## Where's the Math in Origami?

Origami may not seem like it involves very much mathematics. Yes, origami involves symmetry. If we build a polyhedron then, sure, we encounter a shape from geometry. Is that as far as it goes? Do any interesting mathematical questions arise from the process of folding paper? Is there any deep mathematics in origami? Is the mathematics behind origami useful for anything other than making pretty decorations?

People who spend time folding paper often ask themselves questions that are ultimately mathematical in nature. Is there a simpler procedure for folding a certain figure? Where on the original square paper do the wings of a crane come from? What size paper should I use to make a chair to sit at the origami table I already made? Is it possible to make an origami beetle that has six legs and two antennae from a single square sheet of paper? Is there a precise procedure for folding a paper into five equal strips?

In the last few decades, folders inspired by questions like these have revolutionized origami by bringing mathematical techniques to their art. In the early 1990s, Robert Lang proved that for any number of appendages there is an origami base that can produce the desired effect from a single square sheet of paper. Robert has created a computer program that can design a somewhat optimized base for any stick figure outline. This has enabled many folders to create origami animals that were considered impossible years ago.

Recently, mathematical origami theory has been applied to produce an amazing range of practical applications. New technologies being developed include: paper product designs involving no adhesives, better ways of folding maps, unfolding space telescopes and solar sails, software systems that test the safety of airbag packings for car manufacturers, and self-organizing artificial intelligence systems.

### Challenge Problems For Sonobe Modules

- Using two colors, is it possible to construct a cube so that both colors appear on each face?
- Using three colors, is it possible to construct a cube so that only two of the three colors appear on each face?
- Using three colors, is it possible to construct a cube so that all three colors appear on each face?
- Using Sonobe units, can you build a stellated octahedron? A stellated icosahedron?
- Can you use Sonobe units to design your own unusual polyhedron?
- What is the smallest number of Sonobe units you need to make a polyhedron?
- How many different polyhedra can you make using six or fewer Sonobe units? Seven?
- A Sonobe polyhedron is *three-colorable* if there is a way to construct it using only three colors so that no module inserts into a module of the same color. Can you find a three-coloring for a stellated octahedron? What about for a stellated icosahedron? Can you find any polyhedra that are not three-colorable?

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Math on the Street

More Information and Challenges Available At
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