The "Wright" Approach

Session Time: Two, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Appreciate the rich, global history of aviation/aerospace and the historical factors that necessitated rapid industry development and expansion. (EU1)

Understand the importance of professionalism, ethics, and dedication as they relate to all aviation/aerospace operations. (EU4)

ESSENTIAL QUESTIONS

1. What about the Wrights' methods made them successful where others had failed?
2. What questions did the Wrights have to answer to accomplish sustained, controlled flight?
3. How important were these developments in the achievement of powered, controlled flight?

LEARNING GOALS

Students Will Know

- That testing models is a way to prove theory
- The challenges the Wright brothers had to overcome to make powered, controlled flight a reality
- Engineering practices the Wright brothers used to overcome the challenges of powered, controlled flight

Students Will Be Able To

- *Describe* how aircraft today are still designed using the same principles the Wright brothers used. (DOK-L2)
- *Explain* ways in which the Wright Brothers solved for the challenges of controlled flight. (DOK-L4)

ASSESSMENT EVIDENCE

Warm-up
Students list and discuss what they know about controlled flight.

Formative Assessment
Students respond to questions about a video that explains how the Wright brothers improved upon what was already known about flight in order to achieve controlled flight.

Summative Assessment
Students draw a diagram showing how the Wright brothers solved important aircraft control challenges.

LESSON PREPARATION

MATERIALS/RESOURCES

- The "Wright" Approach Presentation
- The "Wright" Approach Student Activity 1
- The "Wright" Approach Student Activity 2

LESSON SUMMARY

Lesson 1: The "Wright" Approach

Lesson 2: Build and Test a Wind Tunnel

Lesson 3: The "Wright" Attitude

This lesson covers two sessions. Students start by listing at least five things they know about controlled flight. A class discussion will follow challenging the notion that the Wright brothers invented flight. According to the creator of the video the students will watch, the Wright brothers didn't invent flight but they did make flight practical. A presentation will inform the class about the three major aircraft control challenges the Wright brothers solved for and the approaches they took to solving them.

Every airplane built today has been designed and built according to principles discovered by the Wright brothers. As an extension during the second session, students will find similarities and differences among the Wright Flyer, a Cessna 172, and the Space Shuttle. A second extension will ask the students take a position on who was actually the first to achieve powered flight. The students will watch a short video and read a detailed article before taking their own stand on the matter.

To end this two-session lesson, the students work in small groups and draw and label a diagram showing how the Wright brothers solved the challenges of aircraft control.

BACKGROUND

The Wright brothers, Orville and Wilbur, are widely credited with having achieved the first powered, controlled flight. They designed and built the world's first successful flying airplane. The first flight happened in Kitty Hawk, NC, on December 17, 1903.

The Wright brothers relied heavily upon the research and information discovered by aviation pioneers before them. They studied the learning and the challenges encountered by Otto Lilienthal, Octave Chanute, George Cayley, Samuel Pierpont Langley, and others.

Unlike the pioneers before them, they solved three major challenges that allowed for the first powered, controlled flight: Creating a wing with sufficient lift; balancing and controlling the airplane; and developing an engine with sufficient power. They became self-taught engineers by employing their own method of testing ideas and designs, analyzing the data, then refining the design based on those results. It was the first time that "engineering practices" were used in aircraft development and they are still used today!

MISCONCEPTIONS

Students may believe the designs used by the "The Wright Flyer" are no longer used in aircraft development today. Students may not realize that some question whether or not the Wright brothers were truly the first in manned, powered flight.

DIFFERENTIATION

To support verbal reasoning in the class discussion during the **EXTEND** section of the lesson, organize the class into groups for Think-Pair-Share before a whole group discussion. This allows learners to think about the question, and discuss their thoughts with a partner before sharing with the larger group. Sharing encourages all students to participate and practice skills, including metacognition.

To support physical activity during the **EXPLAIN** section of the lesson, allow students to stand up and mimic roll, pitch, and yaw. This allows learners to increase oxygen flow to the brain and stay focused.

LEARNING PLAN

ENGAGE

Teacher Material: The "Wright" Approach Presentation

Slides 1-3: Introduce topic and the learning objectives for this lesson.

Slide 4: Conduct **Warm-Up.**

Allow up to five minutes for the warm-up. Ask volunteers to share their list and lead a brief discussion. Collect student work and grade up to five points for completeness and participation. [DOK 1; list]

Warm-Up

Ask students to individually write a list of five things they know about controlling flight.

Possible answers:
Airplanes are flown using controls in the cockpit; flight controls include a yoke and rudder pedals; the throttle increases and decreases engine power; ailerons raise and lower the wings (roll); rudder pedals move the nose left and right (yaw); elevators move the nose up and down (pitch); the Wright brothers are credited with the first powered, controlled flight.

EXPLORE

Teacher Material: The "Wright" Approach Presentation

Slides 5-6: Provide important historical context and introduce three problems the Wright brothers had to overcome in order to achieve flight: creating a wing with sufficient lift, balancing and controlling the airplane, and developing an engine with sufficient power.

Slide 7: Provide information on how the Wright brothers relied heavily upon the research and information discovered by aviation pioneers before them, including George Cayley.

George Cayley is regarded as one of the first true pioneers of aeronautical science, establishing the ideas of the forces of flight, the effectiveness of a cambered wing, and separate systems for propulsion, lift, and control. With Caley's understanding of the mechanics of flight, he developed the first recorded heavier-than-air glider. As he continued his testing of his systems, he shared his findings. Wing dihedral (wings lower in the middle than at the tips) contributes greatly to aircraft stability, and it is one of George Cayley's many discoveries that we can still see in use in modern aircraft today.

Almost a century after George Cayley, the Wright brothers, learning from much of his work, began working on their own glider. The Wright brothers used their glider as a test bed to perfect lift and control techniques before eventually developing it into the first powered, controlled, manned heavier-than-air flight. The first and second gliders that the Wrights created both performed very poorly, and as a result the Wrights continued to research hundred of wing designs with the use of a wind tunnel. The third glider model the Wrights developed flew well--so well, in fact, that they flew it hundreds of times. The reason they conducted so many flights was to continue to perfect the lift and control surfaces. In the nearly hundred years between George Cayley's first ideas and the Wright brothers' first flight, there were numerous other pioneers that continued to build, test, and fly gliders. Each iteration of their glider was an improvement on the last and tested a new idea and concept that continued to drive aviation innovation.

Slide 8: Conduct the **Formative Assessment.**

Show students a video that explains how the Wright brothers improved upon what was already known about flight in order to achieve controlled flight.

- "Wright Brothers Didn't Invent Flight" (Length 2:22)
  http://video.link/w/fKJd

Allow up to 10 minutes for the formative assessment. If time allows, ask groups to share their answers with the class. Collect group work and grade up to 10 points based on completeness and participation. [DOK-L2; infer, summarize]

Formative Assessment

Have students work in groups of two to three to respond to the following questions regarding what they just learned in the video "Wright Brothers Didn't Invent Flight." Play the video again if needed and allow groups to use their notes.

1.
Why do you think the video is titled "Wright Brothers Didn't Invent Flight"?

2.
What important design changes did the Wright brothers make to their predecessor's design?

EXPLAIN

Teacher Material: The "Wright" Approach Presentation

According to the creator of the video, the Wright brothers didn't invent flight. However, they were definitely the very first pioneers to make flight practical. They did this by solving three major challenges that allowed for the first powered, controlled flight: CONTROL, LIFT and PROPULSION.

Slides 9-14: Guide the students through a discussion about how the Wright brothers solved each of these problems. Also, discuss the mechanisms the brothers used to overcome these challenges in terms of the engineering practices.

Slide 9: Wilbur and Orville conducted preliminary tests on as many as 200 different model wing shapes as they perfected the operation of their wind tunnel. They made formal tests and recorded data on nearly 50 of these.

The wind tunnel and instruments the Wright brothers designed worked accurately and efficiently. They designed their wind tunnel balances to determine two specific values in the lift and drag equations: the coefficients of lift and drag. Not only were they able to check the accuracy of Otto Lilienthal's table of coefficients for his single wing shape, but they also collected data for dozens of other shapes. This allowed them to select the most efficient wing for the aircraft they wanted to build.

Slide 10: Have students demonstrate roll, pitch and yaw. They should stand up and put their arms "wings"out to their sides and make a "T" shape.

To demonstrate “roll”

- Have students stand with the feet planted and arms outstretched, then ask students to “tilt” their bodies at the waist to the left, keeping their right arm high and their left arm low. “Roll” back and have students “tilt” their bodies as the waist to the right but keeping their right arm low and left arm high.

To demonstrate “pitch”

- Have students bend forward and then backward at the waist while keeping their head upright and arms outstretched.

To demonstrate “yaw”

- Have students stand with their feet planted and arms outstretched, then ask students to “twist” at the waist to the left and then to the right.

Slide 11: The Wrights realized that if the wing on one side of the aircraft met the oncoming flow of air at a greater angle than the opposite wing, it would generate more lift on that side. In response, that wing would rise, causing the aircraft to bank. If the pilot could manipulate the wings in this way, he could maintain balance and turn the aircraft as well.

The brothers considered using a system of gears and pivoting shafts to angle the wings in opposite directions, but they quickly realized such a system would be too heavy and complex. Then they conceived the elegant concept of twisting, or warping, the wing structure itself, a method they called wing-warping.

Slide 12: To control pitch, the Wright brothers put the elevator in front of the wings. Ask students where elevators are located on aircraft today. The answer is generally on the tail of the airplane.

Slide 13: To solve the control reversal problem, the Wrights made the rudder movable, so its position could be coordinated with the wing-warping. They connected the rudder control cables to the wing-warping hip cradle, so a single motion by the pilot operated both controls. They also changed the original double rudder to a single rudder.

Slide 14: The Wright engine, with its aluminum crankcase, marked the first time this breakthrough material was used in aircraft construction. Lightweight aluminum became essential in aircraft design development and remains a primary construction material for all types of aircraft.

The simple motor produced 12 horsepower, an acceptable margin above the Wrights’ minimum requirement of 8 horsepower.

EXTEND

Teacher Material: The “Wright” Approach Presentation
Student Material: The “Wright” Approach Student Activity 1, The “Wright” Approach Student Activity 2

Slide 15: Today’s airplanes still have all the “Wright” parts. Every airplane built today has been designed and built according to principles discovered by the Wright brothers. Some parts look much different, but the elements remain the same.

In this extension, students will find similarities and differences among the Wright Flyer, a Cessna 172, and the Space Shuttle. Have students complete the Venn Diagram provided on **The "Wright" Approach Student Activity 1** to help underscore just how enduring the Wright brothers’ discoveries have been. When the students are finished with their worksheets, have them present their findings. Keep a running list of the items the students find that are common to all three aircraft. This activity will likely extend into the second session of this lesson.

Slide 16: As a second extension activity, have students take a position on who actually flew first.

Some people believe that a Connecticut aviation pioneer named Gustave Whitehead, not the Wright brothers, was the first to achieve powered flight.

Set up the activity with a video that describes the controversy.

- "Who Flew First?" (Length 01:57)
  http://video.link/w/jKJd

Provide copies of **The "Wright" Approach Student Activity 2** for students to answer questions and take a position. The AOPA article below is including in the activity and will help students gather evidence and form their opinion.

https://www.aopa.org/news-and-media/all-news/2013/march/20/who-flew-first

After students have completed the worksheet, lead a class discussion that will allow the students to make a case for their chosen side of the issue.

EVALUATE

Teacher Material: The "Wright" Approach Presentation

Slide 17: Conduct **Summative Assessment.**

[DOK-L4; explain, DOK-L1, define]

Summative Assessment

Working in groups of two to three, have students draw and label a diagram showing how the Wright brothers solved the problem of aircraft control. Include the terms roll, pitch, and yaw in the diagram.

Summative Assessment Scoring Rubric

Follows assignment instructions

Diagram shows evidence of one or more of the following:

- Knowledge of how the Wright brothers solved the problems of flight control.
- Knowledge of the terms, *roll, pitch*, and *yaw*

Diagram shows an understanding of the concepts covered in the lesson

Diagram shows in-depth thinking including analysis or synthesis of lesson objectives

Points	Performance Levels
9-10	Consistently demonstrates criteria
7-8	Usually demonstrates criteria
5-6	Sometimes demonstrates criteria
0-4	Rarely to never demonstrates criteria

GOING FURTHER

Read an AOPA article and watch a video about a team attempting to recreate the Wright Flyer. https://www.aopa.org/news-and-media/all-news/2016/december/14/virginias-wright-experience-honors-original-1903-flyer

Students can watch the "STEM in 30" video about the Wright brothers for a more in-depth understanding of how the brothers' ownership of a bicycle business and their meticulous attention to detail helped make them "first in flight."

https://airandspace.si.edu/events/wilbur-and-orville-wright-process-invention-0

STANDARDS ALIGNMENT

NGSS STANDARDS

Three-dimensional Learning

- **HS-ETS1-1** - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
    - Science and Engineering Practices
        - Asking Questions and Defining Problems
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.A: Defining and Delimiting Engineering Problems
    - Crosscutting Concepts
        - Systems and System Models
        - Influence of Science, Engineering, and Technology on Society and the Natural World
- **HS-ETS1-3** - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - Influence of Science, Engineering, and Technology on Society and the Natural World
- **HS-ETS1-4** - Use a computer simulation to model the impact of proposed solutions to a complex real- world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
    - Science and Engineering Practices
        - Using Mathematics and Computational Thinking
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - Systems and System Models

COMMON CORE STATE STANDARDS

- **RST.9-10.1** - Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- **RST.9-10.2** - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9-10.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **SL.9-10.1.C** - Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
- **WHST.9-10.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.9-10.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

https://wright.nasa.gov/airplane/flyer.html
http://www.wright-brothers.org/Information_Desk/Just_the_Facts/Engines_&_Props/1903_Engine.htm
https://wright.nasa.gov/overview.htm
https://www.nps.gov/wrbr/learn/historyculture/thefirstflight.htm
https://wright.nasa.gov/index.htm
https://youtu.be/WCPapu78SNM