Just Twist,
About Minimal Origami Models Based on Polyhedra Structure

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Abstract

Origami is usually recognized as an art activity that requires a lot of folding to convert a plain sheet of paper into a piece of art. As mathematicians we asked a question what is the lower number of crease lines that create a non-trivial origami model. And we have found that the answer is: zero lines.

The paper presents a method that leads to astonishing origami models without any single crease line.

Background

Origami, the art of folding paper into a piece of art, meets mathematics in many places. An origami purist says that only a model starting from a square piece of paper and made without cutting and glue is a true origami model, however such approach is not justified by tradition. Modular origami is based on two-step approach. First a sheet of paper is folded into a module according to purist rules. In the second step many modules are assembled without glue into a final model, usually based on a polyhedra structure. A single module may correspond to a vertex of a polyhedron (vertex module), an edge of a polyhedron (edge module) or a face of a polyhedron (face module). Most modular models can be described by a set of parameters, see [7] that generate broad families of similar, but sometimes surprisingly different origami models.

Below, we will discuss effects of two parameters: shape of a paper sheet and location of flaps on a final model in case of a minimal edge module.

Just Twist

There are many different techniques to join modules without glue into a stable origami model, usually based on the friction of paper. Herman van Goubergen introduced a paper tension technique based on flaps of a module twisted into conical spirals [8]. We have developed his idea for the last 10 years [1-7] and called the resulting models twirls. After designing many complex modules and models, we asked a question: how many creases do we really need to make a twirl model. We were surprised by the answer: none. And we were surprised by the huge variety of such models as well as the appealing visual effect (see cover of [9]).

We discovered that we do not need any crease to create a flap to be twisted as unfolded piece of paper has already flaps. Moreover, unfolded paper gives us more freedom to position flaps as there are no lines that bound flap area.

Results

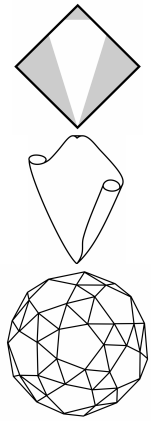


Figure 1: *Just squares.*

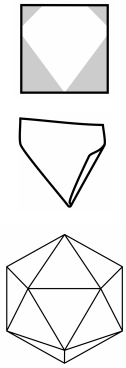
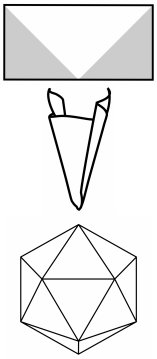


Figure 2: *Squares.*



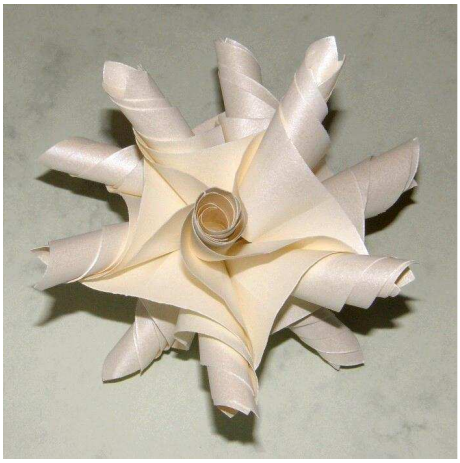


Figure 3: *Rectangles.*

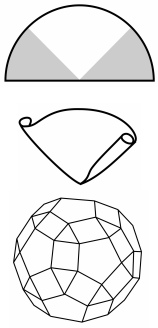


Figure 4: *Geodesics.*

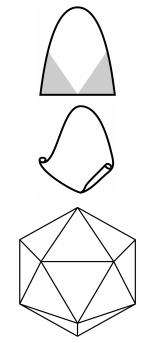


Figure 5: *Parabolas.*

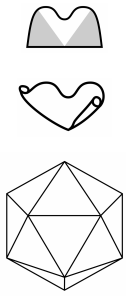


Figure 6: *Polynomial shapes.*

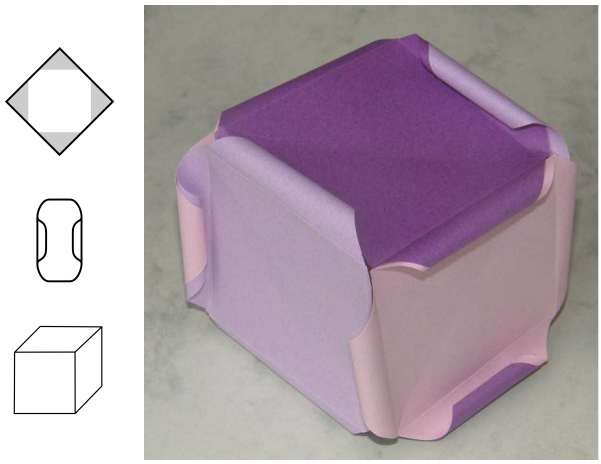


Figure 7: *Cube.*

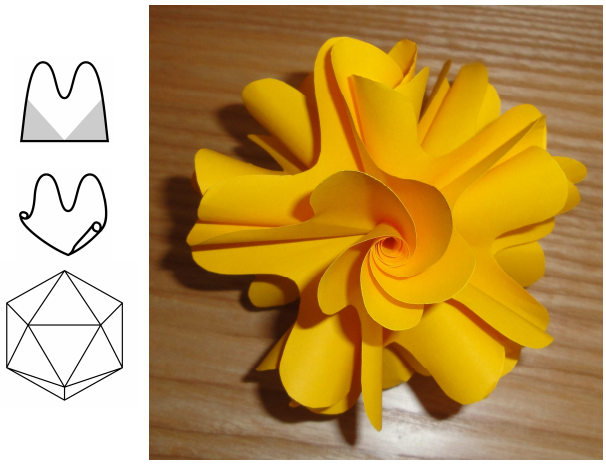


Figure 8: *Polynomial shapes.*

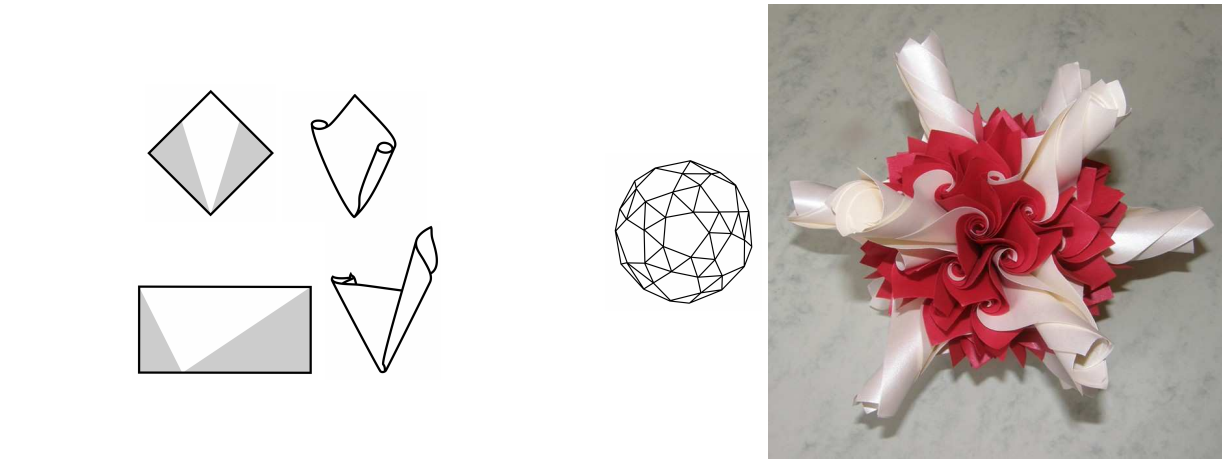


Figure 9: *Rectangles and squares.*

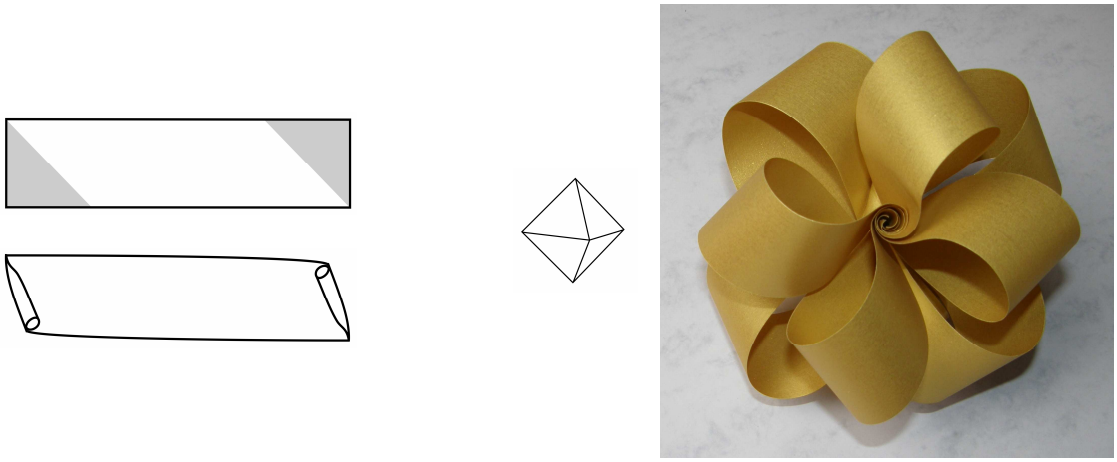


Figure 10: *Twelve strips.*

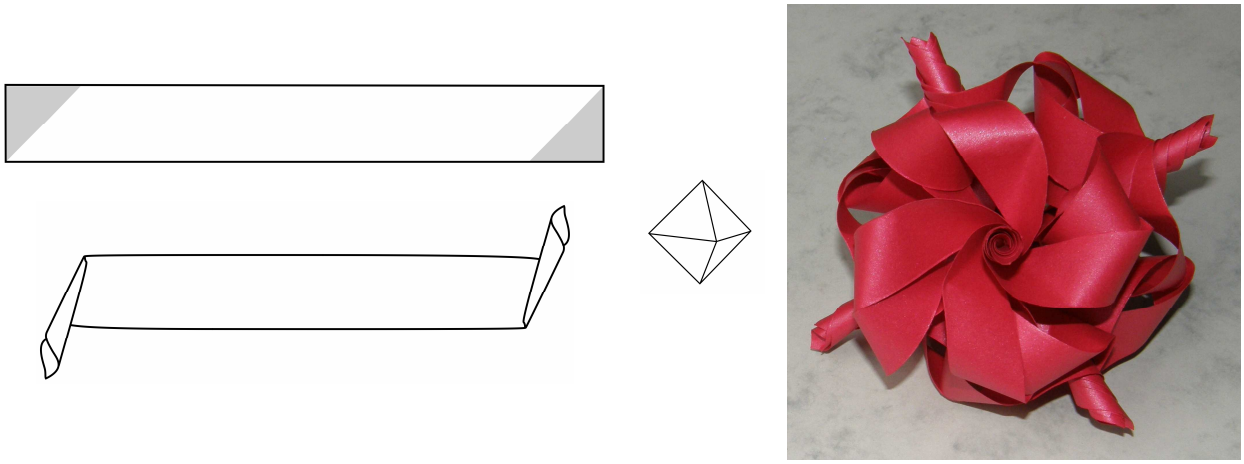


Figure 11: *Loops.*

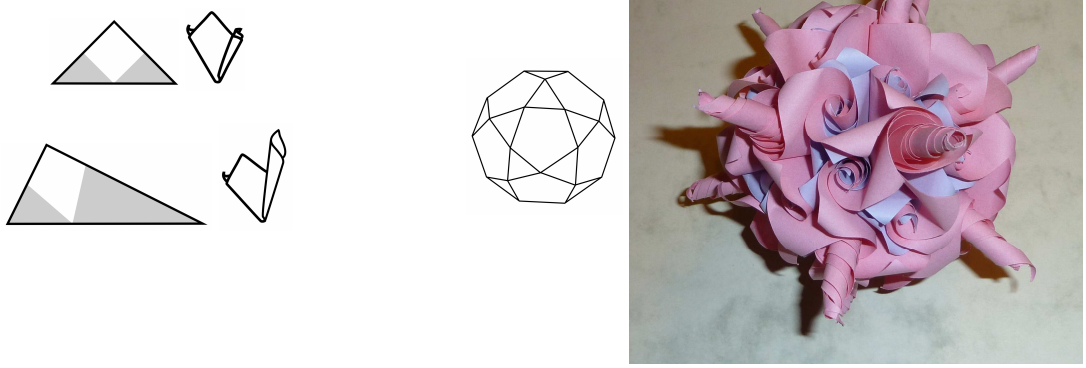


Figure 12: *Triangles.*

References

[1] K. Burczyk, *Kręciołki. Twirls*, Zabierzów 2003.
[2] K. Burczyk, *Kręciołki kręcone inaczej. Twirls Differently Twisted*, Zabierzów, 2003.
[3] K. Burczyk, *Kręciołkowe kusudamy 1. Twirl Kusudamas 1*, Zabierzów, 2008
[4] K. Burczyk, W. Burczyk, *Kręciołkowe kusudamy 2. Twirl Kusudamas 2*, Zabierzów, 2009
[5] K. Burczyk, W. Burczyk, *Kręciołkowe kusudamy 3. Twirl Kusudamas 3*, Zabierzów , 2009
[6] K. Burczyk, W. Burczyk, *Kręciołkowe kusudamy 4. Twirl Kusudamas 4*, to be printed
[7] K. Burczyk, W. Burczyk, *A Systematic Approach to Twirls Design*, in P. Wang-Iverson, R. J. Lang (ed.) Origami 5: Fifth International Meeting of Origami Science, Mathematics, and Education, A. K. Peters 2011
[8] Herman van Goubergen, *Curler unit"*, British Origami 205 (2000), pp. 17-18.
[9] G. W. Hart, R. Sarhangi (ed.) *Bridges Pécs. Mathematics, Music, Art, Architecture, Culture. Procedings 2010.* Tesselation Publishing, 2010.