FUTURE U.

Aircraft Through the Ages

Objectives

Students will be able to:

- **Research** aircraft design and innovation during a specific time period
- **Analyze** the reasoning behind this aircraft design
- **Create** a visual presentation that educates their peers about this era of flight
- **Apply** what they learn to **predict** what aircraft will look like in the future

Overview

In this lesson, students will pretend that they work at the National Air and Space Museum. As museum employees, they will create an exhibit that highlights how airplanes have changed over the decades and hypothesize where aircraft design is headed next. After researching aircraft from one specific era, student groups will create an exhibit that shares their findings and explains the reasoning behind each era's aircraft design. Students will then apply what they learned from their own research and their peers' work as they create designs for the future.

This lesson focuses on the following

Engineering Design Process

- Defining the Problem
- Designing Solutions
- Creating or Prototyping

21st-Century Skills

- Communication
- Collaboration
- Critical thinking
- Creativity

Timing

Two 60-minute class periods

Materials

Day 1

- Device with the ability to project, one for the instructor
- Wright Flyer images, to project
- Boeing 777-8 Characteristics 3D image, to project
- Smithsonian National Air and Space Museum website, to project
- Devices with internet access, enough for at least half the class
- Handout 1: History of Aircraft, one per student
- Lined paper, several sheets per student

- Handout 2: Exhibit Criteria, one per student
- White poster board, enough for one-quarter of the class*
- Markers, for the class to share*

*Not needed if groups use PowerPoint to create their presentations

Day 2

- Handout 3: Exhibit Markers, one for the instructor
- Scissors, one for the instructor
- Tape, one for the instructor
- Handout 4: Aircraft Through the Ages Timeline, one per student
- NBC News video Futuristic 'Flying V' Airplane Could Change The Way We Fly, to project
- Handout 5: Future of Aircraft, one per student

Have you ever wondered…

What significant milestones the aviation industry has seen over the years?

Since the very first flight in 1903, the aviation industry has experienced tremendous innovation. Important aviation accomplishments over the past century include:

- 1919: The first successful transatlantic flight was carried out in a WWI Vickers Vimy long-range bomber. The plane traveled from Canada to Ireland.[1]
- 1934: The Douglas DC-3 was the first aircraft to make passenger flights profitable. Though small—only 64 feet long and capable of carrying no more than 28 people—it was responsible for transporting over 90% of all airline passengers by the end of the 1930s! [2]
- 1969: The Boeing 747 entered the aviation industry as the world's first wide-body airliner. Powered by four efficient high-bypass engines, the 747 could seat up to 400 passengers and had lower operating costs than any other airliner at the time. It is credited with making airline travel more affordable and quickly became the aircraft of choice for long-range service.[3]
- 2011: Boeing produced the 787 Dreamliner, which was the first aircraft composed primarily of composite parts. (Composites are materials made up of more than one element.) This design decision made the Dreamliner stronger and lighter than other planes.[4]

What could flight look like in the future?

Experts suspect that the future of flying will focus on a few main goals. First, aircraft will undergo changes to increase their efficiency and make their flights more sustainable. This may be achieved through electrified propulsion or—until this is possible—hybrid models that use both conventional jet engines and electricity.[5] Automation is also likely to be an important focal point of innovation. While commercial flights are unlikely to go pilot-less anytime soon, more and more components of flight may become automated. In addition, the passenger experience will evolve. Airline passengers are likely to see changes in everything from safety and health precautions to better accommodation of their needs and desire for comfort.[6]

Make Connections

How does this connect to students?

Before the pause put on travel due to COVID-19, airline travel played a huge role in American society. In 2017, 88% of Americans had taken a commercial flight at least once in their lives.7 And for many, air travel is not a one-time occurrence. Each year, millions of passengers travel throughout the United States. In 2019, for example, the TSA screened approximately 2.5 million passengers each day.[8]

This travel—and the airline industry in general— helps "drive more than $1.7 trillion in economic activity and more than 10 million U.S. jobs." [7]

The reach and impact of the airline industry is so broad that it is almost impossible for it not to affect students' lives. Therefore, it makes sense for students to explore the history of this important transportation sector in order to understand how it evolved into the industry it is today. An understanding of its history will also help students envision how the industry may continue to grow, change, expand, and impact their lives in the future.

How does this connect to careers?

Aeronautical engineer: Aeronautical engineers study the aerodynamics of materials and designs in order to design, develop, test, and produce aircraft and propulsion systems.

Museum curator: Museum curators design and install exhibits in museums. They usually specialize in a particular field, and they may work with one museum or a variety of museums. They are also responsible for organizing lectures, educational events, and more to help the public learn from their exhibits.

Aircraft Design Engineer: Aircraft design engineers can design, construct, and test aircraft. They may be responsible for the structural design of the overall aircraft. They may also design aircraft interiors to ensure that they meet quality standards and requirements from the Federal Aviation Administration.

How does this connect to our world?

The aviation industry connects and supports our world.

Before airplanes, global ideas, goods, and people rarely crossed paths. But ever since the first transatlantic commercial flight took passengers from New York to France in 1939, intercontinental flights have boomed and global tourism has skyrocketed. In 2019 alone, there were just over 79 million international visitors to the US from overseas, Mexico, and Canada.[9]

In addition to travel, the development and evolution of planes enables foreign trade and shipping. Our world becomes smaller and our opportunities become larger because of air transportation. According to the International Civil Aviation Organization, "Aviation provides the only rapid worldwide transportation network, which makes it essential for global business. It generates economic growth, creates jobs, and facilitates international trade and tourism."[10]

The aviation industry also plays an enormous role in people's economic well-being. According to Aviation Benefits Beyond Borders, the aviation industry supports 87.7 million jobs around the world—including those employed directly within the industry as well as those "supported through the industry's supply chain." [11]

Sources

[1] "The Sky's the Limit." Live Science. livescience.com/59185-key-milestones-in-aviation-history.html.

[2] "Douglas DC-3." Smithsonian Air and Space Museum. airandspace.si.edu/collection-objects/douglas-dc-3/nasm_A19530075000.

[3] "The Era of Wide Body Airplanes." Smithsonian Air and Space Museum. airandspace.si.edu/exhibitions/america-by-air/online/jetage/jetage06.cfm.

[4] "How the Boeing Dreamliner Works." How Stuff Works. science.howstuffworks.com/transport/flight/modern/boeing-dreamliner.htm#pt3.

[5] "NextGen Aircraft Design is Key to Aviation Sustainability." NASA. nasa.gov/aero/nextgen-aircraft-design-is-key-to-aviation-sustainability.

[6] "What Will Passenger Planes Look Like in 2068?" CNN. cnn.com/travel/article/passenger-planes-future-look/index.html

[7] "Air Travel More Accessible in 2017." Airlines for America. airlines.org/news/air-travel-more-accessible-in-2017-according-to-latest-air-travelers-in-america-report.

[8] "Looking to the Future of Air Travel." Harvard Business Review. hbr.org/2020/05/looking-to-the-future-of-air-travel.

[9] "U.S. Travel Answer Sheet." U.S. Travel Association. ustravel.org/answer sheet.

[10] "Aviation Benefits." Uniting Aviation. unitingaviation.com/news/economic-development/aviation-benefits-for-a-better-future.

[11] "Employment." Aviation Benefits Without Borders. aviationbenefits.org/economic-growth/supporting-employment/.

Blueprint for Discovery

Educator Prep: This lesson includes two options for the creation of the students' museum exhibits. The low-tech option is to have students use poster boards, and the higher-tech option is to have students use PowerPoint. Try to check in with the classroom teacher in advance to see which option they recommend. If you are unable to check before your visit, be prepared for the lower-tech option just in case!

DAY 1

1. Begin the class session by toggling through the Wright Flyer images. As you do, explain that this airplane took the world's first successful flight. It lasted 12 seconds, traveled 120 feet, and carried one person: the pilot.

   Then project the Boeing 777-8 Characteristics 3D image (available halfway down the webpage). Explain that this plane is still in its design phase, and it will likely take its first flight in 2023. Once complete, it should be able to travel up to 8,730 miles and carry as many as 384 passengers, in addition to the pilot and flight staff!

   Ask students to guess how many years separate the Wright Flyer's first successful flight and the 2023 flight of the Boeing 777-8. Take student guesses and then explain that the Wright Flyer first flew in 1903. Therefore, 120 years (and a huge amount of innovation!) separate the two flights.

2. Go on to explain that students are about to pretend that they work at the Smithsonian National Air and Space Museum in Washington, D.C. Project the museum's website and tell students that this museum has the world's largest and most important collection of aerospace artifacts.

   Go on to tell students that, as employees at the Air and Space Museum, they will be responsible for creating an exhibit that highlights how airplanes have changed over the decades. They will also be challenged to hypothesize where aircraft design will be headed in the future.

3. Divide students into groups of four and distribute one *Handout 1: History of Aircraft* and a piece of lined paper to each student. Then prepare students for their first activity by performing the following:

- Assign each group one of the following time periods and instruct them to record their time period in the space provided on the top of their handout:

  1900–1920 1921–1940 1941–1960 1961–1980

  1981–2000 2001–Today

- Read through the handout's directions and each of the steps.
- Explain that each group will use their research to create a section of the Aircraft Through the Ages exhibit. The sections will then be compiled to create one full exhibit.
- Encourage groups to break into pairs to complete their research. Groups can then come back together and share what they have learned.
- Tell students that they will have about 30 minutes to complete their research.
- Then answer any outstanding questions, and encourage students to begin!

4. When 20 minutes have passed, give students a 10-minute warning. Then bring the class back together when 30 minutes have passed.
5. Explain that for the remainder of the class session, students will share their research notes with their group members and then work together to complete their Aircraft Through the Ages exhibit.

   Pass out one *Handout 2: Exhibit Criteria* (half sheet) to each student. Then review one of the following two options:

   - Option #1 (low-tech): Explain that each group will get one poster board for their exhibit. Review *Handout 2: Exhibit Criteria* and explain that each of these criteria must be included on their poster. To create the exhibit, the completed boards will be placed around the room in chronological order.
   - Option #2 (higher-tech): Explain that each group will use PowerPoint to create their portion of the exhibit. *Review Handout 2: Exhibit Criteria* and explain that they must include all of these criteria within the slide presentation. Presentations should be no more than five slides.

   Stress that the students' exhibits should be entirely self-sufficient. In other words, museum visitors should be able to independently view the poster or click through the slides and completely understand the content.
6. Once any questions have been answered, explain that groups will continue working on their exhibits until the end of class. Tell students they will have a little time at the beginning of the following class session to finish, but they should try to get as far as they can today.
7. When the class session is complete, collect students' poster boards and store them in a safe place. Or, if students have created PowerPoints, work with the classroom teacher to ensure they are saved properly so they can be easily accessed next class session.

DAY 2

1. As the class session begins, encourage students to join their group members and continue working on their exhibit. Give students about 15–20 minutes to finish.

   As they work, cut out the *Handout 3: Exhibit Markers* and tape them in chronological order around the classroom. Remember: Students will rotate around the room as they look at the different exhibit sections, so think about the flow of the exhibit.

2. Once 15–20 minutes have passed, instruct groups to place their portion of the exhibit in the appropriate section of the classroom.
3. Then distribute one *Handout 4: Aircraft through the Ages Timeline* to each student, and review the directions.

   Take a moment to expand on the handout's fuel efficiency grade by explaining the following:

   - Fuel efficiency is an important quality for aircraft because:
     1. A fuel efficient plane is less expensive to fly
     2. A fuel efficient plane is better for the environment. When a plane uses less fuel, it also releases less carbon dioxide.
   - For a plane to be as fuel efficient as possible, these factors are especially important:
     3. Weight: Heavier planes are less fuel efficient because they require more power to fly. Therefore, the plane's materials are important. Lightweight materials make an aircraft more fuel efficient!
     4. Design: When a plane flies through the air, it encounters drag. Drag is resistance (or friction) that the plane experiences as it flies. Drag pushes the plane backward as the plane tries to move forward. There are different designs that can reduce drag and help an airplane fly more easily. For instance, a long thin airplane with a narrow, pointed nose would experience less drag than a large, wide airplane with a flat front.
4. Once you answer any student questions, give the class about 15 minutes to rotate through the exhibit and take notes on *Handout 4*.
5. Then bring the class back together for the final challenge. Explain that the Air and Space Museum would also like to create a new exhibit section that hypothesizes what aircraft may look like in the future.
6. Play the NBC News video, and explain that this is one idea of where aircraft are headed. However, the Air and Space museum would like to present the public with several ideas.
7. Pass out one *Handout 5: Future of Aircraft* to each student, and review the directions. Explain that while Design 1 should keep in mind what is actually feasible, Design 2 should have no constraints. The two design ideas will be displayed in separate sections of the exhibit.

   Deduct five minutes from the time remaining until the end of the class session, and tell students they will have this much time to complete their work independently.
8. When there are five minutes left in class, call on several students to share the two versions of their designs and explain the reasoning behind each one.

   Then wrap up by thanking the class for their hard work and acknowledging that the future potential of flight seems limitless. There are so many possibilities for innovation that you wouldn't be surprised if some of their designs came true!

Extend

Students can construct a 3D model (digitally or using materials like modeling clay) of one of their futurisc planes. Once the prototypes bring their ideas to life, they can then collaborate to review and critique their peers' designs.

National Standards

Next Generation Science Standards
Engineering Design

- MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

ITEEA Standards for Technological Literacy
Standard 1: Scope of Technology Inquiry. In order to comprehend the scope of technology, students in Grades 6-8 should learn that:

- F. New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.

Common Core State Standards for English Language Arts

- CCSS.ELA-LITERACY.CCRA.SL.2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

History of Aircraft

Time Period: _____

Directions: Research your assigned decades of aircraft history.

Some research questions, and research starting points, are included below. Use the websites provided to begin answering the questions. Answer the questions on a separate piece of paper.

Once you review the research starting points, you may complete additional research if needed.

Research Questions:

During your time period…

- What aircraft innovations or milestones occurred?
- What did aircraft typically look like?
    - What material(s) were most airplanes made out of?
    - What special features did airplanes have?
- Why were aircraft designed like this?

Research Starting Points:

1. First, review at least one of the following timelines:
    - National Air and Space Museum Poster: tinyurl.com/y5ezrwlj
    - Library of Congress Flight Timeline: tinyurl.com/y3c46bem
    - Federal Aviation Administration Timeline of Aerospace History: faa.gov/about/history/timeline/
2. Then read through at least two of the following websites/articles:
    - The Atlantic: A Century in the Sky: tinyurl.com/y28xebc6
    - Air & Space Magazine: Aircraft That Changed the World: tinyurl.com/y6gn6yg4
    - CNN: Boeing Through the Ages: tinyurl.com/y3qga9lr
    - Skyscanner: Here's How Air Travel Has Changed in the Past 100 Years: tinyurl.com/y4vcnlyc

Exhibit Criteria

STUDENT HANDOUT 2

Your portion of the Aircraft Through the Ages Exhibit must include the following:

- At least three key aircraft innovations or milestones
- A labeled image of what one type of aircraft looked like during this time period, including:
    - Its exterior design, as well as any important interior features
    - Materials that the plane was made out of
- An explanation of *why* aircraft were designed like this
- At least one additional fun fact

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1900–1920

1921–1940

1941–1960

1961–1980

1981–2000

2001–Today

Aircraft Through the Ages

Directions: As you browse the new Aircraft Through the Ages Exhibit, jot notes and/or sketches on the key characteristics of each time period's aircraft. Be sure to include the following details:

- What made this time period unique?
- What letter grade (A, B, C, D, or F) would you give this time period for fuel efficiency, based on the aircraft's design and/or the weight of its materials?

1900–1920 **Grade:**	1921–1940 **Grade:**
1941–1960 **Grade:**	1961–1980 **Grade:**
1981–2000 **Grade:**	2000–Today **Grade:**

Future of Aircraft

Directions: Review *Handout 4: Aircraft Through the Ages*. Think about how aircraft designs have evolved over the years, and consider what the next generation of aircraft may look like.

Then sketch and label the following two designs in the boxes below:

- Design #1: A realistic design that predicts what may come next based on how aircraft have been transformed over the years.
- Design #2: A creative design that assumes *anything* is possible!

Though your two designs should be very different, they must both:

- apply what has already been learned about aircraft design.
- consider the design's weight and drag in order to be as fuel efficient as possible.

Design #1:
Design #2: