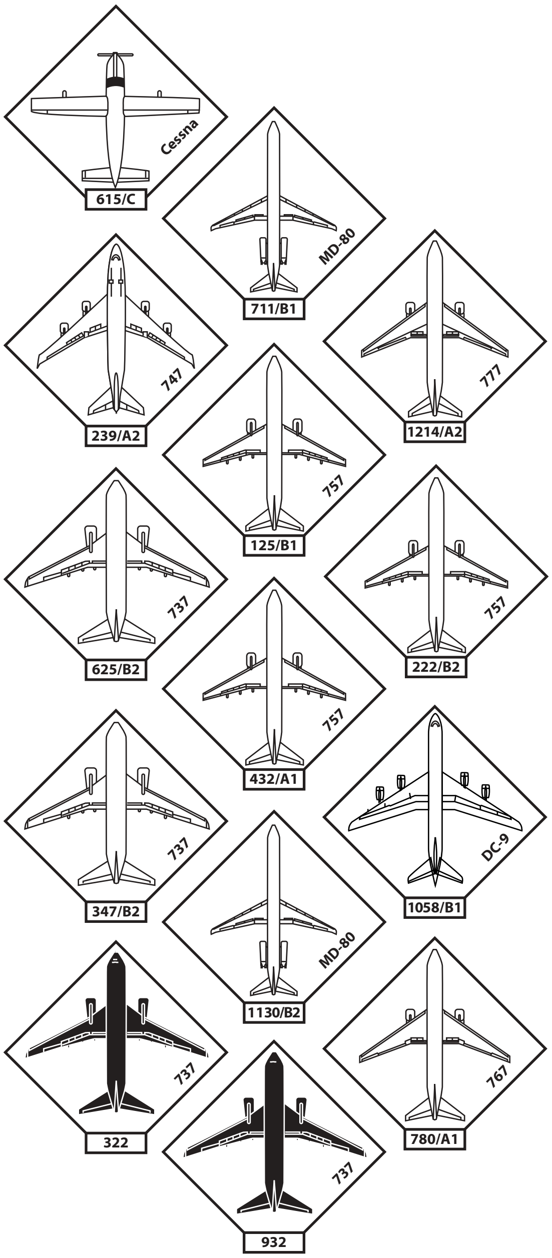
____
____
____
____
____

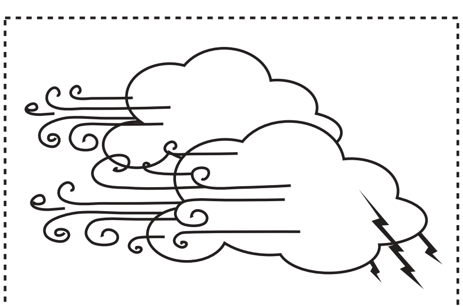
3. Analyzing the graph, what factors do you think influenced the air traffic controllers' responses?

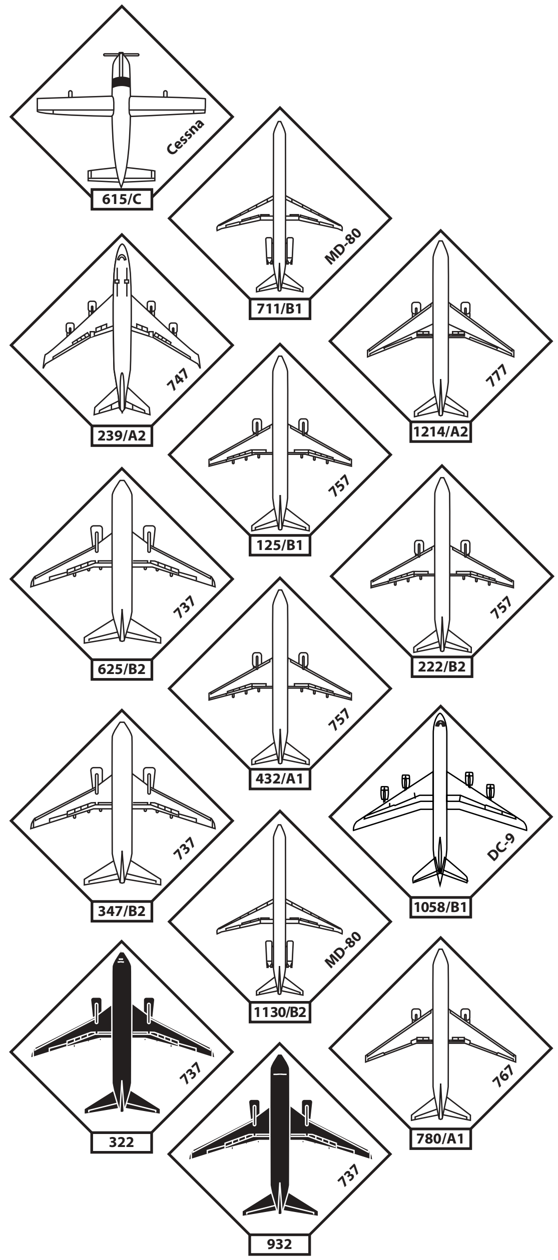
____
____
____
____
____

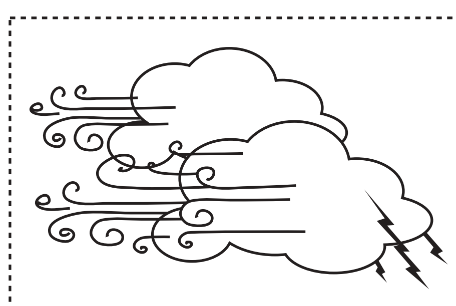
Teacher Materials

AIRCRAFT AND STORM GAME PIECES









Cue Card Answers

John Foster, Senior Research Engineer, NASA Langley Research Center

1 How will NASA contribute to airplane safety in the future?

Possible answers: Researchers and engineers involved in NASA's Aviation Safety Program will use wind tunnel tests to study ways to prevent accidents from occuring and will provide new ideas and technologies to airplane manufacturers and airlines.

2 How do NASA engineers use math in their wind tunnel tests?

Possible answers: They use ratios to scale models and solve for different variables. They use graphs to see relationships between data collected in the wind tunnel and to determine if the airplane will be difficult to control.

3 What happens to an airplane when the angle of attack becomes too great?

Possible answers: Aerodynamic stall could occur; the lift coefficient will decrease; the airplane may be difficult to control.

Nancy Tucker, NASA FutureFlight Central, NASA Ames Research Center

1 Why was NASA FutureFlight Central built?

Possible answers: to simulate a full-scale, real-time airport; to allow for interaction between ATC's, pilots and airport personnel; to test new technologies

2 How does NASA use technology to simulate airports?

Possible answers: Computers create a virtual environment of airports from satellite pictures, surveys of the airport from the air, and digitial pictures. Pilots use computers to fly the virtual planes; computers can also simulate weather conditions.

3 Analyzing the graph, what factors do you think influenced the air traffic controllers' responses?

Possible answers: traffic complexity, overall traffic level, aircraft movements, pilot communication, aircraft taxi speeds, gate-related operation, ambient sound effects, etc. For the actual survey taken by the LAX ATC's, see page 18.

EXCERPTS FROM FFC-LAX LOCAL CONTROLLER SURVEY

FFC = Future Flight Center LAX= Los Angeles International Airport

Print your name: ______________________________ Today's Date: ______________

The tower position just worked: ______________________________ Present Local Time: ______________

INSTRUCTIONS: Please complete the following survey and then give it to the NASA experimenter. Circle the most appropriate answer for each question and also tell why you chose it. All questions are relative to your experience at LAX under normal operations. Add any other comments/observations on the opposite side if necessary.

A. The amount of coordination required with the ground position on my side of the airport was (circle one)

Much less Less About the same More Much more

If more or less please tell why: ______________________________

B. The amount of coordination required with the local position on the other side of the airport was (circle one)

Much less Less About the same More Much more

If more or less please tell why: ______________________________

C. The coordination with the ground position on my side of the airport was (circle one)

Much easier About the Same More difficult Much more difficult

If easier or more difficult tell why: ______________________________

D. The amount of communication with the pilots was (circle one)

Much less Less About the Same More Much more

If less or more tell why: ______________________________

E. The overall efficiency of this operation was (circle one)

Much less Less About the Same More Much more

If less or more tell why: ______________________________

G. The overall realism of NASA's FFC tower simulation (concentrating on departure operations) with your experiences at LAX under comparable conditions was (circle one number)

1 2 3 4 5

Much poorer About the same As high as I thought possible

H. The overall realism of NASA's FFC tower simulation (concentrating on arrival operations) with your experiences at LAX under comparable conditions was (circle one number)

1 2 3 4 5

Much poorer About the same As high as I thought possible

Now, please rate the realism of NASA's simulation of the LAX environment by using any whole number from one to five.

I. Traffic complexity: _____

J. Overall traffic level: _____

K. Aircraft movements: _____

L. Pilot communication: _____

M. Aircraft taxi speeds: _____

N. Gate-related operations: _____

O. Ambient sound effects in cab: _____

Rating Scale Numbers to Use

1. not at all realistic
2. somewhat realistic
3. realistic
4. very realistic
5. identical to LAX

Instructional Technology Activity

THE ACTIVITY

Fasten your seatbelt and get ready for a flight through the U.S. air traffic control system! *Gate to Gate*, a multimedia CD-ROM, takes your students behind the scenes to meet the people who manage air traffic and highlights some of the tools they use everyday. From preflight to landing, students will navigate through the phases of a San Francisco to New York flight and become familiar with the air traffic management facilities that monitor their flight.

Also included with this CD-ROM is the Career Guidance Packet. This downloadable print material introduces students to many of the job opportunities available in air traffic management. The print material is designed to enhance the students' experience with the CD-ROM while engaging them in activities similar to the work of controllers.

To access *Gate to Gate*, contact NASA Central Operation of Resources for Educators at **http://core.nasa.gov**. Additional web activities, on-line resources, and a link to Career Corner, featuring researchers and NASA CONNECT team members, can be found in Dan's Domain on the NASA CONNECT web site.

In addition to *Gate to Gate*, Riverdeep Interactive Learning provides registered NASA CONNECT educators with an interactive instructional technology activity from one of their Destination Math courses. Spanning grades K-12, Riverdeep's Destination Math courses focus on the importance of mastering the underlying skills and concepts of the topics presented and the ability to apply the learned skills and concepts to solve meaningful problems. Destination Math exposes abstract mathematical concepts with a blend of animation, real-life scenarios, and interactive problem solving. The Destination Math activity for this program introduces students to a rectangular coordinate plane by applying the concept with latitude and longitude on a map and can be accessed from **http://connect.larc.nasa.gov/dansdomain.html**.

NATIONAL STANDARDS

Technology (ITEA) Standards

The Nature of Technology

- Develop an understanding of the characteristics and scope of technology.
- Develop an understanding of the core concepts of technology.
- Develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

- Develop an understanding of the cultural, social, economic, and political effects of technology.

Design

- Develop an understanding of the attributes of design.

Technology (NET) Standards

- Use content-specific tools, software, and simulations to support learning and research
- Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration, and learning throughout the curriculum
- Design, develop, publish, and present products by using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom
- Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems
- Research and evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources concerning real-world problems

NATIONAL STANDARDS

Science (NSE) Standards

- Science as Inquiry
  Abilities necessary to do scientific inquiry
- Science in Personal and Social Perspectives
  Risks and benefits
  Science and technology in society

Mathematics (NCTM) Standards

- Model and solve contextualized problems using various representations such as graphs, tables, and equations
- Solve problems involving scale factors, by using ratio and proportion
- Understand that measurements are approximations and understand how differences in units affect precision

INSTRUCTIONAL OBJECTIVES

Students will

- be introduced to many of the personnel who operate the Air Traffic Control System.
- become familiar with the Air Traffic System as it operates today.
- learn how developing sophisticated software tools fit into the Air Traffic Control System.
- navigate through a seven-phase flight from preflight to landing.

Resources

BOOKS, PAMPLETS, AND PERIODICALS

Beatty, David: *The Human Factor in Aircraft Accidents*, Amazon.com, 1996.

Cushing, Steven: *Fatal Words: Communication Clashes and Aircraft Crashes*, University of Chicago, Chicago, 1994.

Friel, Susan; Rachlin, Sid; and Doyle, Dot: N*avigating through Algebra in Grades 6-8 (with CD-ROM)*, NCTM, 2001. (This book is also available for purchase on **http://nctm.org/publications** under new books.)

Job, MacArthur: *Air Disaster (Volume 3)*, Australian Aviation, 1999.

Krause, Shari Stamford: *Aircraft Safety: Accident Investigations, Analyses and Applications*, McGraw Hill, 1996.

Profitt, Richard: *Systemic Safety Management in the Air Traffic Services*, Euromoney Publishing PLC, 1996.

Reithmaier, Larry W.: *Controlling Pilot Error: Maintenance and Mechanics*, McGraw Hill, 2001.

Stewart, Stanley: *Emergency: Crisis in the Cockpit*, Tab Books, 1991.

Stewart, Stanley: *Flying the Big Jets*, Specialty PR, 2000.

WEB SITES

Aviation Safety / General Information

http://aviation-safety.net/index.shtml
http://www.airsafetyonline.com
http://www.airsafe.com

Aviation Activities and Games

http://www.faa.gov/education/

Interactive Cybercockpit Activities

http://www.msnbc.com/onair/nbc/nightlynews/aviation/cockpit_video.htm
http://www.grouper.com/francois/#AIRSPEED

National Air Traffic Controllers / General Information

http://www.natca.org.htm
http://www.fly.faa.gov/flyFAA/index.html

Live Broadcasts of Air Traffic Controllers

http://www.angelfire.com/mn/PilotInCommand/

Figure This!

Offers Mathematics Challenges that middle school students can do at home with their families to emphasize the importance of a high-quality mathematics education for all.

http://www.figurethis.org

Engineer Girl

Part of the National Academy of Engineering's Celebration of Women in the Engineering project. The project brings national attention to the opportunity that engineering represents to all people at any age, but particularly to women and girls.

http://www.engineergirl.org

GetTech

Through its web site and collateral materials, GetTech helps prepare students in fun ways for tomorrow's great jobs.

http://gettech.org