

MUSEUM TOOLKIT



LEGENDS OF FLIGHT

FOR RELEASE IN **2D** AND **3D**

THE FILM

Legends of Flight is an inspiring and exciting documentary for IMAX® and other Giant Screen theaters featuring milestone 20th century aircraft, including the Stearman wooden biplane, Constellation, Harrier Jump Jet and Schleicher glider. Discover the design challenges, financial risks and the many lessons learned from a century of aviation trial and error, bringing us to the dawn of a new era of revolutionary aircraft—Boeing’s 787 Dreamliner and the Airbus A380. Witness the construction and final assembly of the 787, and join 787 Chief Pilot Mike Carriker as he puts the new airliner through its rigorous test flights.

Throughout the history of flight, inventors and engineers have worked to mimic the properties and techniques that enable winged creatures to fly nearly effortlessly. The leading-edge aviation innovators in *Legends of Flight* 3D are keen examples, applying composite materials and variable wings to better achieve bird-like strength, weight and flight agility. To illustrate these innovations in a way that comes to life for young people and adults, filmmaker Stephen Low uses SANDDE [Stereoscopic Animation Drawing Device] animation technology as a perfect tool to bring the organic nature of flight alive in 3D for giant screen audiences. (This film also plays in 2D.)

www.legendsofflightfilm.com

INTRODUCTION

The Informal Educator’s Toolkit is an innovative resource that has never before been available to museums that showcase IMAX® films. The Toolkit provides educational staff at museums with a comprehensive guide for developing their own informal education programs to support the film. By pairing the IMAX film with the Toolkit, each museum is given the flexibility to design its own customized educational programming, while ensuring that the content of the programming is relevant, scientifically accurate, and representative of the *Legends of Flight* film.

In an effort to make this Toolkit as user friendly as possible, we have provided in this document the main elements that a museum would need to customize programming and provide background for docents and volunteers for *Legends of Flight*. There is also a link to additional relevant information compiled in one online location, www.legendsofflightfilm.com.

All activities in the Toolkit were developed using inquiry-based science teaching methods, which are considered to be among the best practices in science education. Each activity has been prototyped in age-appropriate classrooms. The Toolkit provides museum education staff with a flexible, researched, innovative resource designed specifically to meet their programming needs.

IN THIS TOOLKIT

The Legends of Flight Informal Educator’s Toolkit includes the following valuable components:

- **Using the Toolkit:** This section provides information on how to use this Toolkit to develop your own programming.
- **Basic Background Science:** This section provides brief information featuring the main science topics related to the film and the two Teacher’s Guides accompanying the film.
- **Concept Connections:** This section outlines which concepts presented in the Toolkit may be a natural fit for different types of museums.
- **Sample Education Materials:** This section contains brief descriptions of five sample education programs typically found in museums: a “60 Second Science” activity, a cart activity station, a demonstration, and two workshops. These materials can be used as they are, or may be taken apart and recombined to tailor programs to your needs. Full outlines of these activities are provided in the **Online Web Resource**.
- **Online Web Resource:** This section summarizes the additional resources that have been compiled on the film website and provides a summary of the **Sample Education Materials**.

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USING THE TOOLKIT

Many museums create customized educational programming around the content of an IMAX® film. This allows the museum to enhance the patron’s experience while viewing the film. Some films come packaged with suggested content for museums. However, while there may be many similarities between museums, each museum has its own unique way of presenting content and programs. Because of this, museums are often driven to change, augment, or reinvent the presentation of content that was originally provided with the film. The *Informal Educator’s Toolkit* is focused on providing the resources that a museum educator needs to create custom programming for a film while also providing the flexibility that museum educators desire.

BACKGROUND INFORMATION

This Toolkit provides a comprehensive collection of background information. The background information can be used to prepare docents, volunteers, and staff to talk about the film and to augment their content knowledge when presenting educational programming. This document provides quick access to basic science content and also provides a summary of full content that is available at the **Online Web Resource**. The **Online Web Resource** is a compilation of more in-depth information related to the film. It includes *Legends of Flight Biographies*, *Airplane Profiles*, and *Additional Background Information* with more extensive content information on the concepts presented in the film. It also contains complete outlines of the *Sample Education Materials* summarized in this document. We have collected the research and background information in this document that is needed to create tailored programs, thus eliminating the need for time-consuming research on the part of the museum educator.

SAMPLE EDUCATION MATERIALS

This Toolkit provides five sample education program outlines that can be used to create unique programming. The activities have been summarized in this document, but full activity outlines are provided in the **Online Web Resource**.

Each sample activity includes suggestions for **National Science Education Standards** alignment. The **Sample Education Materials** also include **Career Links** to help connect the content of each activity with careers in science and other disciplines. The activities can be combined to create workshops, used alone at activity stations, and taken apart and reassembled in any way the museum needs.

BACKGROUND

This section provides information on the basic science concepts and other background information related to the Legends of Flight film. The **Online Web Resource** provides additional information about all of the concepts listed below including common misconceptions, flight facts, and other topic links. A listing of the information available online is provided at the end of this section.

IMPORTANT CONCEPTS AND INFORMATION

Gravity: Gravity is the invisible force of attraction between any two objects. It is a force that depends on the size and distance of the two objects. An object with a very large mass, like a star or planet, exerts a very strong gravitational force on objects that are nearby and exerts a lesser force on objects that are farther away.

Lift: Lift is the force that opposes gravity. Flight is possible only when the force of lift is strong enough to overcome the downward force of gravity. Lift is created with moving air and an airfoil. Most airplanes have wings that are shaped like an airfoil, which has a curved top surface and a flat bottom surface. Scientists have two explanations of how lift is created by an airfoil.

One explanation is that the curved top surface of the airfoil causes the air traveling above the wing to take a longer path. The longer path means the air above the airfoil must travel faster than the air below it. Faster moving air is lower in pressure than slower moving air. The slower moving air, with greater pressure, pushes the underside of the airfoil up into the faster air flow. According to Bernoulli's Principle, the differences in air pressure between the bottom and top of the wing pushes the wing up. When the force of lift is greater than the force of gravity on that object, then that object takes flight.

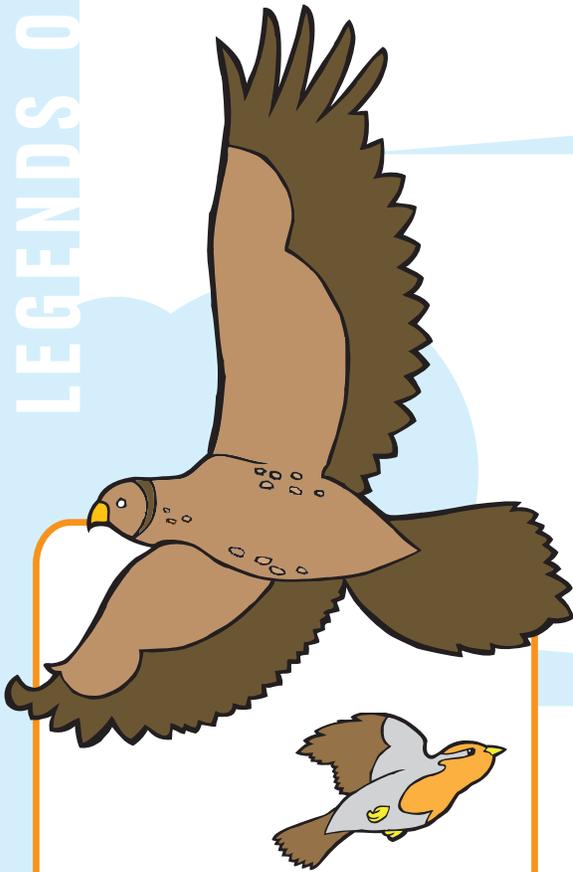
Airflow is faster over the upper surface and decreases pressure



Airflow is slower over the lower surface and increases pressure

A compatible explanation is that as air moves over and underneath the airfoil, it is directed downward by the trailing edge of the wing. This is called a downwash. Newton's laws state that there must be an equal and opposite reaction to the downward force of the air, which forces the wing upward, and creates lift.

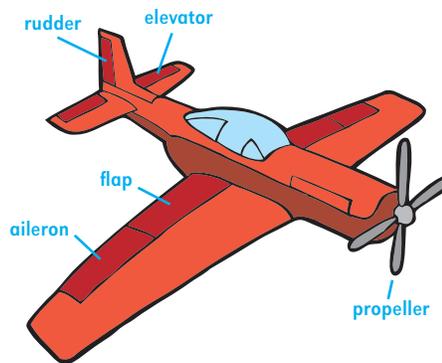
Drag: Drag is the force of resistance caused by air on anything trying to move through it. If you have ever held your hand out the window of a moving car and felt the air pushing against it, you have experienced drag. When an airplane moves through the air, drag is created when the airplane moves the air in front of it. The air then fills in the empty space left behind the airplane, which causes the air to pull—or slow—the airplane. In order for an airplane to fly, the force of thrust must overcome the drag.



CHECK IT OUT!

By bringing its wings close to its body at the beginning of each flap, this robin reduces drag for more efficient flight. The spotted harrier opens its wings wide to increase drag and slowly fly over open fields looking for its prey.

Drag is necessary for the pilot's controls to work properly. By increasing the drag on specific parts of the plane, small flaps called ailerons, elevators, and rudders make it possible for the pilot to control the flight of the airplane. No drag, no control!



Thrust: Thrust is the force that pushes an airplane forward and allows enough air to run above and below the wing in order to create lift. Developing thrust was the final hurdle for the early pioneers of flight in getting aircraft off the ground. Thrust is the force that opposes drag and can be achieved by either pulling or pushing the airplane in a forward direction.

CHECK IT OUT!

Harrier Jump Jets

These amazing aircraft are called V/STOL (Vertical/Short Take-Off and Landing) airplanes. They use jet turbine engines for forward thrust, just like a standard jet. But what makes these planes special is their ability to change the direction of their jet nozzles. When they land and take off, their jets can be pointed straight down, allowing the jump jet to lift straight off from the ground. Harriers can even hover like hummingbirds.



Airplane Design: What colors and patterns are most restful to weary travelers? What shapes and lighting will make passengers feel most comfortable? These questions and many others were examined by the interior designers who designed the cabin of the new Boeing 787 Dreamliner.

“Passenger well-being, on both an emotional and physical level, relies heavily on collaborative and research-orientated design practices. In designing the highly-anticipated 787 Dreamliner, Teague and Boeing employed a variety of design research techniques to determine the needs and desires of commercial travelers the world over. Defining and responding to the collective needs and desires of air travelers fueled the design process, permitting new, unconventional ideas to flourish and succeed in an industry renowned for strict standards. The results surpassed expectations.”

- John Barratt, CEO of Teague, the interior design firm for the Dreamliner.

GOING GREEN!

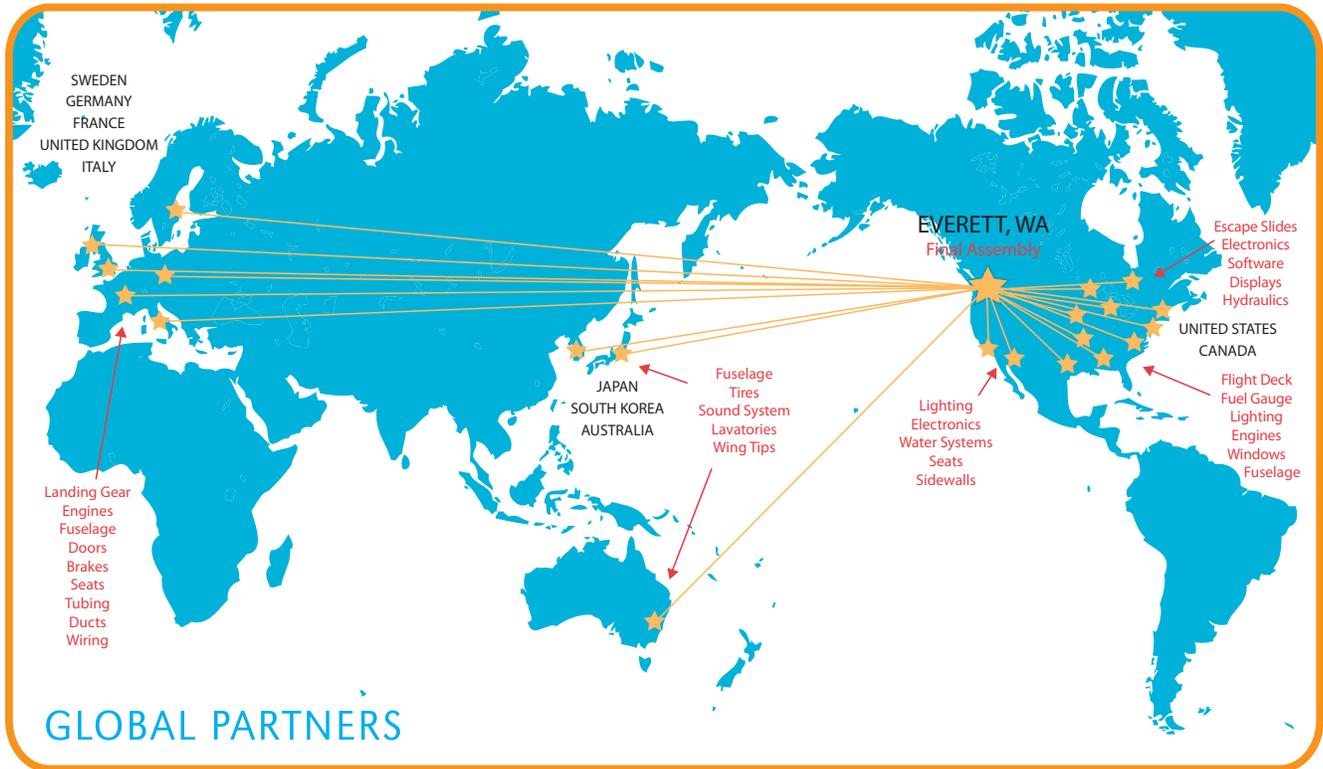


The Boeing 787 Dreamliner and the Airbus A380 both were designed to minimize their impact on the environment. Both aircraft use efficient LED lights throughout their cabins. LEDs last about three times longer than fluorescent tubes and more than 40 times longer than incandescent bulbs.



International Teamwork: In order to design and construct the Boeing 787 Dreamliner, Boeing employees traveled around the globe in search of partners. In the end, they formed the most far-reaching international development team in the history of commercial aviation. Unlike the partnerships of the past, in which suppliers made parts and systems to fulfill a Boeing design, the new project asked a higher level of involvement and commitment from other companies. Boeing decided to share the responsibility for design and development, as well as manufacturing. This meant higher risks, because Boeing would need to entrust others with the work they only trusted themselves to do in the past. But it also guaranteed that in order to take part in the team, partners would need to be the very best in their fields. In the end, partners in 11 different countries across four continents were selected to build parts and design systems that would all fit together into one airplane. The final assembly point was chosen—the Boeing Everett Plant in Washington, U.S.A.—and the challenge of figuring out how to transport all these separate parts to one place began.

The **Online Web Resource** provides additional information about the International Teamwork used to complete the Dreamliner including distances traveled by Boeing 787 parts, flight facts, and other topic links.



Composite Materials: A composite is a combination of two or more different ingredients. When combined, the features of each ingredient are shared and the composite benefits beyond the individual parts. There are a variety of different types of composite materials. Composites found in the layers of plywood are called fiber reinforced polymers (FRP). Super strong composites may contain metal matrix composites (MMC). Composites designed to withstand heat may include glass reinforced plastics (GRP). There is a new type of cement that has ceramic matrix composites (CMC) as an ingredient. There are even OMCACs—organic matrix/ceramic aggregate composites. OMCACs can be found in nature, such as the shiny surface on some shells, which is called nacre or mother of pearl.

Carbon Fiber Composite: Carbon fiber composites are a composite—or an inseparable combination—of carbon fibers and polymer epoxy resin, which is a liquid that hardens into a plastic with the help of high temperatures and/or specific hardening chemicals. Carbon fiber composites can be made in a variety of ways, including cold press, hot press, chill plate, and dry impregnation process.

Compressive Strength: The maximum amount of compression (squishing, crunching, etc.) that a material can handle before it fails. An example of compressive strength is stomping on an aluminum soda can.

Tensile Strength: The maximum amount of loading that a material can handle before it fails. Some materials will stretch before breaking. An example of tensile strength is piling pennies on top of a paper towel until the towel tears.

Shear Strength: The maximum amount of stress along a plane that a material can handle before it fails. An example of shear strength is tearing a piece of fabric into strips. Shear strength can be measured across the width, length, and diagonal of a material.

INFORMATION AVAILABLE IN THE ONLINE WEB RESOURCE

Terms

The **Online Web Resource** provides additional information about each of the following terms including common misconceptions, flight facts, and other topic links.

Gravity

- Newton's Laws of Motion
- Apollo 15 Space Mission

Lift

- Airfoils
- Bernoulli's Principle
- Newton's Third Law
- Bird wings
- Shark fins

Drag

- Pitch
- Roll
- Yaw
- Bird flight

Thrust

- Propellers
- Rockets
- Jet turbines
- Ramjets
- Gliders
- Jump jets
- Newton's Third Law of Motion

Airplane Design

- LEDs
- Color psychology
- Elements of design

International Teamwork

- International partners
- Aircraft assembly
- Dreamlifter cargo plane

Composite Materials

- Material strength
- How composites are created
- Carbon fiber composites
- Icarus myth

Background on Aviation Careers

The **Online Web Resource** provides additional information about each of the following careers:

- Aeronautical Engineer
- Air Traffic Controller
- Baggage Handler
- Civil Engineer
- Electrical Engineer
- Flight Attendant
- Ground Crew
- Interior Designer
- Maintenance Mechanic
- Mechanical Engineer
- Meteorologist
- Pilot
- Psychologist
- Security
- Scientist
- Skycap
- Technician
- Ticket Agent

Legends of Flight Biographies

The **Online Web Resource** provides brief biographies about each of the following legends of flight:

- Mike Carriker
- Steve Fossett
- Charles Yeager
- Nancy Bird-Walton
- Sir Frank Whittle
- Hans J. Von Ohain
- Jacqueline Cochran
- Olive Ann Beech
- Charles Lindbergh
- Bessie Coleman
- Earle L. Ovington
- Jacob Christian Ellehammer
- Orville, Wilbur, and Katherine Wright
- Tsu Wong
- Hugo Junkers
- Daniel Bernoulli

Airplane Profiles

The **Online Web Resource** provides information about each of the planes featured in the Legends of Flight film:

- Boeing Stearman Bi-plane
- Lockheed Constellation
- Schleicher Glider
- Harrier V/STOL
- Airbus A380
- Boeing 787 Dreamliner

Bibliography

The bibliography for the Informal Educator's Toolkit is available in the **Online Web Resource**.



CONCEPT CONNECTIONS

While the *Legends of Flight* content will most naturally fit with the missions of aerospace, aviation, and flight museums, there are many interesting connections for other types of museums. The information below is intended to help highlight which concepts may be most appropriate and useful to museums not focused on aerospace, aviation, and flight.

Science Museums

- Four forces of flight.
- Gravity and Earth’s tides.
- Newton’s Laws of Motion.
- Bernoulli’s Principle.
- Air pressure and airplane cabin pressurization.
- Airplane noise footprints.
- Airplane emissions.
- Airplane fuel consumption and efficiency.
- Careers in aviation.
- The invention of different types of aircraft engines.
- Pioneers in airplane design and early flight.
- Carbon fiber composites.
- Strength-to-weight comparisons of airplane construction materials.
- Science as a human endeavor.
- How scientists develop new technologies to solve problems, such as solutions for passengers’ jet lag, airsickness, claustrophobia, and dehydration.

Art Museums

- Color psychology related to advertising, interior design, and airplane lighting design.
- Interior design of an airplane cabin.
- Carbon fiber composites related to the textile industry.
- Carbon fiber composites and traditional weave patterns.
- Popular films featuring the Harrier V/STOL jet.
- The representation of flight in modern and classical art.

History Museums

- Development of human flight.
- Pioneers of airplane design and early flight.
- Major advances in airplane design.
- Women in aviation, including the Women Airforce Service Pilots (WASP).
- Greek myth of Icarus related to carbon fiber composites.
- International teamwork related to different languages and cultures.

Natural History Museums, Zoos, and Aquariums

- The four forces of flight related to animal flight.
- The movement of air compared to the movement of water.
- The concept of lift related to bird wings and shark fins and tails.
- The concept of thrust related to birds, insects, and sharks.
- Composite materials in the 787 compared to wing structure of birds and other flying creatures.
- Airfoil and propeller design related to bird wings.
- Sailplanes related to gliding animals, such as:
 - Sugar gliders and other gliding marsupials
 - Flying squirrels
 - Flying fish (there are more than fifty species of fish that can glide)
 - Draco lizards
 - Flying geckos
 - Flying frogs. (The Chinese flying frog uses the webbing between its toes to control its glide. The frog can roll and yaw to land just where it wants)
 - Tree snakes
 - Gliding ants
- The relationship between lighting and circadian rhythms.
- The Harrier V/STOL’s hovering ability related to animals that can hover, including:
 - Northern harrier
 - Hummingbirds

SAMPLE EDUCATION MATERIALS

Summaries of the sample educational materials have been provided below. For full lesson plans, see the **Online Web Resource**.

60 SECOND SCIENCE ACTIVITY FOR MUSEUM DOCENTS

Forces of Flight: Propeller & Parachute Toys (1 minute)

Four forces are required for flight: gravity, lift, drag, and thrust. With two simple toys and sixty seconds, you can quickly demonstrate the forces of flight. Lift, thrust, and gravity can be demonstrated with a propeller toy. Drag and gravity can be demonstrated with a parachute toy.

Key Information

Ages: Appropriate for ages five and older.

Key Concept: Four forces of flight: gravity, lift, thrust, and drag.

Objectives: Museum visitors will be able to understand that gravity, lift, thrust, and drag are the four forces that are needed for flight.

Standards:

National Science Education Standards for Grades K-4

- **Position and Motion of Objects:** Students develop abilities to describe the position and motion of objects.

National Science Education Standards for Grades 5-8

- **Motions and Forces:** Students develop abilities to describe the position, direction, motion, and speed of objects.

National Science Education Standards for Grades 9-12

- **Motions and Forces:** Students develop abilities to describe and measure the position, direction, motion, and speed of objects.

CART ACTIVITY FOR MUSEUM DOCENTS

Materials Science: Build an Airplane (5-10 minutes)

Throughout history, aviation engineers and material scientists have designed airplanes from a variety of materials, from the first wood and fabric bi-planes to the carbon fiber composite planes of today. Each material used in the aviation industry is chosen based on its specific characteristics, including weight, strength, flexibility, and resistance to corrosion.

Key Information

Ages: Appropriate for ages eight and older.

Key Concept: Properties of materials.

Objectives: Museum visitors will be able to understand that materials have different characteristics, such as weight and strength.

Standards:

National Science Education Standards for Grades K-4

- **Properties of Objects and Materials:** Students develop the ability to observe and describe the properties of objects and materials.
- **Science and Technology:** Students develop an understanding about science and technology.

National Science Education Standards for Grades 5-8

- **Properties and Changes of Properties in Matter:** Students develop the abilities to observe and describe properties of substances.
- **Science and Technology:** Students develop an understanding about science and technology.

National Science Education Standards for Grades 9-12

- **Science and Technology:** Students develop an understanding about science and technology.

Air fills the parachute, increasing drag and slowing the skydiver's fall.

Gravity pulls the skydiver down.

What would happen if the parachute did not fill with air?



DEMONSTRATION ACTIVITY FOR MUSEUM DOCENTS

One-Breath Bernoulli Bag (5 minutes)

Can you blow up an eight foot long bag with just one breath? If you use Bernoulli's Principle of air pressure, you can! (This demonstration element can be used as part of a larger demonstration program on the forces of flight).

Key Information

Ages: Appropriate for all ages.

Key Concept: Air pressure and Bernoulli's Principle.

Objectives: Museum visitors will be able to understand the basic concept of Bernoulli's Principle: that as the speed of air increases, the pressure of the air decreases.

Airflow is faster over the upper surface and decreases pressure



Airflow is slower over the lower surface and increases pressure

Standards:

National Science Education Standards for Grades K-4

- **Position and Motion of Objects:** Students develop abilities to describe the position and motion of objects.
- **Properties of Earth Materials:** Students develop an understanding of earth materials, including the gases of the atmosphere.

National Science Education Standards for Grades 5-8

- **Motions and Forces:** Students develop abilities to describe the position, direction, motion, and speed of objects.

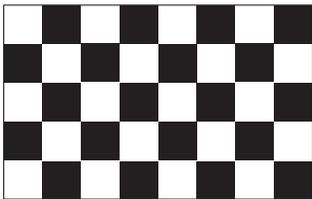
National Science Education Standards for Grades 9-12

- **Motions and Forces:** Students develop abilities to describe and measure the position, direction, motion, and speed of objects.

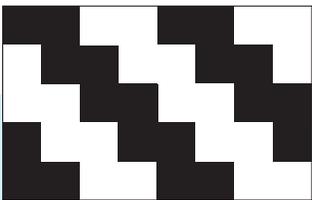
WORKSHOP #1 FOR MUSEUM EDUCATORS

Carbon Fiber: A New Kind of Weave (90 minutes)

Workshop participants will investigate the amazing properties of carbon fiber composites in five different activities. Participants will begin by examining everyday composites. They will discover the process of creating carbon fiber composites by using an analogy to the textile industry. The participants then examine weave patterns of different fabrics and then will have a chance to add their own unique weave patterns to a **Lap Loom**. In the **Composite Factory**, participants will make their own woven mats to model the process of making carbon fiber composite materials for airplane construction. Then, participants will put their woven mats to the test in the **Composite Testing Laboratory**.



1 over 1



2 over 2

Key Information

Ages: Appropriate for ages nine to eleven (grades 3-5).

Key Concept: Carbon fiber composites.

Objectives: Workshop participants will be able to:

- Define and give examples of a composite.
- Model one way in which carbon fiber composites are manufactured.
- Understand the connection between carbon fiber composites and the textile industry.
- Determine the tensile strength of weave patterns of their own design.

Standards:

National Science Education Standards for Grades K-4

- **Science as Inquiry:** Students develop abilities necessary to conduct scientific inquiry.
- **Properties of Objects and Materials:** Students develop the ability to observe and describe the properties of objects and materials.
- **Science and Technology:** Students develop the abilities of technological design.
- **Science and Technology:** Students develop an understanding about science and technology.

List of Workshop Activities

Activity #1: Everyday Composites (15 minutes)

Activity #2: Textile Tests (10 minutes)

Activity #3: Make & Take—Lap Loom (20 minutes)

Activity #4: Composite Factory (20 minutes)

Activity #5: Composite Testing Laboratory (25 minutes)

WORKSHOP #2 FOR MUSEUM EDUCATORS

Lighting Design Studio (45 minutes)

Can the lighting in an airplane cabin make travelers happy, sleepy, or hungry? Investigate the impacts of lighting in the Lighting Design Studio and discover how modern lighting helps travelers arrive at their destinations fresh and rested. (Depending on how you present the Lighting Design Studio workshop, it could be used as part of a longer program focused on light and color, or on aviation engineering and aircraft design).

Key Information

Ages: Appropriate for ages twelve to fourteen (grades 6-8).

Concept: Color psychology and airplane cabin design.

Objective: Workshop participants will be able to understand that color can impact how people feel and can make them feel more comfortable.

Standards:

National Science Education Standards for Grades 5-8

- **Science as Inquiry:** Students develop abilities necessary to conduct scientific inquiry.
- **Science and Technology:** Students develop an understanding about science and technology.
- **Science and Technology in Society:** Students develop an understanding of the roles of science and technology in society.

List of Workshop Activities

Activity #1: Color Psychology (15 minutes)

Activity #2: Cabin Design Challenge (20 minutes)

Activity #3: Color Lab (10 minutes)



SUGGESTED RESOURCES

If you do not find what you are looking for in the **Online Web Resource**, here are some additional resources to consider.

WEB SITES

ALLSTAR Network

This site from the Aeronautics Learning Laboratory for Science, Technology, and Research (ALLSTAR) Network answers the question: "What makes an airplane fly?"
<http://www.allstar.fiu.edu/aero/fltmidfly.htm>

NASA's Four Forces on an Airplane

Students and educators can find age-appropriate information and activities on this NASA site.
<http://www.grc.nasa.gov/WWW/K-12/airplane/forces.html>

Boeing's Forces of Flight Program

Boeing's Forces of Flight program provides engaging activities and online exhibits to help educator teach topics of flight to students in grades 5-8.
<http://www.boeing.com/companyoffices/aboutus/community/fof.html>

Centennial of Flight

With pages for kids and educators, this site is full of information, including primary source documents.
<http://www.centennialofflight.gov/index2.cfm>

Flights of Inspiration

This site from the Franklin Institute looks at flight through the lens of both history and science. Both students and educators will find valuable information at this site.
<http://www.fi.edu/flights/index.html>

Wright Brothers Aeroplane Company & Museum of Pioneer Aviation

This virtual museum exhibit tells the story of the pioneers of aviation.
<http://www.first-to-fly.com/>

Wings across America

An on-line exhibit that chronicles the Women Airforce Service Pilots (WASP), the first women to pilot military aircraft in the United States.
<http://wingsacrossamerica.us/wings/index.htm>

Fly Girls

This site accompanies the PBS film, Fly Girls (1999, 60 min.), which chronicles the Women Airforce Service Pilots of WWII.
<http://www.pbs.org/wgbh/amex/flygirls/>

Dreamliner 101: All about the Boeing 787

This online exhibit tells all about the Dreamliner, from its history to its innovations.
<http://seattlepi.nwsourc.com/boeing/787/787primer.asp>

Airbus Cabin Showroom

Go inside the Airbus family of aircraft, including the possibility to explore the cabin of the new A380.
<http://www.airbus.com/cabin-showroom/preview/index.jsp?article=0>.

Make Your Own A380

Build your own A380 paper airplane using this template.
http://events.airbus.com/a380/seeing/learnandplay/pdf/A380_airbuscolours.pdf

BOOKS

The Smithsonian Book of Flight for Young People.

Boyne, Walter J. New York: Atheneum, Macmillan Publishing Company, 1988.

Boeing 787 Dreamliner - Flying Redefined

Norris, Guy, Geoffrey Thomas, Mark Wagner, and Christine Forbes Smith.
Western Australia: Aerospace Technical Publications International Pty Ltd, 2005.

MATERIAL SUPPLIERS

Aero-Prop™ toy propeller

Available from Aero-Motion at: <http://www.aero-motion.com>.

Carbon fiber laminate sample and carbon fiber sandwich sample

Sample packs are available from Robot Marketplace at: <http://www.robotmarketplace.com>

Colored acetate sheets

Item #WW6672093. 8.5 x 11" plastic sheets in red, blue, green, yellow, and orange.
Available from Boreal at: <http://boreal.com>

Windbags®

Available from science supply companies, such as Steve Spangler Science at:
<http://www.stevespanglerscience.com>

CREDITS

The *Legends of Flight Informal Educator's Toolkit* was developed by Kristen Clapper Bergsman and Matthew Merritt for Pacific Science Center, under the direction of project manager Heather Gibbons.

All materials produced for the film, *Legends of Flight*. Reviewed for The Boeing Company by Scott Lefeber.

Layout, design, and illustrations by Clayton Defrate.

Editing by Sally Armbrecht.

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LEGENDS OF FLIGHT

Directed by Stephen Low

Produced by Stephen Low and Pietro L. Serapiglia

Executive produced by Bob Kresser and Jan Baird

In Association with the Smithsonian
National Air and Space Museum

NOTES:

NOTES:

LEGENDS OF FLIGHT

SEE HOW THE AIRPLANES OF THE 20TH CENTURY HELPED INFLUENCE THE RADICAL NEW DESIGN OF 21ST CENTURY AIRCRAFT.

GO BEHIND THE SCENES TO OBSERVE HIGH TECH MANUFACTURERS AROUND THE WORLD USING MODERN TECHNOLOGY TO COORDINATE THE DESIGN AND CONSTRUCTION OF NEW AIRCRAFT.

FLY IN THE COCKPIT WITH 787 CHIEF PILOT, MIKE GARRIKER, AS HE TAKES THE NEW DREAMLINER ON ITS FIRST TEST FLIGHT.

FOR FILM INFORMATION PLEASE CONTACT

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