Aerodynamics

This activity is designed to help Mission Team members learn about basic aircraft design and to explore the effects of weight and balance on the flight characteristics of a model glider. Mission Team members use science process skills to construct and fly the Styrofoam glider. Mission Team members will: 1. Construct a flying model glider; 2. Learn how to change the flight characteristics of a glider; 3. Conduct an experiment to answer a question.

Objectives
Standards and Skills
Background

Science
Science as Inquiry
Physical Science
Science and Technology
Unifying Concepts and Processes
Science Process Skills
Observing
Measuring
Collecting Data
Inferring
Predicting
Making Models
Controlling Variables
Mathematics
Problem Solving
Reasoning
Prediction
Measurement

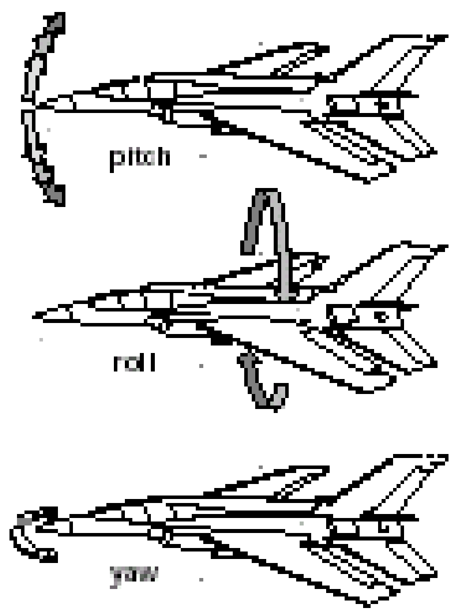
DISCUSSION

On December 17, 1903, two brothers, Wilbur and Orville Wright, became the first humans to fly a controllable, powered airplane. To unravel the mysteries of flight, the Wright brothers built and experimented extensively with model gliders. Gliders are airplanes without motors or a power source.

Building and flying model gliders helped the Wright brothers learn and understand the importance of weight and balance in airplanes. If the weight of the airplane is not positioned properly, the airplane will not fly. For example, too much weight in the front (nose) will cause the airplane to dive toward the ground.

Wilbur and Orville also learned that the design of an airplane was very important. Experimenting with models of different designs showed that airplanes fly best when the wings, fuselage, and tail are designed and balanced to interact with each other. The Wright Flyer was the first airplane to complete a controlled takeoff and landing. To manage flight direction, airplanes use control surfaces. Elevators are control surfaces that make the nose of the airplane pitch up and down. A rudder is used to move the nose left and right. The Wright Flyer used a technique called wing warping to begin a turn. On modern airplanes, ailerons are used to roll the airplane into a turn. Model airplanes are used to develop new concepts, create new designs, and test ideas in aviation. Some models fly in the air using remote control, while others are tested in wind tunnels.

Information learned from models is an important part of aeronautical research programs. The goals of such research are to make airplanes fly safer, perform better, and become more efficient.



Predicting

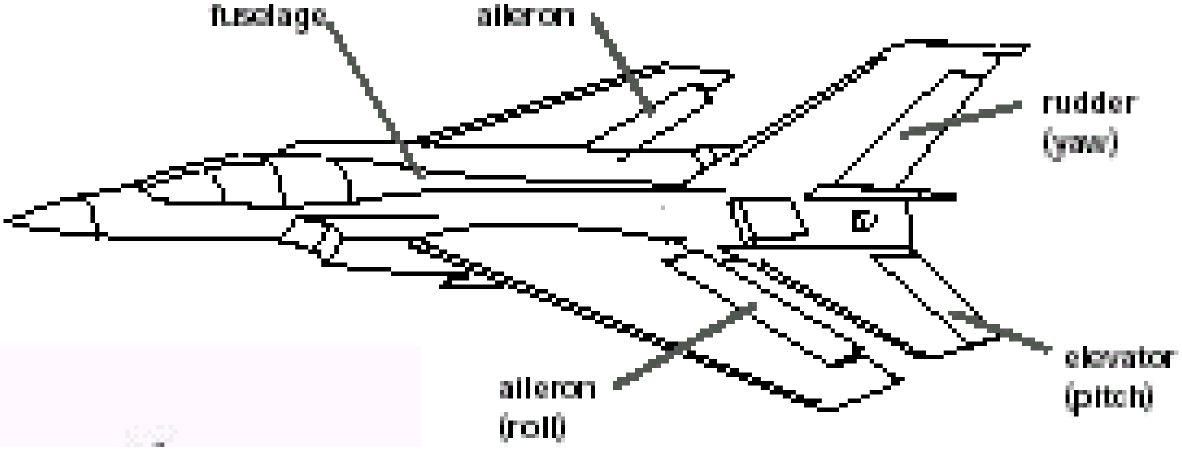
There are many types of vehicles used to transport people and objects from place to place on Earth. How are these vehicles guided to a destination? Turning the steering wheel changes a car's direction. The rudder is used to control the direction of a boat. A bicycle is controlled by turning the handle bars and shifting the rider's weight. For most land and sea vehicles, directional control is accomplished by moving the front end right or left. **Movement in this one axis of rotation or direction is called yaw.**

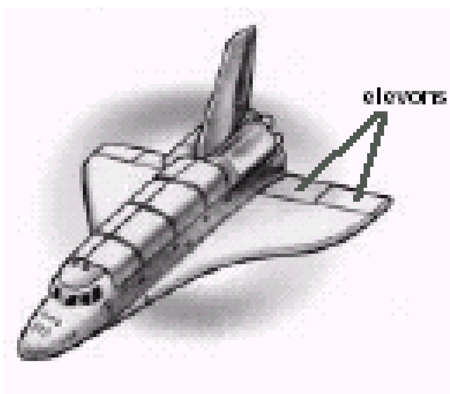
Flying an airplane requires control of three axes of rotation or movement. **The nose of the plane can be moved right and left (yaw), rotated up and down (pitch) and the fuselage can be rolled left and right (roll).** A pilot uses the control wheel or stick inside the airplane to move control surfaces on the wings and tail of the plane. These control surfaces turn the airplane by varying the forces of lift.

Materials

Preparation

Airplanes with conventional wings use ailerons to control roll, a rudder to control yaw, and elevators to control pitch. Airplanes with delta or triangular shape wings have a rudder, but only one control surface (elevon) to control pitch and roll. An elevon serves the same function as an elevator and an aileron.

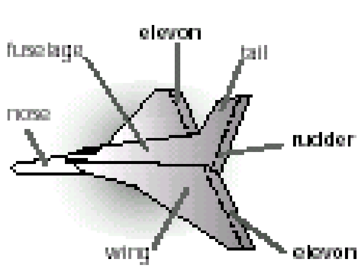




Elevons (pitch and roll) are moveable control surfaces located on the trailing edge of the wings. Working in unison (both up or both down) they function as elevators. Working differentially (one up and one down), they function as ailerons. The Space Shuttle uses elevons for control in the air close to the Earth as it descends from space.

Materials
Styrofoam food tray, about 28 cm X 23 cm (Size 12)
Cellophane tape
Paper clip
Ball point pen
Plastic knife or scissors
Toothpicks
Goggles (eye protection)
Emery boards or sandpaper

1. Show the class a Styrofoam food tray and ask them to identify it. Ask the Mission Team members to list other uses for Styrofoam. Responses may include cups, fast food containers, egg cartons, packaging material, and insulation.
Discuss with the Mission Team members some reasons for using Styrofoam in the construction of a model glider. Materials for building airplanes must be lightweight, strong, and readily available. These qualities make Styrofoam a good material for the construction of flying models. Real airplanes are made from another lightweight, strong, and readily available material called aluminum.

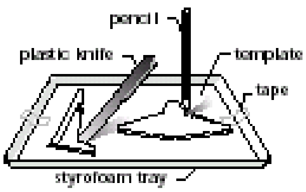


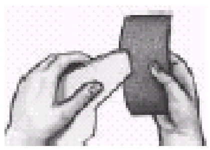
3. Styrofoam can be cut using scissors or a serrated plastic knife.
Mission Team members can also use a sharp pencil or round toothpick to punch a series of holes approximately 2 mm apart around the outside edge of the part. The part can then be pushed out from the tray. Pre-cut the Styrofoam parts for younger Mission Team members.

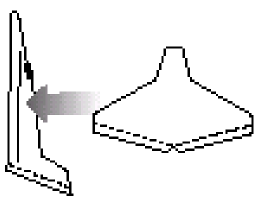
4. Provide the Mission Team members with a word list for parts of the glider.

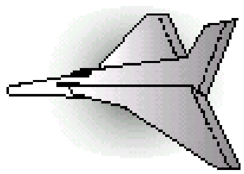
Fuselage (body of the glider), wing (provides lift), rudder (yaw control), elevons (roll and pitch control).

Activity









1. A Mission Team members page contains a template used to cut out the Styrofoam parts of the glider, and instructions for assembling the parts. Educators of K-2 Mission Team members may want to cut out the gliders ahead of time.
2. Ask the Mission Team members to write the name of each airplane part on the template.
3. Tape the glider template to the Styrofoam meat tray.
4. Use a sharpened pencil or toothpick to punch holes around the outline of the wing and fuselage. Make sure the hole goes through the Styrofoam.
5. Remove the template and trace around the outline of the wing and fuselage on the tray using a pencil or toothpick. Punch out each part.
6. Smooth the edges of each part using sandpaper or an emery board.
7. Mark both elevon hinges with a pencil. (Note: to make the elevons hinge up and down, use a pen to lightly score the hinge line on the Styrofoam wing. If a break occurs at the hinge line, use clear tape to repair the break.)
8. Carefully cut a slot in the fuselage and slide the wing into it.

Discussion
Extensions

9. After constructing the glider, the Mission Team members determine the “weight and balance” by attaching a paper clip or binder clip to the fuselage. Mission Team members should vary the position of the clip with each flight until the glider flies the greatest distance in a straight line.
The flight test questions found on the Mission Team members Page can be answered by conducting flight experiments. The Mission Team members change the position of the elevons and draw a diagram to record the flight path of the glider. Test fly the glider and record the results.

1. Do all gliders fly alike? No. Small differences in construction can change the flight characteristics of a model glider.
2. Why do we predict what will happen before a test? Predictions help scientists decide what questions the experiment will answer.
1. Have Mission Team members measure and record the distance of the longest flight.
2. Have the Mission Team members change the size or shape of the wing. Test fly the redesigned glider and record any changes in the flight characteristics.
1. Bend the control surfaces on a model glider and ask the Mission Team members to predict what flight path it will follow. Mission Team members can walk the predicted flight path, and launch a glider to test the prediction.
2. Group Mission Team members together and have them submit a Team Mission Team members Record Sheet that summarizes the experimental flight test results.

Mission Team Questions:

Does changing the position of the elevons on a delta wing glider change its flight path?

Bend the elevons into the positions listed below. Be sure to predict the flight path before flying the glider. Test fly the glider and record the results (up, down, left, right).

Mission Team members Test Pilot Record Sheet (What I Observed)

Predicted Flight Path

Does moving the elevons change the way the glider flies?

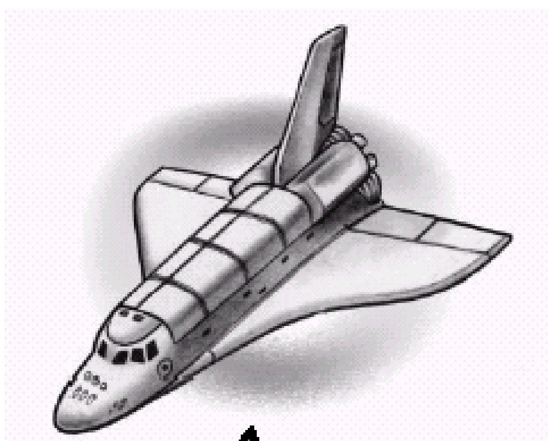
What happens when both elevons are in the up position?

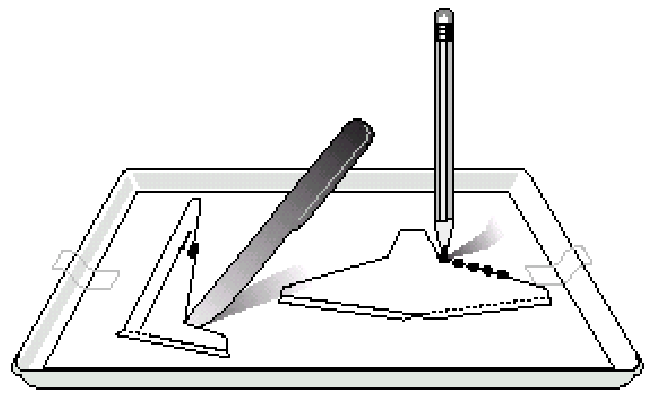
What happens when both elevons are in the down position?

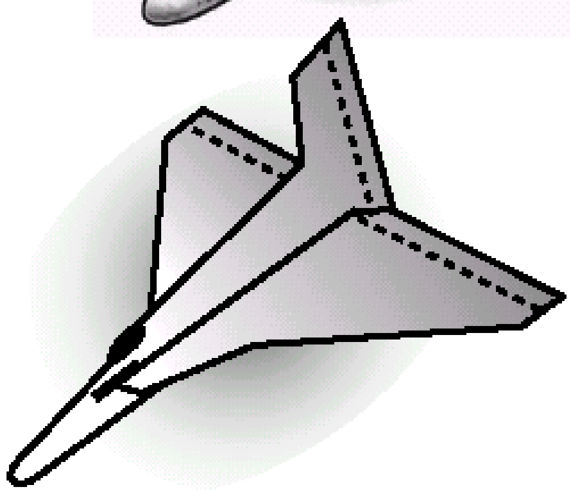
Does changing the position of elevons on a delta wing glider change its flight path?

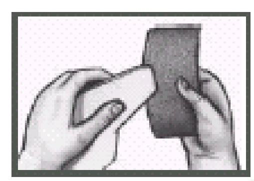
Delta Wing Glider

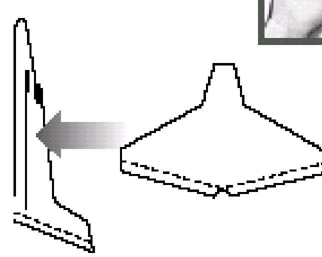
Draw the flight path

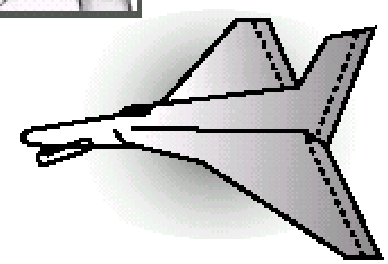




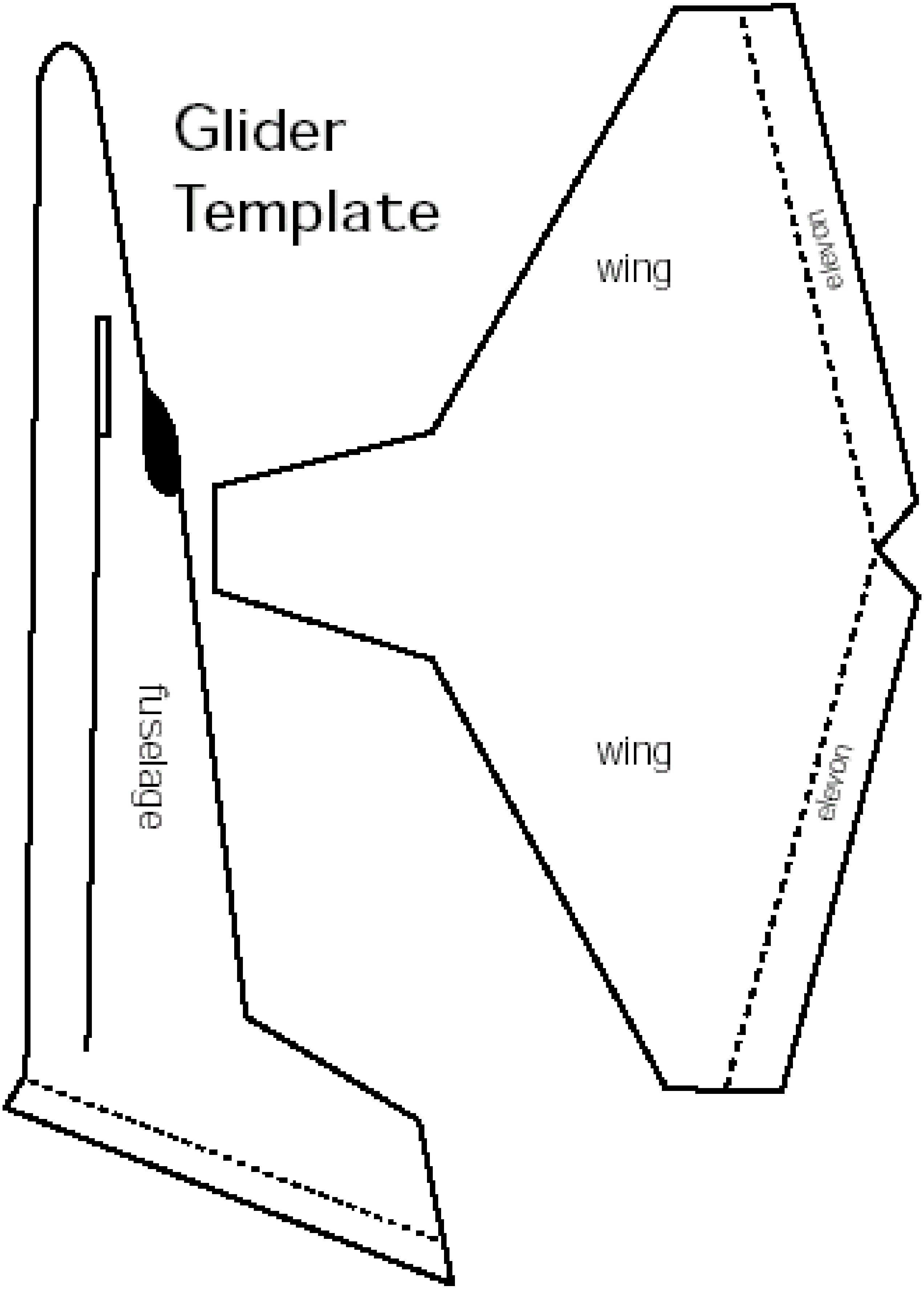








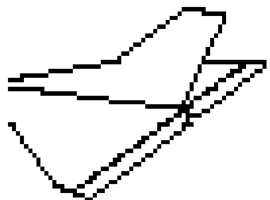
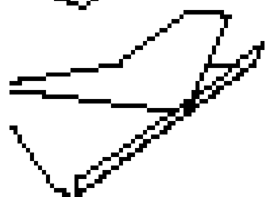
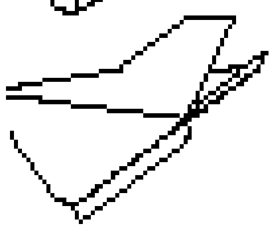
Glider Template



Test Question: Does changing the position of the elevons on a delta wing glider change its flight path?

Directions: Bend the elevons into the positions listed below. Be sure to predict the flight path before flying the glider. Test fly the glider and record the results (up, down, left, right).

Student Test Pilot Record Sheet (What I Observed)

Position of elevons		Predicted Flight Path	*Path of Test Flight*
Right and left straight		__________	__________
Right and left up		__________	__________
Right and left down		__________	__________
Right down, left up		__________	__________
Right up, left down		__________	__________

Does moving the elevons change the way the glider flies?

What happens when both elevons are in the up position?

What happens when both elevons are in the down position?

Does changing the position of elevons on a delta wing glider change its flight path?

Draw the flight path