Origami Design
Tree Theory for Uniaxial Bases

Robert J. Lang
robert@langorigami.com

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Context
Background

- Origami: Japanese paper-folding.

- Traditional form: Decorative abstract shapes & child’s craft

- Modern extension: a form of sculpture in which the primary means of creating the form consists of folding

- Most common version: a figure folded from one sheet of paper, usually a square, with no cuts.
Traditional Origami

- Japanese newspaper from 1734: Crane, boat, table, “yakko-san”
- By 1734, it is already well-developed
Modern Origami

- The modern art form was reborn in the early 20th century through the efforts of a Japanese artist, Akira Yoshizawa, who created new figures of artistic beauty and developed a written instructional language.

A. Yoshizawa, *Origami Dokuhon I*

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The Design Revolution

• “Creative” origami caught on worldwide in the 1950s and 1960s.

• Beginning in the 1970s, many geometric design techniques were developed that enabled the creation of figures of undreamed-of complexity.

• The mathematical theory of origami was greatly expanded in the 1990s, leading to computer-aided origami design.
Origami today

- “Black Forest Cuckoo Clock,” designed in 1987
- One sheet, no cuts
- 216 steps
  - not including repeats
- Several hours to fold
Scaled Koi
Western Pond Turtle
Rattlesnake
White-tailed Deer
Hummingbird & Trumpet Vine
Grizzly Bear
Tree Frog
Tarantula
Murex
Spindle Murex
12-Spined Shell
Banana Slug
Spiral Tessellation
Egg17 Tessellation
Molecular Tessellation
Chalk time…
A Tree & Active Polygons

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Subtrees
Chalk time...
Molecules

- Crease patterns that collapse a polygon so that all edges lie on a single line are called “bun-shi,” or molecules (Meguro).
- Different bun-shi are known from the origami literature.
- Triangles have only one possible molecule.

the “rabbit ear” molecule
Quadrilateral molecules

- There are two possible trees and several different molecules for a quadrilateral.
- Beyond 4 sides, the possibilities grow rapidly.

Husimi/Kawasaki
Maekawa
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Four is enough

- It is always possible to add flaps (circles) to a base so that the only polygons are triangles and quadrilaterals, so these molecules suffice.
Universal molecule

- An algorithm that produces the crease pattern to collapse an arbitrary valid convex polygon into a base whose projection is a specified tree.
A pentagonal UM
Insetting
Gusset formation
Finished gussets
Creases & Folded Form
Chalk time...
Resources

- Origami design software *TreeMaker* (with 170 pp manual) can be downloaded from:
  - http://origami.kvi.nl/programs/treemaker
- ...or Google-search for “TreeMaker”
- Version 5.0 (*Mac/Linux/Windows*) is under construction.
- Other origami-related software, including *ReferenceFinder*, is at the same site
More Resources

- *Origami Design Secrets*, my new book teaching how to design origami (and more), was published by A. K. Peters in October 2003.

- *Origami Insects II*, my latest, contains a collection of fairly challenging insect designs

- Both (and other books) available from the OrigamiUSA Source (www.origami-usa.org).

- Further information may be found at [http://www.langorigami.com](http://www.langorigami.com), or email me at robert@langorigami.com