

Exploration 8: The Rotorcraft Challenge

Students work in teams and use their knowledge of rotorcraft flight, models, and “fair tests” to design a rotorcraft model that will carry an unsharpened pencil for at least three seconds.



Main Concept

Engineering design involves the use of models and “fair tests” to find the optimum shape, size, weight, and strength for rotor blades in order to generate lift.



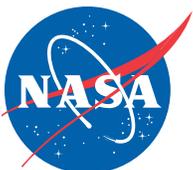
Goal

Students will work in a team and use methods of scientific investigation to design a rotorcraft model.



Objectives and Standards

<i>Objectives</i>	<i>Standards</i>
<ol style="list-style-type: none"> 1. Students will design and construct simple models that use rotor blades of different shapes, lengths, widths and weight/strength to create lift. 2. Students will conduct an investigation in rotorcraft flight using these models. 3. Students will measure the length and width of rotor blades with a ruler. 4. Students will develop an understanding of engineering design. 	<p>Meets: 2061: 1B (K-2) #1 2061: 1C (K-2) #2 2061: 1B (3-5) #1 NSES: A (K-4) #1, #2</p> <p>Partially Meets: ITEA: #9</p> <p>Addresses: 2061: 4F (3-5) #1 2061: 4F (3-5) #1 NCTM, Measurement, K-2 #7</p>





Prerequisite Concepts

- A model of a rotorcraft can be used to test how a rotorcraft flies.
- The rotor blades on a rotorcraft spin and provide the force to lift the rotorcraft.
- Spinning rotor blades generate lift.

Links to Resources that Address Prerequisite Concepts

Robin Whirlybird Exploration #1: What is a Model?

Robin Whirlybird Exploration #2: How Do Rotorcraft Fly?

Robin Whirlybird Exploration #3: How Do Rotors Create Lift?

Robin Whirlybird Exploration #4: Rotorcraft Flight and Lift

Robin Whirlybird Exploration #5: Rotor Blade Shape and Flight

Robin Whirlybird Exploration #6: Long and Short Rotor Blades

Robin Whirlybird Exploration #7: Rotor Blade Weight and Flight

Robin Whirlybird

<http://rotored.arc.nasa.gov/story/robin18.html>

<http://rotored.arc.nasa.gov/story/robin3.html>

Click on button “Rotorcraft Activities”



New Concepts

- Methods of scientific investigation can be used to design a rotorcraft model.



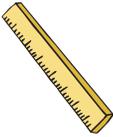
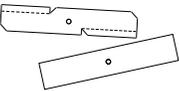
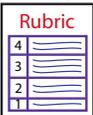
Schedule

Allow 2-3 sessions of 20-40 minutes.





Materials

- Protective eyewear for each student, available from most school science supply stores and catalogs 
- Chalk or tape  
- Drawing paper and crayons or coloring pencils   
- Chart paper 
- Two unsharpened pencils per pair or group of students 
- Non-articulated, plastic drinking straws of a sturdy variety (approximately 5-10 straws per team/pair) 
- Sheets of paper of various weights for students to use in their rotor blade construction based upon their own designs 
- Hole punchers 1 per team/pair 
- Cellophane tape roll 1 per team/pair 
- Rulers 1 per team/pair 
- Scissors 1 per team/pair 
- Straight pins 
- Needle-nose pliers 
- Stopwatches or watch/clock with second-hand 
- Template for rotor blades of 3-5 different lengths (see this exploration's appendix) 
- At least one Data Table (in this exploration's appendix) for each team/pair 
- Evaluation rubric in this exploration's appendix 





Safety Precautions

When using flying objects in a classroom, post very strict rules and review them with the students. All students **MUST** wear protective eyewear while any object is in flight. Clearly delineate one or more staging areas, preferably with students' input. Mark on the ground with chalk or tape, where all "test flights" will take place. Caution students to "secure the area" before beginning any "test flight."



Engage

1. Review what students have learned about models by asking them:
 - How do scientists study how things work?
 - How did you study what type of rotor blade creates the greatest lift?

Students should say that they used models and "fair tests." They might also say that they changed the shape, length and weight of rotor blades.

2. Tell students that their challenge in this lesson is to create a rotorcraft model that can carry an unsharpened pencil and stay aloft for at least three seconds.
3. Ask students to work in pairs or groups of three.
4. Distribute drawing paper and crayons or colored pencils.
5. Ask students to draw their model designs.
6. Circulate among the groups and have students explain their model designs.



Explore

1. Discuss safety issues. Distribute the protective eyewear.
2. Have students build their models and test them.
3. If the models do not stay aloft for at least three seconds, ask students what they could change to improve the performance of their rotorcraft models.



4. Remind students that they have tested each aspect of a rotor blade: the shape, length and weight/ strength. They should perform “fair tests” and change only one aspect of the rotor blade at a time.
5. Ask students to modify their designs before they proceed with a modification to their models.
6. Remind students that they may need to go back and redesign their rotorcraft many times. Seldom does the first design work.



Explain

1. Have students show their rotorcraft designs to the class and explain why they came up with that particular design.
2. Ask students to describe how they plan to change their design if the flight is not successful. Look for responses that indicate that they will change one variable at a time.
3. Have students rebuild and test their models.
4. Gather students together for a discussion. Reflect upon the questions the students raised based upon your own classroom observations during their exploration time.
5. Ask the group to draw a conclusion about the rotor blades’ characteristics for optimum flight performance. If age appropriate, ask each group to write their conclusions.



Extend

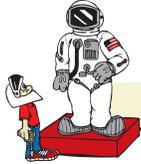
- Ask students to change their models so that they stay aloft longer or lift two pencils.





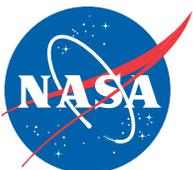
Evaluate

1. Collect student's original and modified designs.
2. Students are successful if they modify one aspect of the blades at a time and then test their rotorcraft model.
3. Use the rubric in this exploration's appendix for assessment.

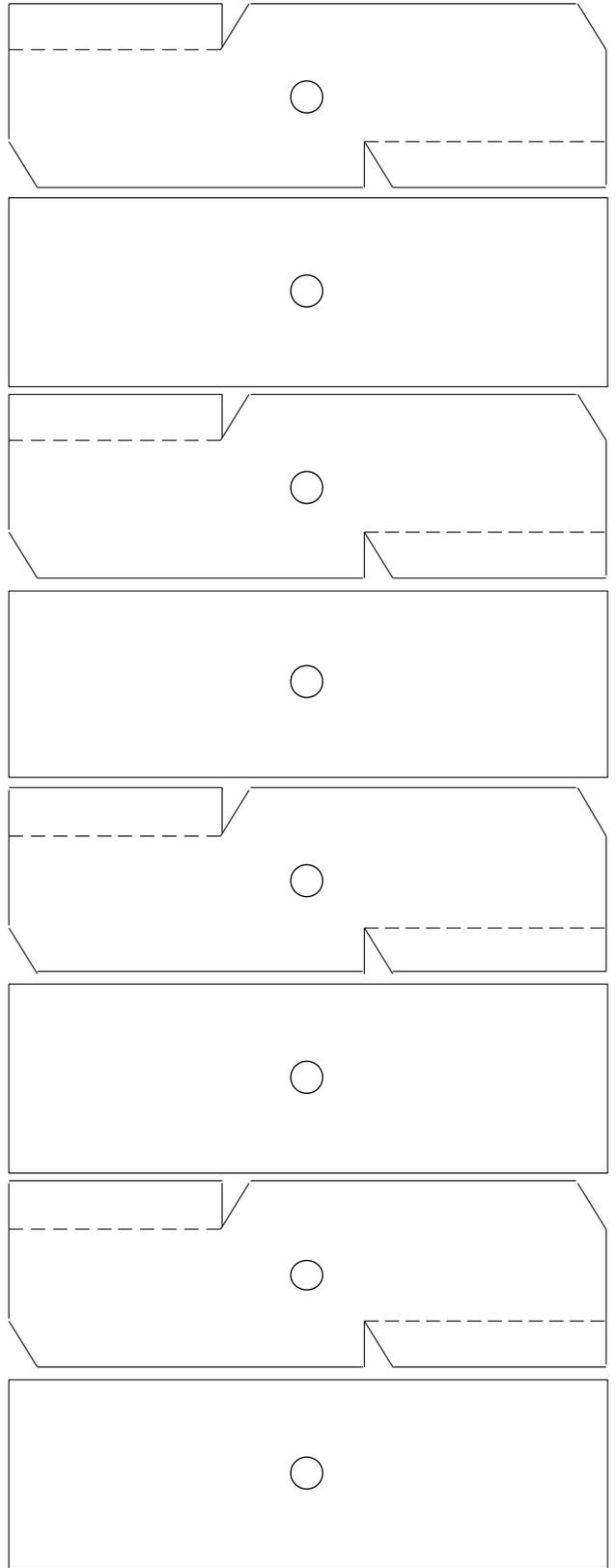
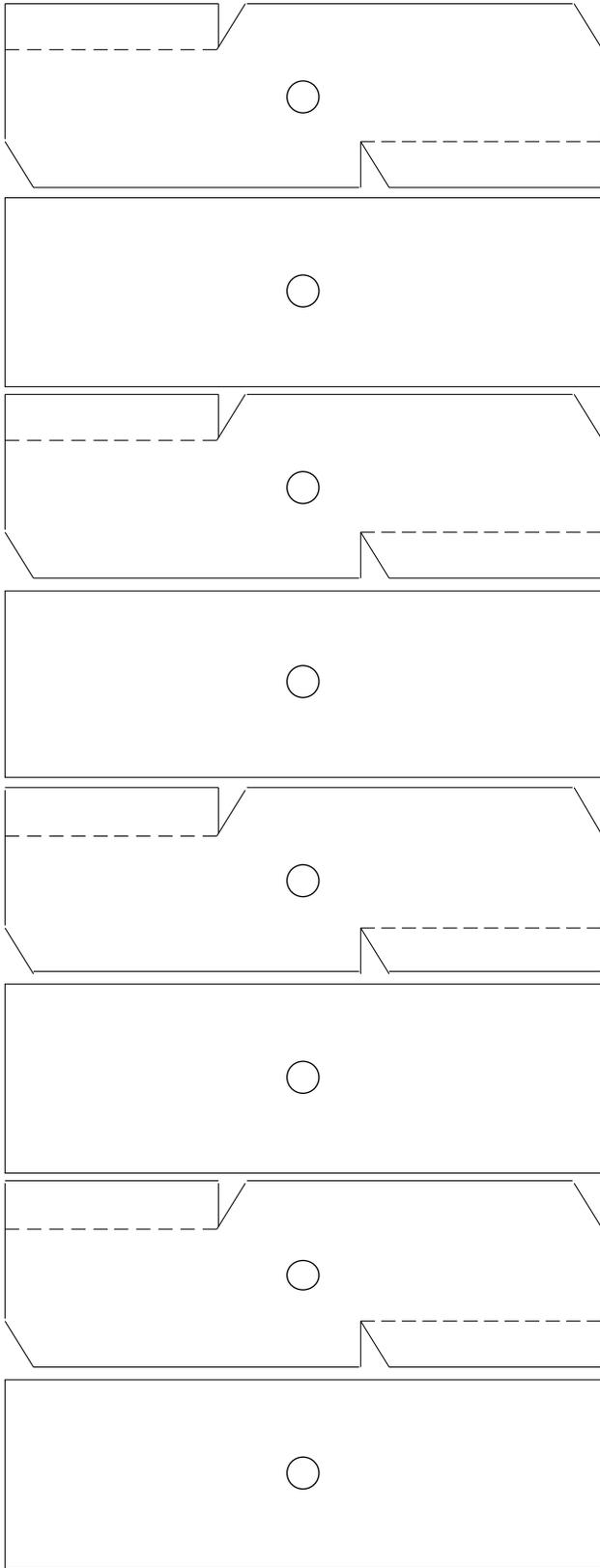


Further Exploration

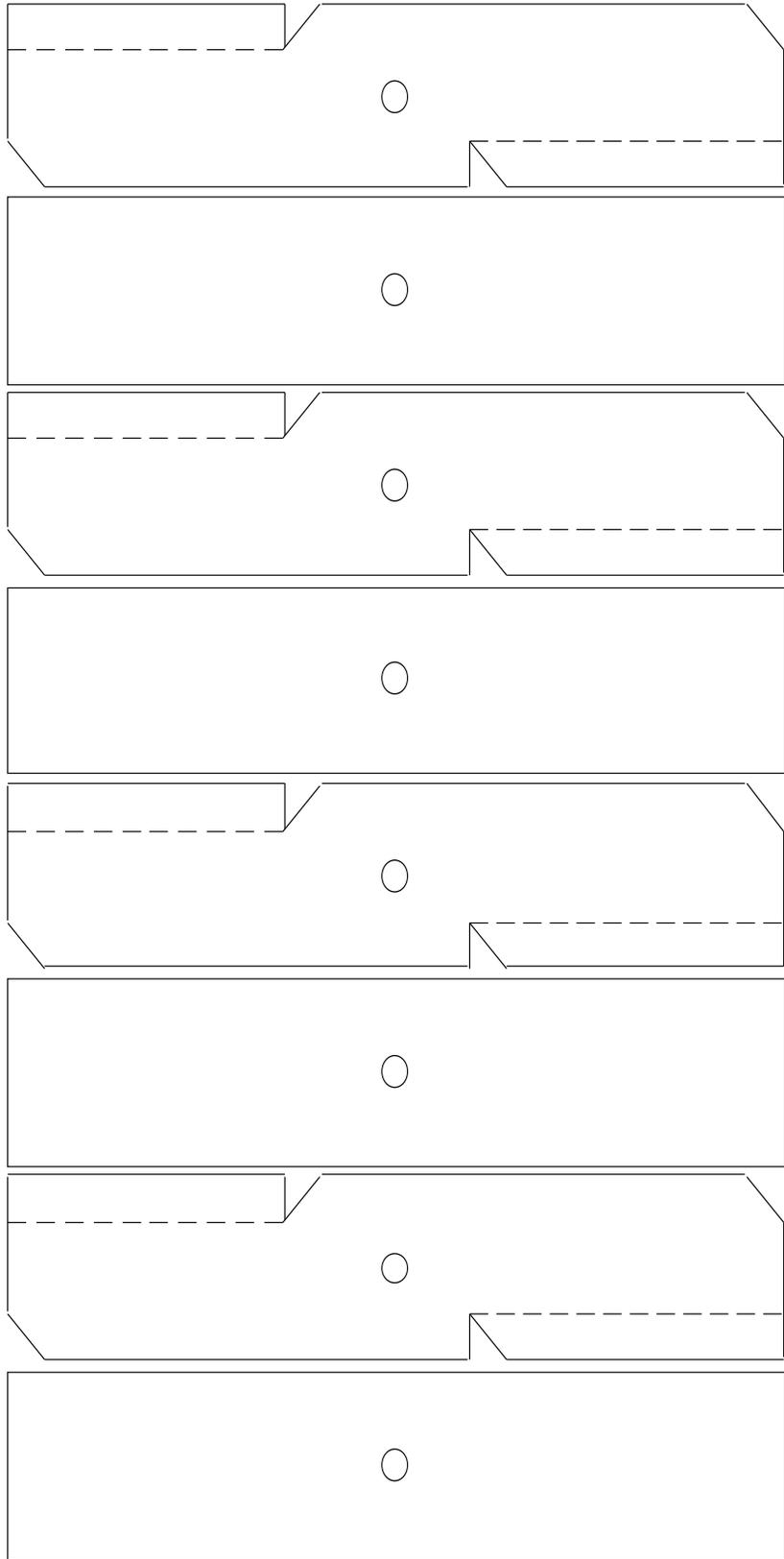
- Students might have additional questions regarding the connection between a rotorcraft's design and its intended usage. That is, are rotorcraft designed to perform certain tasks? If so, how would the shape and length of the rotor blades be different for different tasks (tasks such as heavy lifting, speed, high maneuverability, observation, and passenger or cargo transportation).
- Use the Web to research various types of helicopter uses as well as helicopter manufacturers to review the many different types of rotorcraft.



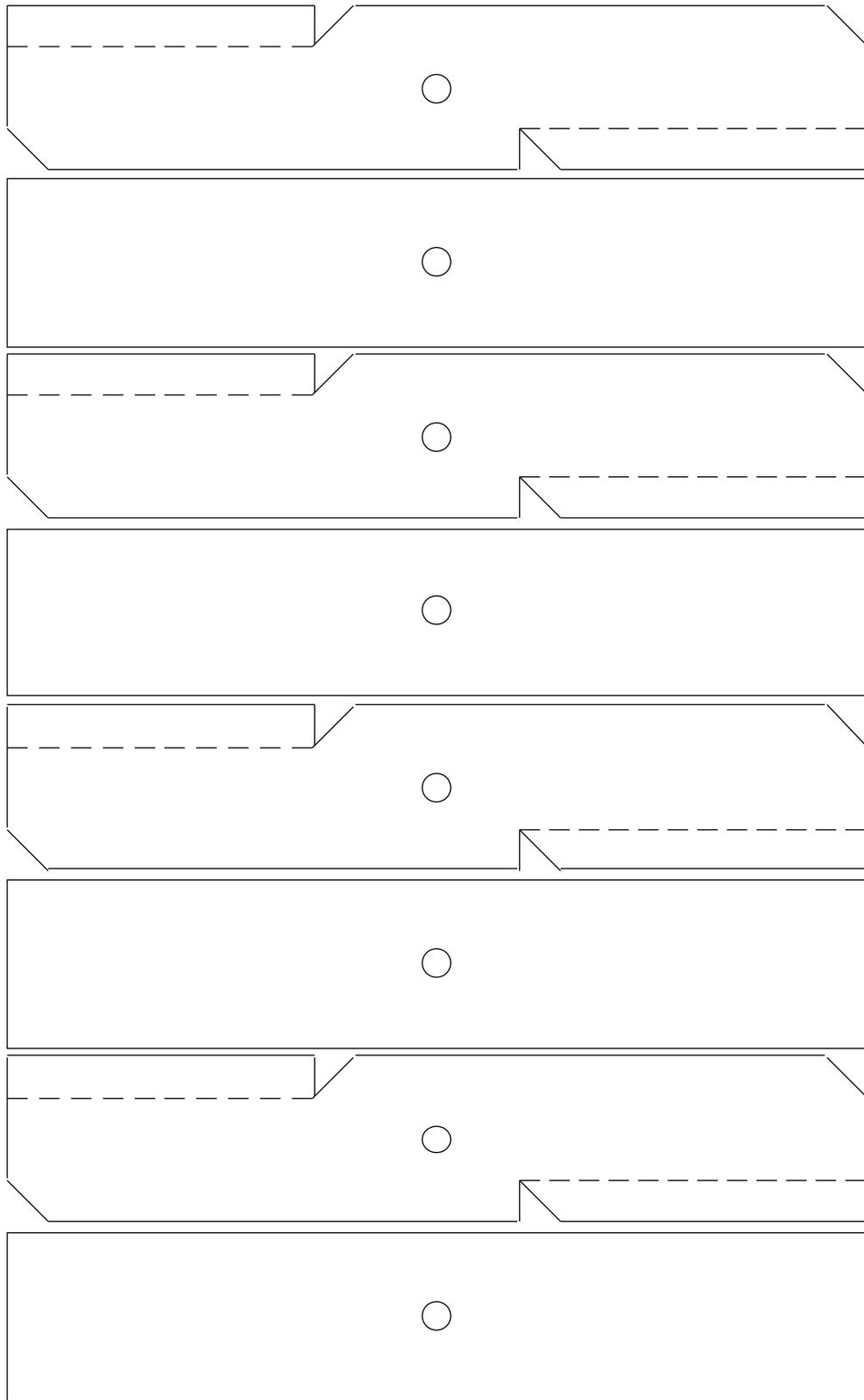
Appendix: Propeller Template - Size 1



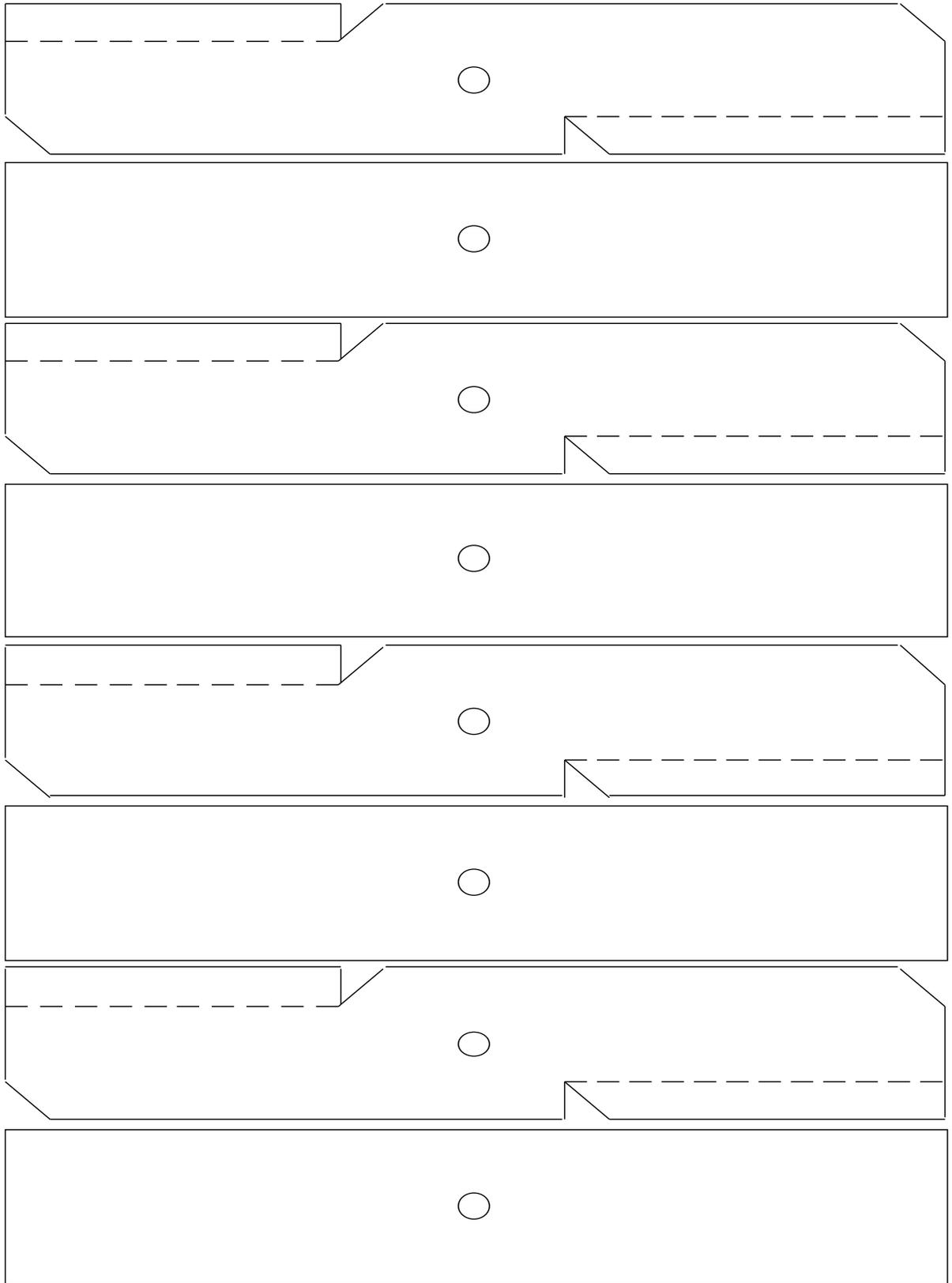
Appendix: Propeller Template - Size 2



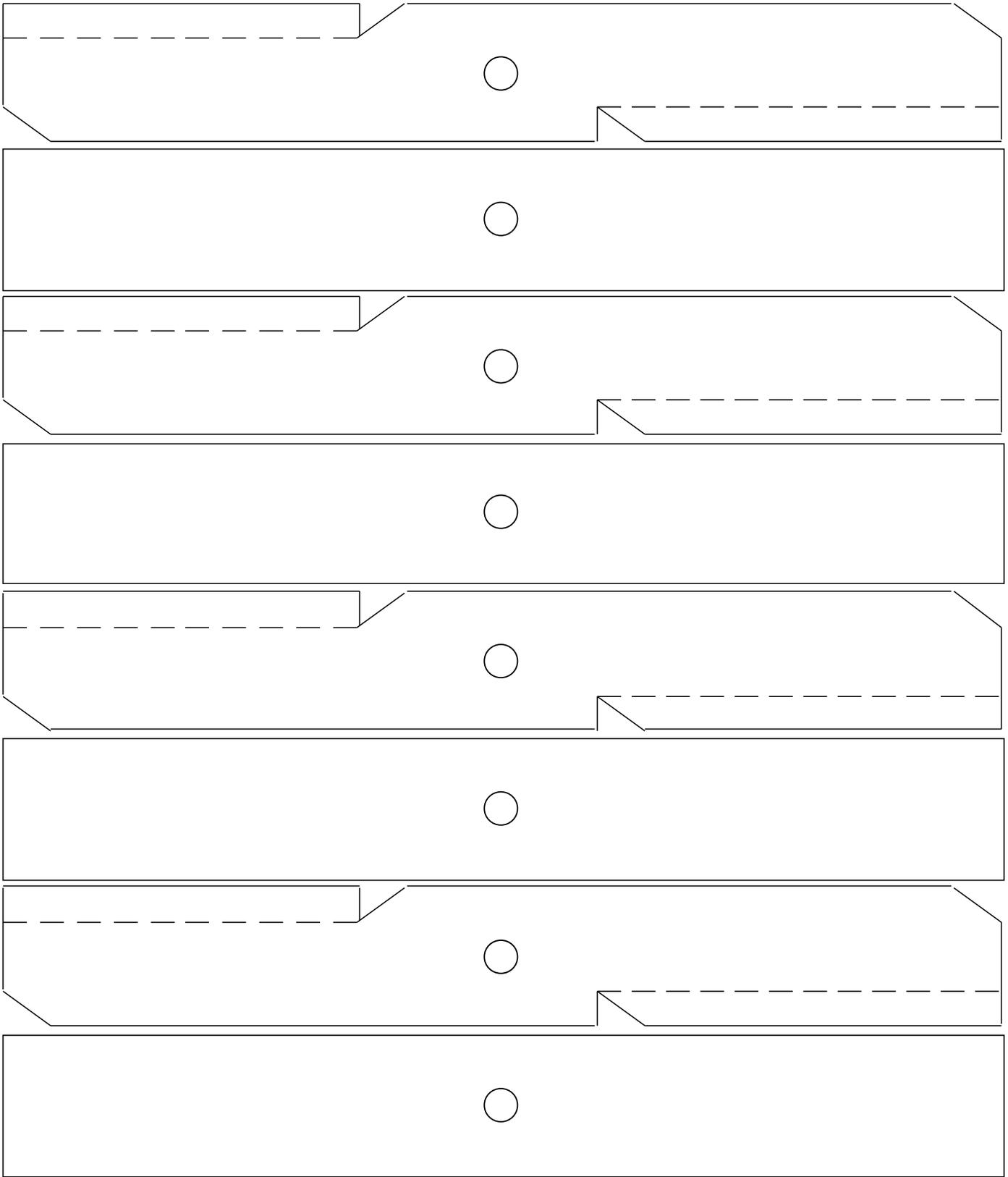
Appendix: Propeller Template - Size 3



Appendix: Propeller Template - Size 4



Appendix: Propeller Template - Size 5



Exploration 8: The Rotorcraft Challenge

Data Table

Team Members:

Use this table to record your observations. Draw or describe the rotor blade.

<i>Rotor Blade</i>	<i>Time</i>



Exploration 8: The Rotorcraft Challenge Rubric

Students work in teams and use their knowledge of rotorcraft flight, models, and “fair tests” to design a rotorcraft model that will carry an unsharpened pencil for at least three seconds.

Evaluate students’ work using the following rubric:

4	<ul style="list-style-type: none">• Good, clear design and drawing of model design• Use of “fair testing” with one variable changed at a time• Redesign based on tests and observations• Good exchange of ideas and collaborative teamwork
3	<ul style="list-style-type: none">• Fair drawing of model design• Attempt to conduct a “fair test” and some understanding of variables• Some redesign based on tests and observations• Some exchange of ideas and collaborative teamwork
2	<ul style="list-style-type: none">• Sketchy drawing of model design• Test method shows some understanding of variables• Redesign based on only a few observations• Attempts at teamwork
1	<ul style="list-style-type: none">• Drawing not entirely suitable for design• Test method exhibits lack of understanding of variables• Little or no redesign• Little or no teamwork

