

# ORIGAMI-SCISSOR hinged geometry method

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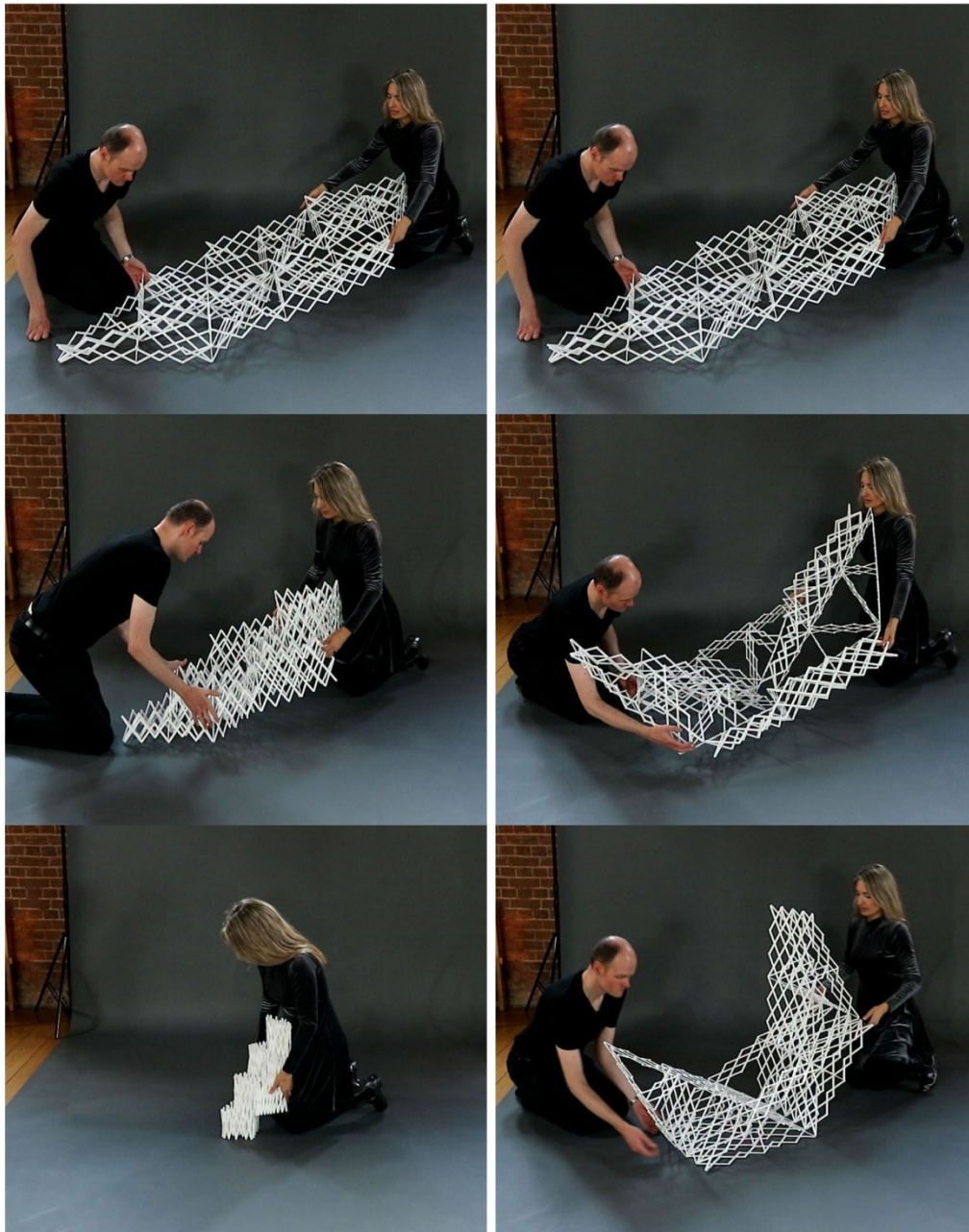
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## Abstract

Origami and scissor hinged are different types of deployable structures out of many others that exist (1). Deployable structures can transform, expand and contract due to their geometrical, material and mechanical properties. Applications include architecture, robotics, aerospace technology and art. The author of this research has unified both types and made a diamond origami-scissor hinged structure by combining two methods: ‘origami of thick panels’ by Chen, Peng and You (2), and the ‘form generation method of relative ratios for two-bar scissors’ developed by the author of this research (3). This signifies the birth of a hybrid new type of deployable structure: origami-scissor hinged.

‘Origami of thick panels’ by Chen, Peng and You (2) provides a comprehensive method for making origami with thick panels, effective for different types of origami, which demonstrates that origami of thick panels can be devised by mechanism theory alone without referring to its parent zero-thickness kinematic model. The ‘form generation method of relative ratios for two-bar scissors’ by Rivas-Adrover (3) can be applied to infinite combinations of lines, and therefore allows for infinite scissor structures to be made with optimum deployment and the minimum number of different bars. Origami made with thick panels has a geometry that can be understood as a series of combinations of lines, segments, to which the ‘form generation method of relative ratios for two-bar scissors’ can be applied which generates a set of ratios and equations. This geometry method has been applied to the diamond origami of thick panels. Figure 1 displays the deployment of the diamond origami-scissor prototype made of six triangulated faces. This prototype is made of 744 nodes and 462 bars (with six different types of bars). The prototype is structurally stable and has a fluid motion. This prototype has two degrees of freedom.

The aim of this research is to establish whether this geometry method can be extended and generalized to other types of origami of thick panels. The diamond origami-scissor structure was fundamentally made of two equal thicknesses superimposed; this facilitated placing one triangle of pantographs on top of another, where both triangles were made of equal sizes of scissor units. Further research will establish whether the method could be extended to origami of thick panels made with thicknesses that are non-proportional, therefore with different lengths of bars for the scissor pantographs. Another key issue is that the diamond origami was essentially made of one type of triangulated face that was mirrored; further research will establish whether this geometry method could be applied to other types of origami that join different faces which do not necessarily have bilateral symmetry.



**Figure 1:** Deployment of the diamond origami-scissor structure; scissor deployment and origami fold.

### References

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2. Y. Chen, R. Peng, Z. You, Origami of thick panels. *Science* 349, 396-400 (2015).
3. E. Rivas-Adrover , Classification Of Geometry For Deployable Structures Used For Innovation: Design Of New Surfaces With Scissor 2 Bar, And Form Generation Method Of Relative Ratios, *International Journal of Computational Methods and Experimental Measurements* 5, No. 4, 464–474 (2017)