



Getting the Drop on Flight With the “X” Planes

LESSON THEME

This lesson uses the online NASA CONNECT: Proportionality: The X-Plane Generation Educator guide and the NASA aeronautics bookmark; Designing the 21st Century Aerospace Vehicle; and Ring Wing Glider activity to help students learn how small-scale models developed with simple materials can result in new aircraft and future space launch vehicles.

OBJECTIVES

Students will

- Discuss what makes a model a “scale model” and how engineers use models in research, design, development, and testing
- Construct a scale model aircraft using an approved pattern and discuss its advantages to full-scale testing
- Use measurement tools to determine the linear dimensions of the model
- Construct and fly a small, simple-scale model and determine how it could be controlled

NASA SUMMER OF INNOVATION

UNIT

Engineering - Aeronautics

GRADE LEVELS

7 – 9

CONNECTION TO CURRICULUM

Technology Research Tools and Science and Technology in Society

TEACHER PREPARATION TIME

1 hour (includes 30-minute video viewing)

LESSON TIME NEEDED

Construction lesson: 1 hour (X–33 and Ring Wing Models)

Testing activity: 15 minutes (Ring Wing Model)

Complexity: X–33 Model (Moderate-Difficult) and Ring Wing (Easy)

NATIONAL STANDARDS

National Science Education Standards (NSTA)

Science and Technology

- Abilities of technological design
- Understanding about science and technology

Science in Personal and Social Perspectives

- Science and technology in society

History and Nature of Science

- History of Science

ISTE NETS and Performance Indicators for Students

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

Technology Operations and Concepts

- Understand and use technology systems
- Troubleshoot systems and applications

MANAGEMENT

The lesson is most effective if the teacher constructs the X-33 paper model prior to the activity as an example. Use the template found in the NASA CONNECT: The X-Plane Generation Guide activity on pages 21 and 22. The X-33 model is best constructed in groups of two students. The Ring Wing Glider is a simple model that can be constructed and flown at the beginning or at the end of the lesson by each student.

CONTENT RESEARCH

The X-33 was a proposed engineering concept design to replace the space shuttle with a single stage to orbit fully and be a reusable space vehicle. Its goal was to lower the cost of placing equipment into orbit by a factor of 10. It was the first step to determine if a larger vehicle "VentureStar" was feasible. Numerous companies worked together to construct this ½ scale spacecraft. It was nearly constructed when the project was cancelled after a long series of technical difficulties indicated that much more engineering work was needed.

KEY CONCEPTS:

- When designing a new system an engineer often use small models to gather data and test designs.
- Each design choice has an effect on the overall design of the final system.
- The math concepts of ratio and proportion are often used by engineers to predict performance of larger designs.
- Engineers must predict performance of a full scale designs based on scale models.
- Testing of the final design is always an essential part of the process.
- Other factors such as funding and national policy determine whether projects are completed.

KEY TERMS:

- **Canted:** Slanting.
- **Proportionality:** Two objects that have the same ratio between all of their corresponding dimensions.
- **Scale:** Ratio between the dimensions of an object and the corresponding dimensions of a drawing or model of the object, often written as 1:x, where x is the scale factor.
- **Surface Area:** Area enclosed in a two-dimensional surface; for example, the area of a rectangle.

LESSON ACTIVITIES

Constructing the X-33

Students create a paper model of the proposed X-33. Measurements of each surface and comparisons to the full-scale versions introduces students to scale model concepts.

- Download the X-Plane Generation activity guide and video from: Utah State University's "Teacherlink"
- **username: nasamovies; password: aesp**
 - URL: <http://teacherlink.ed.usu.edu/tlnasa/>
 - Video download from NASA Video & Multimedia
 - NASA Connect Series 1999-2000 Season; Proportionality: X-Plane Generation

Constructing and testing the Ring Wing Glider

- Students create a paper model of the Ring Wing flying model. They test fly this vehicle and determine how they might be able to add control surfaces to adjust the flight pattern of this model
- Download the Designing the 21st Century Aerospace Vehicle bookmark from

MATERIALS

Teacher Preparation Materials

- **Download** the X-Plane Generation activity guide and video from: Utah State University's "Teacherlink"
- **username: nasamovies**
password: aesp
 - URL: [Here](#)
 - Select: NASA Video & Multimedia
 - NASA Connect Series 1999-2000 Season; Proportionality: X-Plane Generation
- Download Designing the 21st Century Aerospace Vehicle bookmark from: Utah State University's "Teacherlink"
- **username: nasamovies**
password: aesp
 - URL: [Here](#)
 - Select: Other NASA Print Resources
 - Select: NASA Bookmarks and Trading Cards

Student Materials (per 3-student groups)

- X-33 template copied on heavy weight paper; plain 8- by 11-inch paper; 1 piece of copy paper needed for Ring Wing Glider student
- Metric rulers
- Hobby glue and masking tape (to hold folds while drying)
- Scissors

- URL: <http://teacherlink.ed.usu.edu/tlnasa/>
- Select: Other Print Resources

RELATED RESOURCES

Solar System Exploration: paper models: <http://solarsystem.nasa.gov/kids/papermodels.cfm>
 NASA X-1 Paper Glider Kit: <http://futureflight.arc.nasa.gov/resources.html>.

DISCUSSION QUESTIONS

If the entire X-Plane Generation is viewed, there are numerous “Cue Card” questions included in the teacher activity guide that can be answered. These are best reviewed by stopping the video at the appropriate point during the showing (see page 14 of activity guide).

Example:

- How do engineers use models to test their ideas? *Scale models provide realistic data that can be used to determine performance of a full-scale design.*
- What are some of the reasons that resulted in this project being cancelled? *Equipment failure, engineering design flaws, funding policy, and the unavailability of advanced technology can all contribute to unique design projects not being completed.*

ASSESSMENT ACTIVITIES

Student progress for each activity will be assessed by observing the final quality of the constructed X-33 aircraft. Students should work as a team and be evaluated as to how well this “team” accomplished the job.

ENRICHMENT

If computers are available, participants can visit the NASA Aeronautics site to view the interactive feature called NASA Aeronautics Research Onboard at <http://www.nasa.gov/externalflash/aeroonboard/> to determine how research has affected the entire aircraft industry.