ANOTHER **FREE** EDUCATIONAL PROGRAM FROM

PHYSICS TAKES FLIGHT!

Dear Educator,

You're on a mission—to teach physics in an exciting and meaningful way. *Flight Simulator X* from Microsoft® can help you do just that.

This teaching program from Microsoft® and curriculum specialists Young Minds Inspired (YMI) is the perfect way to show students that physics not only has real-world applications, but can be fun to learn. It's based on the popular computer game *Flight Simulator X.* There's no better way to capture students' attention and imagination than by using a medium popular with teens.

The activities in this guide meet national standards for high school physics, and feature lessons on the physics of flight—including lift, thrust, weight, and drag. Students will also learn about basic speed principles, including acceleration and velocity. These activities are perfect as an introduction to these principles or as a review.

Flight Simulator X is extremely true-to-life. It's used by high schools to teach the science of flight, by flight schools to train pilots, and is endorsed by major flight organizations. To find out more, go to **www.FlightSimulatorX.com**

Although these materials are copyrighted, you may make as many copies as necessary. To download extra copies, go to **www.ymiteacher.com**

Show your students how physics comes to life—in the skies and in the classroom.

Sincerely,

Roberta Nusim
Publisher and former teacher

Activities inspired by:

Microsoft® Flight Simulator X
DELUXE EDITION

YOUNG MINDS INSPIRED

is the only company developing free, creative and innovative classroom materials that is owned and directed by award-winning former teachers. All YMI teaching materials are approved by our exclusive Educational Advisory Board. E-mail us at **feedback@ymiclassroom.com** or visit our Web site at **www.ymiteacher.com** to send feedback and download more free programs.

National Education Standards

The activities in this guide meet National Science Standards for grades 9-12 in Motions and Forces. In addition, they focus on the physics of flight, acceleration and velocity, vectors, and displacement.

Extra 300S

Program Components

- This teacher's guide
- Three reproducible masters
- A wall poster illustrating the physics of flight
- Two CD-ROMs. Disc 1 highlights physics principles. Disc 2 is a free trial version of the game.
- Student magazine on the exciting world of flight simulation
- A reply card for your comments. **The first 100 teachers who return the reply card receive a FREE *Flight Simulator X* game!**

How To Use This Guide

Use the activities in class to show how exciting physics can be. **Activities 1** and **2** can be done in class and **Reproducible 3** can be used as a handout. Distribute the student magazine for additional insight on the world of flight simulation.

How To Use the Wall Poster

Hang this poster prominently in the classroom. Refer to it when discussing the physics of flight, acceleration and velocity, vectors, and displacement.

About *Flight Simulator X*

Flight Simulator X is the culmination of nearly 25 years of the landmark *Flight Simulator* franchise. Players fly their own aircraft and contend with weather conditions and the mechanics of the plane. This newest addition immerses players in a beautifully rich and realistic world, offering a completely new and innovative gaming experience with dozens of new aircraft and missions to choose from. Players fly the aircraft of their dreams—from the deHavilland DHC-2 Beaver floatplane to the Maule M7-260C Orion with wheels and skis.

Flight Simulator X offers incredible graphics and added realism, including weather, time of day and seasons. Players can choose from more than 50 missions. They can fight a forest fire in the Rockies or bring relief material to the Congo, keeping track of their progress on each mission.

Players of all ages, types and skill levels experience firsthand what it's like to be an aviator, traveling the globe from 100 to 100,000 feet up—either alone or online with others. They can even assume the role of air traffic controller to get an entirely different perspective.

How To Use the CD-ROM

Show the CD-ROMs to students. Use the video on Disc 1 to introduce this teaching unit in an exciting way. The disc also includes a description of the missions featured in the free trial version as well as the physics principles listed below. Disc 2 is the free trial version of the game.

Getting Started (Novice)
deHavilland Beaver

This mission is geared towards first-time flyers. It shows you how to get off the ground and up into the air so you can explore the ocean and island of St. Maarten. It provides step-by-step instructions until you're up and flying. Using the Beaver floatplane, you'll take off from and land in the ocean.

Physics Principles:
1. Acceleration
2. Distance equations
3. Buoyancy

Flour Power (Medium difficulty)
Air Creation Buggy 582 SL Ultralight

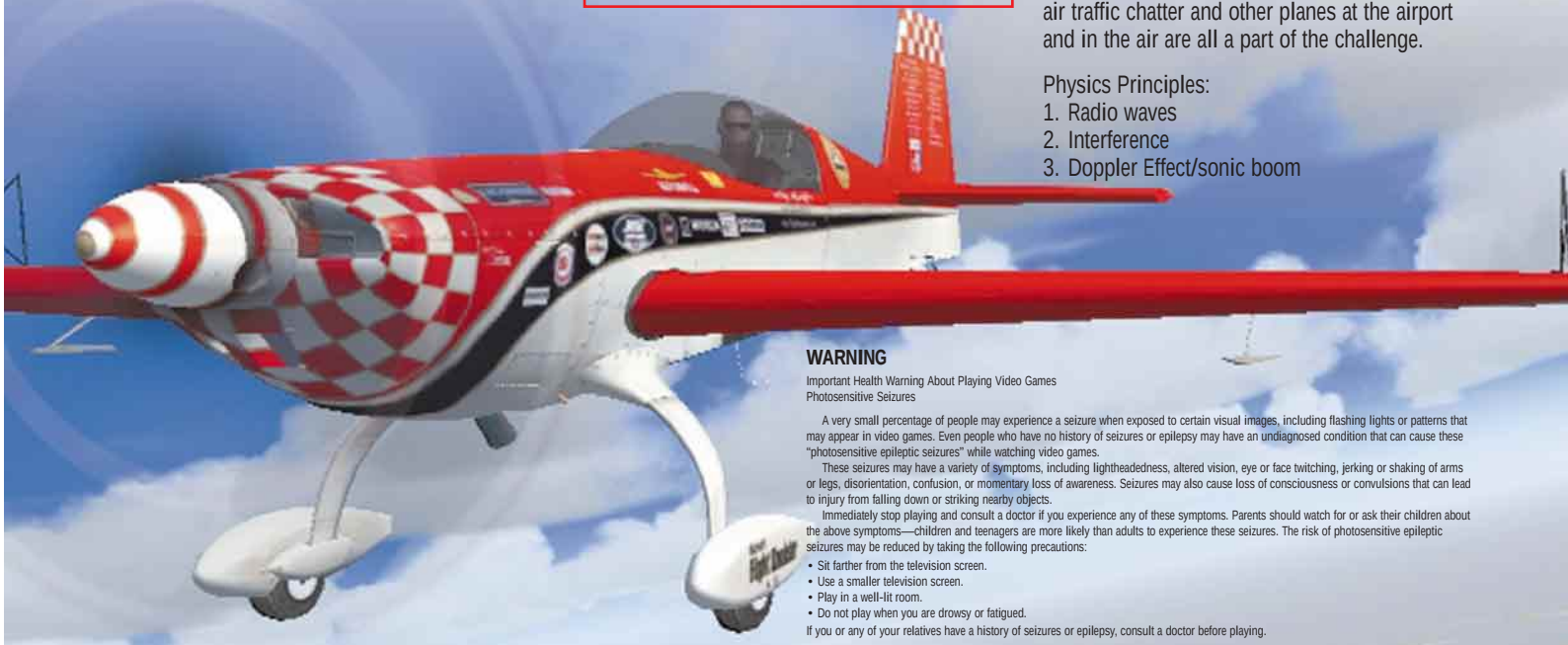
Flyers will pilot the easy-to-fly glider called an Ultralight, with sacks of flour attached. The object is to drop these sacks onto targets throughout the ocean as quickly and accurately as possible. The more targets you hit, the more time you get to hit them. But, if you hit targets like spectators or dolphins, there's a penalty.

Physics Principles:
1. Acceleration due to gravity
2. Trajectories
3. Independence of axis

Caribbean Landing (Most challenging)
Bombardier CRJ 700

This is the most technical of the three activities. Flyers take off and land a Bombardier in a technically challenging airport. You'll find that air traffic chatter and other planes at the airport and in the air are all a part of the challenge.

Physics Principles:
1. Radio waves
2. Interference
3. Doppler Effect/sonic boom



WARNING

Important Health Warning About Playing Video Games
Photosensitive Seizures

A very small percentage of people may experience a seizure when exposed to certain visual images, including flashing lights or patterns that may appear in video games. Even people who have no history of seizures or epilepsy may have an undiagnosed condition that can cause these "photosensitive epileptic seizures" while watching video games.

These seizures may have a variety of symptoms, including lightheadedness, altered vision, eye or face twitching, jerking or shaking of arms or legs, disorientation, confusion, or momentary loss of awareness. Seizures may also cause loss of consciousness or convulsions that can lead to injury from falling down or striking nearby objects.

Immediately stop playing and consult a doctor if you experience any of these symptoms. Parents should watch for or ask their children about the above symptoms—children and teenagers are more likely than adults to experience these seizures. The risk of photosensitive epileptic seizures may be reduced by taking the following precautions:

- Sit farther from the television screen.
- Use a smaller television screen.
- Play in a well-lit room.
- Do not play when you are drowsy or fatigued.

If you or any of your relatives have a history of seizures or epilepsy, consult a doctor before playing.

ACTIVITY ONE SPEED IT UP

Physics Topics:

- Displacement
- Average velocity
- Measurement: time and distance

Materials Needed:

Paper, tape measure (or meter stick), stopwatch

In this activity, students will build paper airplanes and test them for **time aloft** and **displacement,** and then calculate **average velocity.** They will also compare and contrast factors that influence their plane's performance. Students should work with a partner and construct 4 different types of planes. Go to **www.paperairplanes.co.uk/planes.php** to find a variety of designs.

Answer to Activity Sheet Question 7:

One possible answer: The plane was going fastest when it was first thrown, slowest just before it landed, and should have reached the average velocity in the middle of the trip (assuming acceleration was uniform).

Extended Activities:

Determining lift. Have students measure the mass of a piece of paper and the height of their shoulder. Then use this height as the launch height of their planes.

Tell students that the trajectory of the plane is an example of projectile motion. Following this principle, the acceleration at which the plane is "falling" can be calculated if the height from which the plane is launched is known (and the plane does not climb or loop).

$$\text{Acceleration downward} = \frac{2 \times \text{height}}{\text{time}^2}$$

Then, using Newton's 2nd Law, we can determine the net force acting on the plane in the vertical direction:

Net vertical force = mass of plane x acceleration

The Net vertical force is a vectorial sum of the lift, giving the plane its rise, and the force of gravity on the plane (also known as the weight) pulling the plane down. See Poster.

Net vertical force = lift + force of gravity

We can use this equation to solve for lift.

Lift = net vertical force - force of gravity

(where the force of gravity = weight = mass of plane x -9.8 m/s^2)

ACTIVITY TWO A DARING MISSION

Physics Topics:

- Measurement
- Distance
- Displacement
- Vectors
- Scale conversions

Materials Needed:

Map, ruler, and pencil

The activity sheet has a map in which students must draw displacement vectors showing the directions a plane would take while traveling in Peru, from Huarez, to Sipan and then to Iquitos, while avoiding tropical storms.

The map has a scale of 1 cm = 155 km, showing the starting point, two destinations and the locations of the storms.

Answers to Activity 2 Questions:

5. This depends on the route the student took. There is enough gas to go the minimum distance of approximately 2,092 km.
6. The distance traveled is (at least) twice the displacement.
7. It adds to the total distance because the total distance is the sum of the distance from Huarez to Sipan and the distance from Sipan to Iquitos.
8. It does not affect the displacement.
9. Displacement is a vector that does not take into consideration the path taken.

Extended Activities:

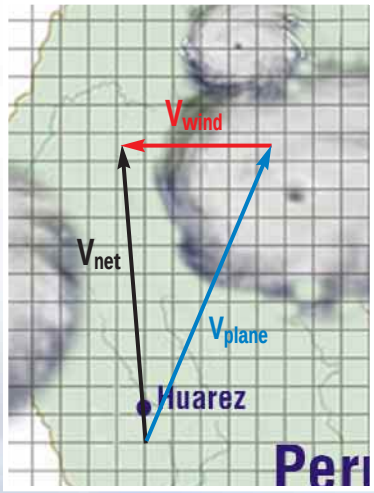
Velocity Vectors. Repeat the experiment, but this time have students draw the **velocity vectors** of the plane, taking into consideration the high winds caused by the storms. Inform students that you want the plane to maintain its course at a constant speed of 80 m/s.

Starting again from Huarez, the max speed that the Goose Flying Boat could obtain is 95 m/s (approx. 210 mph) and the winds are heading westward at 40 m/s (approx. 90 mph). The net velocity vectors drawn for the plane will have to be the sum of the plane's velocity and the wind velocity.

Remember: The net velocity vector for the plane MUST be in the same direction as its displacement from the first activity.

Scale 1 cm = 20 m/s

The plane's velocity vector (V_{plane}) must be (approximately) 4.5 cm to acquire the desired net speed (V_{net}). At a scale of 1 cm = 20 m/s, the plane must fly at approximately 90 m/s at approximately 70° to maintain the desired velocity.



Reproducible 3

Copy and distribute to students for reference.

Resources

www.fsinsider.com
www.microsoft.com/games/pc/flightsimulatorx.aspx
www.paperairplanes.co.uk/planes.php
www.physicsclassroom.com
www.ymiteacher.com

Microsoft YMI YOUNG MINDS INSPIRED

ACTIVITY ONE SPEED IT UP

Right now you're on a mission to pilot a Boeing 737. In order to take off, you need to be traveling at approximately 150 mph or 67 m/s. Of course, this varies with the number of passengers and amount of cargo.

In this activity, you are going to see how fast you can get a paper airplane to fly by measuring its **time aloft** and **displacement** and then calculating its **velocity.**

Materials Needed:

Paper, tape measure (or meter stick), stopwatch

With a partner, construct four different types of paper airplanes using the paper provided and give them each a name. If you are having trouble, go to **www.paperairplanes.co.uk/planes.php**

or ask your teacher for different plans. Your goal is to construct a plane that you think can go the farthest and the fastest.

1. In the hallway (or outside) take turns throwing your paper airplanes. With a stopwatch, have your partner measure the time your plane was in the air. Record the time on the table provided.
2. Measure the displacement (in meters), which is the straight-line distance from where you threw the plane to where the plane hit the ground. Record the displacement on the table provided.
3. Calculate your plane's average velocity by using:

$$\text{Average velocity} = \frac{\text{displacement}}{\text{time}}$$

Answer the following questions on a separate sheet:

1. Which of your four planes went the farthest?
2. Was there anything different about the plane that allowed it to go farther? If so, what was it?
3. Which of your four planes had the longest air time?
4. Was there anything different about the plane that had the longest air time? If so, what was it?
5. Which of your four planes had the highest average velocity?
6. Was there anything different about the plane that allowed it to go faster? If so, what was it?
7. In this activity we calculated the average speed or velocity of your airplanes. Was your plane always traveling at this speed? If not, when was it going faster? When was it going slower?

Name of Plane	Time aloft (s)	Displacement (m)	Average Velocity (m/s)

ACTIVITY TWO A DARING MISSION

While searching for lost treasure in Peru, you are asked to pilot the Goose Flying Boat from Huarez to Sipan, where you will be picking up medical supplies and delivering them to Iquitos. Unfortunately, tropical storms are ravaging Peru, blocking any chance of a direct route, and you only have enough gas to go 2,500 km. So keep your route as short as possible! You can do all this and more using Microsoft®'s *Flight Simulator X.*

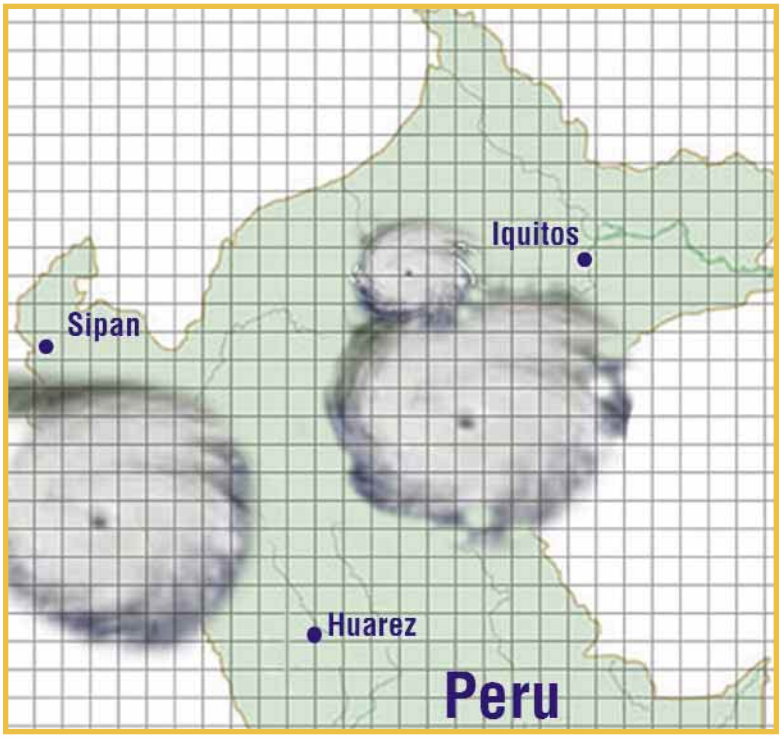
In this activity, you will be given a map with a scale of 1 cm = 155 km, showing your starting point, two destinations and the locations of the storms.

Materials Needed:

Map, ruler, and pencil

1. Using your ruler, construct **displacement vectors** starting from Huarez and ending up in Sipan, but you may NOT enter a storm!

   Remember, vectors are drawn as straight arrows. The arrows point in the direction of the plane's displacement and the length represents the distance traveled. A proceeding vector starts exactly where the last ended.



2. After you have reached Sipan, continue your vectors until you reach Iquitos.

3. Measure the total distance in centimeters the Goose Flying Boat has traveled by adding up the lengths of all your vectors. Then use the scale to find out how far it went in kilometers.

   Distance traveled = _____ cm = _____ km

4. Measure the magnitude of the Goose Flying Boat's displacement.

   Displacement = _____ cm = _____ km

Answer the following questions on a separate sheet:

5. Did your plane have enough fuel to make the trip?

6. How does your displacement compare with the distance traveled?

7. How does the fact that you had to stop at Sipan affect your total distance traveled?

8. How does the fact that you had to stop at Sipan affect your displacement?

9. What is the difference between distance and displacement?

Physics Takes Flight

THE FORCES OF FLIGHT

Microsoft®'s *Flight Simulator X* allows you to choose from dozens of amazing aircraft and 50 exciting missions, and even choose your role in the mission. You can explore the ocean and island of St. Maarten from the air, drop sacks of flour onto targets in the ocean, or land a Bombardier in an extremely difficult location.

You must first understand the forces involved—**drag, thrust, weight, and lift.**

DRAG

When a plane flies through the air, it is moving through a fluid. This fluid offers resistance to the plane's motion. This resistance is called *drag.* Drag occurs because the airplane is experiencing collisions with the air molecules. In these collisions, momentum is gained by the air molecules, therefore momentum must be lost by the plane. The direction of the force is opposite of the direction of the plane's velocity.

Drag can be reduced by reducing the surface area of the plane and the plane's speed.

WEIGHT

Gravity is always pulling the plane towards the center of the earth. The magnitude of this force is proportional to the mass of the plane and its altitude. At or near the surface of the earth, all objects are accelerated towards the earth with an acceleration of $g = 9.8\ m/s^2$ (ignoring all effects of air friction).

Newton's 2nd Law shows us that the force on an object is the product of the object's mass and its acceleration. So the weight of an object is equal to the product of its mass and the acceleration due to gravity: $w = mg$

THRUST

Thrust is the force created by the airplane through its jet engines or propellers. It is a reaction pair (see Newton's 3rd Law) created when one mass (air) is accelerated in one direction causing another mass (the plane) to accelerate in the other. The direction of the thrust is the same as the velocity of the plane.

For a plane to accelerate forward, the amount of thrust must be greater than the drag created by the air. For the plane to travel at constant speed, the amount of thrust must equal the drag. To slow down, the plane's thrust must be less than the drag.

LIFT

Lift is created when an object moves through the air. A wing is shaped so the air flows faster over the top of the wing than at the bottom, causing there to be lower pressure acting on the top of the wing than at the bottom. This pressure difference produces the lift.

For a plane to rise, the amount of lift must be greater than the plane's weight. For the plane to travel at constant altitude, the amount of lift must equal the weight. To lose altitude, the plane's lift must be less than its weight.

Air Creation Buggy 582 SL Ultralight

PHYSICS TAKES FLIGHT!

$a = \frac{\Delta v}{t}$

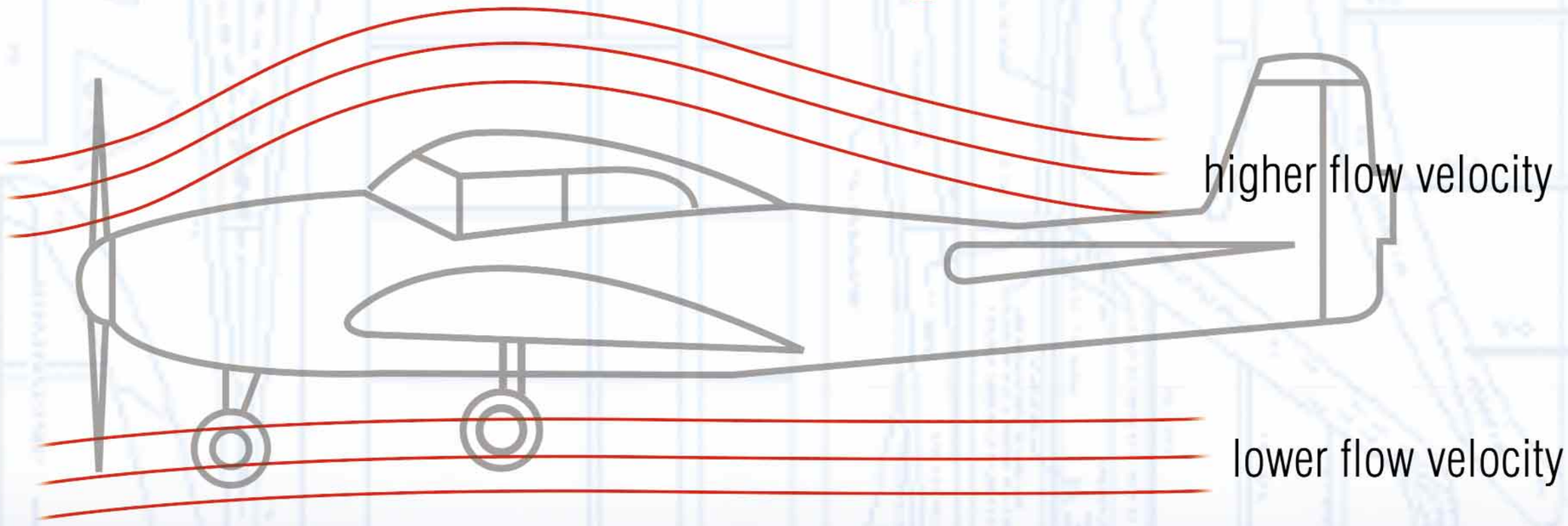
$F_{net} = ma$

$\bar{v} = \frac{d}{t}$

$d = v_i t + \frac{1}{2} a t^2$

$w = mg$

$g = -9.8 m/s^2$



d = displacement	t = time
a = acceleration	F_{net} = net force
g = acceleration due to gravity	w = weight
$\bar{v}$ = average velocity	m = mass
v_i = initial velocity	v = velocity

Choose from dozens of planes—from the deHavilland DHC-2 Beaver floatplane to the Maule M7-260C Orion with wheels and skis. Become the pilot, co-pilot or even air traffic controller as you play *Flight Simulator X* online with other aviators around the globe in real time. Go to www.fsinsider.com to find out more!

Microsoft YMI YOUNG MINDS INSPIRED

Here's what they say about why they fly:

The experience—Just like real pilots, virtual pilots have the challenges of bad weather, dangerous approaches and other airplane traffic that make each flying experience a unique one.

The community—The community that surrounds *Flight Simulator* makes flying online fun! Interacting with other virtual pilots and simulated air traffic controllers makes flying online always exciting.

The dream—I can command one of those "big boys." With *Flight Simulator,* you can hop in that left seat and fly a big Boeing 757 or a small Cessna Skyhawk all over the world.

The realism—Whether you're learning about the basics of flight, how to make an approach, or even what to do in an emergency, it's all based on real info that real pilots use.

Go to **www.fsinsider.com** to find out more.

Microsoft® YMI™ YOUNG MINDS INSPIRED

Grumman G-21A Goose

MAKE YOUR FLIGHT PLAN ONLINE AND IN SYNCH

Flight Simulator X takes off

Experience what it's really like to soar thousands of feet into the sky. Take the role of air traffic controller and be responsible for plane and passenger safety. Perform rescue missions during your time in the sky. You can do all this and more with *Flight Simulator X* from Microsoft®. It's the culmination of nearly 25 years of development and sets the standard for technological innovation, incredible graphics and realism. From classic sea-planes like the deHavilland Beaver and Grumman Goose to the Cessna 172, there is a plane for every terrain and every player.

Flight Simulator X lets players join a connected world through an interactive online experience. With more than 24,000 air-ports located on every continent, players can explore their home town or a favorite far-off city.

Flight Simulator X is available in stores everywhere. To find out more, go to **www.fsinsider.com**

Extra 300S

A pilot just like you...

Andrew Steinberg, High School Senior, New York
Hobbies: Fencing, video games, ultimate frisbee

I started to play Flight Simulator and got hooked. I found an online community that simulated air traffic controlling all across the world. I began "flying" all of the time. A few months later, I decided I wanted to become an air traffic controller, too, so I learned what real air traffic controllers do. After a few weeks, I was allowed to control by the people I fly with. I've not only learned how airplanes fly, but also all of the operations that go into getting planes from the gate into the air and back to the ground again.

A word from the development team...

Microsoft's Bruce Williams has been a pilot since the mid-1970s. He's also a certified flight and instrument flight instructor and teaches part-time at a flight school. Here's what he has to say about Flight Simulator X.

Today, *Flight Simulator X* is being used to help train pilots. The U.S. Navy issues *Flight Simulator* to its student pilots. As part of the Career Pilot Program at the FlightSafety International Academy in Vero Beach, FL, students must complete 27 hours of instruction in a Microsoft® *Flight Simulator* lab. Working under the direct supervision of FlightSafety instructors, students practice running checklists, following ATC (Air Traffic Control) clearances, performing basic flight maneuvers, and polishing IFR (Instrument Flight Rules) flying skills.

Flight Simulator X includes enhanced flight analysis and an instructor's station—and those features make it an excellent training aid. Replay any flight and see both horizontal and vertical profiles. An instructor can monitor another *Flight Simulator* pilot over the Internet or a local area network to offer help, change the weather, or to cause failures in the plane's engine, an instrument, or an aircraft system.

Soar to new heights

Immersive world. *Flight Simulator X* offers players a rich and innovative gaming experience with new technological advancements, incredible graphics and realism, including weather, time of day, and seasons. Pilots can watch moving cars and detailed buildings in cities below, traffic on highways, indigenous houses, farmland and livestock, and wildlife in their natural habitats.

Mission-based gameplay. With more than 50 new missions to choose from, players can compete in the Red Bull air race or bring relief material to the Congo, keeping track of their progress on each mission.

New aircraft. Aviators fly the aircraft of their dreams, from the deHavilland DHC-2 Beaver floatplane to the Maule M7-260C Orion with wheels and skis. Players view the world from 100 to 100,000 feet up.

Connected world. Players choose whom they want to be—from an air traffic controller, pilot, or co-pilot—as they interact with other aviators around the globe by chatting in real time via headset and keyboard.

Interactive airports. More than 24,000 airports feature artificial intelligence-controlled jetways, fuel trucks, and moving baggage carts, allowing players to explore their hometown or an intriguing far-off city.

Some of the people you might meet when you're in the interactive online *Flight Simulator X* community.

Dan C., Age 17, Hobbies—Flying (in real life), *Flight Simulator,* marching band, computers

Matthew L., Age 18, Hobbies—*Flight Simulator,* computers, bowling, sports

Cory M., Age 14, Hobbies—Flying on VATSIM, jazz band, flying (in real life), flying RC airplanes

Nick C., Age 16, Hobbies—Air traffic controlling in online *Flight Sim* (VATSIM), table tennis, football (soccer)

Tyler T., Age 15, Hobbies—Controlling and flying, racing, computers, sports

Ethan K., Age 16, Hobbies—Flying online, TV production, politics, music

Alan F., Age 17, Hobbies—*Flight Simulator* pilot, robotics, air hockey, reading, writing, computer art