I'm worried after listening to your voice slightly sped up, it will sound weird in person!

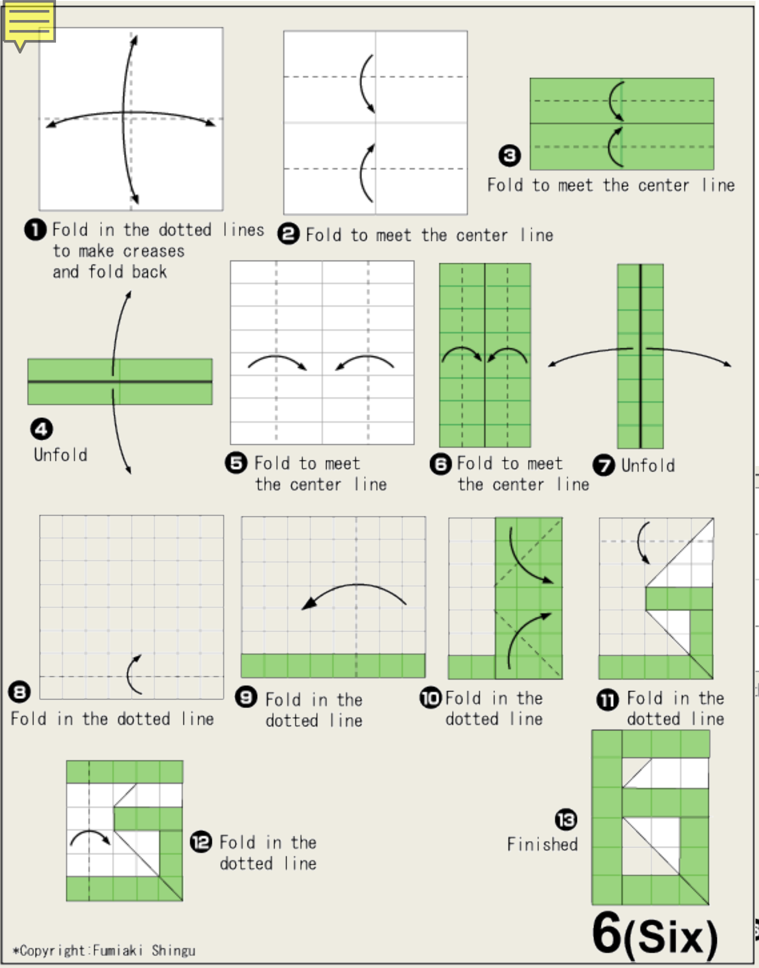
I quite enjoyed the Double Rainbow joke. :)

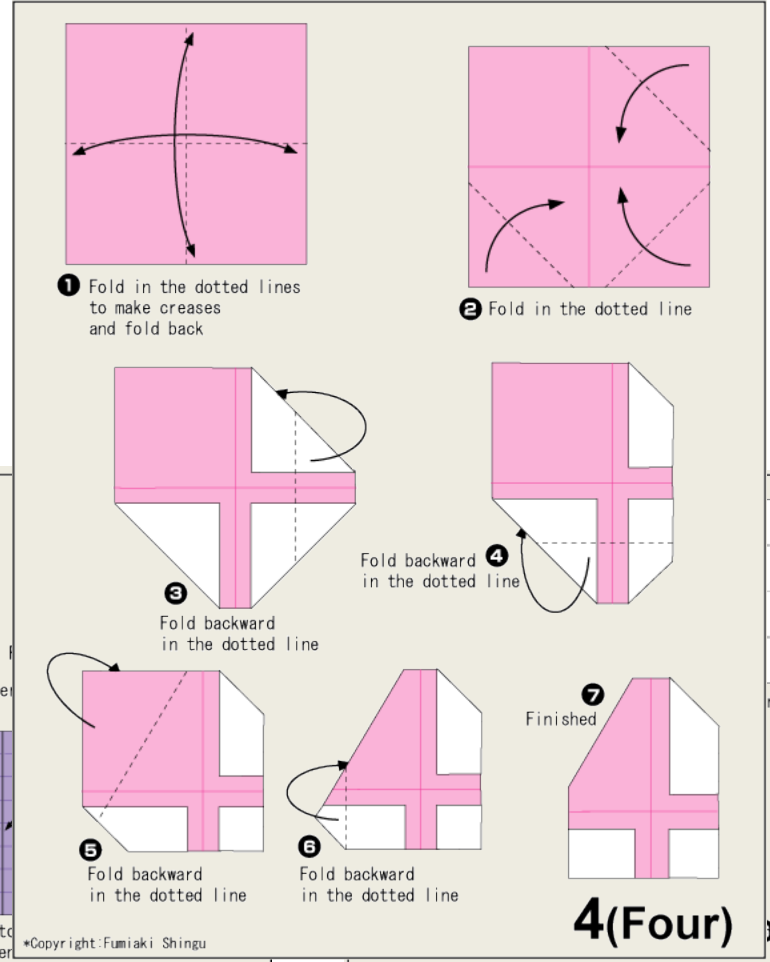
I hope every lecture is this exciting! All results were really interesting and proved much more elegantly than I would have expected.

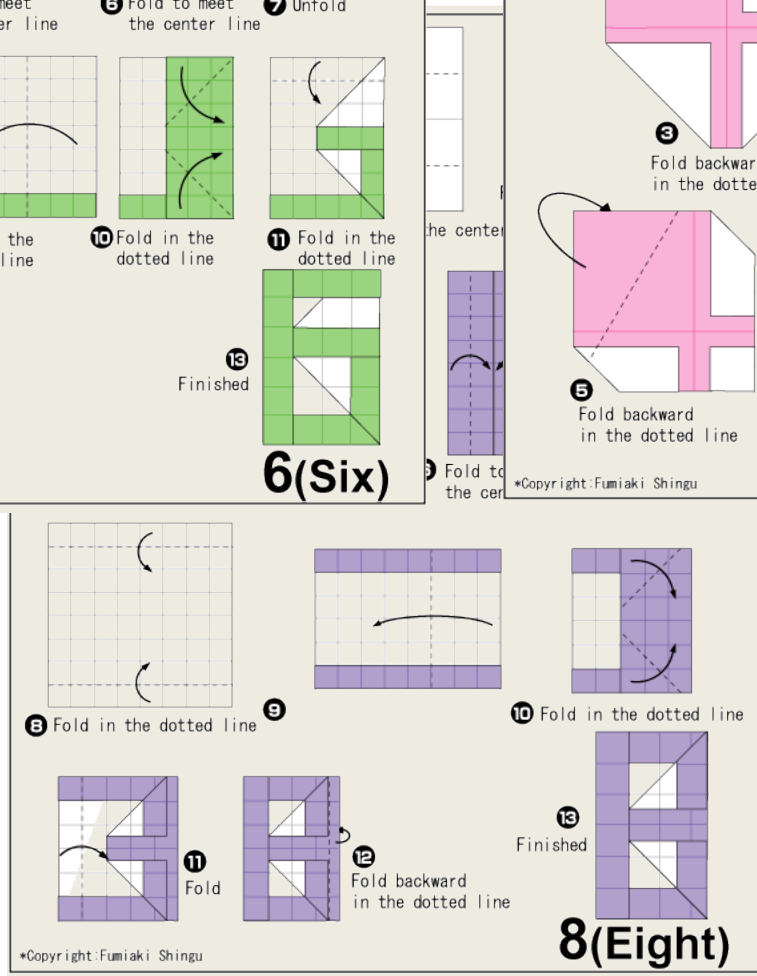
I'm sort of surprised we proved such a powerful theorem, so quickly in the class...

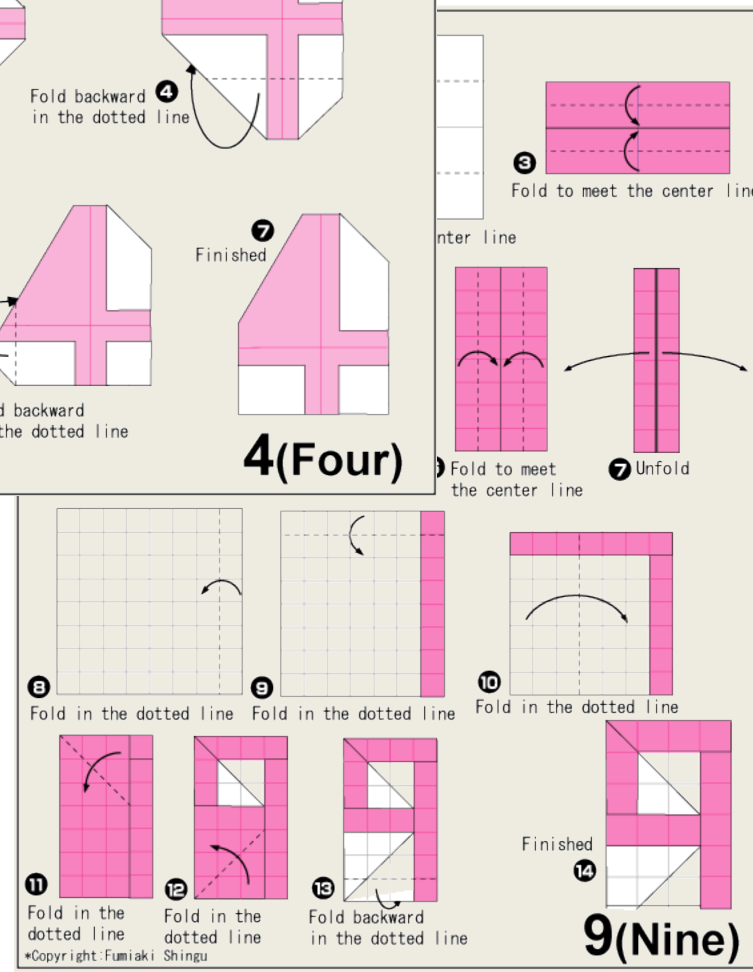
Class should probably include folding practice.

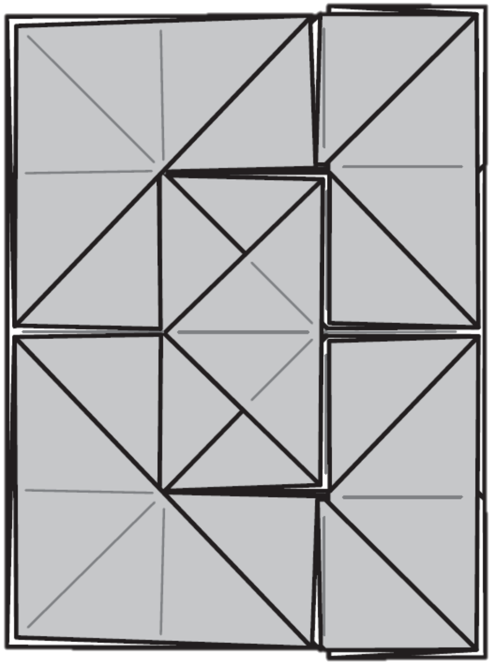
Fumiaki Shingu / Origami Club



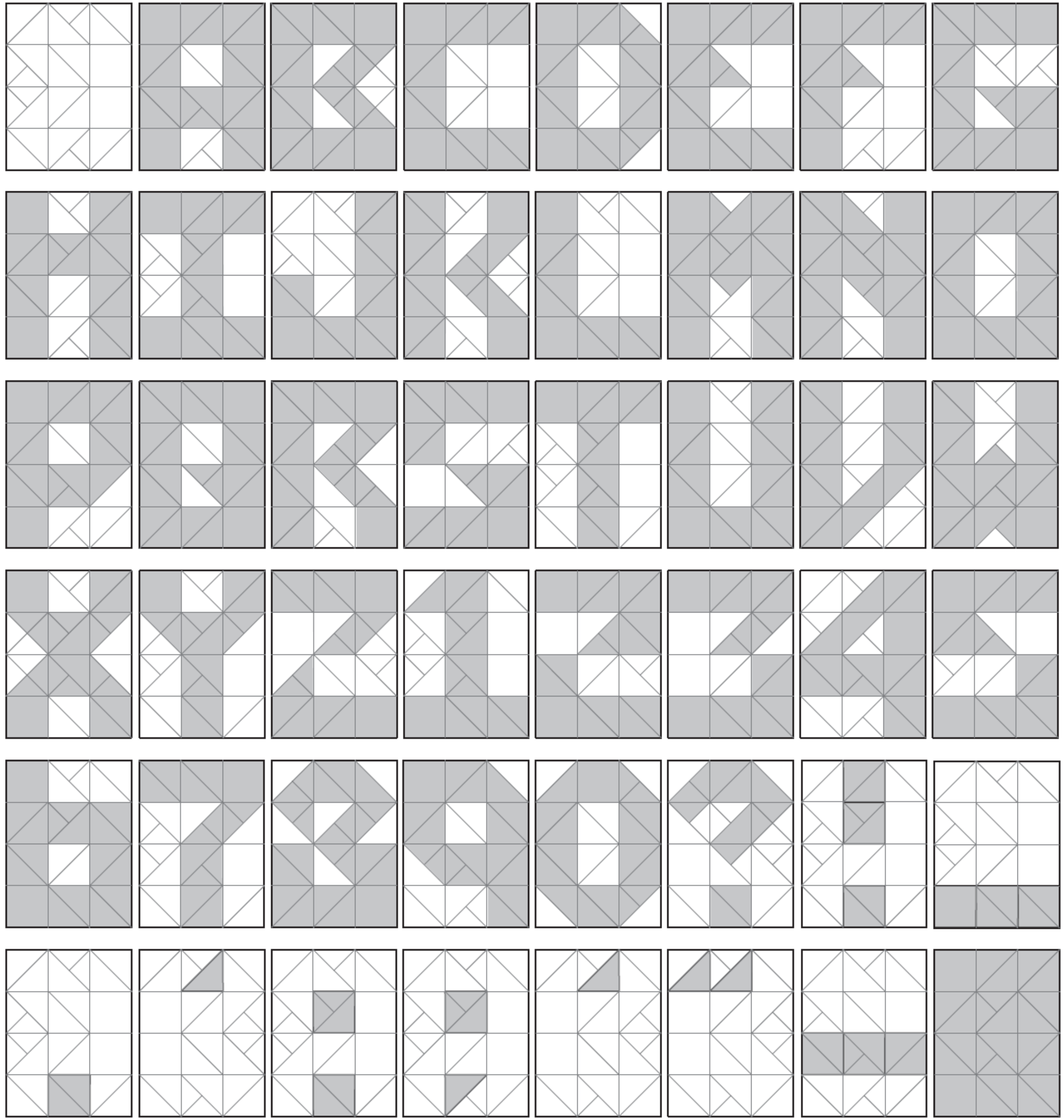




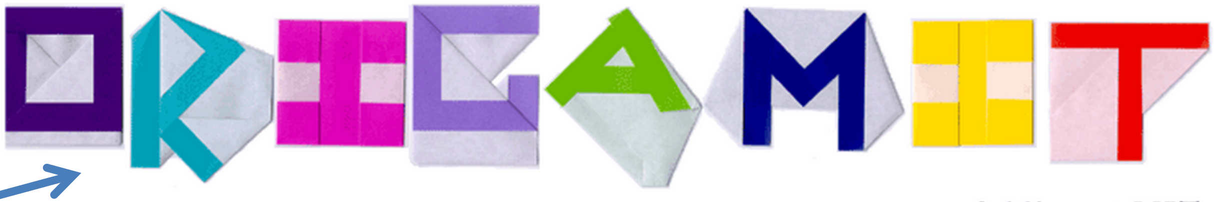




“Typeset”
Jason Ku
2009



origamit.scripts.mit.edu



paperfolding at MIT

Mosely, 2002

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OrigaMIT Calendar

Sunday, September 16	
14:00	Meeting (OrigaMIT)
Sunday, September 23	
15:00	Meeting (OrigaMIT)
Sunday, September 30	
15:00	Meeting (OrigaMIT)
Sunday, October 7	
15:00	Meeting (OrigaMIT)

2nd OrigaMIT Convention

meetings Sunday

Welcome to OrigaMIT, MIT's origami club, which exists to promote, practice, and teach origami folding, analysis, and design.

FULLER CRAFT MUSEUM PRESENTS
Mens et Manus: Folded Paper of MIT
Click here for more information!

Meetings and Workshops

This semester, our meetings will be held weekly on Sunday afternoons. Details for our next meeting can be found in the events section or on the calendar on the left. Anyone interested in origami is invited to attend, regardless of MIT affiliation - and origami beginners are always welcome!

OrigaMIT Convention!

During the Fall 2011 semester, OrigaMIT held its *first ever* origami convention on Nov. 19th. It was a resounding success, and we've already started planning next year's convention! We've reserved substantial space in the MIT Student Center for Oct. 27th, 2012, so mark your calendars and save the date!

Support Us!

We do our best at OrigaMIT to provide the MIT community with high level Workshops and Lectures free of charge. Much of our funding comes from the MIT Undergraduate Association, but this funding is only supposed to be used to fund the activities of

The header graphic is composed of letters from MIT alum and OrigaMIT member Jeannine Mosely's "Four-Fold Origami Alphabet," published in *Origami Tanteidan Convention Diagrams, Vol. 8*. Photo depicts *Mens et Manus II*, copyright 2007 Brian Chan.

convention on October 27!

I'm curious why page 3 of the notes refer to the universality results as silhouette and gift-wrapping.

Folding any shape: [Demaine, Demaine, Mitchell 2000]

(a.k.a. silhouette [Bern & Hayes 1998] / gift wrapping [Akiyama/Gardner])

Every connected union of polygons in 3D, each with a specified visible color (on each side), can be folded from a sufficiently large piece of bicolor paper of any shape (e.g., square).

Folding Flat Silhouettes and Wrapping Polyhedral Packages: New Results in Computational Origami ⋆

Erik D. Demaine and Martin L. Demaine

Department of Computer Science, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada, email: {`eddemaine`, `mldemaine`}`@uwaterloo.ca`.

Joseph S. B. Mitchell

Department of Applied Mathematics and Statistics, State University of New York, Stony Brook, NY 11794-3600, email: `jsbm@ams.sunysb.edu`.

Abstract

We show a remarkable fact about folding paper: From a single rectangular sheet of paper, one can fold it into a flat origami that takes the (scaled) shape of *any* connected polygonal region, even if it has holes. This resolves a long-standing open

A classic open question in origami mathematics is whether every simple polygon is the silhouette of a flat origami. This question was first formally stated within the algorithms community by Bern and Hayes at the ACM-SIAM Symposium on Discrete Algorithms in 1996 [7].

[Demaine, Demaine, Mitchell 1998/2000]

4. Is every simple polygon, when scaled sufficiently small, the silhouette of a flat origami? How many creases are necessary to fold an n-vertex polygon? How thick (number of layers of paper) must the origami be? This last question is motivated by the fact that in practice it is very difficult to simultaneously fold a large number of layers.

[Bern & Hayes 1996]

A more general question asks whether every polyhedron can be *wrapped* with a piece of rectangular paper. This is motivated not only by the problem of constructing three-dimensional origamis, but also the "gift wrapping problem," which was introduced to us by Jin Akiyama [3,4].

[3] Jin Akiyama, Why Taro can do geometry, in: Proceedings of the 9th Canadian Conference on Computational Geometry (1997) 112. Invited talk.

[4] Jin Akiyama, Takemasa Ooya, and Yuko Segawa, Wrapping a cube, Teaching Mathematics and Its Applications 16 (1997) 95–100.

[Demaine, Demaine, Mitchell 1998/2000]

Have you ever actually folded a model using this method, of triangulating the surface and then zigzagging across the triangles? Is this technique used in any "real" or "sensible" or "pretty" origami models or is it purely for the sake of the universality result?

"Woven paper
gift topper"

Kate / Mini-eco
June 2011

"woven paper basket"
Dasa Severova
July 2012

"Geeky weaves"

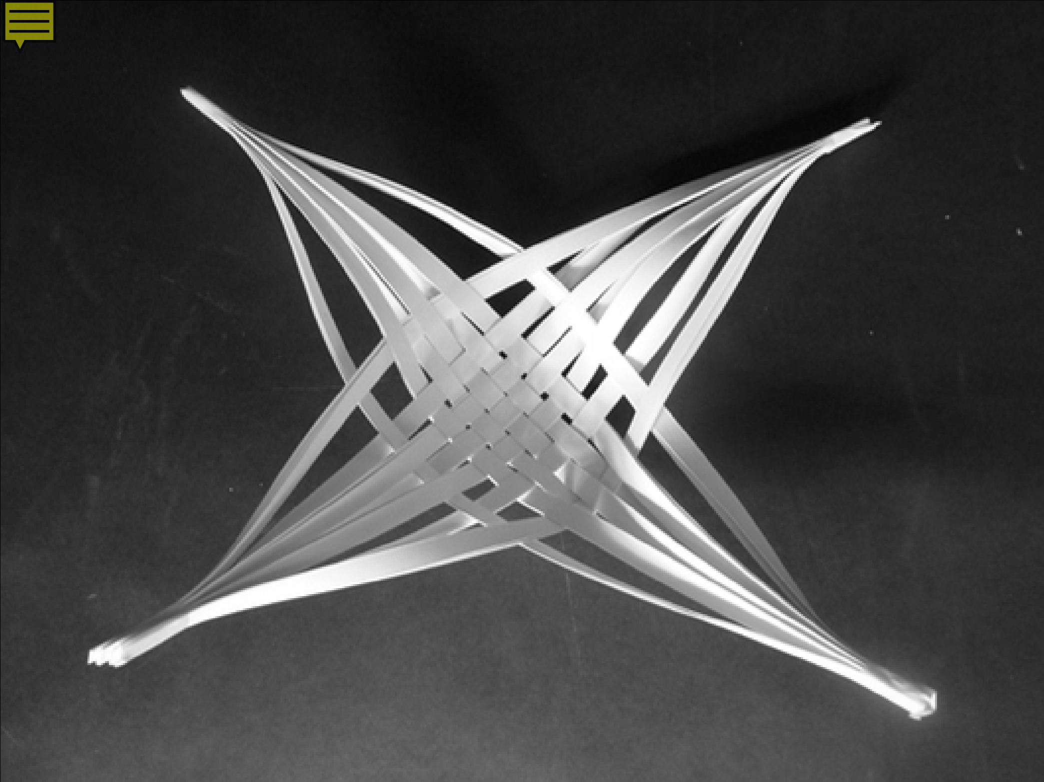
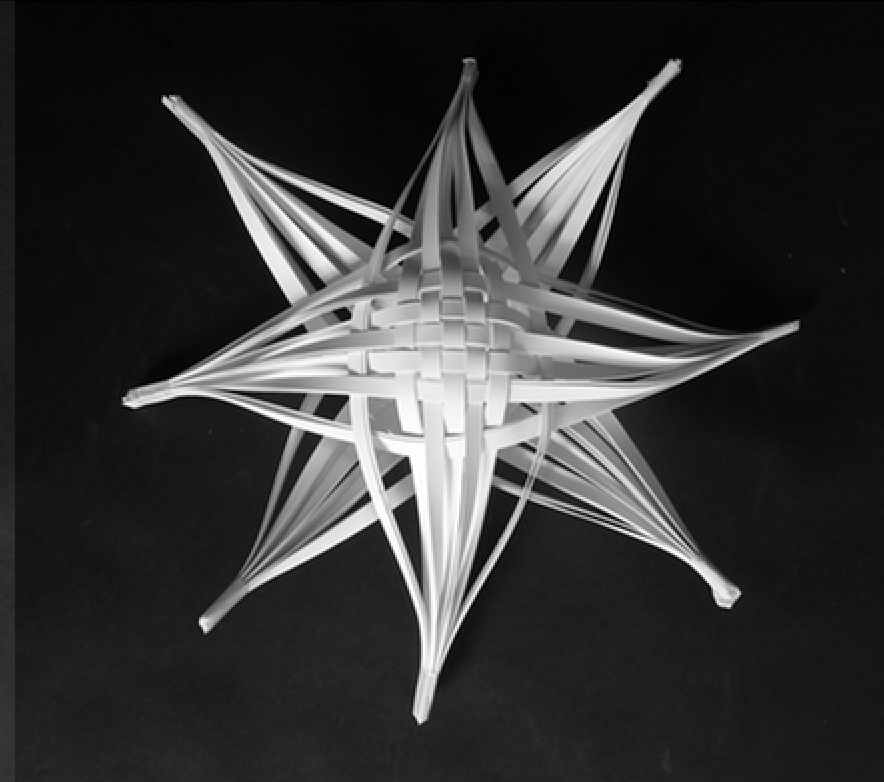
“Woven Paper Heart Ornament”

February 2010

Carol / extremecards.blogspot.com

“Woven Paper Discs”
January 2011

“Inexpensive Valentine Kid-Crafts”
Splaneyo
February 2009

“Woven Paper Pods” Zachary Futterer November 2011

Gum/candy wrapper handbags

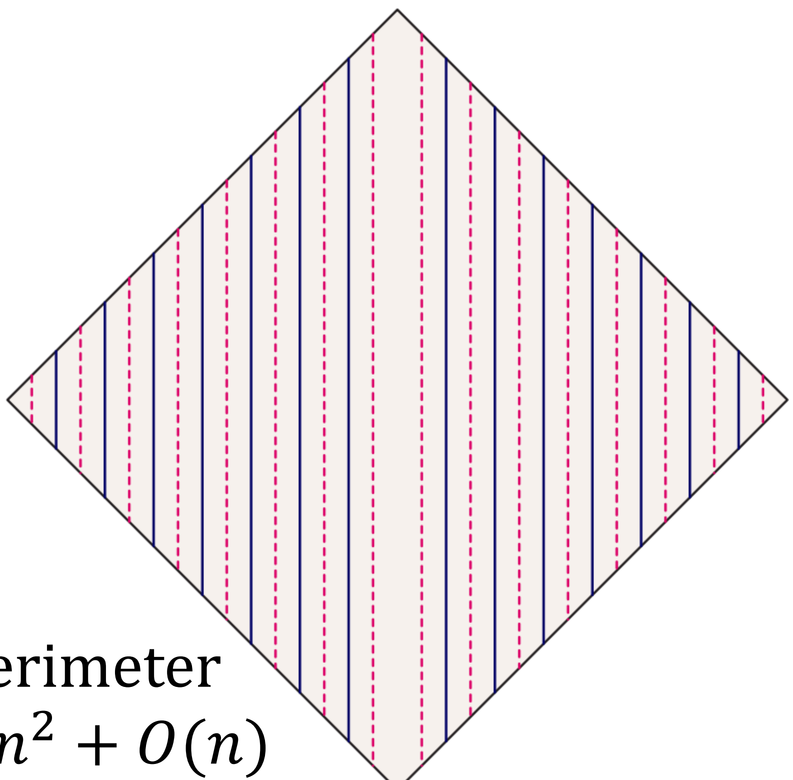
Nahui Ollin collection
Jute & Jackfruit, 2008

Folding a Better Checkerboard

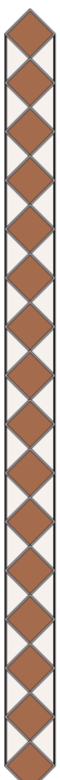
2011

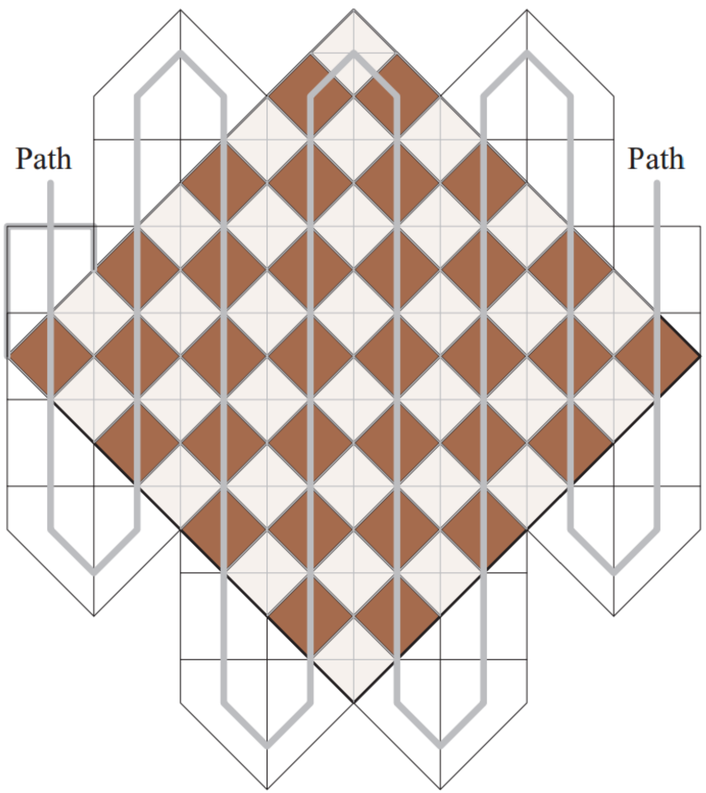
Erik D. Demaine[1*], Martin L. Demaine[1],
Goran Konjevod[2], and Robert J. Lang[3]

[1] MIT Computer Science and Artificial Intelligence Laboratory, 32 Vassar St., Cambridge, MA 02139, USA, {edemaine,mdemaine}@mit.edu
[2] Department of Computer Science and Engineering, Arizona State University, Tempe, AZ 85287, USA, goran@asu.edu
[3] http://langorigami.com



perimeter
$2n^2 + O(n)$





What are unmentioned open questions from slide 5?

$\boxed{\underline{\text{OPEN}}}$: pseudopolynomial upper bound? lower bound?

Theorem 1 *Given any (nonconvex) polyhedron, with each face assigned one of two colors, there is a folding of a sufficiently large square of bicolor paper that folds into the polyhedron with the desired colors showing on each face. An implicit representation of such a folding can be computed in time polynomial in n. The folding requires a number of folds polynomial in n and the ratio of the maximum diameter of a face of $\mathcal{P}$ to the minimum feature size of $\mathcal{P}$ (the smallest altitude of a triangle determined by any three vertices of any one face of $\mathcal{P}$).*

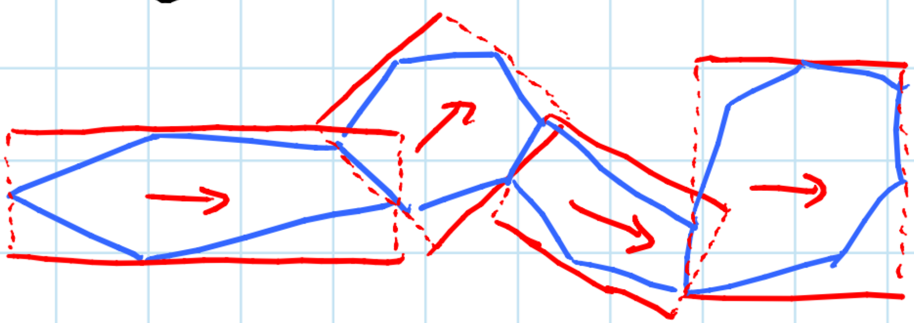
[Demaine, Demaine, Mitchell 1998/2000]

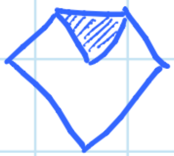
What are unmentioned open questions from … Slide 6?

(uncovered:)

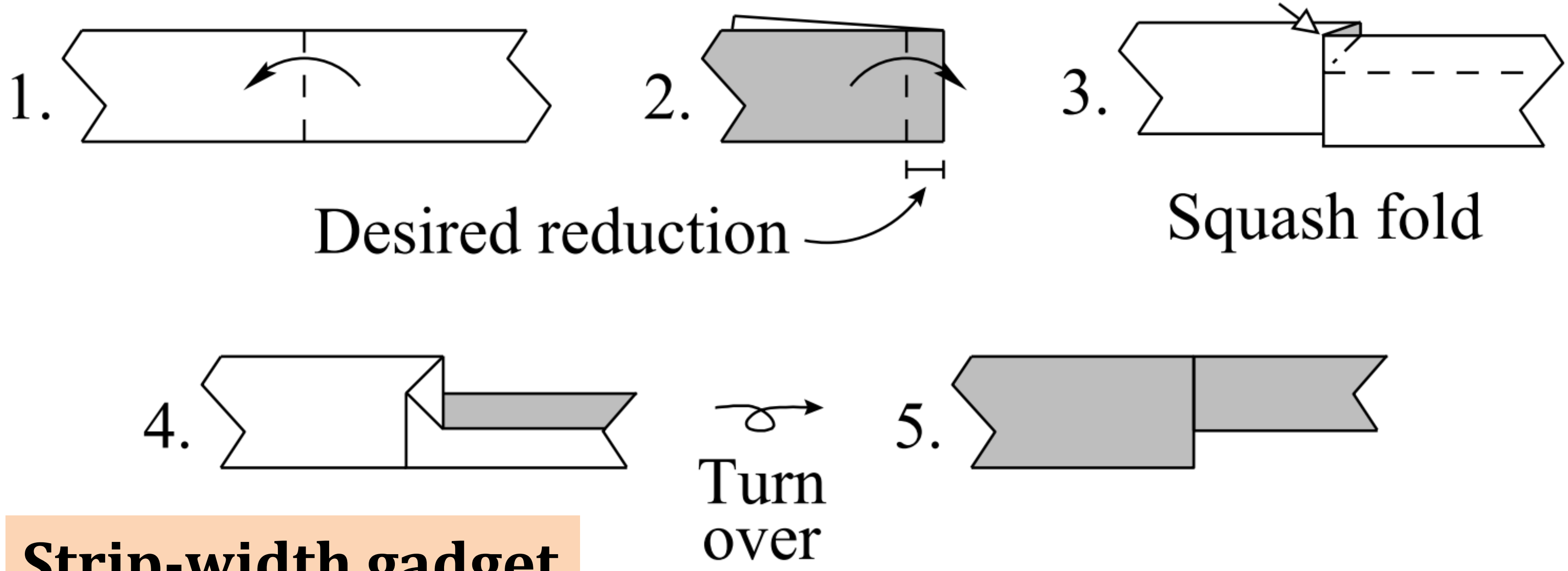
Seam placement: can place seams (visible creases/ paper boundary) as desired, provided regions between seams are convex

— idea: vary strip width, use hide gadget



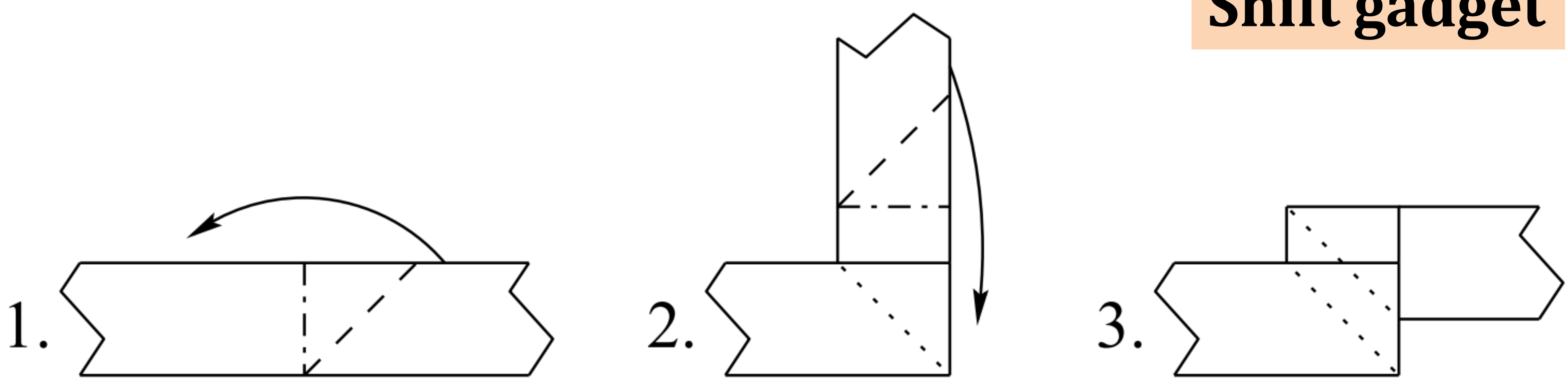


OPEN: what seam placements are possible?



Strip-width gadget

Shift gadget



[Demaine, Demaine, Mitchell 1998/2000]

Was the open problem with the "hide gadget" solved? (i.e. is it possible with just simple folds?)

Couldn't we fold the long strip of paper behind the adjacent triangle so to avoid any collision?

It seems like you can get this by making valley folds instead of mountain folds (folding the excess on top), then folding it back halfway to ensure the right color is up.

When Can You Fold a Map?

Esther M. Arkin* Michael A. Bender† Erik D. Demaine‡ Martin L. Demaine‡
Joseph S. B. Mitchell* Saurabh Sethia† Steven S. Skiena§

Abstract

We explore the following problem: given a collection of creases on a piece of paper, each assigned a folding direction of mountain or valley, is there a flat folding by a sequence of simple folds? There are several models of simple folds; the simplest *one-layer simple fold* rotates a portion of paper about a crease in the paper by $\pm 180°$. We first consider the analogous questions in one dimension lower—bending a segment into a flat object—which lead to interesting problems on strings. We develop efficient algorithms for the recognition of simply foldable 1D crease patterns, and reconstruction of a sequence of simple folds. Indeed, we prove that a 1D crease pattern is flat-foldable by any means precisely if it is by a sequence of one-layer simple folds.

Next we explore simple foldability in two dimensions, and find a surprising contrast: "map" folding and variants are polynomial, but slight generalizations are NP-complete. Specifically, we develop a linear-time algorithm for deciding foldability of an orthogonal crease pattern on a rectangular piece of paper, and prove that it is (weakly) NP-complete to decide foldability of (1) an orthogonal crease pattern on a orthogonal piece of paper, (2) a crease pattern of axis-parallel and diagonal (45-degree) creases on a square piece of paper, and (3) crease patterns without a mountain/valley assignment.

1 Introduction

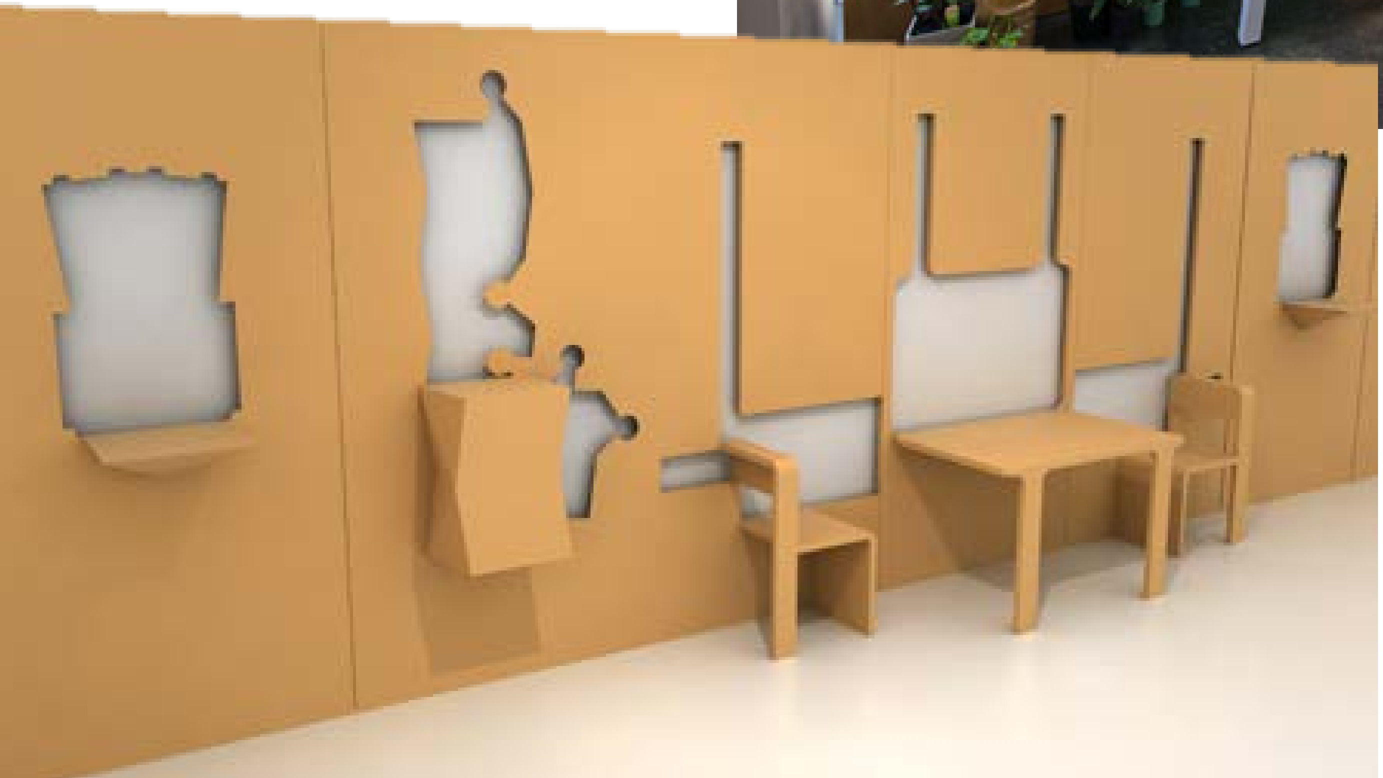
> The easiest way to refold a road map is differently.
>
> — Jones's Rule of the Road (M. Gardner [10])

Motivation. In addition to its inherent interest in the mathematics of origami, our study is motivated by applications in sheet metal and paper product manufacturing, where one is interested in determining whether a given structure can be manufactured using a given machine. […] While origamists can develop particular skill in performing nonsimple folds to make beautiful artwork, practical problems of manufacturing with sheet goods require simple and constrained folding operations. Our goal is to develop a first suite of results that may be helpful towards a fuller algorithmic understanding of the several manufacturing problems that arise, e.g., in making three-dimensional cardboard and sheet-metal structures.

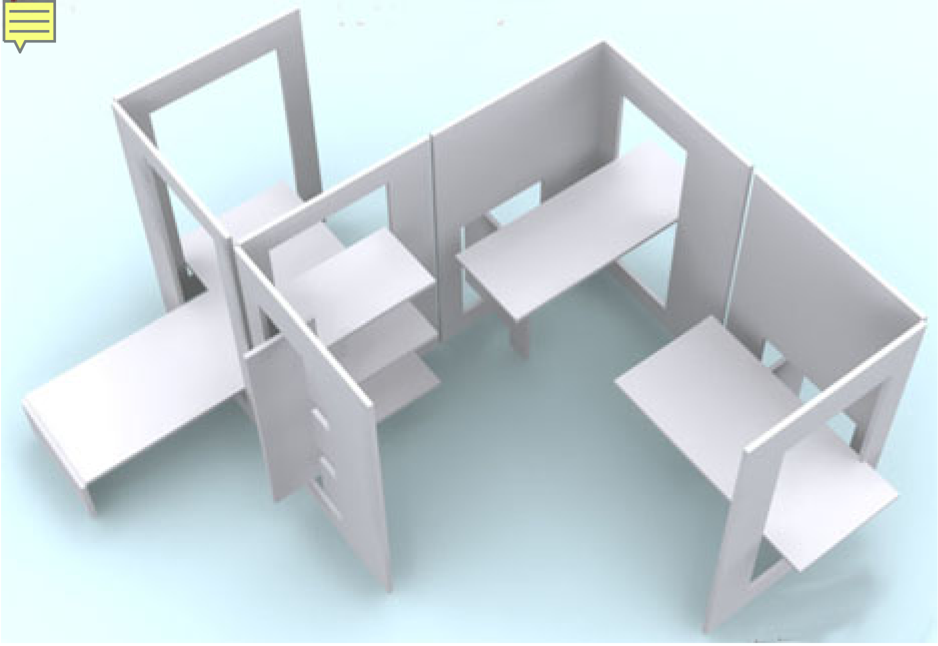
[Arkin, Bender, Demaine, Demaine, Mitchell, Sethia, Skiena 2000/2004]

Electrabrake Manual Folder Press & Shear

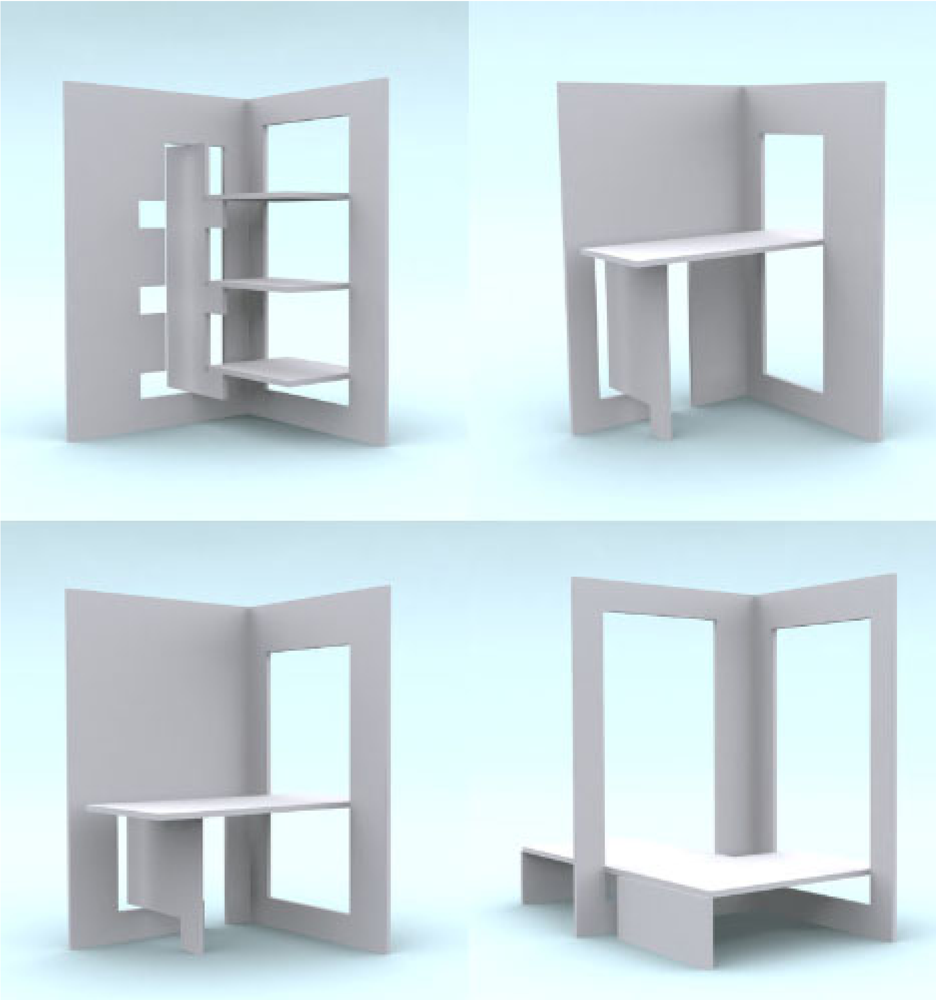
Luxury and Elegant Home Design In The World / designinteriorart.com July 2011

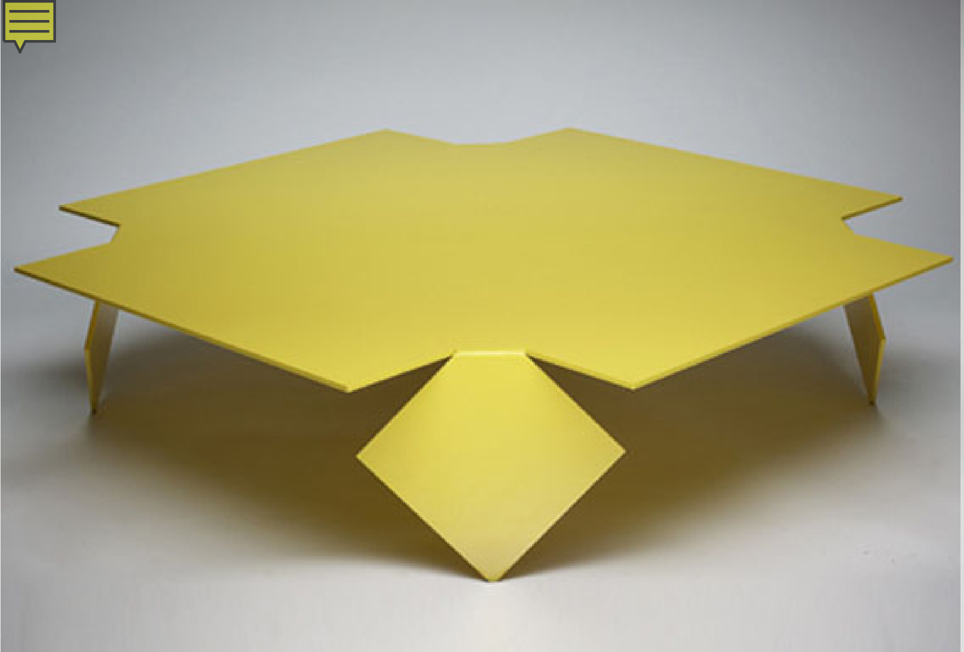


“Sheetseat”
Ufuk Keskin & Efecem Kutuk
2009



“Flat-Pack Furniture” dornob





“Folded Steel Design Furniture Ideas: Unique Coffee Table”

Home Gallery Design October 2010

In a simple fold, when I fold 180 along a crease is it allowed to bend the rest of the paper so that the parts of the paper can pass through each other? And the end product after each simple fold step must be a flat 1-D surface, right?

I got lost on the proof on flat foldable → mingling and inducting from a sequence of crimps and end folds (page 8, handwritten notes). Can we go through an example?

I wouldn't mind hearing more detail/explanation/deconfusion about mingling and "forever", since that confused us quite a bit

If given a mountain-valley assignment, I am still confused about how an algorithm would work to determine through crimps/end folds if the folding would be valid.

"forever" (from about the 1-hour mark) is unsatisfying. Does crimping change the parenthesis pattern? (Fortunately, the proof that flat-foldability implies mingling also gives mingling forever.) Is there an easierly checkable condition?

Is it correct that you can always take a 1-D MV pattern and make it flat foldable by adding folds? It seems like you can always create the mingling property at any maximal non-mingling sequence by adding a fold near the end.

What could it possibly mean to fold something in 4+ dimensions? How does one imagine such a folding?