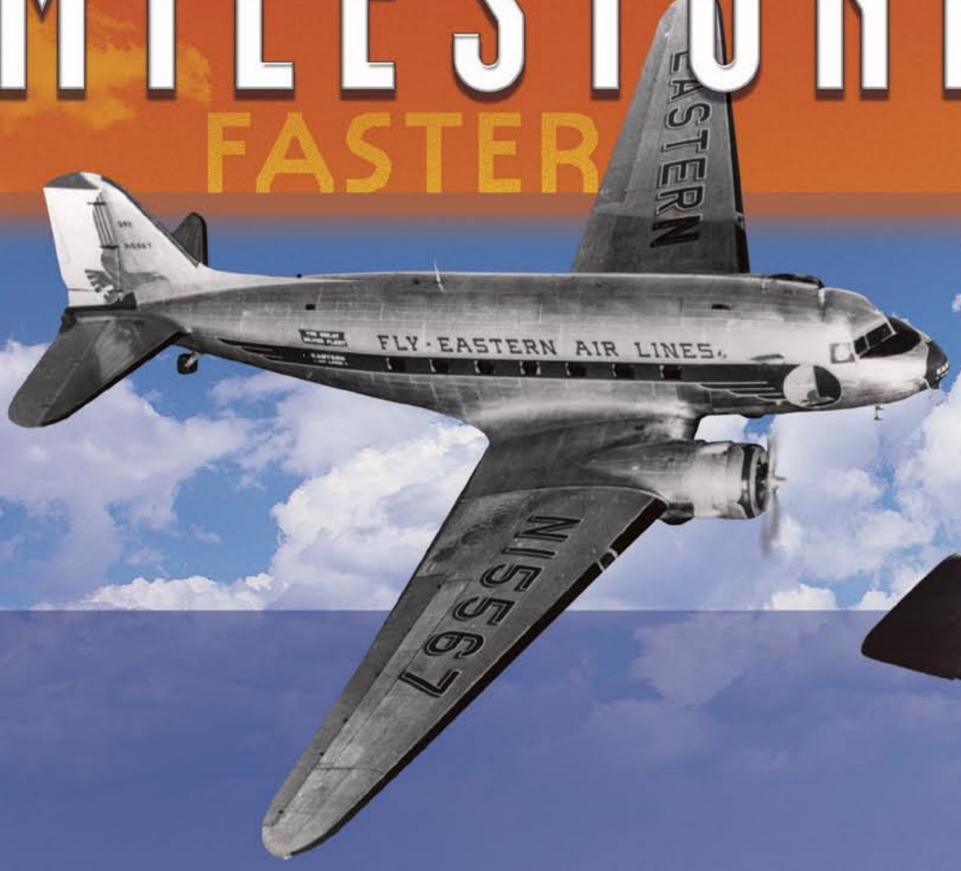




MILESTONES *of* FLIGHT

FARTHER
FASTER
HIGHER



DOUGLAS DC-3

RYAN-NYP SPIRIT OF ST. LOUIS

1903 WRIGHT FLYER

MILESTONES of FLIGHT

OVERVIEW

THIS POSTER PROVIDES AN ACTIVITY THAT INTRODUCES students to seven of the most historic aircraft and spacecraft in the collections of the National Air and Space Museum. Students learn about the technological advances of these craft as well as their impact on society. They analyze significant features of the craft using line drawings supplied as Blackline Masters. Then, based on the design features they observe, students place the craft in chronological order along a timeline. They discuss what these aircraft and spacecraft achieved and how they affected society—in both positive and negative ways.

The poster is designed as a flexible teaching tool. The activity is written for fourth through sixth grade students who are studying advances in science and technology or the relationships among science, technology, and society. Older students also can benefit from the activity and extensions. You are encouraged to visit the National Air and Space Museum in order to give students the opportunity to see these historic artifacts. However, if you are unable to visit the Museum, the poster and activity can stand alone as a worthwhile part of your science and social studies programs.

Grade Level: 4 through 6

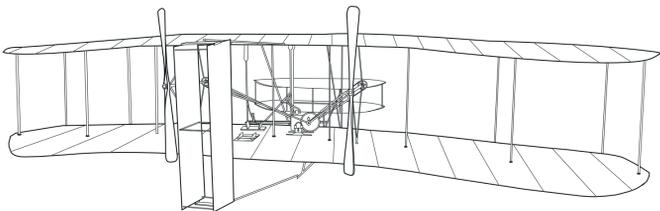
Time Required: one to three class periods (50 minutes each)



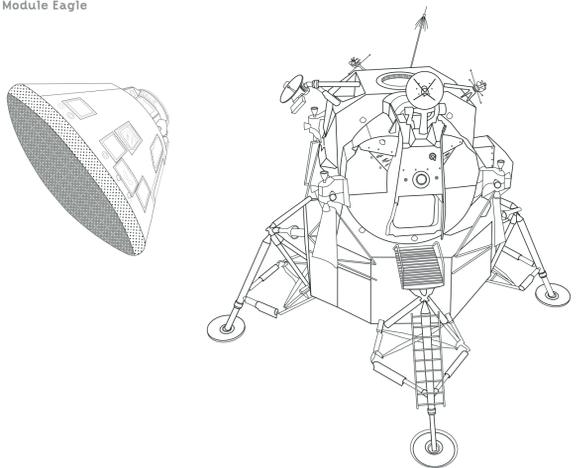
Smithsonian
National Air and Space Museum

BLACKLINE MASTERS

1903 Wright Flyer



Apollo 11 Command Module Columbia and Lunar Module Eagle



PREPARATION

Copy and collate the three Blackline Masters for each student. Cut each master in half so that each student will have a set of six line drawings. A few days before beginning the activity, display the poster and encourage students to take a close look at it. Prepare a simple timeline with six dates corresponding to the six milestones on the poster. You can also add other important dates (e.g., World War I and II, the Great Depression, the Vietnam War) to provide a context for the six milestones.

PROCEDURE

A. SCIENCE AND TECHNOLOGY

1. Explain that the seven aircraft and spacecraft on the poster are among the most important in the history of flight. Discuss what a milestone is.

2. Discuss students' initial observations of the seven craft. What similarities and differences did they notice? Why would engineers invent so many different kinds of aircraft and spacecraft? Try to bring out these responses:

- to fly faster
- to fly higher and farther
- to build safer machines
- to serve different purposes—e.g., carrying passengers, transporting cargo, conducting research, traveling to other parts of the Solar System.

3. Divide students into three groups. Assign each group a different design feature to study. Hand each student a set of drawings for the six milestones, and give students a few minutes to study the drawings. Then give each group a set of questions to guide their observations and discussion. Tell students to examine the drawings to find the answers to the questions and to take notes on their observations so they can report back to the rest of the class.

Group 1: Wings

Sort the craft into those with wings and those without. Why do you think some craft don't have wings? Which craft have two wings? One wing? Which craft has the shortest wings? Which has the longest? What other differences do you notice about the wings?

OBJECTIVES

- Recognize features that enable craft to fly in air or space
- Identify major technological advances in aviation and spaceflight
- Describe how advances in aircraft and spacecraft have affected the lives of people

EDUCATION STANDARDS ADDRESSED IN THIS ACTIVITY

NATIONAL SCIENCE EDUCATION STANDARDS

Science and Technology

Content Standard E:

As a result of activities in grades 5–8, all students should develop

- Understandings about science and technology

NATIONAL SOCIAL STUDIES STANDARDS

VIII. Science, Technology, and Society

Social studies programs should include experiences that provide for the study of relationships among science, technology, and society.

BACKGROUND INFORMATION FOR TEACHERS

Airplanes and spacecraft are such an integral part of our lives that it's hard to imagine neither existed a little over a century ago. America's incredible advances in aviation and spaceflight since then grew out of the cherished belief that technology leads to progress and opens up new frontiers. These advances reflect a passionate quest to fly ever faster, higher, and farther.

Six of the most significant milestones in the history of flight are represented by the aircraft and spacecraft featured on this poster. Their technological achievements transformed not only aviation but society as well—redefining travel, influencing commerce and culture, changing warfare, creating new industries, and bringing together distant peoples.

MILESTONE ONE

FIRST SUCCESSFUL AIRPLANE

Aircraft: 1903 Wright Flyer
First flight December 17, 1903

SCIENCE AND TECHNOLOGY

The first airplane flight lasted only 12 seconds, covered just 120 feet, and traveled at a mere 30 mph. But Wilbur and Orville Wright had come up with the basic solutions for powered, controlled flight. Their contributions included an innovative propeller design that provided thrust, and a system for controlling movement in three directions—vertical (pitch), horizontal (yaw), and lateral (roll). Every airplane built since flies by the same basic principles.

SOCIAL IMPACT

The Wright Flyer's inaugural flight launched the aerial age and excited people worldwide about the possibilities of flight. Writers like Franz Kafka and artists like Pablo Picasso incorporated flight into their work. Tin Pan Alley churned out tunes like "Come Josephine in My Flying Machine." Airplane images were emblazoned on clocks, cigarette cases, plates, and other everyday items. Soon airplanes were delivering mail and freight, dusting crops, mapping the Earth, and carrying passengers. By World War II, the airplane had changed the nature of warfare.

MILESTONE TWO

FIRST AIRPLANE TO FLY NONSTOP ACROSS THE ATLANTIC OCEAN WITH A SINGLE PILOT

Aircraft: Spirit of St. Louis (Ryan NYP)
Left New York May 20, 1927

SCIENCE AND TECHNOLOGY

By the time of Charles Lindbergh's historic flight, the airplane was evolving into a reliable flying machine. Larger and more powerful engines enabled airplanes to travel faster, higher, and farther. The Spirit of St. Louis was built for maximum range. Extra fuel tanks carried the 450 gallons of fuel needed for the 4,000-mile, 33½-hour nonstop flight. The wings were designed to lift 2,700 pounds of fuel.

SOCIAL IMPACT

Lindbergh's flight electrified the world. It helped demonstrate the safety of airplanes, leading to an aviation boom and to heavy investment in the aviation industry. Lindbergh himself helped develop TWA and Pan American World Airways. Within a few years, airplanes were crossing the continent in 48 hours (compared to 72 hours by train). Songs, novels, comic books, and movies about aviation proliferated—including the 1927 Academy-Award-winning film *Wings*.

MILESTONE THREE

FIRST PROFITABLE PASSENGER AIRPLANE

Aircraft: Douglas DC-3
First flown 1935

SCIENCE AND TECHNOLOGY

The DC-3 was built of aluminum, making it stronger and more durable than earlier aircraft. It also had a larger fuselage and wings, and it could carry more weight. It transported as many as 21 passengers at speeds of up to 212 mph. The DC-3 is a model of streamlining with a porpoise-shaped fuselage, two powerful engines enclosed by cowlings, and retractable landing gear.

SOCIAL IMPACT

The DC-3 was the first modern airliner, the fastest commercial transport of the day, and the first airplane to make a profit carrying only passengers. It made air travel popular and affordable. Its sleek shape influenced the design of automobiles, locomotives, radios,

cameras, toasters, and other utilitarian objects. By this time, military airplane technology also had advanced significantly, resulting in the dramatic airpower utilized in World War II. The military version of the DC-3, nicknamed the Gooney Bird, was used to transport troops and supplies.

MILESTONE FOUR

FIRST WIDE-BODY COMMERCIAL JET AIRPLANE

Aircraft: Boeing 747
First flown January 1970

SCIENCE AND TECHNOLOGY

The development of the jet engine opened the era of high-speed flight, and the Boeing 747 is one of the most successful jet-propelled airliners. It is highly streamlined with wings swept back 35° to reduce drag and four jet engines tucked under the wings. The 747-100 can cruise at 589 mph and has a range of 7000 miles.

SOCIAL IMPACT

The jet airplane revolutionized air travel. Because it could fly longer distances and carry more passengers for less cost, the jet airplane made air travel affordable for many more people. Now sports teams, business travelers, and families can travel from coast to coast within a day. The Boeing 747 enables large numbers of people to fly quickly and cheaply across the country and all over the world. At the same time, though, viruses and diseases can travel quickly and easily from continent to continent. Suddenly the planet seems much smaller.

MILESTONE FIVE

WORLD'S FASTEST, HIGHEST FLYING AIRCRAFT THAT REACHED THE EDGE OF SPACE

Aircraft: North American X-15
First flown 1959

SCIENCE AND TECHNOLOGY

This rocket-powered research airplane was designed to fly in both air and space and to gather information for future space exploration. It was the first winged aircraft to reach the fringes of Earth's atmosphere—an altitude of over 67 miles. It was also the first airplane to attain speeds of up to 4,500 miles per hour. To minimize shock waves at hypersonic speeds, the X-15 has a pointed

nose, extremely slender fuselage, and thin, swept-back wings. It is made of a special heat-resistant metal alloy that endures temperatures of up to 1,200°F.

SOCIAL IMPACT:

Information gained during the development of the X-15—particularly its ability to land after reaching the edge of space—was applied to the development of the space shuttle. Many test pilots, including Neil Armstrong, later become astronauts. Test pilots became heroes, as dramatized in the popular book and movie *The Right Stuff*. Around the same time, commercial supersonic transport was developed—raising concerns about pollution in cities and communities near airports.

MILESTONE SIX

FIRST SPACECRAFT TO CARRY HUMANS TO THE MOON AND LAND THERE

Spacecraft: Apollo 11 Command Module Columbia and Apollo Lunar Module Eagle
Flown July 1969

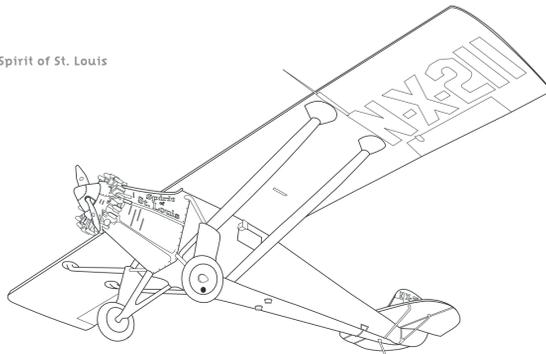
SCIENCE AND TECHNOLOGY

These two spacecraft were part of the most complicated flying machine ever built. They carried Neil Armstrong, Buzz Aldrin, and Michael Collins on their historic voyage to the Moon and back. Collins flew the *Columbia* around the Moon for 28 hours while Armstrong and Aldrin landed on the Moon in the *Eagle*. On the return to Earth, the *Columbia* reached speeds of 25,000 miles an hour. A heat shield on the blunt end protected the astronauts from temperatures of up to 5,000°F.

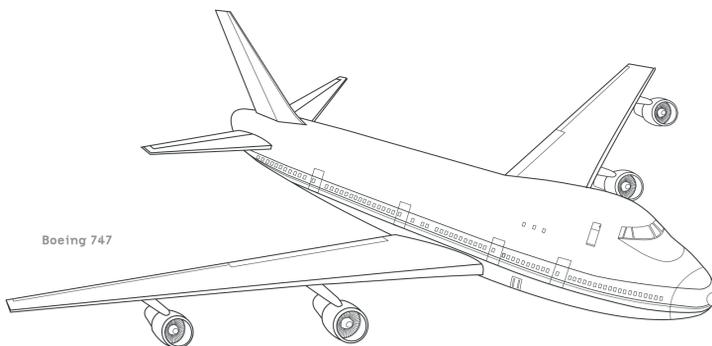
SOCIAL IMPACT

The Apollo mission traveled faster, higher, and farther in a whole new way. It culminated in the first human steps on another world. People became fascinated with the Moon landing program. The Apollo mission fired the development of spin-offs in computers, medical technology, and systems engineering. Apollo also enabled the world's people to view their home in a new way. Through the lens of a camera, humanity saw Earth from afar—a tiny, lovely, and fragile "blue marble" hanging in the blackness of space. The Apollo program would not be repeated. Because of the great technological requirements and expense of space travel, government support was needed, and some people objected to the cost.

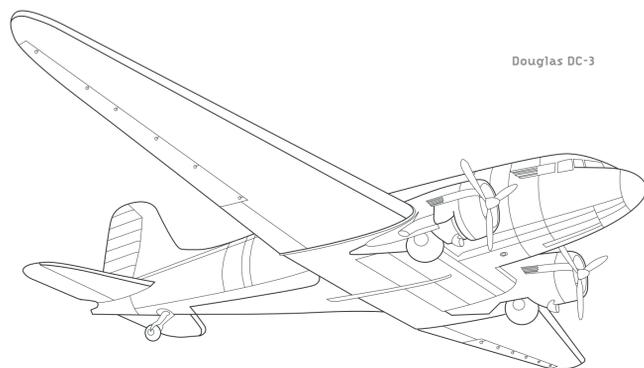
Spirit of St. Louis



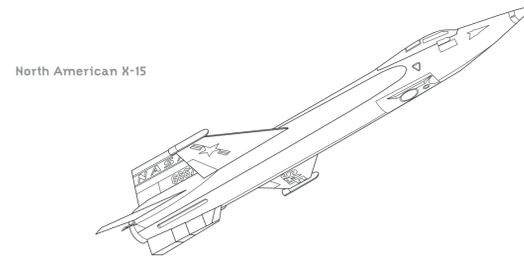
Boeing 747



Douglas DC-3



North American X-15



Group 3: Streamlining

Put the craft in order from the least streamlined to the most streamlined.

Which is the most streamlined? Which is the least streamlined?

List at least three features that make a craft streamlined.

How does streamlining help a craft fly?

What other differences do you notice about the shapes of the craft?

Answers to questions:

The least streamlined craft are the Apollo Command and Lunar Modules. They fly only in space, where there is no air to provide resistance.

The most streamlined craft is the X-15, the fastest of the four airplanes.

Some streamlining features are: long and narrow fuselage; no wing struts; engine cowlings; retractable wheels; swept-back wings.

Streamlining reduces drag and helps an airplane fly faster.

4. Have each group report to the rest of the class on its observations. Discuss how changes in design helped airplanes fly faster, higher, and farther.

B. TIMELINE AND SOCIAL IMPACT

1. Individually or in small groups, have students put their six drawings in order from the earliest to the most recent craft. Tell them to be sure to consider the design features they just studied as they make their decisions.

2. Beginning with the first date on your timeline, ask students which craft should go in that spot. Have them give reasons for their decision. Once the class has agreed on the correct craft, attach an image of the 1903 Wright Flyer to that spot. Explain what milestone this airplane achieved, and discuss with students some of the ways people reacted to this event. Continue until the entire timeline is filled in.

3. Now ask the class to think of ways that these milestones in flight have affected their lives and the lives of other people. List students' ideas on the board, with one column for benefits and one for problems. Examples of responses might include:

Benefits

People can travel quickly and easily to all parts of the world.

We receive mail within days.

We can enjoy fresh foods from all parts of the country. Sports teams and musical groups can travel from city to city within hours.

We're learning about the Moon and other parts of the Solar System.

The airline industry provides many different kinds of jobs.

Airplanes are used to protect people during wars.

Problems

Airplanes make a lot of noise.

Airplanes also pollute the air.

The skies have become very crowded.

Diseases and viruses now travel easily from continent to continent.

Airplanes are used to kill people during wars.

4. Conclude by asking students: How has aviation benefited society? What can we do to reduce the problems? You also might share with them the following quotation from Orville Wright. During World War II, a journalist asked him if he regretted inventing the airplane, since it had become the instrument of so much destruction. Wright replied:

I feel about the airplane much the same as I do in regard to fire. That is, I regret all the terrible damage caused by fire. But I think it is good for the human race that someone discovered how to start fires and that we have learned how to put fire to thousands of important uses.

EXTENSIONS

1. Take students on a field trip to the National Air and Space Museum to see the aircraft and spacecraft. You can download a student self-guide to these artifacts, "What's Tops at the National Air and Space Museum?" Visit the Museum's web site at http://www.nasm.edu/education/resources_guides.cfm. The self-guide sends students on a mission to select their favorite craft

based on its achievement and design features. Before your visit, explain the mission and get students excited about the fact that they are going to see the actual aircraft and spacecraft they just studied. After the visit, review students' responses.

- Ask which students voted for each craft and have them defend their choices.
- Tally the votes and announce the winner.

2. Assign each student to do more research on one of the aircraft or spacecraft and its effect on people and society.

3. Have each student research one of the following people who broke barriers in the history of aviation: Wilbur and Orville Wright, Amelia Earhart, Charles Lindbergh, Frederick Gregory, Mae Jameson, Bessie Coleman, Amy Johnson, Chuck Yeager, Scott Crossfield, Neil Armstrong, Michael Collins, Buzz Aldrin, Sally Ride.

4. Have students write about which aircraft or spacecraft they would most like to fly in, why, and what they think the flight would be like.

5. Have students write about what the next milestone in flight might be and how it will affect people's lives. If they want, they can draw a picture of their imaginary craft.

VISITING THE NATIONAL AIR AND SPACE MUSEUM



RESOURCES FOR TEACHERS

BOOKS

The Airplane: A History of Its Technology, by John D. Anderson, Jr.

Aiming for the Stars: The Dreamers and Doers of the Space Age, by Tom D. Crouch

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

WEB SITE

For additional resources and information, visit the web site of the National Air and Space Museum at <http://www.nasm.edu>.

For more information on milestones in flight, navigate to "Exhibitions" and then select current for the following galleries: *Milestones of Flight*, *The Wright Brothers & the Invention of the Aerial Age*, and *How Things Fly*.

For additional teaching resources, navigate to "Education" and then select "Resources" for resources and web sites.

The Smithsonian's National Air and Space Museum's two locations are home to the largest collection of historic air- and spacecraft in the world. Both sites are open daily, except December 25, from 10:00 a.m. to 5:30 p.m. School groups are welcome at the flagship building on the National Mall as well as the Steven F. Udvar-Hazy Center near Dulles International Airport.

Tours, demonstrations, and learning labs are available free of charge for school groups. Advance registration is required. Groups can also make reservations for paid programs such as IMAX® films and Planetarium shows. For more information on school programs, visit the Museum's web site at <http://www.nasm.si.edu>. Navigate to "Education" and select "School Groups."

NATIONAL AIR AND SPACE MUSEUM
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