Gliding into the Future

Lesson 8

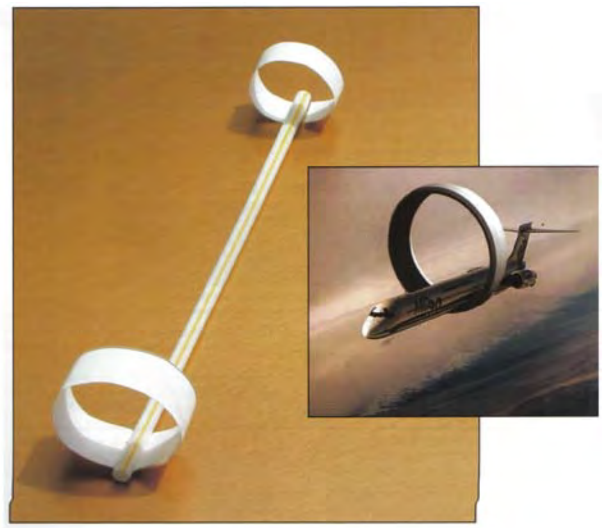
Lesson Reference: CAP's AEX II, vol. 2; NASA lesson, Getting the Drop on Flight with the "X" Planes, at http://www.nasa.gov/pdf/546442main_E1_GettingTheDropOnXPlanes_C4.pdf

Objectives:

- Students will compare past flying machines to flying machines of today and the future, identifying similarities and differences using a Venn diagram.
- Students will discuss how engineers use models in research, design, development, and testing.
- Students will construct and fly an aircraft using an approved pattern and discuss its advantages to full-scale testing.
- Students will use measurement tools to determine the dimensions to build an experimental model.
- Students will construct a flying machine and conduct an experiment with it following the scientific method.

National Standards:

<u>Math</u>



- Understand and apply basic concepts of probability
    - o Use proportionality and a basic understanding of probability to make and test conjectures about the results of experiments and simulations
- Communication
    - o Organize and consolidate mathematical thinking through communication
- Connections
    - o Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
    - o Recognize and apply mathematics in contexts outside of mathematics
- Representation
    - o Create and use representations to organize, record, and communicate mathematical ideas

<u>Science</u>

- Unifying Concepts and Processes
    - o Evidence, models, and explanation
- Content Standard A: Science as Inquiry
- Content Standard B: Physical Science
    - o Properties and changes of properties in matter

- Content Standard E: Science and Technology
    - Abilities of technological design
    - Understanding about science and technology
- Content Standard G: Science in Personal and Social Perspectives
    - Science and technology in society
- Content Standard H: History and Nature of Science
    - History of Science

ISTE NETS Technology Standards
- 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
    - Develop an understanding of engineering design
- Critical Thinking, Problem Solving, and Decision Making
- Technology Operations and Concepts
    - Understand and use technology systems
    - Troubleshoot systems and applications

Background Information: (based on the Ring Wing lesson from AEX II, vol. 2, and http://www.nasa.gov/pdf/546442main_E1_GettingTheDropOnXPlanes_C4.pdf)

From the very beginning, man has had some pretty strange thoughts of what a flying machine should look like. The original idea was that if it looked like a bird and flapped like a bird, it just had to fly. They quickly learned that flapping did not work with their current technology. In fact, it was not until the early Nineteenth century that someone actually came up with the idea that wings did not necessarily have to flap in order to fly. An English nobleman, Sir George Cayley, created a glider that looked very similar to aircraft of today. It consisted of a wing in the front, a stick fuselage, and a horizontal and vertical stabilizer in back.

Over time, the scientific method of coming up with a hypothesis, testing, and arriving at a conclusion was what worked. The credit belongs to men like Samuel Langley, Otto Lilienthal, Octave Chanute, and the Wright Brothers for finally making it all come together. Everyone followed, for the most part, Cayley's concept of how an aircraft should look; however, conventional wings, fuselage and tail are not the only way to fly. This activity stretches the students' thinking to an unconventional means of flying.

X-Planes (the "X" designation originally "XS" or eXperimental Supersonic) are a family of experimental aircraft created by NASA. There are a limited number of X-Planes created due to the fact that they are built solely for flight research. These planes have a cutting-edge design and are often not what you would expect of a conventional airplane.

The X-33 was a proposed engineering concept design created to replace the space shuttle using a single stage to orbit and be fully reusable as well. The goal was to decrease the cost of putting equipment into orbit by 10. It was the first step to see if the larger vehicle, "VentureStar," was possible. Many companies worked together to build this ½ scale spacecraft. It was almost totally finished when the project was cancelled after a long string of technical difficulties that proved more engineering work was needed.

Dryden Flight Research Center ED97-43938-3
X-33 Reusable Launch Vehicle (Artist concept courtesy of Lockheed Martin)

It is important for students to remember that in the design process, engineers use small models to gather data and test designs. The choices that the engineers make have an effect on the overall outcome of the final system. Engineers often use math, specifically ratio and proportion, to predict how designs will function. These models are used to give engineers an idea of how the full scale design will work. The final part of the design process is always testing the final design. As a side note, students need to understand that other factors, including funding and national policy, can often play into whether or not projects are completed.

Materials:

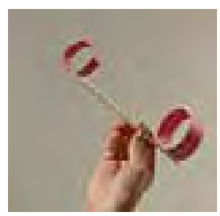
- Plastic soda straw
- Paper
- Scissors
- Scotch tape
- Ruler
- Cotton
- Data Collection Form

Lesson Presentation:

1. Engage the students by showing the NASA clip, NASA's Experimental Plane: What It Is and What It Does. The clip is available online at http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/NASAs_Experimental_Plane.html.

2. Explain to the class that the design of aircraft has come a long way. Show and discuss a NASA PowerPoint, The Invention Process, at http://www.grc.nasa.gov/WWW/k-12/airplane/Talks/KidstoWork.ppt. Discuss similarities in the design of early aircraft. You can also use photographs of early aircraft if technology is not available.

3. Discuss airplanes that are currently being produced and designed by NASA at the Dryden Research Center on Edwards Air Force Base in California. Mention that these planes are referred to as "X Planes." (See background information.) Share the website that shows pictures of these more current aircraft: http://www.nasa.gov/centers/dryden/history/HistoricAircraft/X-Planes/1980/index.html.
4. Distribute the Data Collection Form and have the class compare past airplanes and current/future airplanes using the Venn diagram provided. Similarities go in the shared space and differences in the opposing sides of the circles.
5. Tell the students that today they are going to create and fly two different unconventional looking aircrafts.
6. Provide students with an 8.5" x 11" piece of paper and have students build the ring wing glider following the instructions provided on the page that precedes the Data Collect Form in this lesson plan. You may guide students through the process of constructing the glider, make copies of the instructions for students, or project the instructions onto a classroom wall/screen.
7. Perform flight tests of the ring wing glider as a class.
8. Discuss with the class the importance of being creative, but also following guidelines to ensure safety when creating new aircraft. Talk about how the use of models helps the design process.
9. Inform the students that they will be individually creating another new model, the Double Ring Wing aircraft, following the same principles of the ring wing glider.
10. Distribute the supplies ensuring that each student has a ruler, scissors, plastic soda straw, tape, and two sheets of paper.
11. Instruct the students to draw a rectangle that measures 9.5 cm long and 1.5 cm wide. Then, measure a rectangle that measures 15 cm long and 1.5 cm wide. Cut out the rectangles.



12. Instruct the students to overlap the ends and tape them inside and outside of the loop.
13. Next, have them separate the overlapped ends so that a pocket is formed where the straw can slide through and slip the loops over the straw.
14. Guide the students to follow the instructions and answer the questions on the Data Collection Form.
15. Go over the Data Collection Form as a class and discuss the answers. Discuss what combination made the longest flight distance and students' explanations for the result.

Summarization:
The students should discover that aircraft do not need to look like the conventional glider in order to be able to fly. Students should also learn the importance of writing down information as they experiment. They will discover that the glider flies the best when it is released from the center of gravity. Also, the cotton will affect the airflow which will make the glider fly less effectively. The experimental results will vary as far as producing the optimal Double Ring Wing aircraft.

Career Connection: (from http://stemcareer.com/topcareers/ and http://www.onetonline.org/)

Aerospace Engineer – engineering duties to include designing, constructing and testing aircraft, missiles, and spacecraft. Sample job titles include Aerospace Engineer, Flight Test Engineer, Design Engineer, Systems Engineer, Structures Engineer, Test Engineer, Aeronautical Engineer, Aerospace Stress Engineer, Avionics Engineer, and Flight Systems Test Engineer.

Air Traffic Controller – control air traffic on and within a vicinity of an airport according to established procedures and policies to expedite and ensure flight safety. Sample job titles include Air Traffic Control Specialist (ATCS), Air Traffic Controller, Certified Professional Controller (CPC), Air Traffic Controller (Enroute Option), and Air Traffic Controller (Tower Option).

Scientist – plan, direct, or coordinate activities in such fields as life sciences, physical sciences, research and development in these fields. Sample job titles include Natural Science Manager, Water Team Leader, Fisheries Director, Health Sciences Manager, Laboratory Manager, Natural Resources Planner, Research and Development Director, Coastal Management Planner, Environmental Manager, and Mineral and Aggregate Resources Planner.

Pilot – pilot and navigate the flight of fixed-wing, multi-engine aircraft usually for the transport of passengers and cargo. Must have pilot certificate and rating for aircraft type used. Sample job titles include Airline Captain, First Officer, Pilot, Airline Pilot, Check Airman, Co-Pilot, Airline Transport Pilot, and Commuter Pilot.

Evaluation:
- Data Collection Form
- Construction of Double Ring Wing Glider
- Teacher observation

Lesson Enrichment/Extension:

- Extend the experiment by having the students determine the circumference of the circle made by each loop. Next, have them determine the radius of each loop used.
- Hold a class design competition to create the Double Ring Wing Glider with the longest flight duration. Make sure that the students have the data collected so that their prototype is replicable.
- Future Flight Design at http://futureflight.arc.nasa.gov/ is a web-based interactive, problem-based learning environment where students in grades 5-8 learn about forces of flight and design air transportation and aircraft systems of the future. Biographies highlight careers in aeronautics and aerospace engineering.

Associated Websites:

- NASA's Experimental Plane: What It Is and What It Does (video clip) http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/NASAs_Experimental_Plane.html
- NASA Power Points http://www.grc.nasa.gov/WWW/k-12/airplane/topics.htm
- Getting the Drop on Flight With the "X" Planes http://www.nasa.gov/pdf/546442main_E1_GettingTheDropOnXPlanes_C4.pdf
- NASA: The Process Involved in Aircraft Design (Video Clip) http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/The_Process_Involved_in_Aircraft_Design.html
- NASA Engineering Resource http://www.nasa.gov/offices/education/programs/national/summer/education_resources/engineering_grades7-9/E_x-planes.html
- Consider showing students how the commercial aerospace company, Scaled Composites, worked on new and interesting air and space vehicles by showing the students the engaging flight video at http://vimeo.com/37318941. Play the video on full-screen, turn up the speakers, and enjoy.

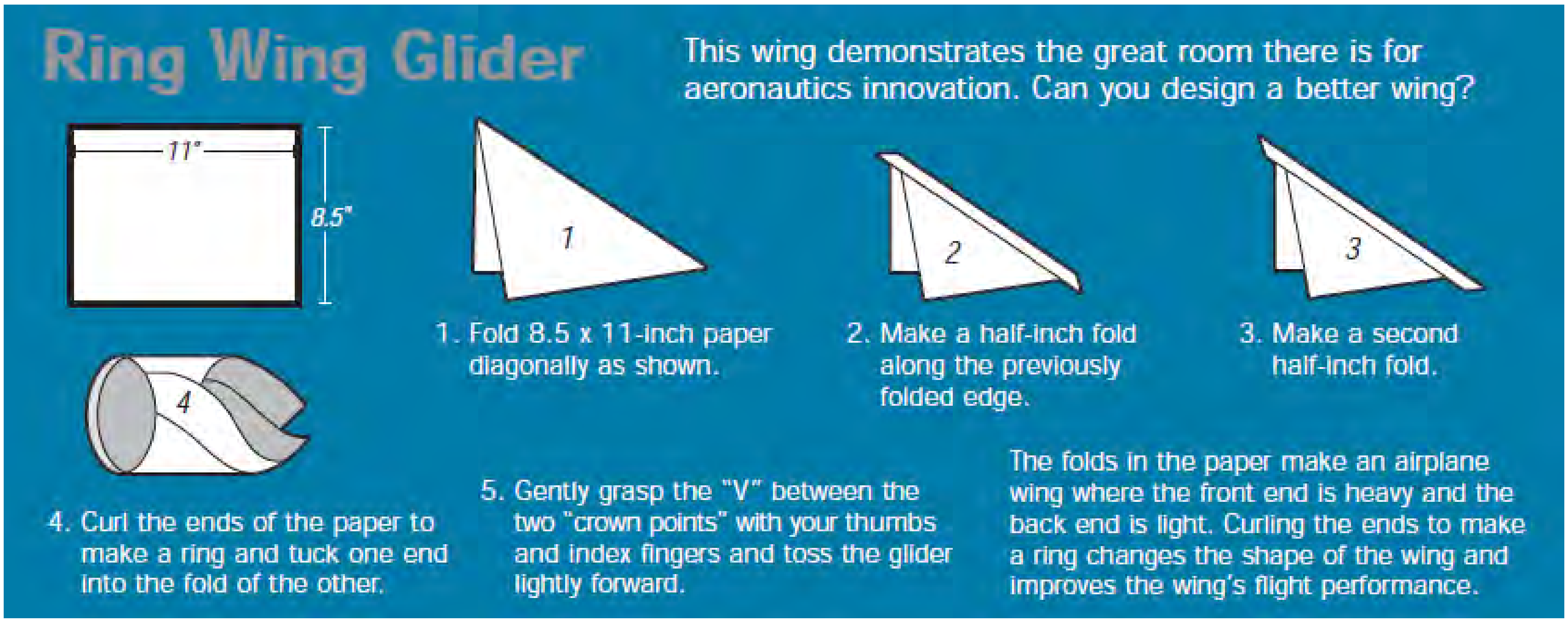
21st Century Aerospace Vehicles

NASA research in nanotechnology, information technology, and biologically inspired technology is opening the door to a new era in aircraft development. It is envisioned that aerospace vehicles in the 21st century will employ sensors that act like a bird's "nervous system" to measure air pressure over the surface of an airplane's wings. Actuators will respond to the sensors like a bird's "muscles," and change the shape of the wings to maintain optimal flight characteristics.

These aircraft of the future will be built of self-healing materials. They will monitor their own performance, their environment, and even their operators, in order to improve safety, increase fuel efficiency, and minimize airframe noise.

Source: http://teacherlink.ed.usu.edu/tlnasa/OtherPRINT/Bookmarks/21stAerospaceVehicle.pdf

Ring Wing Glider



Source: http://history.nasa.gov/SP-09-511.pdf

Name: ______________________________

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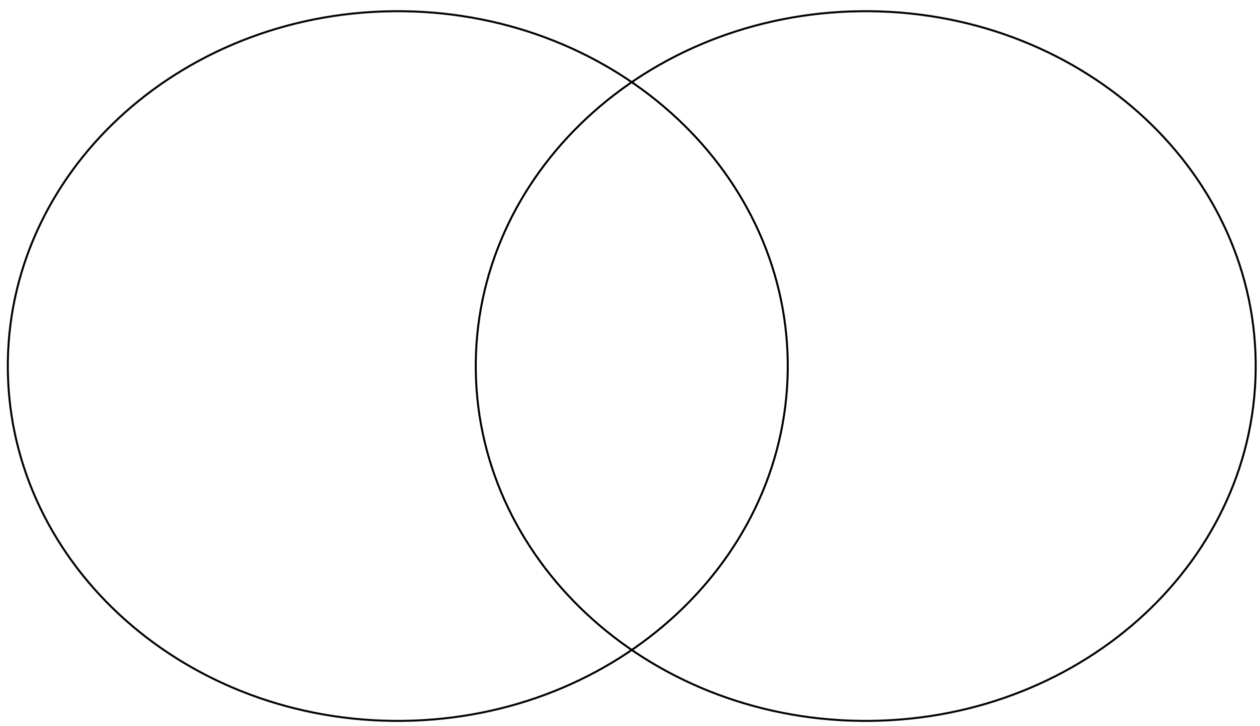
Data Collection Form

Historical Aircraft — Present/Future Aircraft



The point where the glider balances on your finger is the center of gravity. Find the center of gravity. Try holding the glider at different places when you throw it to see how it performs. How does the center of gravity affect the flight of the Double Ring Wing? Explain your answer.

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Try plugging the straw with cotton so air cannot pass through. Throw your glider. Does this make a difference? Why?

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Draw what you think a real aircraft using this design would look like.

Change variables on the Double Ring Wing such as the loop materials, size of loops, placement of loops on straw, and straw length to determine how each affects flight performance. Record your findings on the chart provided and expand as necessary.

Trial #	Material Used	Size of Loops	Placement of Loops	Straw Length	Results (Distance Traveled)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Source: http://www.nasa.gov/news/budget/Budget_Gallery_Aero.html