Crafting GEOMETRY

BY ARWEN O'REILLY

What coral reefs, chaos, and the bias cut have in common.

Dr. Daina Taimina strides up to the podium in an elaborate crocheted skirt. She's speaking at the Gathering for Gardner, an invitation-only mathematics event in honor of Martin Gardner, the famed mathematician and puzzler (he wrote a column in *Scientific American* for almost 50 years).

Her talk is about crocheting math, a subject that has garnered her increasing media attention in recent years. Much of the audience is well-versed in the geometry of the hyperbolic plane, but most people haven't had a chance to play with some of the best hyperbolic models to come out of academia: Taimina has crocheted them.

Models existed before, but they were fairly fragile. She explains: "William Thurston made a paper and tape model around 1986. In 1997, I was going to teach a class and thought, 'I can't use this; it's falling apart!' So I decided to crochet one."

With the mathematical programming inherent in a crochet pattern, she was able to make a sturdy, pliable model that really gets across the physicality of the hyperbolic plane, even to ordinary observers. Her students went nuts.

"It's not that you haven't seen it before," she points out. "Here are pictures from my garden." Slides flash by of ruffled lettuce, curly kale, the rippled edges of a sea slug. "Well, the sea slug is not from my garden," she laughs. She goes on to explain what geometrists already know: while a sphere has constant positive curvature, a hyperbolic plane is the opposite of a sphere, having constant negative curvature. It is always curving away from itself, causing the ripple we see in nature and in math textbooks.

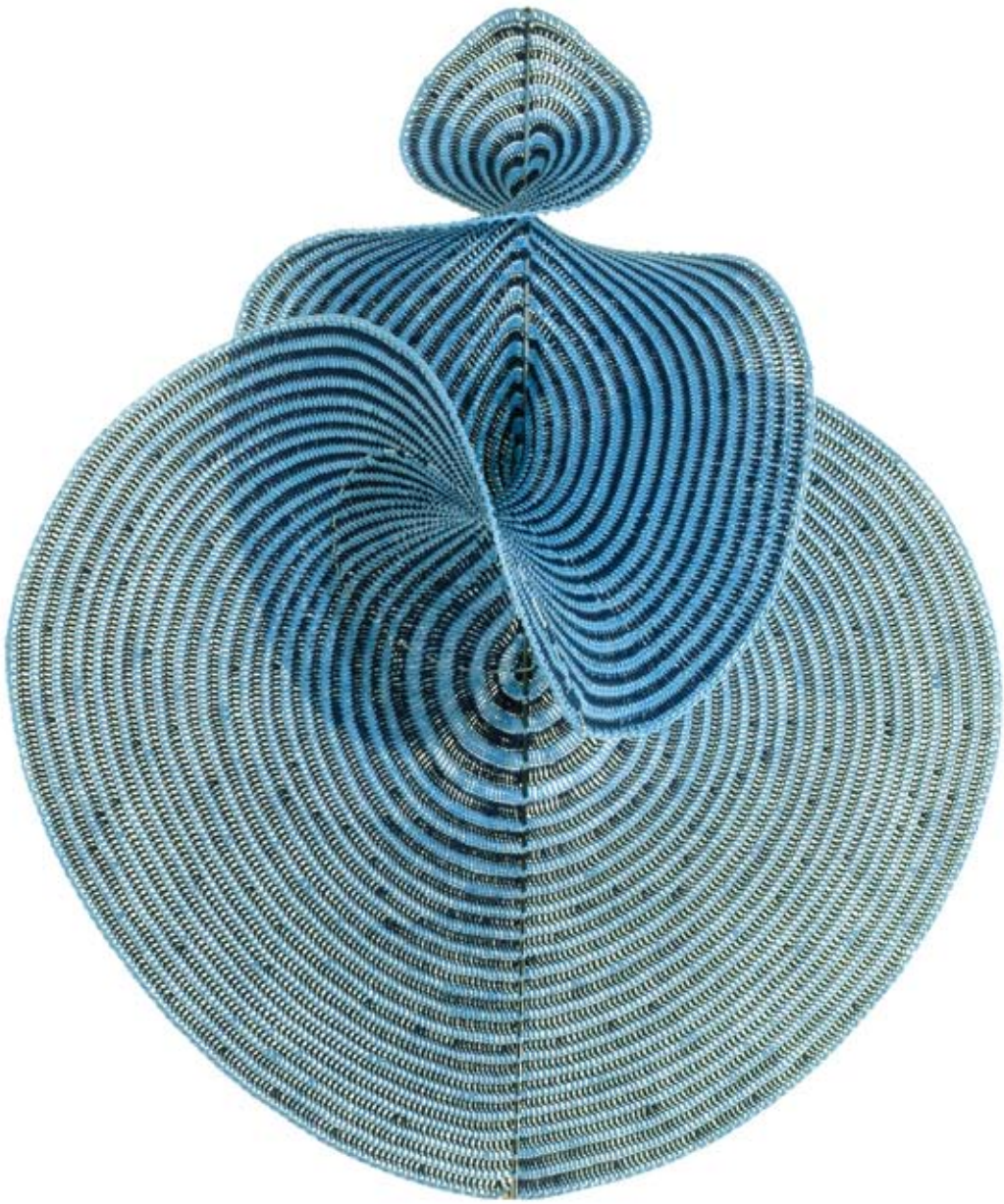
Having the physical models on hand allowed Taimina to explore new ideas and prove new connections. "The other realization is that maybe this can be a fashion line for mathematicians!" she says, twirling her skirt. She gets a big laugh and some eager looks. Mathematical fashion may not have hit the big time yet, but the intersection of crafting and science is definitely on the rise.

Margaret Wertheim, for one, is thrilled about it. A science journalist, she founded the Institute For Figuring in 2003 with the idea of drawing attention to what she calls the "poetic and aesthetic aspects" of science and mathematics. Taimina and her husband, geometrician David Henderson, were among the first people invited to lecture. Ever since then, the Institute has been tackling topics like knot theory, tensegrity structures, and paper folding, as well as continuing to explore hyperbolic crochet. They coordinate lectures and exhibitions, drawing the attention of the art and design worlds to objects like Taimina's.

The Institute has a number of exhibitions coming up in the next year (as well as supporting her with a grant), including the display of a collaborative crocheted coral reef at the LACE gallery. Responding to Taimina's work with hyperbolic space, Wertheim and her sister Christine, a co-director of the Institute, started playing around and crocheting their own forms, including shapes that looked like kelp and cactuses. "We had them arranged on our dining room table," says Wertheim, an Australian, "and as they grew, we realized that it looked like a coral reef." A crocheted reef is no coincidence; like kelp, coral reefs have hyperbolic geometry in them.

The sisters started inviting people to contribute pieces of the reef, and soon had so many submissions that they ended up in the position of curating crochet. In the process of looking for a space to exhibit, they were surprised and delighted to find that a number of other textile artists were also making coral reefs independently. The show is tentatively titled

This amazing crocheted Lorenz manifold took Dr. Hinke Osinga 85 hours and 25,511 stitches to complete.



"I've Got a Coral Reef, Too" and will include different artists' interpretations.

All of a sudden, craft, math, and art are coming together in ways that no one could have predicted. Or, as Wertheim puts it, "crafts have become mechanisms for making really interesting art." On the other side of the Atlantic, University of Bristol researchers Drs. Hinke Osinga and Bernd Krauskopf are finding out the same thing. Like Taimina, Osinga originally crocheted in her spare time, but she and Krauskopf realized that they could apply it to their research. The result was a crocheted Lorenz manifold, which is a representation of chaos in the famous Lorenz system.

The Lorenz manifold is an example of a complicated surface that shows how chaos arises in a system that changes in time. Osinga and Krauskopf develop computer methods to find and visualize such surfaces. (Osinga gives an example: "Such a surface may consist of all possible positions and velocities of a spaceship such that it reaches a specific point." The work has applications in laser dynamics and neurological research as well.) While their work centers on computer methods, the crochet project was "driven by the need to see and feel the real thing ... we realize now how much artistic value the crocheted Lorenz manifold has."

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The Lorenz project turned out to be an inspiration for artists and a great public outreach tool. It's striking how eagerly these mathematicians share their processes, true to the open source roots of crafting. "It was important to us that anyone should be able to repeat our creation, but we were actually worried that nobody would try," admits Osinga, so they offered a bottle of champagne to the first person to crochet another manifold.

She shouldn't have been nervous; they got three responses in two weeks. "We learnt how the use of handcraft for visualization makes complex mathematics extremely accessible to the general public," she says. "It serves as an eye-opener to people who thought mathematics wasn't for them."

Drawing more people into geometry is something Dr. Sarah-Marie Belcastro welcomes. A young, energetic assistant professor at Smith College and the co-director of the Hampshire College Summer Studies in Mathematics program, she bewails the state of university geometry programs. "We're lucky if a given institution has one undergraduate geometry course," she points out. Her homepage, toroidalsnark.net, has a fascinating collection of links to examples of mathematical knitting, crocheting, and fiber arts, and is one of the best resources on the state of this emerging field.

Belcastro knits things most people only vaguely remember from high school or college math classes: three-holed toruses, Klein bottles, and projective planes. Her Klein bottle hat looks like something surrealist fashion designer Elsa Schiaparelli would have sent out on the runway, and she points out that math influences fashion more than we may think. Every time you slip on a bias-cut dress, you're paying homage to Madeleine Vionnet, who invented cutting across the grain of fabric for superior drape and considered herself a geometrician.

The confluence of fashion and math is making waves in the book world, too. Belcastro and her crafting partner are working on a proposal for a book on mathematics and fiber arts, aimed at crafters and mathematicians. *Knitting Nature*, a book by Norah Gaughan, was just published this past summer by Stewart, Talbori and Chang, and features skirts, sweaters, shawls, and shrugs inspired by starfish, tortoise shells, and honeycombs. (The intersection of knitting and math seems to be "out there in the air," as she puts it.) Next year will see the arrival of a long-awaited book of patterns edited by Sabrina Gschwandtner, the founder of knitknit.net, an art and crafting zine that has printed patterns for geodesic hats and ASCII weaving.

While all these books may have seemed completely on the fringe a few years ago, the timing may be just right. Geometry has arrived. Craft is cool again. And maybe those math classes will start filling up now.

For more images and resources, see craftzine.com/go/geometry.

My Brain on Acid, *a huge orange symmetrical hyperbolic plane, 30cm in diameter, by Christine Wertheim of the Institute For Figuring.*

Photograph by Anitra Menning/IFF Archive

Arwen O'Reilly is staff editor of CRAFT.