ORIGAMI IN SPACE; MIURA, TREASE AND MORE...

MIURA FOLDING

Miura folding is famous all over the world. It is an element of the ancient Japanese tradition of origami and reaches as far as astronautical engineering through the construction of solar panels.
The fold is named for its inventor, Japanese astrophysicist Koryo Miura.

The pattern of creases forms a **tessellation of parallelograms**, and the whole structure collapses and unfolds in a single motion — providing an elegant way to fold a map. The idea is used in Japan's Space Flyer Unit satellite in 1995.

Miura folds are considered **shape-memory origami** because the fold can be "remembered"—that is, after unfolding, the sheet can easily be re-folded and returned to its compact shape.

WHY USE MIURA FOLD IN SOLAR PANELS OF THE SPACE SATELLITES?

Working on the port overhead solar array wing of the International Space Station. Credit: NASA.

Rockets launched into space make use of the Sun's energy while they fly. The devices that gather this solar energy are solar panels, but these panels cannot be opened until after the launch. The solar panels are folded down as much as possible in order to pack them into the rocket, and then after the rocket blasts into outer space they quickly unfurl. When the rocket returns to the surface of the Earth, they must be folded down and re-

stowed. The idea of Miura folding was realized after thinking about how this sequence of actions could be achieved not by humans, but by robots. Folded material can be unpacked in one motion by pulling on its opposite ends, and likewise folded by pushing the two ends together. In the solar array application, this property reduces the number of motors required to unfold this shape, reducing weight and complexity.

Watch the YouTube video
How NASA Engineers Use Origami to Design Future Spacecraft
https://www.youtube.com/watch?v=Ly3hMBD4h5E

Other potential applications of this fold include surgical devices such as stents and flat-foldable furniture.

Researchers used the Miura fold to stack hydrogel films, generating electricity similarly to electric eels. The Miura fold is used to cause many parts of the stack to contact each other simultaneously. Even fashion designers have been inspired to incorporate Miura-Ori into dresses and scarves.

HOW:

There are basically two methods for folding Miura.

For younger kids, You can use the Templates on the websites, simply by printing and folding the line from the dashed lines.

One template you can use is from The Economist

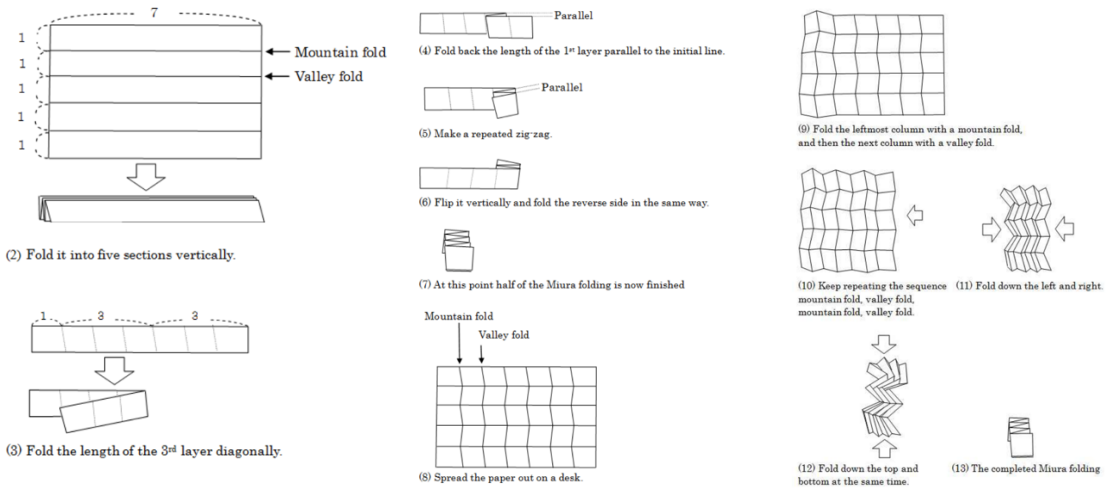
https://infographics.economist.com/2018/xmas/Origami.pdf

The second way is obviously creating and folding your own pattern.

Here, the most useful recommendation would be, to use at least an A3 size of paper to make the folding easier.

I found the article below with the best explained the instructions of the Muira Fold.

https://ijpam.eu/contents/2012-79-2/8/8.pdf



[These visuals are also taken from the article. Please check the webpage for the detailed instructions.]

You can use these instructions to create realistic solar panels for your spacecraft maybe by using aluminum folio.

You can also use the activity from the Discovere.org to create your own solar panels: https://www.discovere.org/sites/default/files/Design%20a%20Folding%20Solar%20Panel_082616.pdf

OR

You can create an extraordinary invitation card for your next birthday like the Smithsonian Museum*, NY. This design simplifies the structure into only a few distinctive folds, while maintaining all of the character and style of the format.

*This outstanding invitation was for C. Hewitt's 2018 Garden Party by the Smithsonian Museum.

Instruction Video for the Invitation Card:
Original invitation Paper Size:13.75x8˝; folds to 4.625x8˝
https://www.youtube.com/watch?v=vv_ofglVVDE

TODAY

Today another fold is used in the solar panel construction. This method is called Trease Method. There is an inspiring story behind the creation of this new fold.

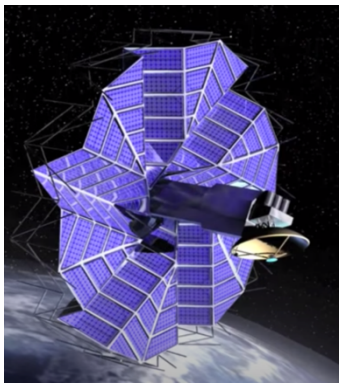
As a high school student at a study program in Japan, Brian Trease would fold wrappers from fast-food cheeseburgers into cranes. He loved discovering different origami techniques in library books.

Today, Trease, a mechanical engineer at NASA's Jet Propulsion Laboratory in Pasadena, California, thinks about how the principles of origami could be used for space-bound devices.

Trease and colleagues are interested in using more intricate folds that simplify the overall mechanical structure and make for easier deployment.

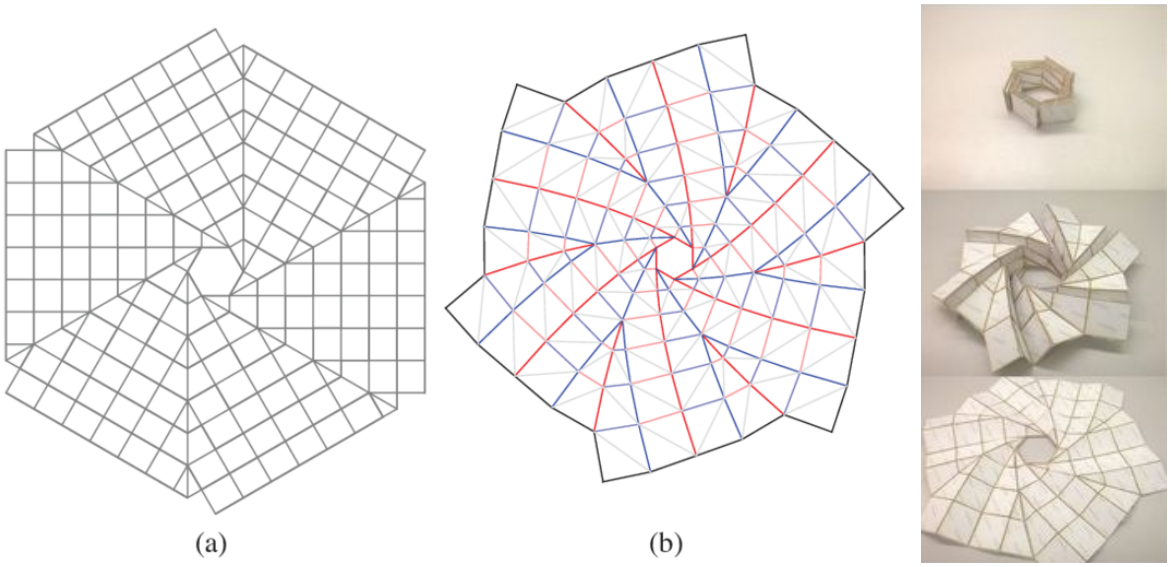
Last year, Zirbel and Trease collaborated with origami expert Robert Lang and BYU professor Larry Howell to develop a solar array that folds up to be 8.9 feet (2.7 meters) in diameter. Unfold it, and you've got a structure 82 feet (25 meters) across. Their 1/20th-scale tabletop prototype expands to a deployed diameter of 4.1 feet (1.25 meters).

The fold that Trease and colleagues used is not a Miura fold, but rather a combination of different folds. Trease's prototype looks like a blooming flower that expands into a large flat circular surface.



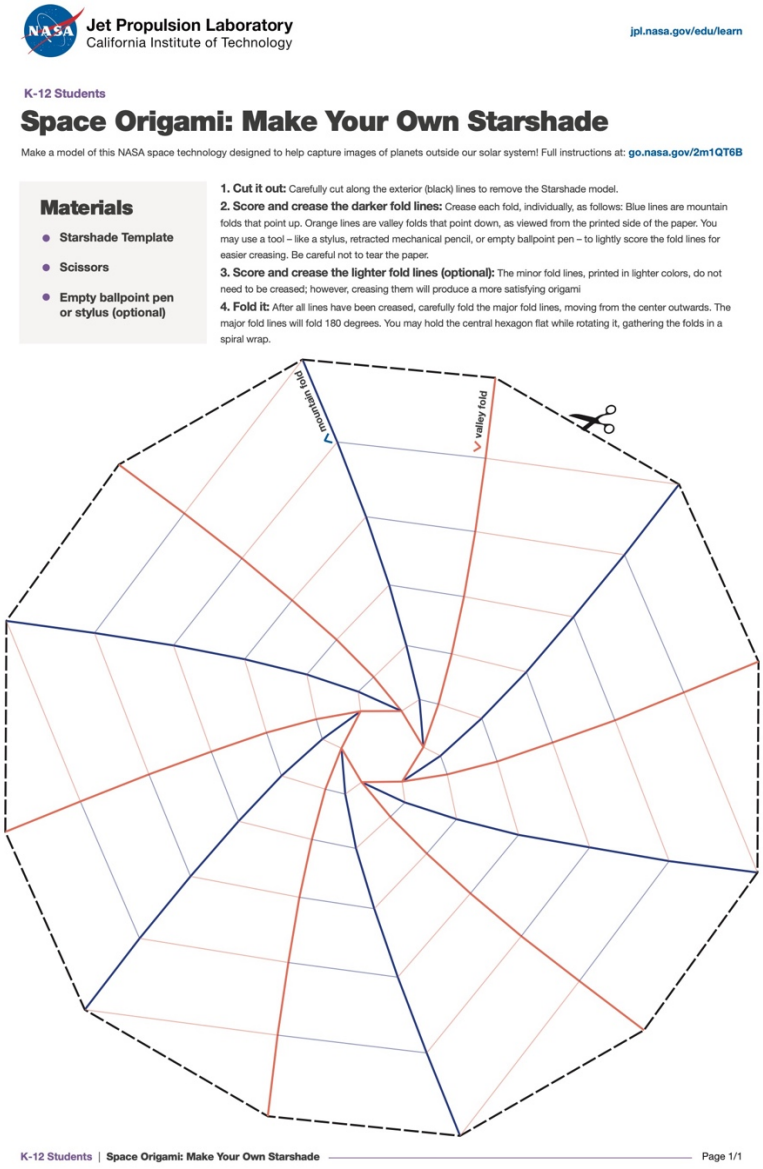
Origami was originally intended for folding paper, which has almost no thickness, so Trease and colleagues had to be creative when working with the bulkier materials needed for solar panels.

For details, please visit the [Nasa's webpage] about Space Origami: Make Your Own Starshade



The six-sided flasher model. (a) Model assuming zero-thickness (b) Crease pattern for the model assuming finite thickness, with additional diagonal folds included to enable rigid-foldability.

Origami has been the subject of serious mathematical analysis only within the last 40 years, Trease said. There is growing interest in integrating the concepts of origami with modern technologies.



Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov/edu/learn

K-12 Students

Space Origami: Make Your Own Starshade

Make a model of this NASA space technology designed to help capture images of planets outside our solar system! Full instructions at: go.nasa.gov/2m1QT6B

Materials

- Starshade Template
- Scissors
- Empty ballpoint pen or stylus (optional)

1. Cut it out: Carefully cut along the exterior (black) lines to remove the Starshade model.

2. Score and crease the darker fold lines: Crease each fold, individually, as follows: Blue lines are mountain folds that point up. Orange lines are valley folds that point down, as viewed from the printed side of the paper. You may use a tool – like a stylus, retracted mechanical pencil, or empty ballpoint pen – to lightly score the fold lines for easier creasing. Be careful not to tear the paper.

3. Score and crease the lighter fold lines (optional): The minor fold lines, printed in lighter colors, do not need to be creased; however, creasing them will produce a more satisfying origami

4. Fold it: After all lines have been creased, carefully fold the major fold lines, moving from the center outwards. The major fold lines will fold 180 degrees. You may hold the central hexagon flat while rotating it, gathering the folds in a spiral wrap.

References:

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