

# *Twists, Tilings, and Tessellations* **Mathematical Methods for Geometric Origami**



*For 17 years, Robert Lang worked tirelessly on a book that kept the ever hungry community of paperfolders quite intrigued. Finally Twists, Tilings and Tessellations: Mathematical Methods for Geometric Origami hit the presses early this year. End of anxieties!*

*Interview by Laura Rozenberg*

At almost four pounds – and 776 pages! – the healthy newborn arrived full of math, diagrams and descriptions. Having asked Robert about inspiration, he agreed to tell us a few secrets about himself – worth reading.

***Your much-anticipated book has created quite a buzz. Why did the publication take so long?***

Mostly because the writing took so long. I started writing bits and pieces with the idea of making a book out of it around 2000, and signed a contract in 2005. But this type of writing requires blocks of focused time with no distractions, and those were few and far between over the next several years. That need for undistracted writing time was a major incentive for me to quit my laser job in 2001 so that I could write *Origami Design Secrets*, but by the time I signed the contract, my life had filled up again.

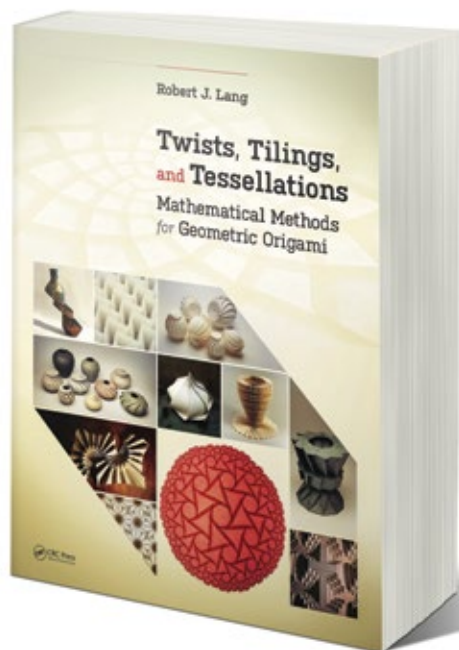
A year or so ago, I decided I had enough bits for the framework of the book and could free up enough time that I could

complete the writing and did so in several months of focused effort. Even so, I left out some topics that I dearly wanted to include: Ron Resch tessellations, flashers, concentrically-creased polygons, and curved folding to name a few. Perhaps they will go into a future edition.

Since I started writing it in 2000, and finished the writing in 2017, it lived underground for 17 years. So I consider this book to be my “cicada book.”

***Twists, Tilings and Tessellations... comes 15 years after your book Origami Design Secrets. During this time, we've been witness to your seemingly unlimited creativity. Does the new book tell us new secrets?***

I think so. What I tried to do was develop and present a coherent mathematical way of designing and analyzing geometric folds and to put both historical folds (Miura-ori, Fujimoto designs, rotational solids) into the framework. Also I was laying some groundwork for further development (both by myself and by my readers). So it contains a mix of historical and other people's work; both background math and some new and



original mathematical theory; and design principles.

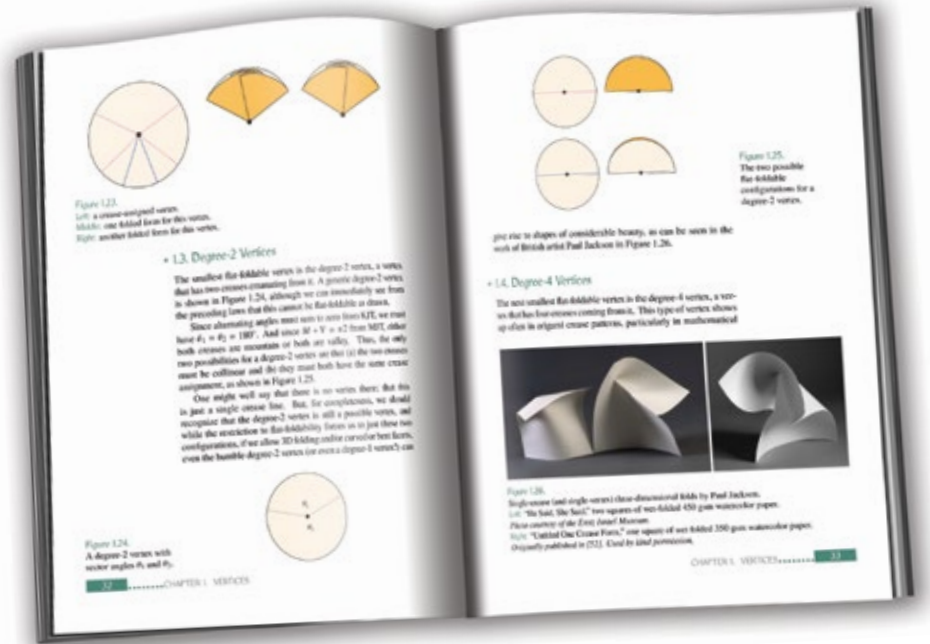
***In a culture ruled by technology, a new art vocabulary - consistent with the sign of the times - should emerge. Gone is the classicism, the romanticism, the conceptualism and the quest for color and light. Now it's all techno.***

I would disagree with this, at least, within the origami art world. I would agree that in the mid-1990s to early 2000s there was a push and focus on technical folding that, in many cases, did not emphasize those other attributes. But I think that in the last decade we have seen a renewed synthesis of art, line, and form with technology and design. We see this with many current origami artists—Beth Johnson and Kate Lukasheva come to mind—finding a perfect

balance between technique and graceful form. And even technological masters like Shuki Kato and Kota Imai manage to create feats of technological derring-do that are also beautiful and evocative. So the pendulum did at one point swing to technique, but it's swinging back. Current origami art now explores romance, emotion, impressionism (with artists as diverse as Sebastien Limet and Giang Dinh), with technique taking its role as an element of the toolkit to be wielded to achieve an artistic vision.

*With the scientific approach that you and others have been developing, origami looks like the perfect technique for interpreting, artistically, our world and social change. However, it has not widely gained recognition in major art galleries and museums. Why?*

All things in good time! Remember that origami received almost no attention in the art world prior to about 2000; it was considered nothing more than a mere "craft" or child's pastime. Exhibitions of origami were generally only to be found in "alternative" venues: library cases, the display walls in a university building, and



the like. The groundbreaking exhibitions at the Mingei Museum in San Diego (and its follow-up a few years later in Encinitas) were the camel nose under the tent wall; the rest of the camel started to follow. Exhibitions like Meher McArthur's Folding Paper: Infinite Possibilities and its follow-on Above the Fold have been

sowing the soil of the art world with their successful runs in mainstream art museums. I fully expect this trend to continue and for origami to make its way into larger and more major galleries and museums in coming years.

*You work in so many fields at once, from being a consultant to NASA to teamworking with high-end sculptors, while continuing your research and the production of books and works of art. Most of us revere you as larger than life. What's your secret for efficiency?*

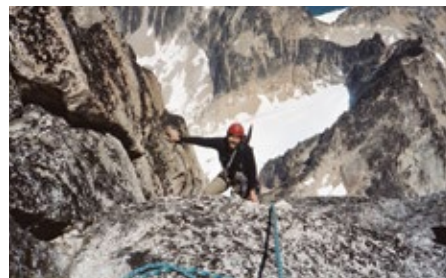
That's hard to answer, because I don't feel like I'm very efficient. I seem to be very good at finding distractions that prevent me from accomplishing things I'd like to accomplish. A more efficient person might not have taken 17 years to write a tessellation book. When it comes to things related to origami, I am pretty curious and I learned a long time ago that following one's curiosity is not just fun, but it sows seeds that very often pay off in the long term when something you studied purely because it was interesting turns out down the road to have a practical application (in either art or technology). The flip side of being curious and interested in a lot of things is that I accumulate a huge stack of half-finished projects that I didn't finish (or in some cases, barely even started) because another squirrel - or a whole pack of

**When ROBERT LANG is not at his office folding complex models or WRITING MAMMOTH BOOKS, he might be outdoors enjoying NATURE and XTREME SPORTS.**



LEFT. Robert Lang does not spare any effort when it comes to investigating a valley fold. He is the speck hanging from rope. (Lost Arrow Spire, Yosemite National Park, 1996).

BELOW. At Canadian Purcells' Bugaboo Spire, he examined mountain folds while trying to avoid a too-rapid encounter with a valley fold. (2004)





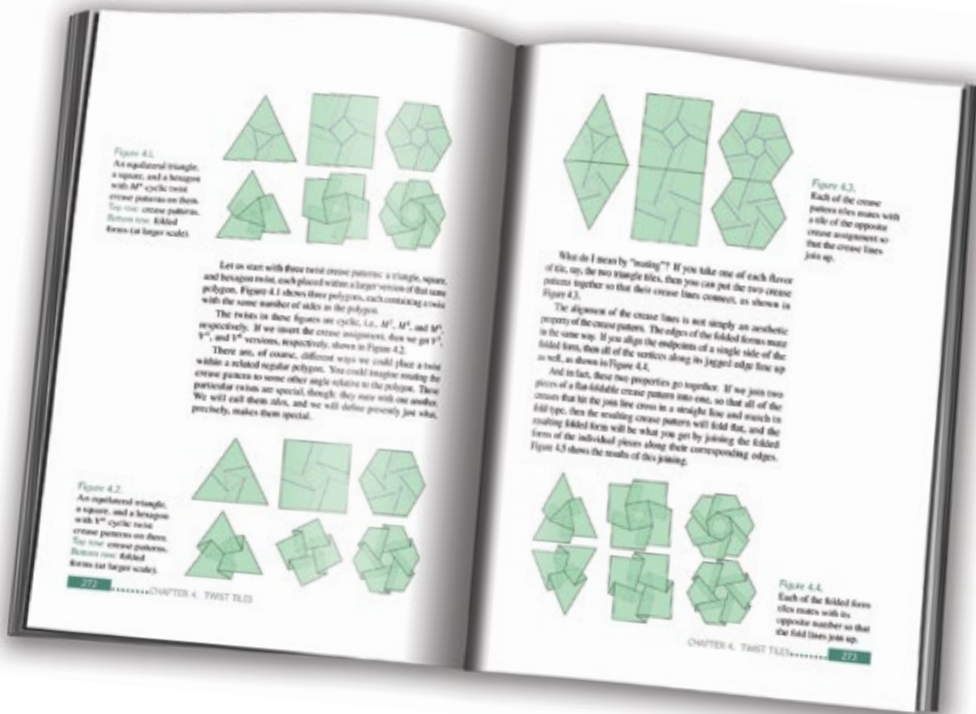
BOOK REVIEW

# Twists, Tilings, and Tessellations: Mathematical Methods for Geometric Origami by Robert J. Lang

Review by Thomas C. Hull

This book is a masterpiece. Lang delves deep into the mathematics behind origami tessellations, a complex genre of origami that has seen a surge of interest in the 21st century. Of particular interest are twist-folds, which are collections of creases that literally allow one to "twist" a section of the paper and then have everything collapse back into a flat, folded form. Square twists have been a standard origami move for decades --- they can be seen in many origami roses, for example. But twists can be made from other polygons as well, not just squares, and as such they can be made to tile a sheet of paper, giving a repetitive crease pattern that will have a similar, "tiled" geometric look when folded. Lang fully describes the math behind how twist folds work and when they can (and when they can't) be made into a full tessellation. But he doesn't stop there, giving full exposure to origami tessellation patterns that have been extensively studied in origami engineering applications, like the famous Miura-ori and the Yoshimura pattern. He also explores and details special families of origami tessellations, like

flagstone woven tessellations. He even describes 3D origami tessellations, where the finished model is structurally 3D, not a flat model. While there are many, many crease patterns and some instructions in this book, it really is a book meant for serious students of origami art. If you're an origami artist who wants to really see what tessellations can add to your work, and who isn't afraid of seeing some (or lots!) of mathematical equations at the same time, you must buy this book! But you don't really need to understand all the math to learn a whole lot about how tessellation folds work. If you **\*\*want\*\*** to see all the math behind such geometric origami, then you absolutely must get your hands on this book. Along with Lang's famous "Origami Design Secrets" book and Erik Demaine & Joe O'Rourke's text "Geometric Folding Algorithms", this book is the next in a progression of work that distills much of the advanced research that has been going on in origami math & science into a coherent, readable form. Highly, highly recommended for serious origami artists, origami scientists and engineers, and students of origami mathematics.



them- ran across my field of view, and I had no choice but to give chase.

A thing that probably helps my productivity, though, is that I can spend substantial time on origami since going full-time in 2001. I generally start work around 7 am, and come in for the evening about 8 pm with breaks for breakfast and dinner with my wife. I do this 7 days a week. That sounds like it might be a grind, but the day is always a mixture of several different things: some tasks might be tedious (plugging away on a commission or consultation project, or doing invoices, billings, reports, and other business paperwork), but some of it is also fun and creative (designing an art figure, folding an art figure, solving a math problem, programming computer code related to one of the preceding). So, overall, I generally end the day exhilarated, rather than tired, and am rarin' to go the next morning when I awake. 🏹

Photos courtesy by Robert Lang