



## Designing Aircraft in 5 Easy Steps? It's a Challenge!

### LESSON THEME

This lesson uses the NASA *Future Flight Design Challenge* activity and website to help students learn how NASA engineers develop and test experimental aircraft to solve a specific problem by using the engineering design process.

### OBJECTIVES

Students will:

- Solve an engineering design challenge based on specific criterion
- Build and design 4 paper aircraft based on actual NASA experimental aircraft
- Conduct and test their models and gather data of the results based on the design process and a specific challenge
- Evaluate the performance of each aircraft based on engineering requirements

**NASA SUMMER OF INNOVATION UNIT**  
*Engineering- The Design Process*

**GRADE LEVELS**  
*7<sup>th</sup> – 9<sup>th</sup>*

**CONNECTION TO CURRICULUM**  
*Problem solving, Design, Forces and Motion*

**TEACHER PREPARATION TIME**  
*45 minutes*

**LESSON TIME NEEDED**  
*60 minutes; 1.5 hrs if website is explored*  
*Complexity: Basic*

The graphic features a collage of images related to aerospace: a person in a flight suit, a paper airplane, a person working at a computer, and a person in a lab coat.

### NATIONAL STANDARDS

The standards addressed in the *Lesson Plan* activities are listed below. Each activity will include some or all of the standards addressed in each or all of these areas.

#### National Science Education Standards (NSTA)

##### *Science as Inquiry*

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

##### *Physical Science*

- Motions and forces

##### *Science and Technology*

- Abilities of technological design Understanding about science and technology

#### ISTE NETS and Performance Indicators for Students (ISTE)

##### *Creativity and Innovation*

- Use models and simulations to explore complex systems and issues
- Develop an understanding of the core concepts of technology

##### *Communication and Collaboration*

- Contribute to project teams to produce original works or solve problems
- Develop an understanding of engineering design

##### *Research and Information Fluency*

- Evaluate and select information sources and digital tools based on the appropriateness to specific tasks

- Process data and report results

##### *Technology Operations and Concepts*

- Understand and use technology systems
- Troubleshoot systems and applications

## MANAGEMENT

The lesson requires a minimum of preparation prior to the lesson. All curriculum and supplementary materials are available on the website. The Future Flight Design poster should be downloaded and the 4 templates for the aircraft printed for each team of two. Each aircraft model should be constructed prior to the lesson to help student visualize the folding. Review the steps of engineering and explain the criteria for this activity.

## CONTENT RESEARCH

This activity examines how shape and materials affect the airplane's ability to carry cargo. This engaging activity has students build 4 types of aircraft to solve a specific design problem. Each student then goes through each of the five steps of engineering design to solve a specific problem.

1. *Define the Problem;*
2. *Generate Ideas;*
3. *Select a Solution;*
4. *Test and Refine;*
5. *Present the results.*

## KEY CONCEPTS:

- When designing a new system an engineer must choose a variety of possible options which results in different performance of the system
- Each design choice has an effect on the overall design of the final system
- Each new system has specific design criterion which engineers are required to meet
- Engineers must predict how each design choice will effect the final result
- Testing of the final design is always an essential part of the process

## KEY TERMS:

- **Design Criterion-** standards or requirements that the design must meet
- **Design Constraints-** are the limits that the design must meet

## LESSON ACTIVITIES

The most effective sequence for this lesson is to start the students progressing through the online activity with the website in teams of two if computers are available. If Internet connection is not available the teacher can download the entire website and show it as a teacher directed activity with the hands on poster activity lesson to follow.

### The Design Laboratory

Students will be introduced to the basic design concepts of aeronautics by progressing through the following interactive labs: fuselage lab, propulsion lab, aeronautics lab, CFD lab, and wind tunnel lab. The basic design challenge has students testing and gathering data for one of 4 different paper airplanes.

<http://futureflight.arc.nasa.gov/map.html>

### The Design Center

Students pick one of three aircraft designs and by choosing a variety of construction variables the aircraft performance is evaluated.

<http://futureflight.arc.nasa.gov/dCenter.html>

### The Poster Activity

Students will take the lessons of the previous two sections and construct 4 different aircraft to accomplish a specific design challenge but applying the tools of the engineering design.

<http://futureflight.arc.nasa.gov/designs/index.html>

## MATERIALS

- Copies of Page 1-4 from downloadable Future Flight design poster (side #2); .pdf from website
- 5-6 Sheets of copy paper for each team of two students
- Cloth tape measure or yard stick for measuring test area
- Standard (3 cm) paperclips; two or three boxes as needed
- Colored markers (optional)

## ADDITIONAL RESOURCES

- Grades 6-9: Learning to Fly: The Wright Brother's Adventure: NASA Educator guide that contains student activity pages and templates for building the 1900- 1903 guide. (Downloadable Educator Guide)
- Grades 9-12; Flight Testing Newton's Laws; a physics orientated CD-ROM and video program that contains 10 lessons covering laws of motion, trigonometry, vector addition and resolution of forces.
- Grades 9-12; The CD "Gate to Gate" was coproduced by the FAA and NASA. This CD-ROM takes gives the student a glimpse of they type of careers of people who manage air traffic and highlights some of the tools they use every day. Contact: Central Operation of Resources for Educators (CORE), Lorain County JVS-CORE, 15181 Route 58 South, Oberlin, Ohio 44074

URL: [Core.nasa.gov](http://Core.nasa.gov)

Phone: (440) 775-1400

Fax: (440) 775-1460

E-mail: [NASA\\_order@lcjvs.net](mailto:NASA_order@lcjvs.net)

## DISCUSSION QUESTIONS

The downloadable Future Flight Activity teacher Guide and Design lab has discussion questions for each section to be completed.

<http://futureflight.arc.nasa.gov/teacher.html>

- Can the body of an aircraft affect its performance? *The shape of the body may reduce drag which may help to increase speed*
- What are some parts of the aircraft system? *Answers will vary: to include cabin, wings, propulsion system, communications system, etc.*

## ASSESSMENT ACTIVITIES

Assess student aircraft designs to determine whether they meet objectives. The poster activity can be evaluated by the quality of the design for the 4 different aircraft and how well they meet the design challenge.

## ENRICHMENT

Upon completion of the design challenge participants can visit the Web-based interactive, problem- based learning environment where students can continue to learn about forces of flight and engineering design, as they design air transportation and aircraft systems of the future. See the additional resources section for more activities that can be done with students. <http://futureflight.arc.nasa.gov/>