Becoming an Aerospace Engineer

Session Time: Two, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Develop interest in one or more aviation/aerospace career pathways and learn what is required to pursue future employment in the industry. (EU3)

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

ESSENTIAL QUESTIONS

1. How important are engineers to aviation and aerospace?
2. What engineering disciplines exist within aviation and aerospace?
3. What skills and abilities does it take to become an aerospace engineer?

LEARNING GOALS

Students Will Know

- Types of aviation and aerospace jobs available to engineers in various disciplines
- Educational requirements that must be met in order to become an aerospace engineer
- The skills and abilities needed to become a successful aerospace engineer

Students Will Be Able To

- *Create* a solution to a problem using essential skills required to be an aerospace engineer. (DOK-L4)
- *Explain* the skills and abilities required to be an aerospace engineer. (DOK-L2)

ASSESSMENT EVIDENCE

Warm-up
Students will watch a video about how an airliner is made and make a list of all the components of an airplane that engineers design, develop, and test.

Formative Assessment
Working in small teams, students will use critical thinking and creativity to design, build, test, and modify a model that will be used to solve a problem.

Summative Assessment
Students will develop and present slideshows that describe in detail specific aerospace engineering subspecialties.

LESSON PREPARATION

MATERIALS/RESOURCES

- Becoming an Aerospace Engineer Presentation
- Becoming an Aerospace Engineer Student Activity 1
- Becoming an Aerospace Engineer Student Activity 2
- Becoming an Aerospace Engineer Teacher Notes 1

Parachute Challenge Activity

Per Team

- 2 plastic bags
- Fabric or other materials to construct the parachute
- 5 feet of string
- 2 raw eggs
- Tape
- Cardboard or foam board
- Sandwich bag
- Scissors
- Other materials determined by the teacher (paper plate, manila folder, etc.)

Per Class

- Hot glue gun and glue sticks
- Other materials determined by the teacher

Engineering Research Activity (per team)

- Access to PowerPoint (or other presentation software) to create a slide presentation

LESSON SUMMARY

To begin this two-session lesson, students will watch a video about how an Airbus A350 is made. Instruct students to make a list of all the components of an airplane that engineers design, develop, and test. During a class discussion, students will learn what aerospace engineers do and the difference between aeronautical and astronautical engineers.

Students will learn about several aerospace engineering subspecialties and about the skills and abilities that engineers must have to succeed. Working in small teams, students will use critical thinking and creativity to design, build, test, and modify a model that will be used to solve a problem. After students have conducted their second test, have each team share their solution and what they discovered when they thought critically about building their solution.

Finally, students will research a subspecialty related to aerospace engineering and present an informative slideshow about their chosen field of engineering.

BACKGROUND

Aerospace engineering is all about flight—commercial and military airplanes and helicopters; remotely piloted aircraft and rotorcraft; spacecraft, including launch vehicles and satellites; and military missiles and rockets. Aerospace engineering includes the study of aerodynamics, aerospace structures, propulsion, flight mechanics and systems, and vehicle design. There are a wide range of jobs, disciplines, and specialties within engineering, and many ways engineers contribute to innovation and development in aviation and aerospace.

Aerospace engineers typically specialize in one of two types of engineering: aeronautical or astronautical.

- Aeronautical engineers work with aircraft that stay within Earth's atmosphere. They are involved primarily in designing aircraft and propulsion systems, and in studying the aerodynamic performance of aircraft and construction materials.
- Astronautical engineers work with spacecraft and how they perform both inside and outside Earth's atmosphere.

Aeronautical and astronautical engineers face different environmental and operational issues, but the two fields overlap a great deal because they both depend on the basic principles of math and physics.

Aerospace engineers are continuously improving flight safety and travel conditions. An aerospace engineer may work on the same project for years before completion. These engineers should possess strong critical-thinking and problem-solving skills, computer aided design (CAD) knowledge, and the ability to prioritize and manage jobs effectively. Interest and aptitude in science, math, and information technology are required.

Entry-level aerospace engineers generally need a bachelor's degree. High school students interested in studying aerospace engineering should take courses in chemistry, physics, and math, including upper-level math like trigonometry and calculus.

Students should know aerospace engineering is a demanding field of study. Core college courses include basic engineering theory, physics, and calculus and differential equations, which lead to specialized study of topics such as aerodynamics, wind flow, computer programming, and flight simulation. Within the major are topics such as fuselage design, wing design, structural design, structural requirements, propulsion mechanisms, fuel types, guidance and instrumentation systems, auxiliary equipment, and production. Students also may be expected to conduct their own experiments under the supervision of an instructor.

MISCONCEPTIONS

Create graphic organizers to help students organize information in the **ENGAGE** section. Recording and reviewing notes in graphic organizers helps some students recall this information more easily.

In the **EVALUATE** section, have students write long-term and short-term goals, along with steps to reach them. This will help encourage consistent, achievable progress and help students feel confident in their skills and abilities.

LEARNING PLAN

ENGAGE

Teacher Material: Becoming an Aerospace Engineer Presentation

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

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

Warm-Up

Students will watch a video about how an Airbus A350 is made. Instruct students to make a list of all the components of an airplane that engineers design, develop, and test. When students are finished, ask volunteers to share their answers with the class, make a list of ideas on the board, and allow for a brief discussion. Allow up to 5 minutes for the warm-up.

- "How Airplanes Are Made" (Length 5:13)
  http://video.link/w/1CSd

[DOK-L2; *predict, summarize*]

Answers may include:
Seats and other interior components, flight controls, structures (wings, fuselage, landing gear, etc.), materials (composites), electronics and avionics (hardware), environmental systems (air-conditioning, pressurization), propulsion (engines), and more.

EXPLORE

Teacher Material: Becoming an Aerospace Engineer Presentation

Slide 5: Aeronautical engineers work at the forefront of developing technology to meet the ever-increasing global travel demands. Aerospace engineering evolved from mechanical engineering, the study of the application of engineering principles to mechanical problems. Therefore, the two fields are closely related.

Aerospace engineering includes the study of aerodynamics, aerospace structures, propulsion, flight mechanics and systems, and vehicle design. There are a wide range of jobs, disciplines, and specialties within engineering, and many ways engineers contribute to innovation and development in aviation and aerospace.

Aeronautical engineers interact with some of the most exciting elements of technology, designing vehicles to operate in extreme environments and under exacting conditions. With the global demands for high-speed travel, the continuing dramatic growth in commercial air travel, and the recent radical designs of commercial space travel and double-decker aircraft (like the Airbus A380), there has never been a better or more interesting time to participate in the field of aeronautical engineering.

Slide 6: Aerospace engineers bring concepts into reality by applying the principles of engineering to design, develop, and maintain highly sophisticated technologies for use in aviation, defense systems, and space exploration. They ensure that aircraft, spacecraft, satellites, and missiles meet safety requirements by creating new and more environmentally friendly designs and manufacturing methods. They often use Computer Aided Design (CAD), robotics, lasers, and advanced electronics to assist them.

On the next few slides, students will learn about the differences between two types of aerospace engineers—aeronautical and astronautical engineers.

Slide 7: Aeronautical engineers work with aircraft that stay within Earth's atmosphere. They are involved primarily in designing aircraft and propulsion systems, and in studying the aerodynamic performance of aircraft and construction materials.

Slide 8: Astronautical engineers work on spacecraft that fly both inside and outside Earth's atmosphere, such as rockets, satellites, space probes, etc. An astronautical engineering student likely would take courses such as Spacecraft Design, Spacecraft Dynamics, and Orbital Mechanics.

Slide 9: There are many aeronautical engineering subspecialities. Aerospace engineers may be experts in aerodynamics, thermodynamics, propulsion, acoustics, human factors, flight test, guidance and control systems, or others.

Referring back to the list of components students made during the warm-up, ask them which components fit into the subspecialities listed on the slide (i.e., wings fall into the subspecialty of structures, and engines belong into the subspecialty of propulsion).

Slides 10-11: Explain to students what is involved in each of the highlighted subspecialties. An alternate to providing students this information via a class discussion is to divide the class into teams and ask each group to research a subspecialty and report back to the class with details regarding what each is responsible for.

Guidance/Navigation—Design of systems to control the movement of aircraft and spacecraft. In many cases these functions can be performed by pilots. However, because of the speed of, for example, a rocket's dynamics, human reaction time is too slow to control this movement. Therefore, systems—now almost exclusively electronic—are used for such control.

Structures—Aerospace structures differ from other structures due to the high demands for performance and weight. Modern aerospace structures typically require the use of advanced materials such as composites. To obtain the level of performance required from flight structures, thorough knowledge of material limitations, structural stability, and strength considerations are needed.

Propulsion—Involves the study of the basic operation and design of aerospace propulsion devices, including both air-breathing engines and rocket powerplants.

Human Factors—Aerospace human factors includes the principles of engineering and psychology in order to evaluate flight systems and how they interact with pilots. Human factors specialists are involved in the analysis and design of flight displays, ejection systems, etc.

Flight Test—Involved in the flight testing of prototype aircraft or aircraft systems. They oversee the building of the aircraft to the proper flight-test configuration, ensure that sensors and recording systems are installed, and prepare the maneuver-by-maneuver plans.

EXPLAIN

Teacher Materials: Becoming an Aerospace Engineer Presentation, Becoming an Aerospace Engineer Teacher Notes 1
Student Material: Becoming an Aerospace Engineer Student Activity 1

Slide 12: In small teams, ask students to discuss, based on what they've learned so far, what skills or qualities they think are needed to become an engineer. Each team should be prepared to share their answers with the class.

Questions

Answers may include:
Engineers typically need strong math and science skills. Engineers also need to be able to work well in cross-disciplinary teams, have strong written and verbal communication skills, be detail-oriented, and be good problem-solvers. Engineers need persistence to solve the difficult challenges they face, and they need to be original thinkers to develop new solutions.

Slides 13-14: Describe the most essential skills and qualities needed to be an engineer. Share that math and science are the "language" that engineers use to conduct their work.

Students will need to pass courses in chemistry, physics, and math, including upper-level math like trigonometry and calculus. Core college courses include basic engineering theory, physics, and calculus and differential equations, which lead to specialized study of topics such as aerodynamics, wind flow, computer programming, and flight simulation.

Slide 15: Conduct the **Formative Assessment.** This activity likely will start and extend through the second session of the lesson.

Formative Assessment

Students have learned that essential skills an engineer must have are the ability to think critically, mathematically, and scientifically. In this activity, they will use critical thinking and creativity to design, build, test, and modify a model that will be used to solve a problem.

Provide students **Becoming an Aerospace Engineer Student Activity 1.** Use **Becoming an Aerospace Engineer Teacher Notes 1** to assess student responses.

After students have conducted their second test, have each team share their solution and what they discovered when they thought critically about building their solution. Did they change their solution as a result of their first test? How?

[DOK L4; *create*, DOK L3; *compare, apprise*]

EXTEND

Teacher Material: Becoming an Aerospace Engineer Presentation
Student Material: Becoming an Aerospace Engineer Student Activity 2

Slide 16: Provide information about the types of skills that engineers need. These essential skills were initially covered in the first unit of the previous semester.

Slides 17-18: Students should know aerospace engineering is a demanding field of study. Emphasize that if students wish to pursue engineering as a career, then taking many high-level math and science courses in high school and college is a necessity.

Core college courses include basic engineering theory, physics, and calculus and differential equations, which lead to specialized study of topics such as aerodynamics, wind flow, computer programming, and flight simulation. Within the major are topics such as fuselage design, wing design, structural design, structural requirements, propulsion mechanisms, fuel types, guidance and instrumentation systems, auxiliary equipment, and production. Students also may be expected to conduct their own experiments under the supervision of an instructor.

EVALUATE

Teacher Material: Becoming an Aerospace Engineer Presentation

Slide 19: Conduct the **Summative Assessment.**

Working in small teams, students will research a subspecialty related to aerospace engineering. A list of subspecialties is provided. Students should receive teacher permission if they would like to research a subspecialty or engineering field not included on the list. Have students organize and record the information they find using **Becoming an Aerospace Engineer Student Activity 2.**

- Guidance/navigation
- Structures

- Propulsion
- Human factors
- Flight test
- Other

Students should seek information about the education and certification or licensing requirements, pay, and types of tasks or projects these engineers typically do. For education and licensing requirements, encourage students to also include what high school courses can be taken to help prepare for a career in their chosen engineering specialty. Based on what they learn about their engineering subspeciality, have students identify several companies that might hire this specific type of engineer.

Summative Assessment

Students will develop informative slideshows that describe in detail the engineering fields their teams researched. The slideshows should include information about the subspecialties, education and licensing requirements, types of activities or projects, jobs in aviation or aerospace, and pay.

Students should be prepared to give 5-minute presentations and take questions from the class.

Summative Assessment Scoring Rubric

- Follows assignment instructions, and submits work that is neat and organized.
- Presentation shows evidence of one or more of the following:
    - Knowledge of the types of aviation and aerospace jobs available to engineers in various disciplines
    - Understanding of requirements that must be met in order to become an aerospace engineer
    - Knowledge of the skills and abilities needed to become a successful aerospace engineer
- Includes photos, graphics, or text treatments that enhance understanding of the topic.
- Presentation shows an understanding of course concepts covered in the lesson.
- Presentation shows an 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

Encourage students to select an engineering field of interest to them and find several job postings for that type of engineer in an aviation or aerospace field. Based on those job postings, have the students develop a list of educational activities, licenses, certifications, and skills they might need to obtain a job in their chosen field.

Students also may benefit by learning what engineering associations exist, such as the Organization of Black Aerospace Professionals or Society of Women Engineers. These associations often offer resources, student programs, or training opportunities.

Many videos are available on YouTube that can provide more information to students interested in pursuing engineering as a career. One website that provides information on 40 different engineering degrees that might be helpful is https://typesofengineeringdegrees.org/.

STANDARDS ALIGNMENT

NGSS STANDARDS

Three-dimensional Learning

- **HS-ETS1-2** — Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
  - Science and Engineering Practices
    - Constructing Explanations and Designing Solutions
  - Disciplinary Core Ideas
    - ETS1.C: Optimizing the Design Solution
  - Crosscutting Concepts
    - None
- **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

- **RL.9-10.4** — Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).
- **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.
- **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

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https://www.nasa.gov/centers/langley/news/factsheets/FS-2001-09-68-LaRC.html
http://www.worldwidelearn.com/online-education-guide/engineering/aerospace-engineering-major.htm
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