



Learning by **folding**

Don't be surprised to see an origami workshop advertised at a high school near you in 2009. New Zealand origami master Jonathan Baxter and Auckland mathematician Hugh Gribben, pictured, took their Great Origami Maths and Science Show on a highly popular national tour in 2006, and they're keen to repeat it. By Jenny Rankine.



Gribben folds coloured pieces of paper as he speaks, creating elegant shapes or modular polyhedra. But folding and talking don't go well together unless he practises, and after a conversation his desk is littered with finished and half-finished shapes, intriguingly creased.

He describes the tour as a "whizz-bang show, not a workshop", which used origami to turn kids onto maths and their teachers onto its ability to illustrate tangibly many maths areas. The show also explored science principles, such as aerodynamics with paper darts and how DNA helixes collapse.

Students were bussed in to main centres for the show, which had booked out audiences of up to 300. The pair folded on stage, with live close ups on a big screen, and invited some students on stage to fold particular shapes. Each class received a copy of the 150-page book of the show.

Gribben has used origami as a first year maths guest lecturer, and is regularly invited to run school workshops. "It is tangible rather than abstract learning; the kids learn it with their hands." He may start by asking them how many ways they can fold a square of paper into a new shape that is half the area of the original square.

His favourite example was first documented in 1893 by T. Sundara Row and starts with all four corners meeting in the middle of the square. The new square is half the area of the original. In Row's book, this is repeated until the square is too small to continue.

Imagining the folding going on for ever provides a proof of the convergence of the geometric series. Gribben says students find this geometrical proof very convincing when they fold it themselves.

Another exercise can involve making a nautilus shell similar to the NZIMA logo, or a

self-similar wave. "If I did that with 100 steps, they would all have the same ratio between the folds of the wave front." Year 13 maths students can then use complex numbers to find the centre of the spiral.

He also gets students exploring Platonic or Archimedean solids. Modular polyhedra are his favourite - "they're simple shapes put together - lots of eye candy". Gribben is pictured making an alpha prism. This semi-regular solid is made of six modules, each a paper square folded three times into a right isosceles triangular shape.

He likes to make them with three paper colours. "I make it so different colours don't lie next to each other; don't share a common edge and the outside is made up of four small triangles. These are aesthetic decisions, but they're also strongly mathematical. To make two the same is difficult - it teaches precision of thinking. It's a very simple but deeply meaningful shape."

Another exercise involves conic sections. "If students mark a point near the bottom of an A4 portrait page and fold different points of the bottom edge to that point, they get a family of folds that are all tangents to a parabola. They can do similar things with an ellipse and a hyperbola."

Famous ancient problems such as doubling a cube and trisecting an arbitrary angle, which the Greeks attempted unsuccessfully to solve with compass and straight edge, can be solved with origami. "I like to believe I could come up with a workshop about any mathematical area," says Gribben.

Computational origami has solved engineering and science problems, such as folding and opening space telescopes and solar panels on satellites. "Studying paper crumpling is an easy way to learn how to model bumpers crumpling during car crashes,

or plane bodies on impact," he says.

"Airbags are another application. They have to unfold very rapidly without hard edges." The solution used algorithms developed by Robert Lang for his Treemaker origami programme. "A stent, which has to move along blood vessels then open up and lock into place, uses a very simple origami technology."

Once Gribben has finished maths studies for a Postgraduate Diploma in Science he wants to be "an itinerant maths teacher, running workshops, doing tangible learning". Watch out for Gribben and Baxter in 2009.

Top: A folded base, and the finished scorpion folded from that base.

Background: Screen shot of the computed crease pattern for the scorpion using TreeMaker 4. Circles correspond to terminal flaps.

See also

The Great Origami Maths and Science Show book, available for \$27 from Origami New Zealand, c/- Rotorua Arts Village Experience, 1240 Hinemaru St, Rotorua, phone 07 348 9008, fax 07 343 7108, email jbax@mindspring.com

The GOMSS website - www.nzamt.org.nz/origami.htm

A talk by Robert Lang - www.ted.com/index.php/talks/robert_lang_folds_way_new_origami.html

Robert Lang's website - www.langorigami.com/science/science.php4