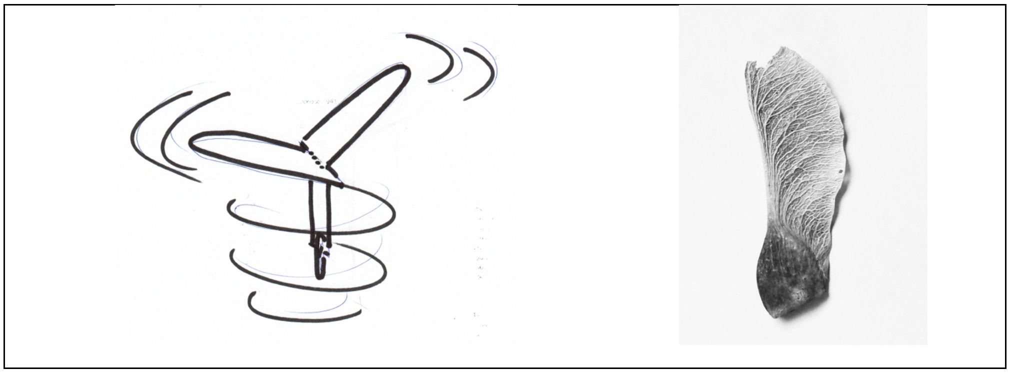
LESSON 5: Inspiration from Nature

Inspiration from Nature: An Engineering Design Challenge



The "Whirligig" (left) is an example of biomimetics. Images by Cary Sneider

One of the most radical features of the *Next Generation Science Standards*[1] is the idea that engineering design should be taught at the same level as science inquiry. However, that does not mean commonly presented activities such as bridge building and egg drop contests necessarily qualify. To meet Next Generation Science Standards, it is important that the engineering design activities be supported by science concepts. For example, consider the Whirligig Challenge. There are many versions of this activity on the Internet. It requires very few materials, engages students in engineering design, and is a lot of fun for upper elementary and middle school students.

The Whirligig Challenge[2]

Context: *Before class*, watch the 5-minute NASA video "Seven Minutes of Terror" **(UCF L5 Mov)** which describes how engineers designed the landing sequence for the Curiosity robotic spacecraft that landed on Mars. The video can be found online at: **https://youtu.be/OHwUrxzrvtg**.

In this lesson, you will engage in all three stages of the engineering design process: (1) Define and delimit the problem; (2) Develop possible solutions; and (3) Begin to optimize the solution.

[1] NGSS Lead States (2013). *Next Generation Science Standards: Practices, Core Ideas, and Crosscutting Concepts*. Washington, DC: National Academy Press.

Define and delimit the problem

1. A team of scientists and engineers is planning to land a robot craft on Titan, a moon of Saturn that has a dense atmosphere (the surface air pressure is about 50% greater than Earth's). Team members are worried that the craft will be traveling too quickly when it lands, damaging the onboard computer. Your job is to improve the current model of the craft (whirligig), by changing its shape so that it **falls more slowly, but stays upright as it falls**. You may use the paper, paperclips, scissors, and ruler at your tables, and your design must be finished and tested in 30 minutes.

   - What problem are you trying to solve?

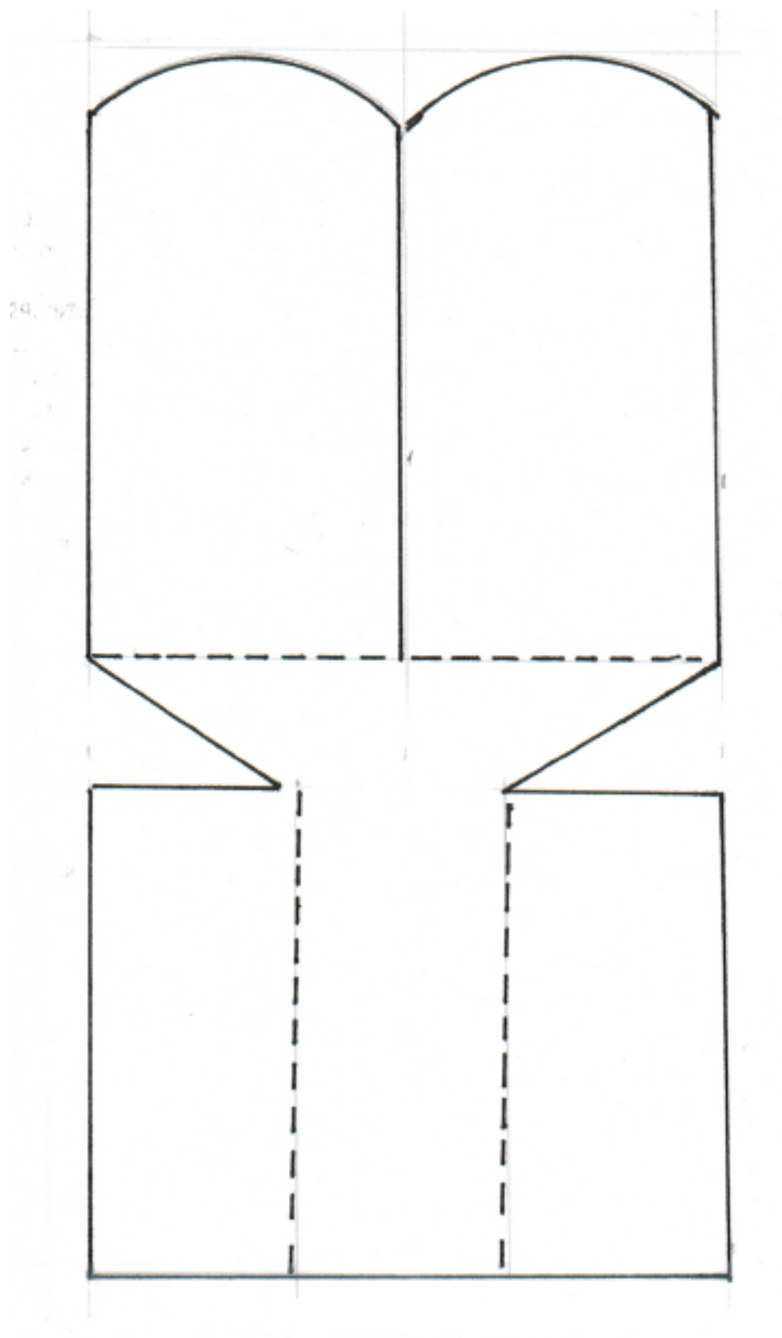
   - What are the criteria for success?

   - What are the constraints or limits?

Develop possible solutions

2. Start by making a whirligig as currently designed. Use the diagram on the next page. Cut along solid lines and fold along dotted lines. Bend the "wings" in opposite directions. Add a paperclip at the bottom if needed for stability. Drop it from as high a height as you can safely.

   Describe how it falls:



3. Make at least two additional models with changes that you think could solve the problem. Plan and carry out an investigation to determine which of the models best solves the problem (the original model plus the two changed models). Be sure that your investigation is a fair test of the models. Summarize below what you are changing and your observations. Include sketches of how your two revised models differ from each other.

Optimize the solution

4. Which of your models best solves the problem, given the constraints or limits? Why?

5. Draw a diagram using arrows to illustrate the forces on your best model, and use the diagram to explain why your model functions differently from the original design.

6. How might you make additional changes to your 'best' model to *optimize* the solution? That is, make the model the best as it can be, given the constraints or limits on the design.