Exercise 2: Flasher*: A Mini Folding Space Telescope

*A flasher is an ideal, infinite origami pattern that shrinks to a finite size when folded.

Objective:

Explore a more complex folding pattern that affords more compression of the paper than a corrugation.

Gain insight into the unfurling method used in some folding space telescopes and sunshades.

Think about how applications are used to move from a paper model to the engineering of a space telescope that is constructed with rigid materials that are unlike paper, very large, and require a great deal of precision.

Materials:

- One piece of kami origami* paper between 10 and 12 inches square for each student.
- Note that the thinness of origami paper is an important factor in the success of completing this project. Copy paper is too thick. Lighter weight letter paper can be used, but it needs to be strong enough not to rip when folded back and forth multiple times.

Ages: high school

Time Needed: at least 1 hour

*Kami is simply the word for paper in Japanese, but in the last fifteen years or so it has come to mean 'ordinary' origami paper, the type that can be bought pre-cut in squares.

Background: Making a Spacecraft

Whether you need a satellite to study what's happening here on Earth, to make images of comets in our Solar System, to learn about our Sun, or to study the history of the Universe itself, each spacecraft requires a few basic components. For example:

- Spacecraft System/Container: A satellite needs a type of container to hold the electronics and devices, and to keep its instruments safe.
- Power Source: A spacecraft needs electricity to run its high-tech instruments. Solar panels and/or batteries are common options.
- Scientific Instruments: Instruments will be used to obtain data of distant galaxies or planets, measure chemicals in the Earth's atmosphere, monitor the Sun's activity, and more.
- Communication Device: Spacecraft need some way to communicate with us back on Earth, such as through antennas (shaped like dishes, poles or rods).
- Orientation Finder: A satellite needs to know where it's pointed and which way is 'up,' through something that looks at the stars (a star tracker) or the sun (a sun tracker).

Launching very large telescopes can take a long time to develop, test, and send up to space. Researchers are trying to build and make use of lighter, more compact spacecraft components that can help satellites fold up into smaller launch vehicles to be deployed and unfurled in space.

One example of potential compactibility is a solar sail, which can propel a spacecraft through space. A nonprofit group, the Planetary Society, recently launched a solar sail, the LightSail, to test such unfurling capabilities. When sunlight bounces off the reflective surface of the sails, the spacecraft gets a small push. It's possible that future spacecraft using solar sails could travel to the moon, asteroids or beyond, without as much need for expensive rocket fuel that takes up a lot of room. The LightSail was designed to result in a package smaller than a loaf of bread. Folded tightly up are four sails of Mylar, the same material some balloons are made of. When unfolded, the sail ends up a bit larger than an average sized living room.

The following activity will use a flasher style of folding to create a mini-space telescope.

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Process:

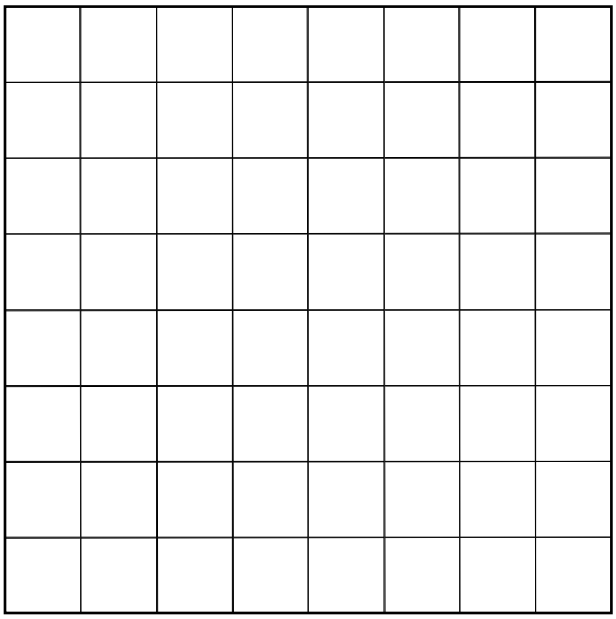
You will need a square piece of paper for this model. The best paper is something lighter weight than copy paper, around 8"-10" square. Something like origami folding paper works well. For practice, copy paper is fine, the lighter weight, the better.

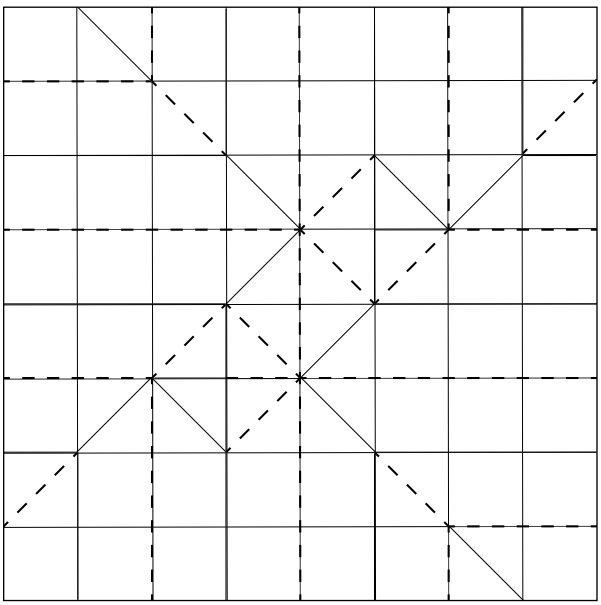
1. Fold the paper into eight equal sections in both the horizontal and vertical directions.

2. Refer to the "Hyperbolic Paraboloid" diagram sheet for guidance about the mountain or valley orientation of the folds. Reorient the grid folds so that they follow the mountain/valley pattern shown on the diagram.

3. Collapse the model around a central core with paper wrapping around. Your model with become three-dimensional. Refer to the instructional video for help with this process.

4. To operate the flasher, grab opposite single layer corners when model is in the closed position. Pull the model open (not all the way flat), then push back into closed position. As the model is opened and closed, it will develop "paper memory" and become easier to operate.





Thought Questions:

- If you folded the Chevron Corrugation, how does the Flasher compare in effectiveness of reducing the footprint of the original paper?

- How do you think an actual space telescope would be made with rigid materials (that don't fold) and using the Flasher folding process?

- How big would the paper have to be to make a model of an actual space telescope?

- Art Connection: Can you color this model in an interesting way? What aspects of the crease pattern can you use to enhance different aspects of the model?