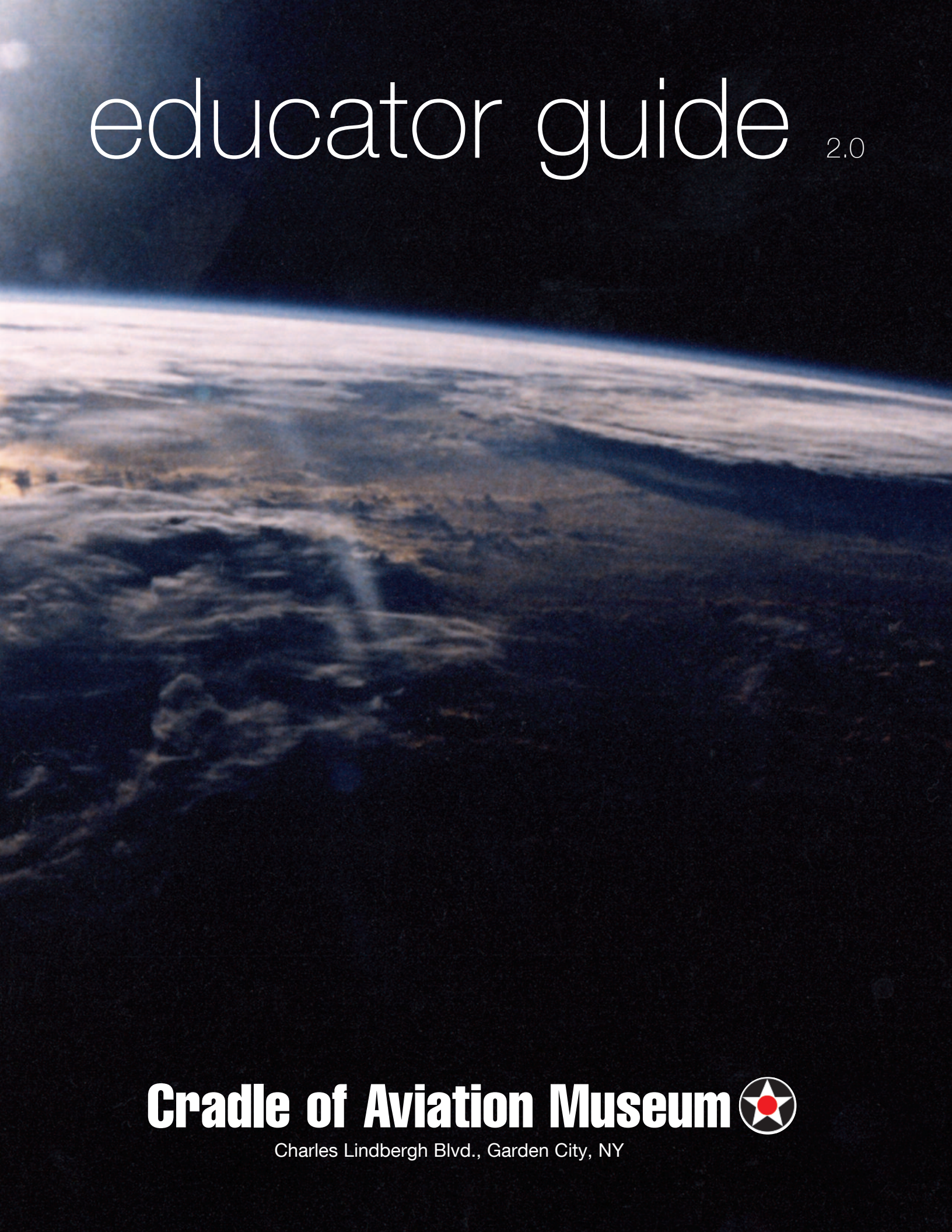


educator guide 2.0

Cradle of Aviation Museum

Charles Lindbergh Blvd., Garden City, NY

Dear Educator,

We hope this guide will enhance your field trip and extend the visit beyond the museum into the classroom. Within each gallery section there are activities and material for you to use before, during and after your visit. You will discover exciting ways to fulfill core curriculum standards through aviation and space exploration.

The Cradle of Aviation Museum's mission is "to inspire future generations through the exploration of air and space technologies." To fulfill this goal, we are dedicated to simultaneously educating and entertaining through the accurate interpretation of the collection and the exhibitions. Programs developed for school groups and the public focus on everyone's universal appreciation for flight. Whether an individual has a passion for flying or is attracted to the crafts that make human flight possible, he/she will find a lasting connection here at the Cradle of Aviation Museum.

We express our appreciation to all educators who use this guide to make the most of our services and to the New York State Council on the Arts for making this teacher guide possible.

Sincerely,

The Cradle of Aviation Museum staff

State of the Arts NYSCA

Special thanks to the Teacher Guide content contributors:
J. Thomas Gwynne; Juliann Gaydos Muller; Rod Leonhard; Joshua Stoff; Shari Abelson; William J. Quinn; Robert H. Muller; Carol Froehlig; Richard Santer; Jennifer Baxmeyer; Robert Tramantano; Fred Truebig and Al Grillo.

About the Cradle

The 150,000-square-foot Cradle of Aviation Museum is a nonprofit educational corporation in partnership with the County of Nassau.

The Donald E. Axinn Exhibit Hall and Cradle of Aviation Annex

Three former Mitchel Field hangars are now home to 73 magnificent flying machines spanning Long Island's aviation heritage. Your visit will take you all the way from an early air meet on the Hempstead Plains to the surface of the moon to witness Neil Armstrong's 1969 "small step... giant leap" from an authentic Grumman Lunar Module.

The Leroy R. and Rose W. Grumman Dome Theater

Large format technology puts you in the picture like no other motion picture form. By using the largest film frame in the industry - 10 times the size of conventional 35mm film - this technology captures breathtaking images of unsurpassed size and impact. Images are projected onto an immense 78-foot dome screen and accompanied by 12-channel wrap around Digital Sound. Our full-dome theater provides a breathtaking experience that stimulates the imagination while teaching new concepts.

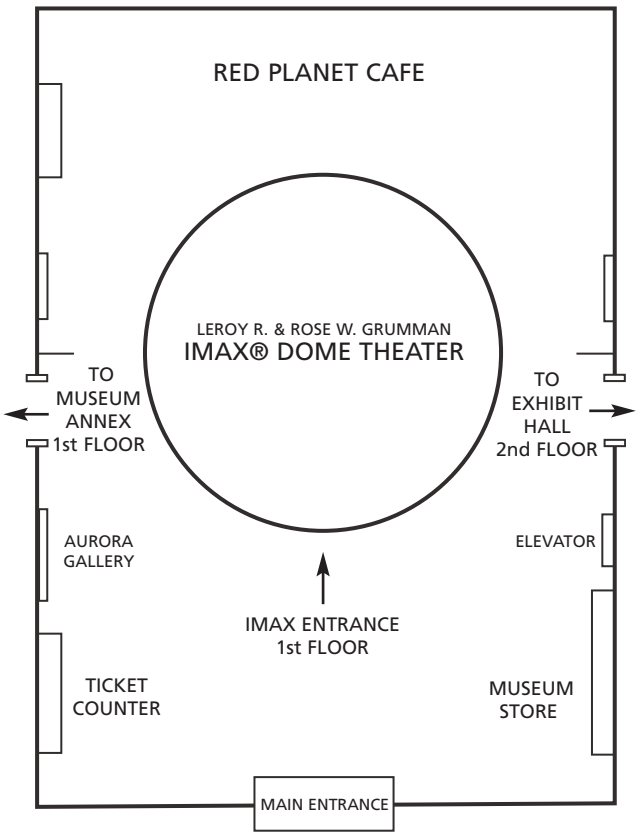
Mitchel Field Outpost - Museum Store

The Museum Store offers a wide variety of books, gifts and toys that reflect the exhibits and collections at the Cradle of Aviation. Enthusiasts can find models of Grumman and Republic aircraft and books spanning the history of aviation from early flight to space exploration. The 1,800-square-foot store also features a quality selection of educational toys and gifts.

Red Planet Cafe

Visitors to the Cradle of Aviation can experience dining in a 21st-century space base on Mars. The café serves fast food from a varied Martian menu that emphasizes nutrition. Visitors can watch activities of the Mars Mining Company, see the original Princess of Mars exploratory spaceship and learn how earthlings viewed Mars way back in the 20th century.

Reckson Center Atrium Floor Plan



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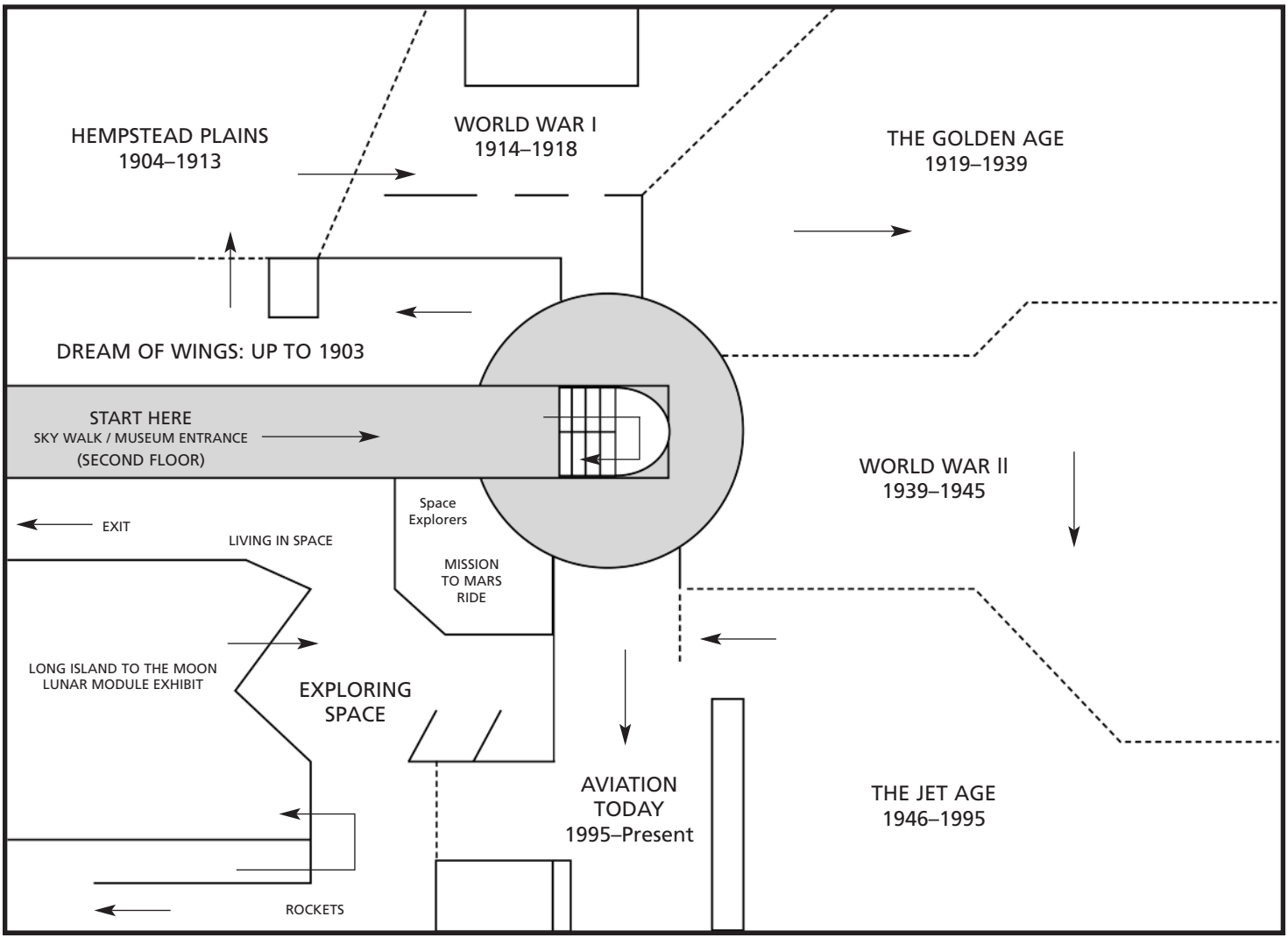
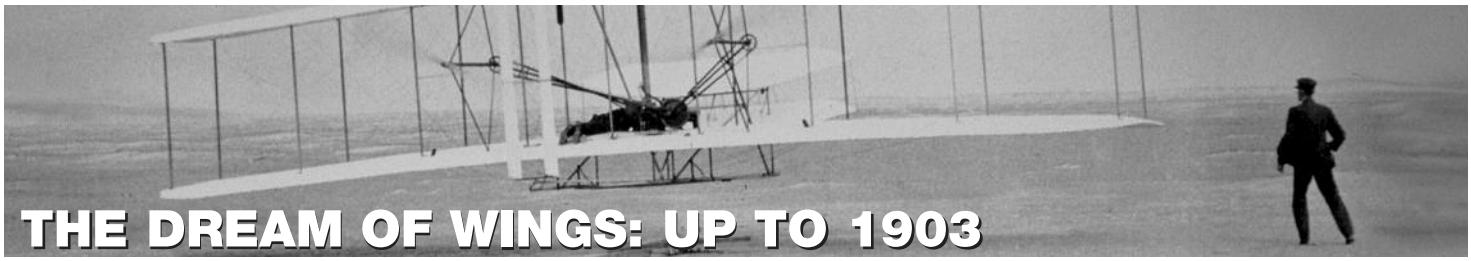
Donald Everett Axinn Air and Space Museum Hall





THE DREAM OF WINGS: UP TO 1903

Since the beginning of recorded history, humans have pursued the dream of flight. The ancient dream of Daedulus to fly was finally realized with the first balloon flights in the late 18th century. During the 19th century, deliberate scientific experimentation with kites, gliders, airships and powered aircraft led to the development of the airplane in the early 20th century. Over the course of decades, experimenters, some of them Long Islanders, solved the basic problems of aircraft design.

ON EXHIBIT

People

Eilmer of Malmesbury . .a medieval monk who experimented with gliders (1010)
Leonardo DaVinci . . . . .Italian “Renaissance Man” - drew plans for several flying machines (1496)
Montgolfier Brothers . . .designed hot-air balloons during the late 18th century (1780s)
Daniel Bernoulli . . . . . .the “first mathematical physicist” - his principle describes how lift is generated by airfoils
Leo Stevens . . . . . .conducted first powered airship flights over Long Island (1902)
Edward Boyce . . . . . .conducted first powered airship flights over Long Island (1902)
Augustus Herring . . . . .from Freeport; experimented with gliders in 1890s
Samuel Langley . . . . . .a scientist from the Smithsonian who experimented with powered flight
Charles Manly . . . . . .a Long Islander who worked with Samuel Langley on powered flight
Wright Brothers . . . . . .made the first sustained powered manned flight in Kitty Hawk, NC (1903)

Aircraft

Hot-air Balloon . . . . . .the oldest successful human flight technology
Airship . . . . . .a powered balloon (dirigible)
Daily Graphic . . . . . .the name of a balloon used in a failed attempt to cross the Atlantic Ocean (1873)
Kite . . . . . .a man-made object, designed to fly by opposing the force of the wind with the tension of a line
Lilienthal Glider . . . . . .a German glider which made the first manned flights (1891)
Aerodrome #5 . . . . . .the first heavier-than-air machine to make a successful powered flight without a pilot (1896)
Wright Flyer . . . . . .the first powered, heavier-than-air machine to achieve controlled, sustained flight with a pilot aboard (1903)

Events

First Manned Balloon Flight, Nov. 21, 1783
1st Powered Airship Flight over Brooklyn, Oct. 1902
Langley’s 1st powered unmanned flight, 1896
Wright Brothers 1st Manned Powered Flight, Dec. 17, 1903

Vocabulary

lighter than air	drag	roll
heavier than air	thrust	yaw
lift	pitch	dirigible

Lesson Plan: The Principles of Control (Grade Level: 5 – 8)

Purpose
This activity will familiarize students with control and the importance and function of the different airplane parts.
(See airplane parts diagram on page 27)

Control involves three movements:

Pitch: A change in pitch raises or lowers the nose of the aircraft. This effect is caused by the operation of the elevator. As the elevator is raised, the force of the airflow pushes the tail down and raises the nose.

Yaw is the movement of the nose to the left or right in relationship to the pilot about the vertical axis. Yaw is controlled by the rudder. If the rudder is deflected left, the pressure from the airflow pushes back around and the aircraft rotates around the vertical axis. Right rudder makes it rotate in the opposite direction so the plane points in the direction you press the rudder.

Roll is the rotation around the longitudinal axis of the fuselage. This effect is caused by the operation of the ailerons. To roll left, the left aileron is raised and the right aileron is lowered. The combined effects of the airflow on the controls lifts the right wing and lowers the left wing. The operation is reversed to roll right.

Curriculum Standards
Math, Science and Technology:

- Standard 1: Analysis, Inquiry, and Design
- Standard 4: Science
- Standard 5: Technology
- Standard 6: Interconnectedness
- Standard 7: Interdisciplinary Problem Solving

Materials
A balsa wood single-wing guillow glider, masking tape

Procedure
Inform the students that you are going to perform a number of experiments with a balsa wood glider to demonstrate how an aircraft changes direction and uses the principles of control.

Experiment 1
1. Put the plane together with the wing in the center of its slot.
2. Gently toss the glider a couple of times to establish a standard flight pattern.
3. Experiment with the wing by moving it to the front of the slot and to the back of the slot. Notice the difference in how the plane reacts (With the wing at the front, the plane is less stable and should porpoise in flight. When the wing is as far back as it can go, the glider is more stable and the glider should have a straight flight path.) Ask why this happens and how it is important for control.

Experiment 2
1. Return the wing to the center of the slot and make a mark so that you can always return the wing to the same position.
2. Add about one inch of masking tape to the back of the vertical stabilizer. (Tail)
3. When the tape is bent to the right, the glider should turn to the right when thrown. (same for left turn)
4. After each flight, make sure to return the wing to the mark you made.

Experiment 3
1. Remove the masking tape from the vertical stabilizer.
2. Add about one inch of masking tape to each of the horizontal stabilizers. (Elevator)
3. When the tape is bent up, the plane should porpoise. (The tape is pushing the tail down and therefore the nose up making the glider climb in the air. Because there is no forward thrust, the plane cannot continue to climb resulting in the porpoising flight.)
4. Now bend the tape down. (The aircraft will tend to dive.)

Experiment 4
1. Remove the tape from the horizontal stabilizer.
2. Place an inch of tape on the trailing edge of the outboard section of the wings. (Ailerons)
3. Bend one piece of tape up and the other down. The plane should roll in the direction of the up tape. (This is because the tape is causing the wing to drag, while the opposite wing is rising.)

Discussion
Talk about the principles of lift and control and how they were causing the glider to make certain maneuvers. Think about doing two of the experiments at the same time and how they would affect the flight path of the glider.

Lesson Plan: Principles of Aerodynamics (Grade Level: 3 – 8)

Purpose
The students will perform three demonstrations that illustrate the principles of aerodynamics.

Curriculum Standards
Math, Science and Technology:
- Standard 1: Analysis, Inquiry, and Design
- Standard 4: Science
- Standard 6: Interconnectedness

Materials
For each pair of students you will need a small drinking straw, two empty soda cans, one piece of 8.5" X 11" white paper, one three ounce cup.

Procedure
Inform students that they are about to perform a series of simple experiments that will demonstrate the principles that make it possible for an airplane to lift into the air and remain aloft. Divide the class into pairs, providing each group with its materials.The groups will perform the following brief experiments. Before each experiment, have group members predict what will happen.

Experiment #1 - Paper Trick
Hold one sheet of paper just below your lips in front of your mouth. Now blow hard over the piece of paper, and observe the result. (The sheet of paper will rise up to the level of your mouth.)

Experiment #2 - Soda Can Experiment
Lay two empty soda cans on their sides, parallel to each other, and fairly close together on a table or desk. Holding a drinking straw between the cans and parallel to them, blow through the straw. What happens to the cans?
(They will move closer together.)

Experiment #3 - Water Experiment
Taking the small drinking straw hold the straw upright in a cup of water, with the top of the straw segment above the surface of the water. Blow across the top of the straw and observe what happens to the water in the straw.
(The water level will rise.)

Discussion
Discuss with the class what they have "figured out" from their experiments. Encourage them to offer reasons for their results. If necessary, explain that increased speed of airflow over a surface causes a decrease in air pressure over that surface. Areas of greater pressure will move toward the areas of lower pressure. Because of the decreased pressure between the soda cans, the soda cans moved closer to each other. Likewise, because less pressure was holding the water down in the straw, the water level went up.

Continue the discussion by asking students to relate what they have learned to an explanation for how a plane lifts into the air. They should be able to figure out that the increased speed of airflow over the wings causes a decrease in pressure over the wings.

Challenge students with one more question: "What would happen if airflow over the wing decreased in midair?" Students should be able to figure out that it would start to descend; a constant airflow over the wing is necessary to keep the plane aloft.

At the Museum
Before your visit call reservations at 516-572-4066 and schedule a guided program called “How does it fly?”

Experiments Demonstrating Aerodynamic Principles
or
“Low Pressure Gives Students a Lift!”

Experiment #1 - Paper Trick

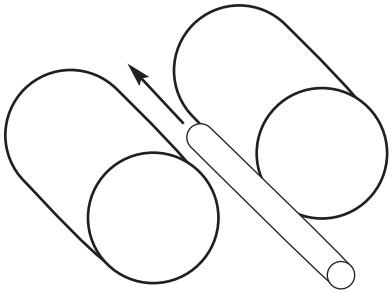
Hold one sheet of paper just below your lips in front of your mouth. Now blow over the piece of paper, and observe the result.

Draw the paper before and after you blow over it.

Experiment #2 - Soda Can Experiment

Lay two empty soda cans on their sides, parallel to each other, and fairly close together on a table or desk. Holding a drinking straw between the cans and parallel to them, blow through the straw. What happens to the cans?

Draw the airflow using arrows for decreased pressure on the diagram.



Experiment #3 - Water Experiment

Taking the small drinking straw hold the straw upright in a cup of water, with the top of the straw segment above the surface of the water. Blow across the top of the straw and observe what happens to the water in the straw.

Explain what happens to the water in the straw. Why does this occur?

Challenge Question
What would happen to an airplane if its forward motion was to stop suddenly? Explain using the results of your three experiments.

THE HEMPSTEAD PLAINS 1909-1913

When you walk into the Hempstead Plains Gallery, you are entering an air meet in the early 20th Century. Around you on the Hempstead Plains are aircraft that flew there. You can see examples of the dress of the period, the transportation vehicles, and the aircraft that were flown there. In addition, there is a period film of early aircraft in action. Other exhibits include information on early local airplane designers and flyers, the Moisant Flying School, and maps of Long Island identifying locations of period airports.

ON EXHIBIT

People

Henri Farman . . . . . .first person to attempt a flight on Long Island (at Brighton Beach)
Glenn Curtiss . . . . . .major contributor to the development of the airplane
Harriet Quimby . . . . . .first woman in the U.S. to get a pilot's license,
first woman to successfully fly the English Channel
Blanche Stuart Scott . .first woman to become airborne
Cal Rodgers . . . . . .completed first transcontinental flight
Dr. Henry Walden . . . . .designer of the first American monoplane
Bessica Raiche . . . . . .first woman to take off and pilot a plane
Matilde Moisant . . . . .second woman in the U.S. to get a pilot's license
Alfred Moisant . . . . . .started and instructed at the Moisant Flying School

Aircraft

French Voisin . . . . . .a model of the first aircraft to attempt flight on LI
piloted by Henri Farman
French Bleriot . . . . . .4th oldest aircraft in the US, possibly 10th in the world
Herring Curtiss Golden Flyer . . . .replica of 1909 plane - first plane to successfully fly on LI
Wright Model B Vin Fiz . . . . . .replica of 1911 plane - 1st transcontinental flight

Events

Farman demonstration flights of July – Aug 1908
Scientific American trophy contest of 1909
International Aviation Meet at Belmont Park 1910
Flight of the Vin Fiz in 1911
Second International Air Meet of 1911

Vocabulary

bi-plane	force	lift
monoplane	propeller	thrust
altitude	horizontal	drag
air meet	vertical	weight
ailerons	aerodynamic	gravity
wingwarping	deflection	laminar
air pressure	streamlined	turbulent
atmosphere	airfoil	stress

Lesson Plans

These lesson plans will introduce the student to the historic period that developed on LI after the Wright Brother's invention of the airplane. The student will also become familiar with the fundamentals of flight, and the effect of thrust on an airfoil. In the second activity, they will follow the path of the first transcontinental flight.

Making an Airfoil (wing) fly (Grade Level 3 – 8)

Purpose
To understand lift.

Curriculum Standards
Math, Science and Technology:
- Standard 1 – Analysis, Inquiry and Design
- Standard 2 - Information systems
- Standard 3 – Mathematics
- Standard 4 – Science
- Standard 5 – Technology

Materials
Paper, straws, fishing line.

Procedure
Give each student a sheet of paper, a straw and a piece of 3 ft. fishing line. Fold the sheet of paper on itself leaving one inch of space to the edge. Staple the paper to itself forming a curve in the paper. Do NOT crease the paper. Using a pencil, create a hole in the curved part of the paper, an inch from the edge. Place the straw in the hole, and tape it to the paper. Insert the fishing line through the straw. Make finger loops at each end. Have the students experiment with their airfoil by walking around. Change the angle that they hold the airfoil to the wind. (Increase and decrease the speed that they move to see the different effects on the wing.) Try the same experiment with a piece of paper that has been folded and is flat. What are the differences?

What's happening: The airfoil's curved shape causes the air to travel faster across the top of the paper than the bottom. This creates a difference in air pressure (high pressure on the bottom, lower pressure at the top), which pushes the airfoil up the string. Airplane wings are also curved to create an upward air motion.

Flight Plan of the First Transcontinental Flight (Grade Level: 5 – 8)

Purpose
To introduce the students to the use of maps and other geographic representations, tools, and technologies to process information.

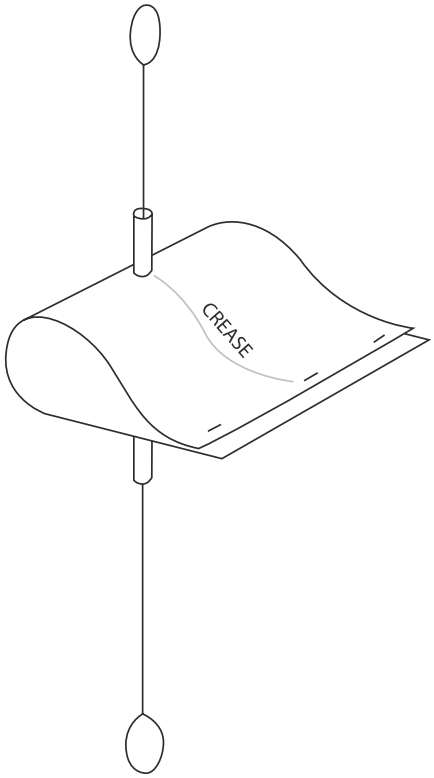
Curriculum Standards
Social Studies:
- Standard 1: History of the US and NY
- Standard 3: Geography

Math, Science and Technology:
- Standard 3 – Mathematics

Materials
"Flight of the Vin Fiz" activity sheet on page 9.

Activity sheet answers: States flown over: NY, PA, OH, IN, IL, MO, KA, OK, TX, NM, AZ, CA. He flew for 82 hours, at an average speed of 51 MPH, and burned 15 gallons per hour (gph). His route followed the railroad tracks.

Creating an Airfoil (Wing) and Seeing the Effects of Thrust!



Materials Needed:

White paper 8.5” x 11”, straws cut into 3” lengths,
clear fishing line cut into 3-foot lengths, stapler & tape.

Steps to Follow

1. Fold the paper in half lengthwise, crease it, then unfold it.

2. Fold the sheet of paper in half the other way without creasing it, leaving a 1 inch overlap and put several staples to hold it.

3. Using a pencil, create a hole in the center of the curved part of the paper. (using the crease as your center mark)

4. Place the straw in the hole, and tape it to the paper.

5. Insert the fishing line through the straw.

6 Make finger loops at each end or tie popsicle sticks to the ends of the string.

Now experiment with your wing. Hold one hand high and one hand low so that the wing is resting on the lower hand with the curved area facing forward. Walking around, move fast enough to make your wing rise up the string. Now, change the angle that you hold the airfoil to the wind. Move a little faster. Move slower. Try using a fan. What happens?

Now do the same experiment but this time crease the paper in step 2. What are the differences you observe? Write several sentences below describing the effect of speed (thrust) on the wing.

My conclusions about the effect of thrust on the wing:

The Flight of the "Vin Fiz" 1911

Cal Rodgers and the first flight across America!

You are Cal Rodgers, the first person to ever fly across the United States from the East coast to the West coast. Your route was a bit strange!

Using the map, identify all the states you flew through.

_____, _____, _____, _____, _____, _____,

_____, _____, _____, _____, _____, _____

2. From information in the Gallery, find the total distance of the trip. _____ miles

3. Find how long it took Cal to fly from coast to coast in hours. _____ hours

4. Calculate his average speed. _____ mph (miles per hour)

5. He used 1,230 gallons of fuel on the flight. What was his hourly fuel burn? _____ gal.

6. Look at his route on the map. Why did he choose this strange route?

_____

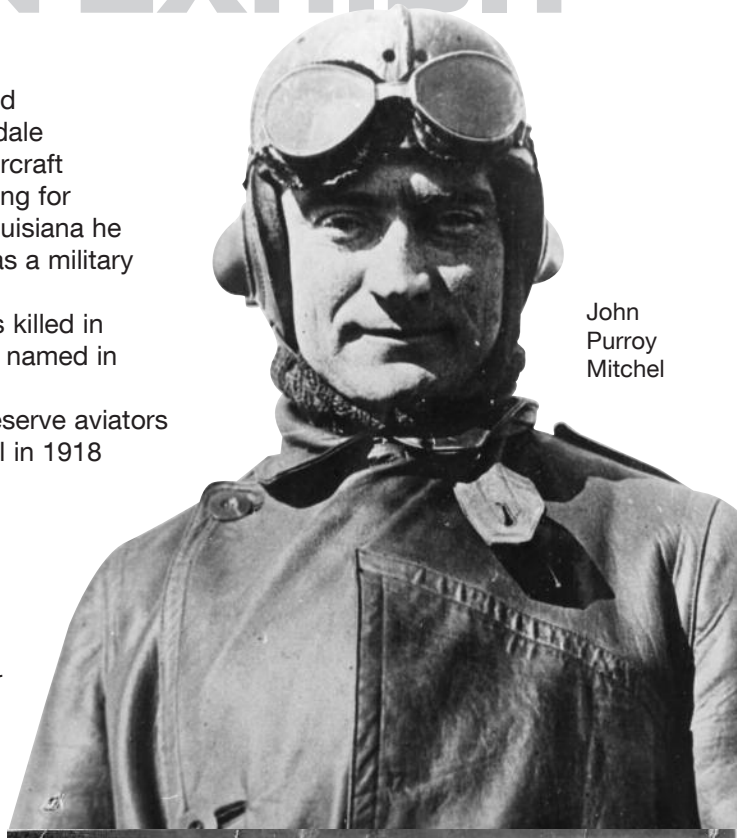
WWI 1914-1918

During World War I, not only did aviators from all over the country train on Long Island, but many local residents entered the air service and saw combat as well. For these young aviators, doing battle in fragile machines high in the thin cold air, fighting for their lives as well as country, was difficult and demanding. This gallery shows some of the aircraft they flew and the Long Island airfields where they trained. Wartime demand also spurred the development of a military aircraft industry on Long Island that continued for many years.

ON EXHIBIT

People & Places

Glenn Curtiss . . . . . .started aircraft factory on Long Island
Lawrence Sperry . . . . .started aircraft company in Farmingdale
Elmer Sperry . . . . . .created many instruments used in aircraft
John Purroy Mitchel . . .was Mayor of NYC before volunteering for service in WWI. During training in Louisiana he died in an accident. Mitchel Field was a military airfield named in his honor.
Quentin Roosevelt . . . .son of President Roosevelt who was killed in France in WWI. Roosevelt Field was named in his honor.
Trubee Davidson . . . . .started Yale unit on LI - first naval reserve aviators
Hazelhurst Field . . . . . .oldest military field, renamed Mitchel in 1918



John Purroy Mitchel

Aircraft

Curtiss JN-4 'Jenny' . . . . . .Lindbergh's first plane
Thomas Morse Scout . . . . .WWI fighter
Breese Penguin . . . . . a basic trainer unable to fly but taught pilots how to control their planes on the ground
Sperry Messenger . . . . . .an army utility plane built in Farmingdale in 1922
Ace Sport Plane . . . . . .sport plane based on a fighter built after WWI in Bethpage
Sperry Aerial Torpedo . . . .WWI guided missile

Events

World War I, 1914–1918

Vocabulary

army air service	aerial torpedo
naval air stations	autopilot
barnstormer	civilian

Lesson Plans (Grade Level 5 – 8)

Purpose
For students to gain an understanding of what it was like to be a pilot during WW I and how the growth and development of the aircraft increased significantly during this time.

Preparation
Study the history of WW I and what led up to the United States entry into the war. Look at how this war was different in both ideology and technology than preceding wars.

Curriculum Standards
English Language Arts:
- Standard 1 – Language for Information and Understanding
- Standard 2 – Language for Literacy Response and Expression
- Standard 3 – Language for Critical Analysis and Evaluation

Social Studies:
- Standard 1 - History of the United States and New York
- Standard 2 – World History

Math, Science and Technology
- Standard 6 – Interconnectedness of Common Themes

The Arts
- Standard 1 –Creating, Performing and Participating in the Arts

Pre-visit Activity
Have the students read the diary entries about what it was like training on the Breese Penguin in France and being a pilot during WWI. After reading the narrative about the Penguin (High Adventure), have the students illustrate part of the story. Ask them what they think the Penguin would look like based on what they read.

At The Museum
Use the following quote as a starting point for a discussion with your students.

Look for the exhibition panel, "From 1920 – The airplane had become a weapon" panel. There is a quote by Orville Wright from 1917, "When my brother and I built and flew the first man-carrying flying machine, we thought that we were introducing into the world an invention which would make further wars practically impossible."

As a group, discuss what you think he meant by that statement? Thoughts to consider:
- How were wars fought previously?
- What caused some wars/conflicts to develop?
- What changed after the invention and growth of aircraft?

Have the students make a list of the pros and cons of the invention of the airplane using Worksheet 1.

Post Visit Activity
Have the students re-read the diary sections from War Birds: Diary of an Unknown Aviator. What would it have been like to be a pilot during WWI? Think about the planes that you saw in the museum. What would have been the challenges to fly one of them?

Give the students the following assignment:
"You are a new pilot training to fight in WWI. Write a letter home telling about your experiences. Describe both what it was like training for a war that is being fought in another country and what it was like being in the military. What is it like to fly an aircraft? What do the planes look like? What are the advantages and disadvantages to being an airman? Include any pictures or diagrams to help illustrate your experiences."

Ideas to help the students with their letters:
1. What if you had never seen an airplane?
2. What would it be like if you had never been away from home?
3. What do you think pilots were like during this time (brave, scared, daredevils, etc)?
4. Think about how aircraft were built during this time.

WORKSHEET ONE

"When my brother and I built and flew the first man-carrying flying machine, we thought that we were introducing into the world an invention which would make further wars practically impossible."

~ Orville Wright, 1917

What are the advantages and disadvantages of the airplane?

PROS	CONS

Do you think the airplane is a worthwhile invention? Why?

From <u>High Adventure</u> by James Norman Hall, 1918

About the Penguin…
"Toward evening the wind freshened and flying was brought to a halt. Then the Penguins were brought from their hangars and Drew and I, properly dressed this time and accompanied by some of the Americans, went out to the field for our first sortie. As is usual on such occasions, there was no dearth of advice. Every graduate of the Penguin class had a method of his own for keeping that unmanageable bird traveling in a direct line, and every one was only too willing to give us the benefit of his experience. Finally, out of the welter of suggestions, one or two points became clear: it was important that one should give the machine full gas, and get the tail off the ground. Then, by skillfully handling the rudder, it might be kept traveling in the same general direction. But, if as usually happened it showed willful tendencies and started to turn within its own length, it was necessary to cut the contact to prevent it from whirling so rapidly as to overturn.

Never have I seen a stranger sight than that of a swarm of Penguins at work. They looked like a brood of prehistoric birds of enormous size, with wings too short for flight. Most unwieldy birds they were, driven by, or more accurately, driving beginners in the art of flying; but they ran along the ground at an amazing speed, zigzagged this way and that, and whirled about as if trying to catch their own tails…

We kept rehearsing the points which we were to remember in driving a Penguin: full gas and tail up at once. Through the interpreter, our moniteur (instructor) explained very carefully what we were to do, and mounted the step to show us, in turn, the proper handling of the gas manet (fuel throttle) and of the coupe-contact button. Then he stepped down and shouted, "Allez! en route!" with a smile meant to be reassuring. I buckled myself in, fastened my helmet, and nodded to my mechanic. "Coupe, plein gaz," he said. "Coupe, plein gaz," I repeated. He gave the propeller a few spins to suck in the mixture. "Contact, reduisez." "Contact, reduisez." Again he spun the propeller and the motor took. I pulled back my manet, full gas, and off I went at what seemed to me then breakneck speed. Remembering instructions, I pushed forward on the lever which governs the elevating planes, and up went my tail so quickly and at such an angle that almost instinctively I cut off my contact. Down dropped my tail again and I whirled round in a circle – my first cheval de bois, as this absurd-looking maneuvre is called. I had forgotten that I had a rudder. I was like a man learning to swim and could not yet coordinate the movements of my hands and feet. My bird was purring gently with the propeller turning slowly. It seemed thoroughly domesticated, but I knew that I had but to pull back on that manet to transform it into a rampant bird of prey."

Questions:
- What country do you think the narrator was training in?
- Do you think the Penguin was capable of flight?
- Why did pilots use the Penguin for training?

From <u>War Birds: Diary of an Unknown Aviator</u>, New York, 1926

1) A British major with the DSO and the M.C. talked to us the other day. He said as I remember it,
"You men are starting a long trip. It's a hard trip and will require a lot of courage. You'll all be frightened many times but most of you will be able to conquer your fear and carry on. But if you find that fear has gotten the best of you and you can't stick with it and you are beyond bucking up, don't go on and cause the death of brave men thru your failure. Quit where you are and try something else. Courage is needed above all else. If five of you meet five Huns and one of you is yellow and doesn't do his part and lets the others down, the four others will be killed thru the failure of one and maybe that one himself. This individual hero stuff is all tommy rot. It's devotion to duty and concerted effort and disciplined team work that will win the war. War is cruel, war is senseless and war is a plague, but we've got to win it and there's no better use of your life than to give it to help stop this eternal slaughter."

2) "I hope I can stick it thru. I know I'm not afraid to die. I'm pretty young to be ready for it and I'm not. Why, I'm just beginning to live! And after going to all this trouble to help make history, I want to live a little while to be able to tell about it. If we make the world safe for democracy, as some salesman remarked, brandishing a Liberty Bond in one hand and a flag in the other, what price salvation if we are not here to be democratic? Glory is hardly a passport to paradise." (pp 35-36)

3) "Again at eleven I went out to do battle. We got into a dogfight over Ostend and had a merry little fracas. I was up above the main formation to see that nothing dropped down out of the sun and a Pfaltz dove on me. He came right out of the sun but I've learned to put my thumb up and close one eye and unless they are at a dead angle, I can see them. I saw this one in time and just as he opened fire, I turned quickly and threw his sights off. His tracer was going a hundred feet behind my tail. The Hun went on by and half rolled onto my tail. I kept turning to keep his sights off me and he followed. We turned around and around – each maneuvering to get into position to fire a burst at close range. But I had learned my lesson well at Ayr and I could do a perfect vertical bank and I began gaining on him. I was getting into position to open up when he half rolled to break away. I half rolled after him and was on his tail like a hawk after a chicken. I let him have both guns at close range. My sights were dead on his cockpit and I must have got in about a hundred and fifty rounds. My Lewis jammed after fifty rounds but my Vickers kept going. The Hun started to turn, then he flopped over on his back and went straight down…I couldn't see him crash so I only got an "out of control." (p 180)

4) "It gives me a dizzy feeling every time I hear of the men that are gone. And they have gone so fast I can't keep track of them; every time two pilots meet it is only to swap news of who's killed…I've lost over a hundred friends, so they tell me, - I've seen only seven or eight killed – but to me they aren't dead yet. They are just around the corner, I think, and I'm expecting to run into them any time…Surely human life is not a candle to be snuffed out." (p 271)

Questions:
- How do you think the pilots would have reacted to the British major's speech?
- Do you think the author's tone has changed between paragraph 2 and paragraph 4?
- Who was the author fighting in the 3rd paragraph?
- What do you think happened to the author of the diary?

THE GOLDEN AGE 1919-1939

A time when more records were broken, more different airplanes were designed and built, more colorful pilots were flying unusual feats…..This was the Golden Age of Aviation on Long Island. This time, sandwiched between two World Wars, brought a sense of excitement and daring to aviation. It was the time when aviation transitioned from a foolhardy sport to a viable form of transportation. During this time, Long Island was the center of the aviation world.

ON EXHIBIT

People

Charles Lindbergh . . . . . first to fly the Atlantic solo
Anne Morrow Lindbergh . . . flew the Atlantic and Pacific with Charles
Elinor Smith . . . . . most famous Long Island aviator
Jimmy Doolittle . . . . . made first “Blind Flight” on Long Island
Leroy Grumman . . . . . started Grumman Aircraft Company
Lawrence Sperry . . . . . built first successful autopilot

Aircraft

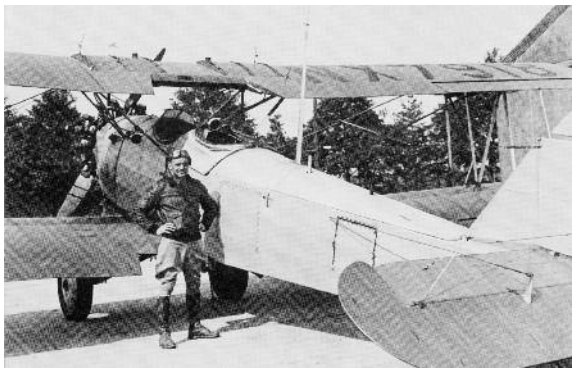
Ryan “Spirit of St. Louis” . . . .Ryan Brougham “sistership” to Lindbergh’s airplane
The Bird . . . . . .sports plane built by Brunner-Winkle Company on Long Island
Grumman Goose . . . . . .amphibian airliner
Peel Glider . . . . . .plane towed behind a boat
Savoia Marchetti S-56 . . . . . .amphibious plane built in Port Washington by American Aeronautical
Grumman F3F-2 . . . . . .full scale model bi-plane fighter
Sperry Messenger . . . . . .flying replica (located outside Skywalk as you enter Exhibit Hall)

Events

First solo crossing of the Atlantic by Charles Lindbergh, 1927
First blind flight over Mitchel Field by Jimmy Doolittle, 1929
Women’s endurance flight record set by Elinor Smith, 1929
Wrong Way Corrigan’s flight to Ireland, 1938

Vocabulary

altimeter	amphibian	gyroscope
airspeed indicator	glider	center of gravity
blind flight	Roosevelt Field	monoplane
retractable gear	periscope	biplane



Lesson Plans

Purpose
To help the students develop an understanding of the different components of aircraft by collecting data and see the relationship between these elements through charting and analysis.

Curriculum Standards:
Math, Science and Technology:

- Standard 1 – Analysis. Inquiry and Design
- Standard 2 - Information systems
- Standard 3 – Mathematics
- Standard 4 – Science
- Standard 5 – Technology

Wow.. Those Crazy Planes

Grade Level: 5 – 8

Materials
Wow... Those Crazy Planes activity sheet on page 16.

Procedure
Students will fill in the chart for each aircraft that is represented in the Golden Age Gallery. They will look to see relationships between weight, airspeed, type of aircraft and design. They will answer the questions based on the data collected.

Math Treasure Hunt

Math Treasure Hunt

Grade Level: 3 – 6

Materials
Math Treasure Hunt activity sheet on page 17.

Procedures
Instructions: Following the directions on the activity sheet, students will use their mathematical skills to arrive at the final number. Treasure Hunt answers: (1.) 1927; (2.) 220; (3.) 25x2=50; (4.) 2150; (5.) 2+1+1=4x5=20; (6.) 1; (7.) 2.
Answer is 33.5 hours.

Wow... Those crazy planes!

Fill in the chart below.
Look at the features of each aircraft.
Compare the differences and similarities between each one.

	Ryan	Brunner Winkle	Peel	Goose	Savoia	F3F-2
Type of Aircraft						
Number of Wings						
Length of Aircraft						
Engine Horsepower						
Top Speed						
Weight						

Write a conclusion for each aircraft based on its data and its relationship to the other aircraft.

Ryan

Brunner Winkle

Peel

Goose

Savoia

F3F-2

Math Treasure Hunt

Follow the directions to find the answer to the Charles Lindbergh Treasure Hunt question:

How many hours did the first transatlantic flight take?

Write the numerals for the year of Lindbergh's transatlantic flight. _____

Add the horsepower of the Ryan aircraft +_____

Total _____

Find out Lindbergh's age when he made his historic flight, multiply by 2 and **Add** to the total. +_____

Total _____

Subtract the weight of the Spirit of St. Louis. -_____

Total _____

Add together the numerals on the wing of the Spirit, **Multiply** by 5, now **Add** that to the total. +_____

Total _____

Multiply by the number of wings on the Spirit of St. Louis. x_____
(Remember, the Spirit of St. Louis is a *mono*plane)

Total _____

Divide by the number of wheels on the Spirit of St. Louis. ÷_____

Total _____

Lindbergh's flight took _____ hours.

WWII 1939-1945

During World War II, American fighter action was dominated by highly successful Long Island built airplanes. Starting with several small companies, the growth of the aircraft industry on Long Island increased rapidly. Local residents provided the manpower necessary for this massive production, and women and minorities were integrated into the workforce in large numbers for the first time. By 1945, over 100,000 people worked in the aviation industry on Long Island. Military activities on the homefront during the war centered around Mitchel, Roosevelt and Floyd Bennett Fields. Life at home was also greatly affected due to military needs, which resulted in the rationing of food, clothing and gasoline.

People & Manufacturers

Francis S. Gabreski . . . . .leading American “Ace” in Europe
Grumman . . . . . .built Navy fighters and bombers
Sperry Company . . . . . .built instruments, gunsights and turrets
Norden . . . . . .built bombsights
Dade Brothers . . . . . .built troop gliders in Mineola
Columbia Aircraft . . . . . .built Navy scout planes
Republic . . . . . .built P-47 fighters

Aircraft

Grumman F4F Wildcat . . . . . .Navy fighter
Grumman F6F Hellcat . . . . . .Navy fighter
Grumman TBF Avenger . . . . . .Navy bomber/torpedo plane
Republic P-47 Thunderbolt . . . . . .Army fighter
Columbia Grumman J2F Duck Amphibian (model) . . .Scout plane
Brewster F2A Buffalo . . . . . .Navy fighter
Waco CG-4 Troop Glider . . . . . .Army transport assault glider

Events

World War II, 1939-1945
Pearl Harbor, December 7, 1941

Vocabulary

aircraft carrier	assembly lines
mass production	amphibian
bombsight	homefront
telegraph	rationing

ON EXHIBIT

Lesson Plan (Grade Level: 5 - 8)

Purpose
To gain an understanding of the extraordinary accomplishments ordinary people, both men and women, achieved to support and defend freedom during World War II.

Preparation
Review the history of WWII.

Curriculum Standards
English Language Arts:
- Standard 1 – Language for Information and Understanding
- Standard 3 – Language for Critical Analysis and Evaluation

Social Studies:
- Standard 1 - History of the United States and New York
- Standard 2 – World History

Math, Science and Technology:
- Standard 1 – Analysis, Inquiry and Design
- Standard 5 – Technology
- Standard 6 – Interconnectedness of Common Themes.
- Standard 7 – Interdisciplinary Problem Solving

The Arts:
- Standard 1 – Creating, Performing and Participating in the Arts
- Standard 3 – Responding to and Analyzing Works of Art

Aircraft Briefing : 1945

Pre-visit Activity and Discussion
In this assignment, students will investigate some of the aircraft that were used by the US and built on Long Island during WWII. Begin by telling students:

"You have been asked to brief the president on the status of some of his air fleet that were used during WWII. We will divide into groups and each group will research and report on a specific plane at the museum. The planes are the Republic P-47, Grumman F4F Wildcat, Grumman F6F Hellcat, TBM Avenger and the Waco CG-4 Troop Glider. Each group will have interviewers, researchers and illustrators. We will use these worksheets to gather our information at the museum and then assemble our reports back in the classroom."

Discuss the significance of Rosie the Riveter and mass production. How did companies respond to the high demand for aircraft and parts? What role did women play in society before the war? How did it change during WWII? How did the companies change with this new work force? What was the cause and effect of the war in this area of manufacturing?

At the Museum
The groups will do their own research on their individual plane. Within each group, each student will have an assignment:
1) Interviewer – 1-2 students will use the questions provided and should develop a list of their own questions to ask the docents about their aircraft.
2) Researchers/Fact Finders – 1-2 students will look for facts/information about the plane in the galleries. Any relevant information about the aircraft companies should also be included.
3) Illustrator – 1-2 students will draw the aircraft and any tools that may have been used to build it. All drawings should be labeled.

Back in the classroom
Students will begin putting together their report. They can go to **www.cradleofaviation.org** for any additional information. Each group will then have the opportunity to present their briefing to the class. Make sure they add any relevant or interesting quotes students heard while conducting their interviews.

Additional Activity - Design a War Poster
During WWII, many war posters were produced to encourage the public to buy war bonds, join the military, promote rationing or work in the factories. They were also used as propaganda to gain support for the war effort.

You can find some examples of the war posters via the online exhibition from the National Archives.
Go to http://www.archives.gov/exhibits/index.html, then click on page 2 to find the exhibit.

After visiting the museum and reading about both the war and homefront and looking at examples of various posters, now it is your turn to design your own poster. What is the objective of the poster? Who is your target audience?

WWII Aviation Crossword Puzzle Answer Key
Across: 1. Grumman, 2. Avenger, 3. Ration, 4. Republic, 5. Riveter
Down: 1. Glider, 2. Mitchel Field, 3. Navy, 4. Roosevelt Field, 5. Buffalo Circle Scramble: Aviation

Aircraft Briefing : Data Collection

Plane:

INTERVIEW

What made this plane unique?

What was its significance to the war effort?

What was the workforce like that built this plane?

How reliable was this plane?

How did this plane perform in the war?

Other questions:

FACTS/RESEARCH

Where was the aircraft built? How many were produced?

Where was it flown?

Size: Weight: Top Speed:

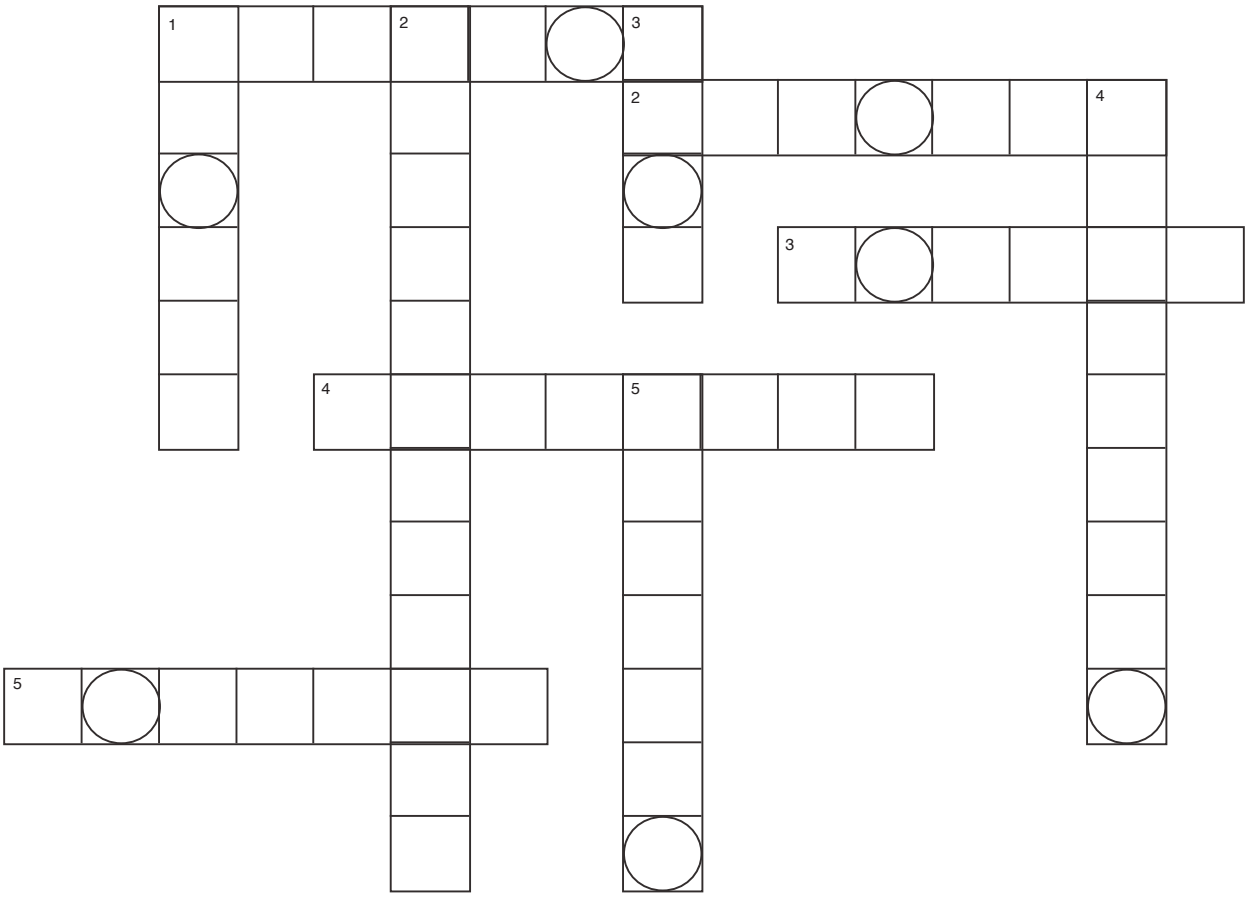
Other Information:

ILLUSTRATIONS

WWII AVIATION CROSSWORD PUZZLE

Across
1) This company built a record number of Hellcats. _____ (7 letters)
2) This plane was shown to the public on December 7, 1941. _____ (7 letters)
3) Because supplies were limited, people were asked to _____food and gas. (6 letters)
4) This company built the P-47. _____ (8 letters)
5) This name was given to women who worked in manufacturing during WWII.
"Rosie the _____ (7 letters)

Down
1) This type of aircraft was used to land troops silently behind enemy lines. _____(6 letters)
2) This was an important Army Air Corps base during WWII.
It is also the home of the Cradle of Aviation Museum. _____(12 letters)
3) This part of the military uses aircraft carriers. _____(4 letters)
4) He was the President of the US during WWII. Franklin _____(9 letters)
5) The Brewster Company named their F2A fighter after what animal? _____(7 letters)



Use the circled letters to fill in the blank (Hint: you may have to unscramble the letters.)

Over 100,000 people on Long Island worked in the _____ industry during WWII.

THE JET AGE GALLERY 1946–1995

The jet age was the beginning of a whole new era in aviation history as well as in world history. The jet engine not only revolutionized military aviation, but it also changed the very way we view our world, as jetliners made the world "smaller." As aircraft speeds increased dramatically, new shapes with swept wing designs were developed. In the 1960's, the introduction of wide-body jetliners, supersonic transports and quieter, more powerful and more efficient turbofans led to dramatic changes in commercial aviation. Similarly, the introduction of the helicopter turbine engine led to the helicopter finally becoming a versatile, practical machine with a wide range of applications.

ON EXHIBIT

People

First Woman Airline Pilot . . . . . .Bonnie Tiburzi
Grumman Test Pilot . . . . . .flight equipment worn by J. Thomas Gwynne
Navy Bomber Pilot . . . . . .equipment worn by Thomas Hagan
First African-American
Airline Pilot . . . . . .August Martin

Aircraft

Republic T-46 NGT . . . . . .prototype for Air Force trainer (1986)
Commonwealth Skyranger . . . . . .Valley Stream built 1946 sport plane
Grumman Kitten . . . . . .post war civilian light plane, 1945
Republic RC-3 Seabee . . . . . .post war civilian amphibian - 1946
Gyrodyne QH-50C . . . . . .St. James built 1965 unmanned anti-submarine helicopter
Gyrodyne 2C . . . . . .largest helicopter built on Long Island, 1954
Republic P-84B Thunderjet . . . . .oldest surviving Long Island built jet, 1946
Grumman F9F Cougar . . . . . .first naval swept-wing jet 1952
Republic A-10 . . . . . .Airforce jet still in service today

Events

Republic builds P-84 Thunderjet, first Long Island built jet aircraft, 1946
New York International (later JFK) Airport opens in Queens, 1948
First Navy Grumman F9F Panther jet sees combat in Korean War, 1950
Roosevelt Field airfield closes, 1951
Grumman builds F-11 Tiger, first Navy supersonic jet, 1954

Vocabulary

ailerons
cockpit
elevator
engine
flaps
fuselage
landing gear
propeller
rudder
stabilizers
flaps
wings
Grumman
Republic

Lesson Plans (Grade Level: 5 - 8)

Purpose
This activity will familiarize students with how a jet engine works and the process of experimentation.

Curriculum Standards
Math, Science and Technology:
- Standard 1 – Analysis, Inquiry, and Design
- Standard 4 – Science
- Standard 5 – Technology
- Standard 6 – Interconnectedness: Common Themes
- Standard 7 – Interdisciplinary Problem Solving

Pre-visit Jet Propulsion Experiments

Materials
A few sets of different kinds of plastic bottles, modeling clay, a tape measure

Experiment 1
Make sure the bottle and clay are pointed away from people. Careful supervision is required.
1. Take a piece of modeling clay, about the size of a "Superball," and lightly press it into the opening of one of the plastic bottles until there are no gaps that will allow air to escape. Lay the bottle on its side facing an unobstructed area.
2. Pick different children of various weight from your class.
3. Experiment with the bottle by testing what happens when people with different weights jump on the bottle.
4. Mark and measure how far the clay goes for each student.

Experiment 2
1. Pick one student from the class to test the clay in different bottle sizes.
2. Test each bottle using the same piece of clay, placing it in the same way each time.
3. Mark and measure how far the clay goes for each bottle.

Discussion
What does this experiment teach us about air? How does air act when put under pressure? A real jet creates enormous air pressure inside the engine. In what ways does this activity relate to how an actual jet engine uses air under pressure to create thrust? Finally, how does the air exiting out the back of the engine push it forward? This is an opportunity to mention Newton's third law of motion which states, "for every action there is an equal and opposite reaction."

At The Museum
Find the operating jet engine, push the button, and discover how jet engines work. Look for the diagram of a Jet Engine in the gallery and have your students label the parts on the Jet Engine worksheet. See teacher reference and worksheet on next two pages.

Before your visit call reservations at 516-572-4066 and schedule a guided program called "How does it fly?"

Teacher Reference: Jet Engines

The jet engine was first built in 1937. Aircraft driven by jet engines do not have propellers. They are propelled by a backward jet of hot gas. These engines, usually in the form of turbofans, propel the fastest aircraft.

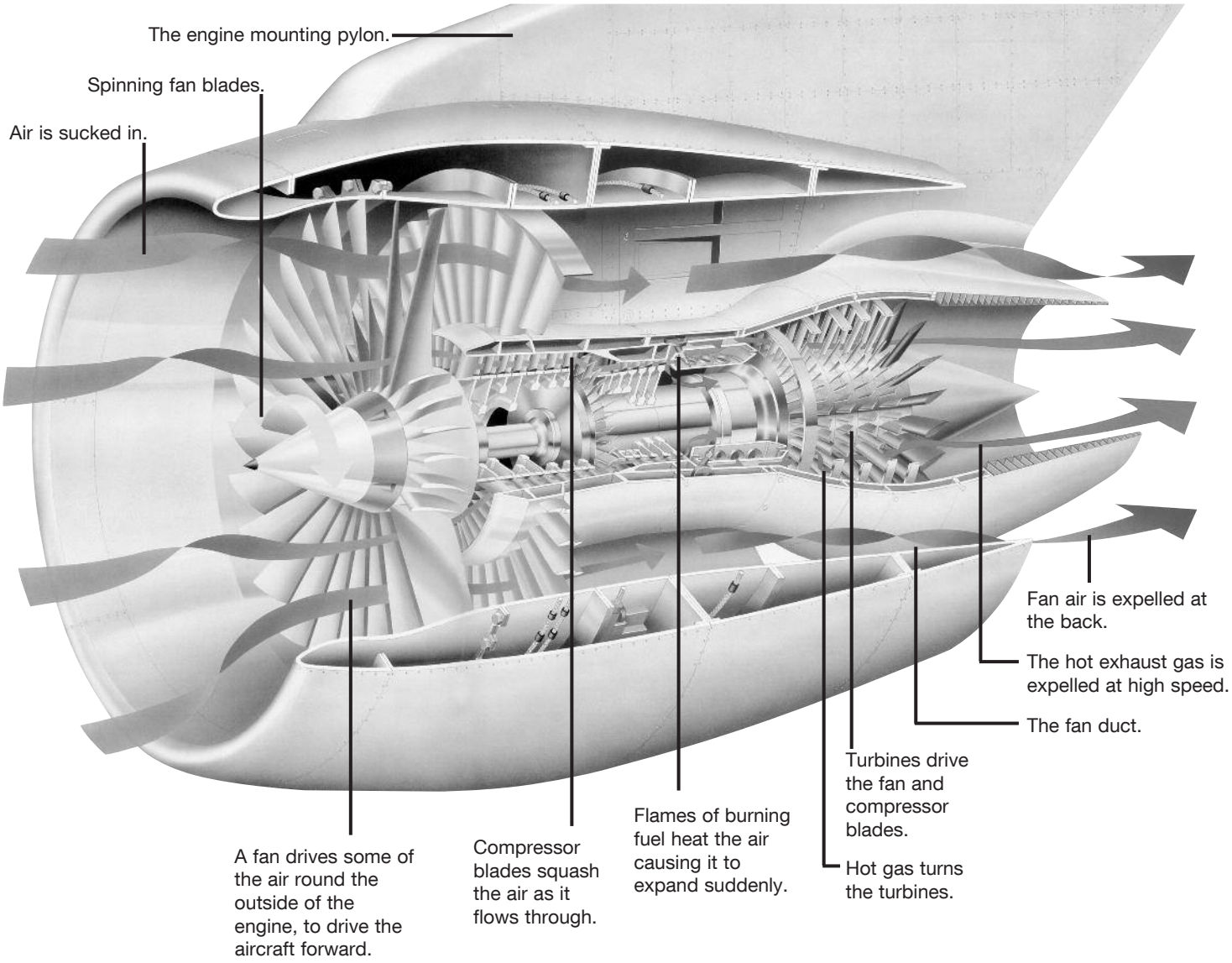
The jet engine drives an aircraft forward with enormous force. Air is sucked in at the front, compressed by blades, and heated with flames of burning fuel in the combustion chamber. The air is then expelled at a high speed from the back. This stream of hot air – the 'jet'—causes a thrust in the opposite direction, propelling the aircraft forward.

At The Museum

Find the operating jet engine, push the button, and discover how jet engines work. Look for the diagram below of a Jet Engine which you will find on the Jet Engine exhibit panel. Have your students label the parts on the Jet Engine worksheet on the following page.

P R O P U L S I O N

Jet engines work on the principle of jet propulsion. An aircraft is thrust forwards because of a reaction to high-speed air travelling backwards.



P R O P U L S I O N

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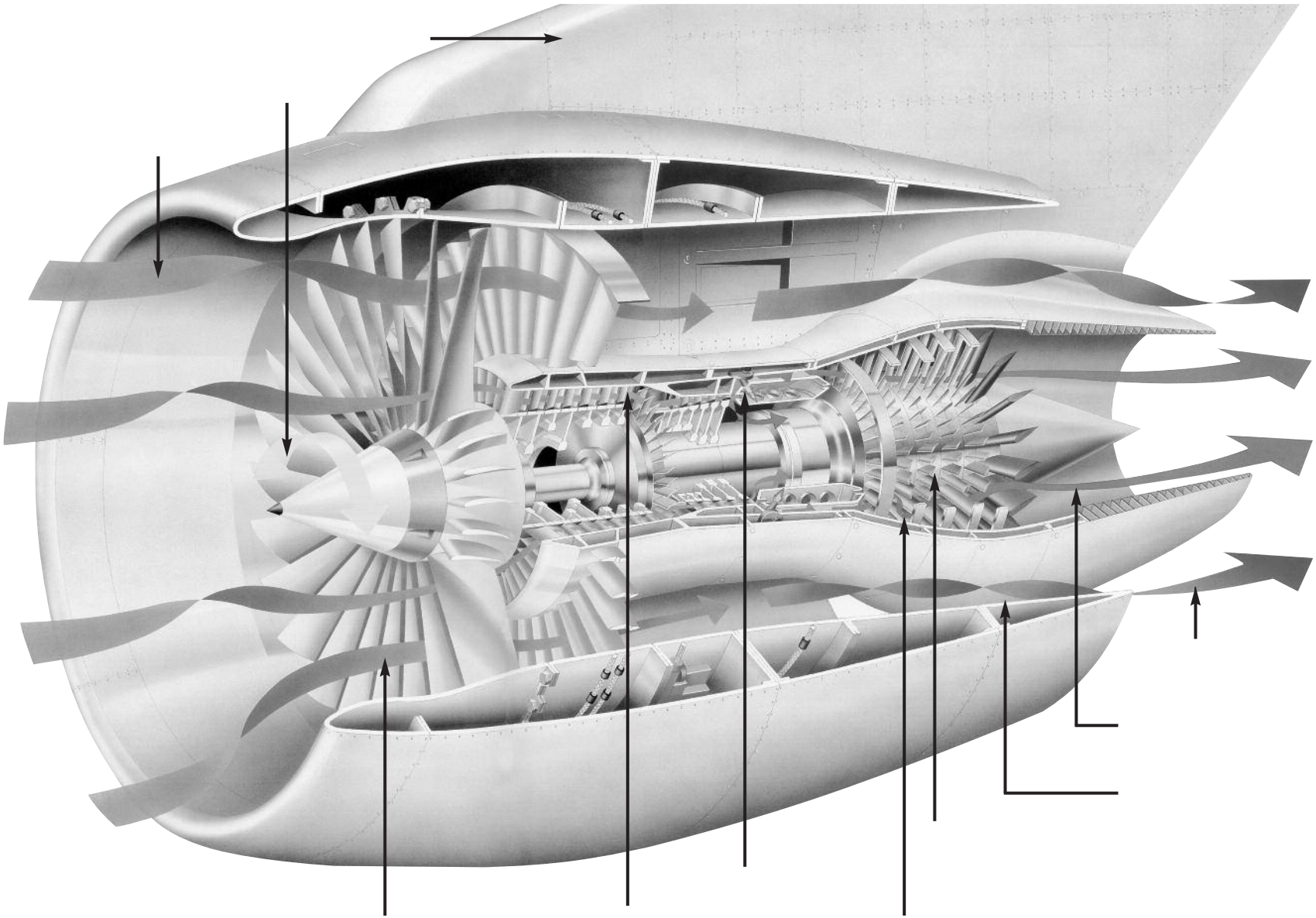


JET ENGINES

AVIATION TODAY GALLERY 1995–PRESENT

By the year 2000, roughly one of every six people on Earth had flown. Many of them have at one time passed through one of the major airports on Long Island, among the busiest in the world. Long Island is also home to the busiest air traffic control centers in the world. Private flying is still popular here, in a wide variety of aircraft types, as Long Island also has the busiest general aviation airport in New York State. The aerospace industry is still a major part of the Long Island economy, as well. Over 250 companies on Long Island produce a wide variety of parts for virtually every American aircraft that flies.

ON EXHIBIT

Aircraft
Simulators
Scale models of airliners
Cassutt Racer . . . . . .Formula One racing plane built in Huntington
Aircraft Radar . . . . . .for Air Traffic Control and locating bad weather

Events
Grumman X-29 experimental jet flies, 1984
First nonstop unrefueled flight around the world by Rutan Voyager, 1986
106th Air Force Rescue Wing from LI saves Hurricane Katrina victims, 2005

Lesson Plan (Grade Level 3 - 6)

Previsit Activity Airplane Parts

Purpose This activity will familiarize students with the parts of an airplane.

Curriculum Standards
Math, Science and Technology: Standards 1, 5-7
Social Studies: Standard 1
English Language Arts: Standard 1

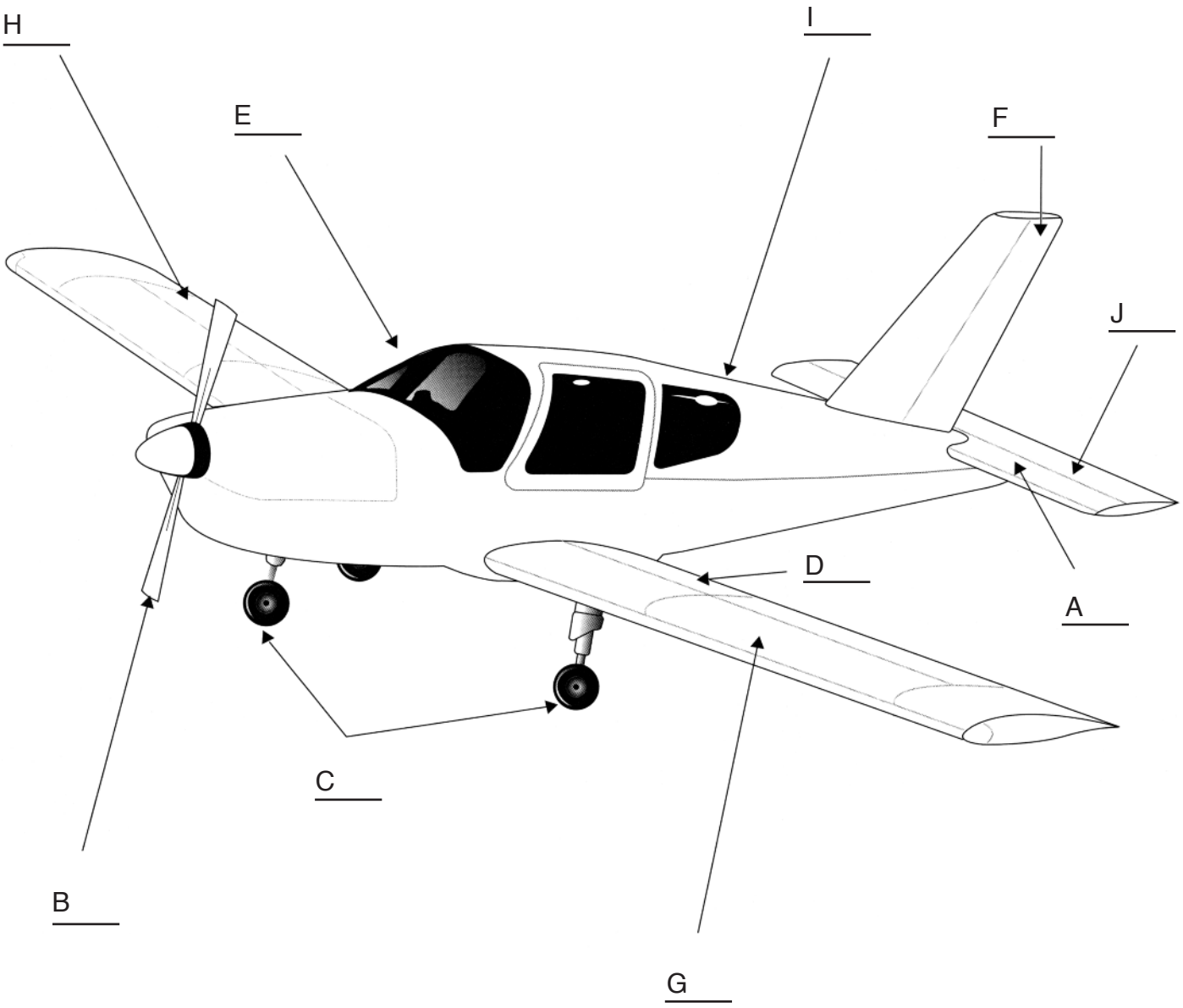
Procedure
Match the part with the definition and write the resulting number in the spaces provided.

Discussion
Talk about airplanes and try to find the corresponding pieces on pictures of different airplanes. You may want to discuss the Wright Flyer and other early airplanes to point out how those early aviation innovations are still in use today.

At the Museum Bring your airplane part sheets with you and use the Cassutt Racer and the many models of airplanes flying over Long Island and identify the basic parts of an airplane. (You can compare the parts on your sheets with all the planes in the museum and make a list of the ones that have all the parts.)

Airplane Parts Answer Key: A5, B6, C4, D7, E8, F3, G9, H2, I10, J1

AIRPLANE PARTS



Draw a line to match parts with definition. Then write the number next to the corresponding letter.

Parts	Definitions
A. Stabilizers	1. Moves to make the plane pitch up or down
B. Propeller	2. Moveable outside edges of the wing that turn the plane
C. Landing Gear	3. Moves left or right and helps keep plane steady
D. Flaps	4. The wheels
E. Cockpit	5. Balance the Plane in Pitch
F. Rudder	6. Turning blade that pulls the plane through the air
G. Wings	7. They can only move down. They slow the plane when landing and create lift on takeoff
H. Ailerons	8. Where the controls are and the pilot sits
I. Fuselage	9. Give lift and support the weight of the plane
J. Elevator	10. Body of the plane, for passengers, plane, cargo

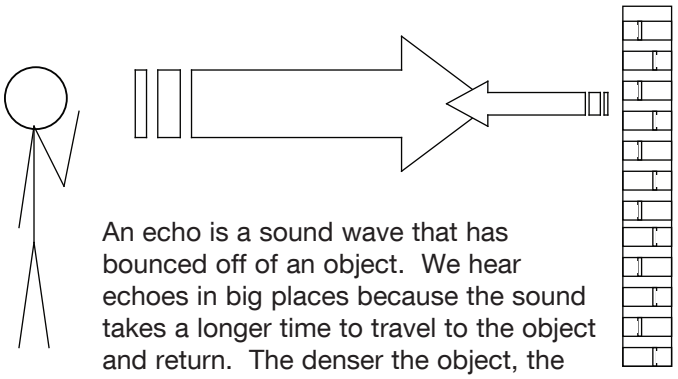
Lesson Plan (Grade Level: 3 - 8)

"Weather or Not!"

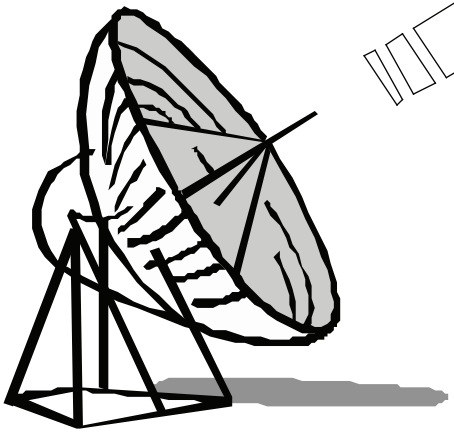
Purpose
For students to gain an understanding of the way a weather radar works and how it measures the density of clouds.

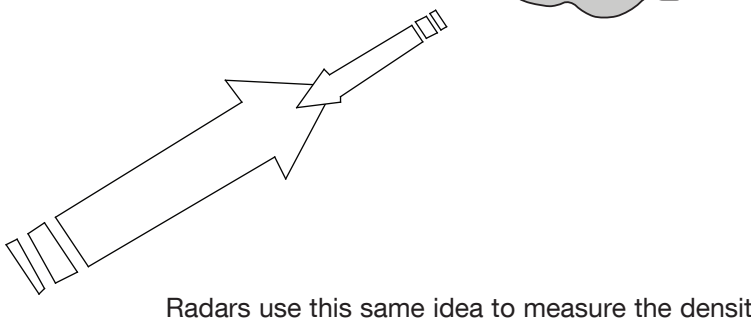
Curriculum Standards
Math, Science and Technology:
- Standard 1 – Analysis, Inquiry, and Design
- Standard 3 – Mathmatics
- Standard 4 – Science
- Standard 5 – Technology
- Standard 6 – Interconnectedness: Common Themes
- Standard 7 – Interdisciplinary Problem Solving

Preparation
Discuss echoes. Have the students ever heard an echo before? Where were the students when they heard the echo? What causes an echo?



An echo is a sound wave that has bounced off of an object. We hear echoes in big places because the sound takes a longer time to travel to the object and return. The denser the object, the stronger the echo will be.



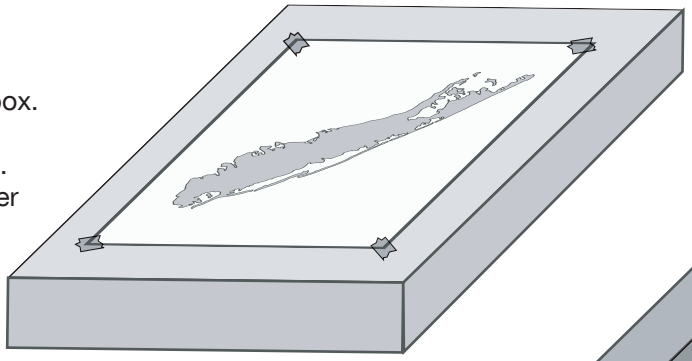


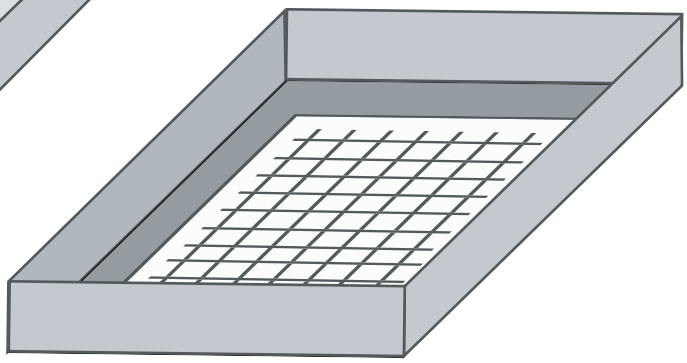
Radars use this same idea to measure the density of clouds. By sending a radio wave towards a cloud, computers will measure the strength of the echo thereby measuring the density of the cloud. They use radio waves instead of sound waves because sound does not travel as well over long distances. And besides, all that noise would make it hard to do homework.

Materials
A shallow box (like one from a clothing store), tape, ruler, glue, paper, a piece of card stock, a paper clip, a pen, a blue and red marker, either a large sponge or several regular size sponges.

Procedure

1.) Take the lid off the box. Photocopy the map of Long Island on page 31. Tape the photocopy over the top of the lid.

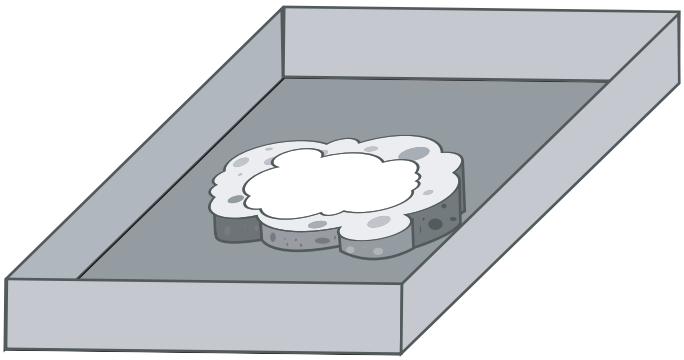




2.) Photocopy the grid on page 30. Tape the grid on the underside of the lid, centering it so it matches the map on the top of the lid. Use a pen, or something sharp, to poke holes in the lid wherever the grid lines cross making sure the pen goes through both pieces of paper as well.

3.) Now you are going to create your storm cloud on the inside of the bottom half of the box. Feel free to consult weather maps like the ones on http://radar.weather.gov/ for inspiration. If you have one large sponge, cut so that it resembles a cloud. If you're using several smaller sponges, put them together and cut so that it resembles a cloud. Once you're done cutting, glue the sponge somewhere in the box—not necessarily the center.

4.) Next, you're going to use a piece of cardstock for the denser center of the cloud. Simply cut the card stock into a shape that fits inside the shape you created with the sponges. Leave the softer sponge exposed around the card stock and glue it down. Put the top of the box back on.



5.) Take a paper clip and pull it straight so that you can poke it through the holes easily. Put the paper clip in a hole that you know has nothing underneath it. Put a small piece of tape around the paperclip to mark how far it has gone down. This will indicate that there is no piece of a cloud there. It's as if the radar is not echoing.

Now the students will use the paperclip in the same way a radar uses radio signals. They will probe for clouds, if any, and the density of those clouds. If the paperclip goes down to the piece of tape, the student will simply move on to the next hole—there is nothing there. If the student feels something soft (representing the part of the cloud with low density) draw a blue circle around the hole. Whenever the student feels something more solid (representing the denser part of the cloud) under the box, draw a red circle around the hole. After the students have checked every hole, they should have an accurate map of the "storm" or sponge(s) underneath. Pull off the top and check your readings against what's inside the box.

Additional Activity
Now go to the National Weather Service web site (http://radar.weather.gov/) and check out the radar for your region. What does the radar picture say for the weather? Besides cloud density, what other factors will impact the weather?

Be sure to stop by our NEW Weather Radar exhibit created by Hofstra University and Pratt Institute.
Sponsored by IEEE Institute of Electrical and Electronics Engineers

"Weather or Not!"

SPACE EXPLORATION

Space exploration has been, and remains, humanity's greatest adventure - a bold leap into the darkness beyond Earth's protective atmosphere; a daring break with the bonds of gravity that tie us to the planet. This fantastic adventure has unfolded entirely in our own time, with Sputnik, Apollo and the Space Shuttle. These advancements were wrapped into a mere quarter century - and Long Islanders have played central roles throughout.

ON EXHIBIT

People

Captain Roys . . . . . .Long Island whaler who experimented with rocket harpoons
Robert Goddard . . . . . ."Father of Rocketry;" designed 1st liquid fueled rocket
Yuri Gagarin . . . . . .1st man to fly in space; 1st man to orbit the Earth
Alan Shepard . . . . . .1st American to fly in space
John Glenn . . . . . .1st American to orbit the Earth
Ed White . . . . . .1st American to "spacewalk"
Neil Armstrong . . . . . .1st man to walk on the Moon
Fred Haise . . . . . .American astronaut; Apollo 13 Lunar Module pilot
Eugene Cernan . . . . . .Last man to walk on the Moon
Sally Ride . . . . . .1st American woman to fly in space and orbit the Earth

Spacecraft, Rockets & Missiles

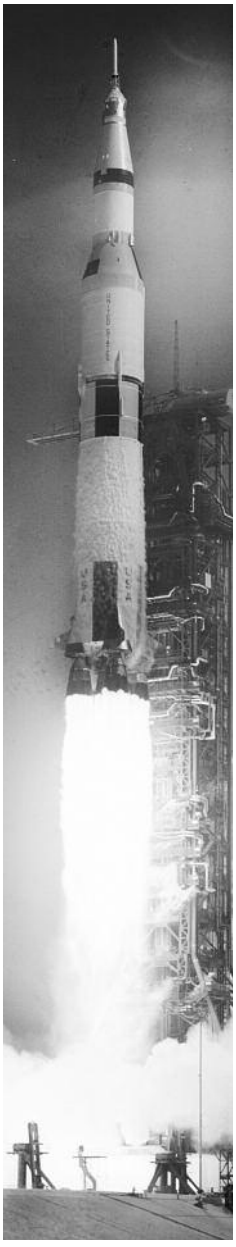
Liquid Fueled Rocket . . . . . .rocket first designed by Dr. Robert Goddard
V-1 . . . . . .German built missile
Sputnik . . . . . .Soviet built 1st artificial satellite
Vostok I . . . . . .Soviet rocket carried 1st man into space
Friendship 7 . . . . . .American Mercury capsule carried 1st American into orbit
Gemini IV . . . . . .two crew American mission; 1st American "spacewalk"
Apollo 11 . . . . . .three crew American mission; 1st to land on the Moon
LM . . . . . .Lunar Module built by Long Island based Grumman Corp.
Space Shuttle . . . . . .1st reusuable spacecraft
International Space Station . .1st multi-national permanent space habitat and laboratory

Events

Launch of Sputnik, October 4, 1957
Gagarin's Flight (1st man in space), April 12, 1961
1st Lunar Landing, July 20, 1969
Apollo 13 Crisis, April 11-17, 1970
Columbia's Maiden Voyage (1st space shuttle spaceflight), April 12, 1981

Vocabulary

satellite orbit SRBs EVA NASA clean room



Lesson Plans (Grade Level: K-4, 5-8)

Previsit Activity Rocket Fuel Testing

Purpose This activity will familiarize students with how rockets use thrust and the process of experimentation.

Curriculum Standards
Math, Science and Technology:
- Standard 1 - Analysis, Inquiry, and Design
- Standard 4 - Science
- Standard 5 - Technology
- Standard 6 - Interconnectedness: Common Themes
- Standard 7 - Interdisciplinary Problem Solving

Social Studies:
- Standard 1 - History of the United States

English Language Arts:
- Standard 1 - Language for Information and Understanding
- Standard 3 - Language for Critical Analysis and Evaluation

Materials At least eight 2-liter soda bottles, a cork which fits snugly into the bottle opening, Alka-Seltzer tablets, a box of baking soda, cola, orange juice, lemon juice, vinegar, a ruler, spoon, and copies of the Rocket Fuel Testing worksheet.

Directions & Discussion See the directions on the Rocket Fuel Testing worksheet on next page. Talk about rockets and determine which combinations of fuel were the best and why. Were any results surprising? How could you alter the experiment to get better performance out of the cork? You may also want to discuss Robert Goddard and the development of the liquid fueled rocket as well as how Newton's third law of motion (for every action there is an equal and opposite reaction) applies to thrust and rockets. For the 5-8 grade level, discuss the difference between these rockets which are monopropellant rockets and Goddard's rockets which were liquid fueled rockets. Make sure to mention solid fuel rockets as well.

At the Museum Look for the Robert Goddard rocket and explore how his innovations were applied to the Saturn V rocket. Visit the "From Long Island to the Moon" area and learn about the challenges of traveling through space to the lunar surface. Look for and explore exhibits on the Saturn V rocket, the Command and Service Modules, and the Lunar Module. Schedule a guided program such as Rockets Away or Living in Space.

Post Visit Activity NASA Design Engineers "NASA NEEDS YOU!" (Grade Level: K-4, 5-8, 9-12)

Purpose This activity will help students understand the conditions and challenges with which scientists must deal when traveling to different places in space.

Curriculum Standards
Math, Science and Technology:
- Standard 1 – Analysis, Inquiry, and Design
- Standard 4 – Science
- Standard 5 – Technology
- Standard 6 – Interconnectedness: Common Themes
- Standard 7 – Interdisciplinary Problem Solving

The Arts:
- Standard 2 – Knowing and Using Arts Materials and Resources

Social Studies:
- Standard 1 – History of the United States

English Language Arts:
- Standard 1 – Language for Information and Understanding
- Standard 3 – Language for Critical Analysis and Evaluation
- Standard 4 – Language for Social Interaction

Materials For the K-4 Grade level "NASA NEEDS YOU!" **version k.4** worksheet, pencils, markers, compasses, etc.

Directions & Discussion Your students are going to work for NASA helping them with human space exploration.They must come up with a mission and design a spacecraft. Have the students discuss their various ideas. Based on your experience at the Museum, discuss historic space engineering challenges, such as the Apollo program and the development of space technology.

Materials For the 5-8, 9-12 Grade level "NASA NEEDS YOU" **version 5.12** worksheet, compasses, protractors, etc.

Directions & Discussion See the directions on the version 5.12 worksheet. Discuss what was learned about the Apollo missions during your visit to the Museum. Talk about the challenges that engineers overcame in order to make space travel possible. Review the purpose and functions of the Saturn V Rocket, Command Module and Lunar Module.

IT'S NOT ROCKET SCIENCE... WELL, ACTUALLY IT IS.

Rocket Fuel Testing

You are going to perform a number of experiments with different combinations of chemicals to understand how rockets work. Practice putting the cork (rocket) into the bottle. Draw a line around the cork using the edge of the bottle. This line will help you determine how far to push the cork in each time.

Procedure

1. Take one bottle and fill it with one of the four liquids to a predetermined height using a ruler (2 inches works well).
2. Put two tablespoons of baking soda into the bottle then cork it immediately.
3. Start counting until the cork pops.
4. Mark and measure how high the cork flew, how long it took for the cork to take off, and what chemicals were used.
6. Perform the same exact experiment with the other three liquids, marking the results each time.
7. Do all four liquids again, but this time use two tablets of Alka-Seltzer each time instead of baking soda.

Rocket One

What did you add together to create a chemical reaction?

How much fuel was added to the bottle?

How long did it take for your cork to launch?

How high do you think it went?

Did anything unusual happen?

Rocket Two

What did you add together to create a chemical reaction?

How much fuel was added to the bottle?

How long did it take for your cork to launch?

How high do you think it went?

Did anything unusual happen?

Rocket Three

What did you add together to create a chemical reaction?

How much fuel was added to the bottle?

How long did it take for your cork to launch?

How high do you think it went?

Did anything unusual happen?

Rocket Four

What did you add together to create a chemical reaction?

How much fuel was added to the bottle?

How long did it take for your cork to launch?

How high do you think it went?

Did anything unusual happen?

NASA NEEDS YOU!

HUMAN SPACE EXPLORATION

version k.4

PLEASE ANSWER THE FOLLOWING BEFORE PROCEEDING TO SPACECRAFT DESIGN

MISSION DESTINATION: Where will you be going?

MISSION DURATION: How long will you be in space?

MISSION SPECIALISTS: How many people will be on the mission?

MISSION SUPPLIES: What will you need to bring with you?

MISSION OBJECTIVES: What is your mission (exploration, experiments, colonization etc)?

NOW DESIGN A SPACECRAFT TO ACCOMPLISH YOUR MISSION.
REMEMBER: FAILURE IS NOT AN OPTION!

NASA NEEDS YOU!

AEROSPACE ENGINEERING

version 5.12

Re-design Apollo hardware for a manned mission to Mars

SATURN V LAUNCH VEHICLE:

What was the function and purpose?

In what environment did it operate?

Changes for Mars mission:

COMMAND MODULE:

What was the function and purpose?

In what environment did it operate?

Changes for Mars mission:

LUNAR EXCURSION MODULE:

What was the function and purpose?

In what environment did it operate?

Changes for Mars mission:

RETURN CAPSULE:

What was the function and purpose?

In what environment did it operate?

Changes for Mars mission:

Now design a program for landing on Mars.

Create detailed diagrams showing the systems and functions of your spacecraft(s) at the different stages of your flight (liftoff, enroute, landing on Mars...etc). Make sure to take into account the unique challenges and conditions a mission to Mars will encounter such as gravity, temperature variations, and atmospheric conditions.

Remember: Failure is not an option!

Grumman F-11 Tiger . . . . . .Navy's first supersonic jet, 1955
Gyrodyne XRON Rotorcycle . . . . . .experimental one-man Marine helicopter, 1959
Fleet 2 . . . . . .1929 Roosevelt Field training plane
Veligdans Sailplane . . . . . .locally built high performance sailplane, 1981
Paramotor . . . . . .only flying machine currently in production on Long Island
Astronaut in MMU . . . . . .replica of Shuttle Astronaut and MMU (Manned Maneuvering Unit)

EL AL Boeing 707 Nose Section . .record breaking passenger jet flight deck section made in the 1960's
A-10 Thunderbolt II . . . . . .a ground attack plane built by Fairchild Republic currently used by the Air Force
F-14 Tomcat . . . . . .a Navy fighter built by Grumman. Our F-14 is the third one built. It was retained for test and evaluation by Grumman.
A-6F Intruder II . . . . . .the final version of the A-6. Earlier versions were used in the Vietnam and Gulf wars as bombers.

Recommended Reading

Wings: A History of Aviation from Kites to the Space Age, by Tom D. Crouch

NASA: A History of the US Civil Space Program, by Roger D. Launius

Apollo: The Race to the Moon, by Charles Murray & Catherine Bly Cox

They had a Dream: The Story of African American Astronauts, by J. Alfred Phelps

Black Wings: The American Black in Aviation, by Von Hardesty and Dominick Pisano

Historic Aircraft and Spacecraft in the Cradle of Aviation Museum, by Joshua Stoff

From Airship to Spaceship: Long Island in Aviation and Spaceflight, by Joshua Stoff

Moon Lander: How We Developed the Apollo Lunar Module, by Thomas J. Kelly

Chariots for Apollo, by Joshua Stoff

Aviatrix, by Elinor Smith

Charles Lindbergh: A Photographic Album, by Joshua Stoff

Advanced Aerospace Quest

America learned to fly on Long Island. Generations of Long Islanders built countless flying machines to defend our country's freedom and leave footprints on the Moon. The Cradle of Aviation Museum is dedicated to preserving Long Island's rich aerospace heritage.

Many of the docents in our galleries were involved in significant ways with the aircraft in our collection. Please ask their help in answering the questions below, especially those marked with an asterisk *

Dream of Wings Gallery: up to 1903

1. In what year and in what country did the first manned hot air balloon flight occur?
2. Which famous "inventor/communicator" built a tetrahedral kite around 1900?
3. Who designed, built and flew the first successful glider to carry a person in the 1890's?
4. What is the name of the first unmanned aircraft?
5. What three basic things does an airplane need to fly?

Hempstead Plains: 1908 - 1914

6. Who was Glenn Curtiss? *
7. What was the first aircraft to fly over Long Island?
8. Who was Calbraith Perry Rodgers?
9. What did the Vin Fiz plane do?
10. How many times did Rodgers crash during his attempt to fly from the East to the West coast?
11. Who was the first licensed female pilot in the U.S.?
12. What is the name of one of the oldest, most successful pioneer airplanes in the world built in 1909?
13. How fast could it fly?
14. Where was the first American aviation school started?
15. What airfields were located in the area of this museum?

World War One: 1914 - 1918

16. What was the primary flight trainer in Mitchel Field in World War I?
17. What was the Breese Penguin used for? *
18. Who is Mitchel Field named after? *

The Golden Age: 1919 - 1939

19. What is the benefit of retracting the landing gear? *
20. What is the unusual capability of the Grumman G-21 Goose?
21. From where did Charles Lindbergh take off as he headed to Paris in the Spirit of St. Louis on May 20, 1927? *

Advanced Aerospace Quest, Cont'd

World War Two: 1939 - 1945

22. What type of plane was President George W. Bush's father shot down in during World War II? *

23. How many Long Islanders worked in the defense industry in WWII?

24. What was the most produced American fighter plane in history?

25. During World War II, why did the Navy and Marine Corps planes on aircraft carriers have folding wings? *

26. How did the Grumman Avenger get its name? *

The Jet Age: 1946 - 1981

27. What was the largest single seat, single engine jet fighter in the U.S.? *

28. What family of animals was used by Grumman as names for their fighter aircraft? *

29. What weather phenomenon was used by Republic as names for their fighter planes? *

30. Why does the Tomcat have wings that can change their sweep angles? *

Contemporary Aviation Gallery: 1982 – present

31. What airline sponsored the first American commercial jet flight from NY to Paris? *

32. How many arrivals and departures do air traffic controllers handle at NY area airports?

33. How many aerospace manufacturers are still on Long Island?

Space Exploration

34. What is the name of the rocket that launched all the astronauts to the moon? *

35. What is the name of the spacecraft that brought the astronauts back to Earth? *

36. What is the name of the spacecraft that landed on the Moon?

37. Where were the lunar modules built? *

38. How many workers on Long Island were involved with building the lunar module? *

39. How far did the Apollo astronauts travel to get to the Moon? *

40. Who was the first astronaut to walk on the Moon?

41. Who was the last astronaut to walk on the Moon? *

42. How much did the astronaut's space suit weigh on Earth? *

43. Why did the spacesuit weigh only 31 lbs. on the Moon? *

44. How many missions landed on the moon? *

45. What material was used as a blanket to protect the lunar module from extreme heat and cold on the Moon? *

46. How many Long Islanders have been in space?

Cradle of Aviation Museum Jet Annex

47. Why does the Tomcat have wings that can change its sweep angles? *

48. Why do the wings fold on the A-6? *

49. Why is the A-10 camouflaged? *

Aerospace Quest Answer Key

Aerospace quests are also available for download at: www.cradleofaviation.org/education

Advanced

1. The Montgolfier brothers balloon in 1783 in France.
2. Alexander Graham Bell.
3. Otto Lilienthal of Germany
4. The steam operated Langley Aerodrome #5 built in 1896
5. Lift, thrust and control.
6. An aviation pioneer who was the first to fly on Long Island.
7. The Golden Flyer.
8. Calbraith Perry Rodgers was the first pilot to fly from NY to California.
9. It was flown from the East Coast to the West Coast.
10. 15.
11. Harriet Quimby 1875-1912
12. The Bleriot XI (It was also the first aircraft to fly across the English Channel).
13. 45 miles per hour.
14. Mineola
15. Mineola, Hempstead Plains, Nassau Boulevard.
16. Curtiss JN-4 Jenny.
17. It was a ground trainer used to help the pilot learn how to operate a plane on the ground.
18. It was named in honor of J. P. Mitchel, the youngest mayor of NY. He died in a flight-training accident during World War I.
19. Less drag on the plane during flight.
20. It is amphibious which means that it can operate on land or water.
21. Roosevelt Field.
22. The Grumman TBM-3E Avenger.
23. 100,000
24. The Republic P47 Thunderbolt.
25. To save space.
26. To avenge the Japanese attack on Pearl Harbor.
27. F-105 Thunderchief.
28. Cats- ie. Hellcat, Tomcat, Kitten, Cougar.
29. Thunder- ie. Thunderchief, Thunderbolt, Thunderjet.
30. To have better control at low speeds and to be more streamlined to attain high speeds.
31. Pan American.
32. Two million per year.
33. About 250.
34. The Saturn V. It stood 365 feet tall and weighed 2850 tons.
35. The Command Module.
36. The Lunar Module.
37. About 8 miles away in Bethpage, LI by Grumman Corporation.
38. 9,000.
39. 238,300 miles.
40. Neil Armstrong.
41. Eugene Cernan.
42. 180 pounds.
43. Because the Moon has 1/6 the gravity.
44. Six- Apollo XI, XII, XIV, XV, XVI and XVII.
45. Aluminized mylar called Kapton.
46. 12 so far.

Intermediate

1. Hot Air.
2. Alexander Graham Bell.
3. Orville Wright.
4. An aviation pioneer who was the first to fly on Long Island.
5. The Vin Fizz.
6. Harriet Quimby.
7. (any of the following 6) Brighton Beach, Sheepshead Bay, Belmont Park, Mineola, Hempstead Plains, Nassau Boulevard.
8. It was a non-flying trainer used to help the pilot learn how to operate a plane on the ground.
9. It was named in honor of J. P. Mitchel, the youngest mayor of NY. He died in a flight-training accident during WWI.
10. Roosevelt Field.
11. It can land on both land and water and the shape of the plane.
12. 100,000
13. To save space.
14. Cheek Baby.
15. Cats.
16. A Helicopter.
17. 2 million per year.
18. Enroute Centers, TRACON and the Tower.
19. Robert Goddard.
20. (any of the following 7) Walter Schirra, Donald Slayton, John Glenn, Malcolm Scott Carpenter, Alan Shepard, Virgil 'Gus' Grissom, Leroy Gordon Cooper.
21. 183 pounds.
22. Either in their seats while in orbit or in a hammock on the moon. Today they sleep in sleeping bags.

Intermediate Aerospace Quest

America learned to fly on Long Island. Generations of Long Islanders built countless flying machines to defend our country's freedom and leave footprints on the Moon. The Cradle of Aviation Museum is dedicated to preserving Long Island's rich aerospace heritage.

Many of the docents in our galleries were involved in significant ways with the aircraft in our collection. Please ask their help in answering the questions below, especially those marked with an asterisk *

Dream of Wings: up to 1903

1. Which is 'lighter' – hot air or cool air?
2. Which famous inventor built a triangular kite around 1900?
3. Who was the first person to fly in an engine powered aircraft?

Hempstead Plains: 1908-1914

4. Who was Glenn Curtiss? *
5. Look for the story about Calbraith Rodgers and his attempt to fly across the US. What was his plane called?
6. Who was the first licensed female pilot in the US?
7. List 3 airfields that were located on Long Island in 1911:

The Great War: 1914-1918

8. Look for the Breese Penguin. What was it used for? *
9. How did Mitchel Field get its name? *

The Golden Age: 1919-1939

10. From where did Charles Lindbergh take off as he headed to Paris in the Spirit of St. Louis in May 20, 1927? *
11. Look for the blue plane named the Grumman G-21 Goose. What is unusual about this plane?

World War II: 1939-1945

12. How many Long Islanders worked in the defense industry in WWII?
13. During WWII, why did the planes on aircraft carriers have folding wings? *
14. Look for the Republic P-47N Thunderbolt. What is the 'nickname' painted on the plane?

The Jet Age: 1946-1981

15. What kind of animal was used by Grumman as names of their fighter planes?
16. Look up at the yellow Gyrodyne hanging from the ceiling. What is it?

Contemporary Aviation Gallery: 1982 – present

17. How many arrivals and departures do air traffic controllers handle at NY area airports each year?
18. What are the 3 levels of Air Traffic Control?

Space Exploration

19. Who was the 'Father of Rocketry'?
20. The first Americans in space were called Mercury astronauts. Look for the picture of the seven astronauts in their space suits. Name one of them.
21. How much did the astronaut's space suit weigh on Earth? *
22. Look for the section "Living in Space". How did the astronauts sleep while in space?

contact

general info	516.572.4111
reservations	516.572.4066
fax	516.572.4065
web	www.CradleOfAviation.org
email	info@cradleofaviation.org

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