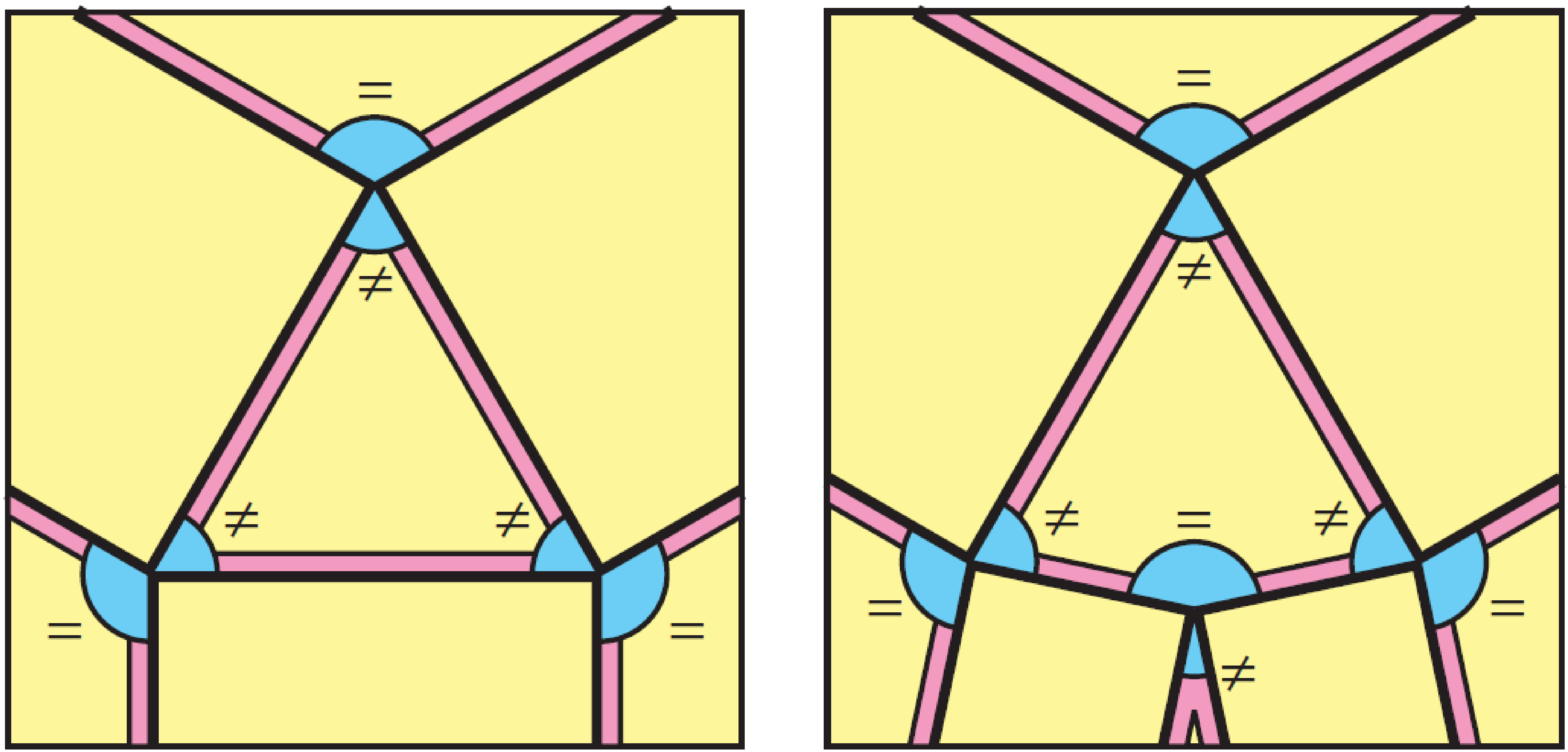
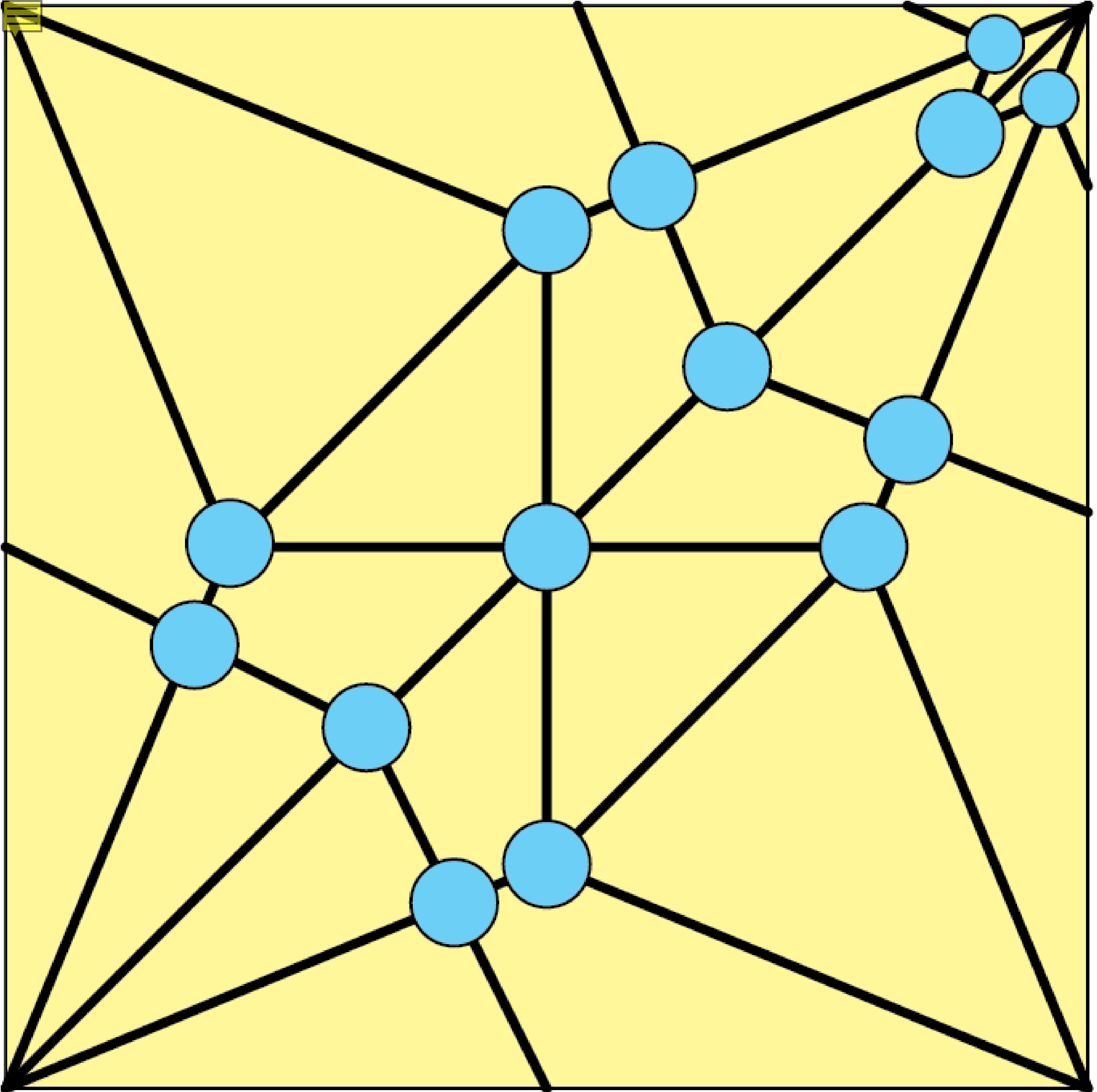
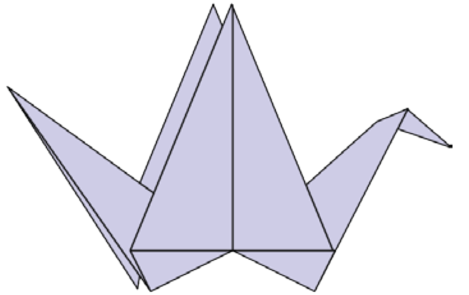
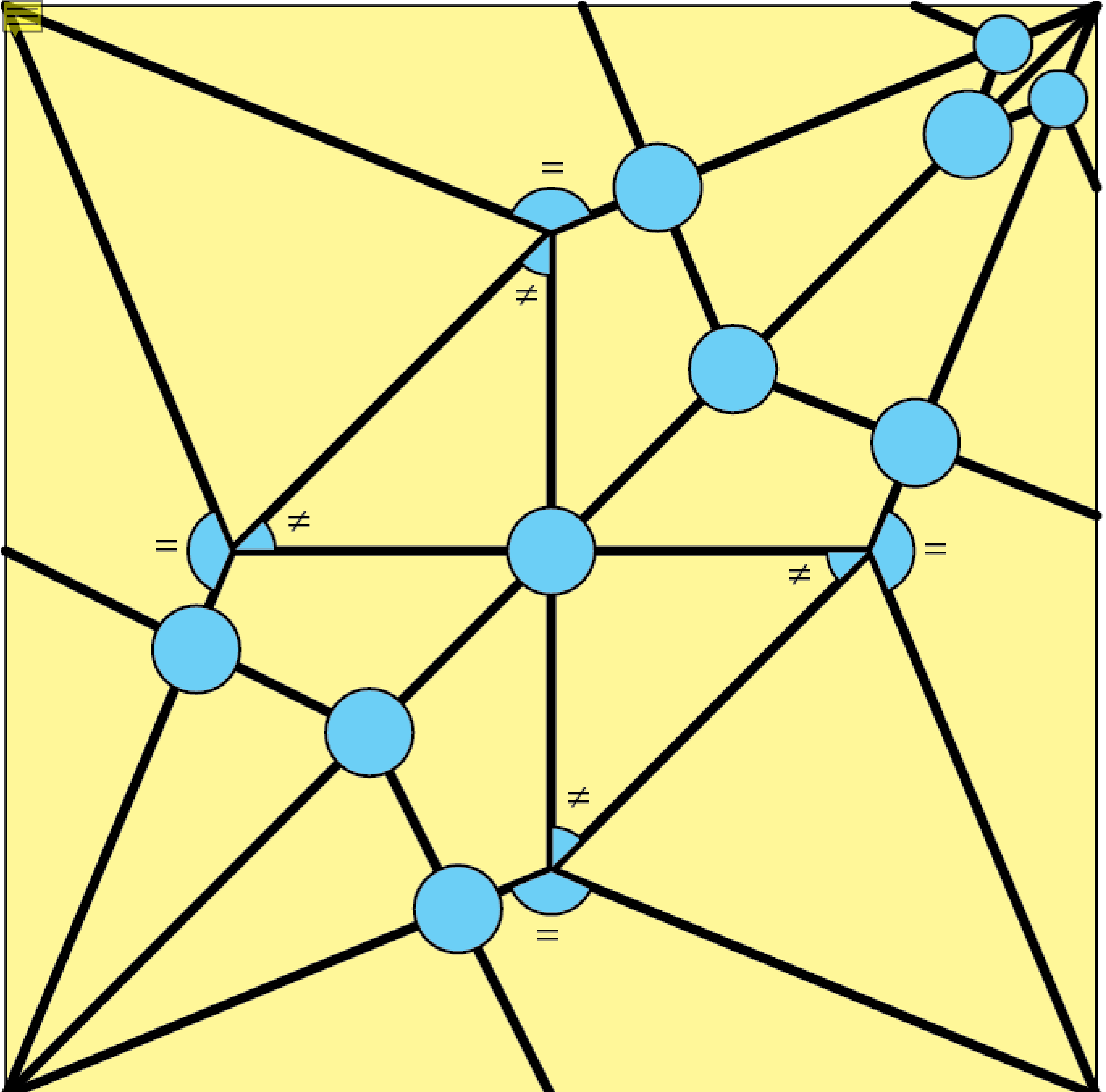
[...] you refer to a result from L2 that you can determine in linear time whether something folds flat. Is this referring to the mingling algorithm? I haven't thought about this in detail, but it appears to take something like quadratic time [...]

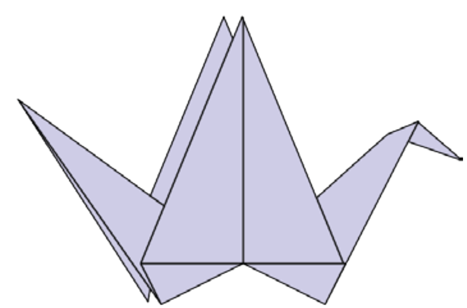
I was a tad confused on the local foldability algorithm. An example in class actually running the algorithm would probably clear it up.

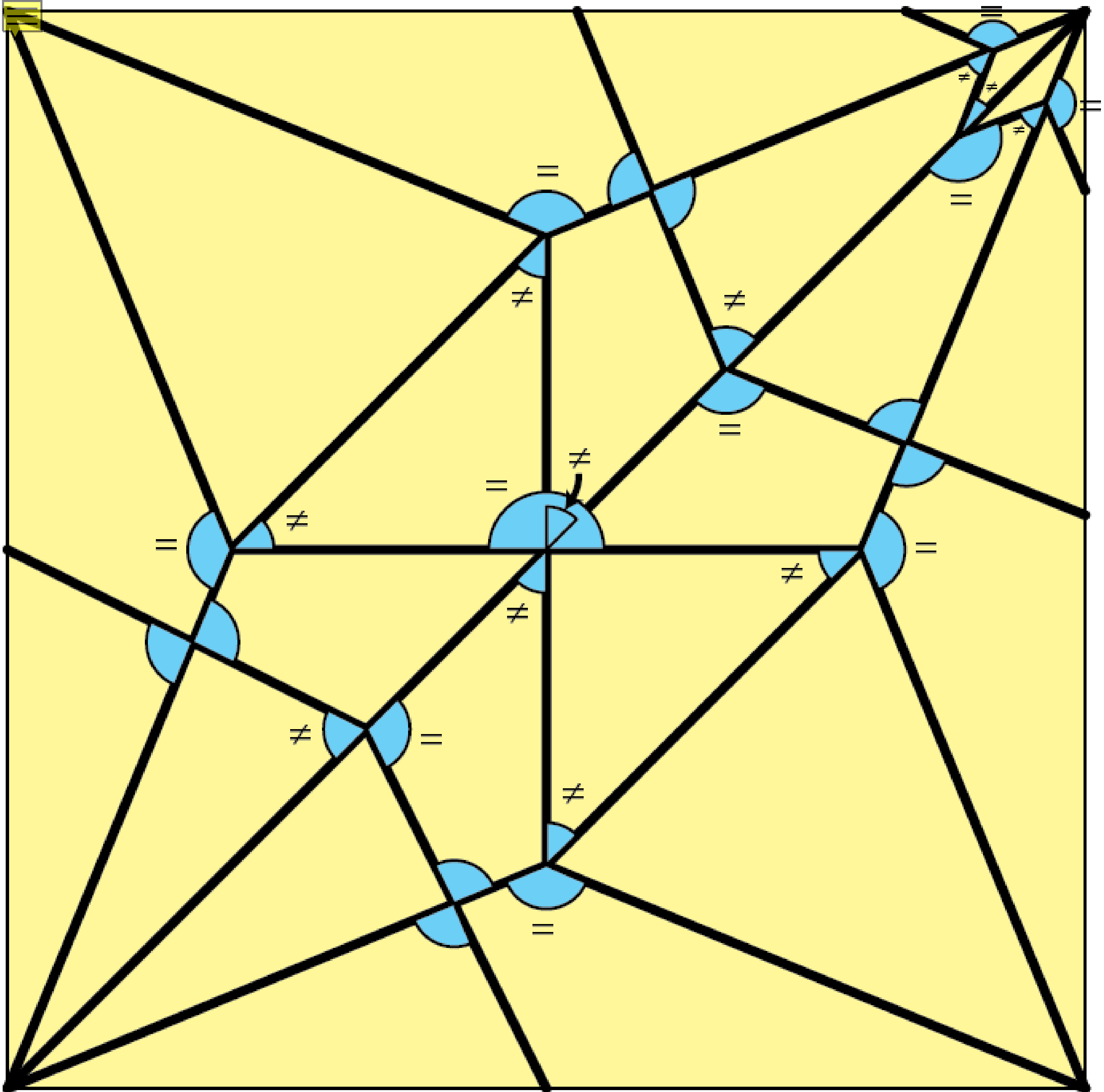
Can you clarify what you mean by a path or cycle?

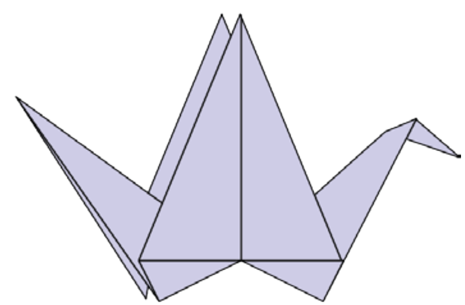


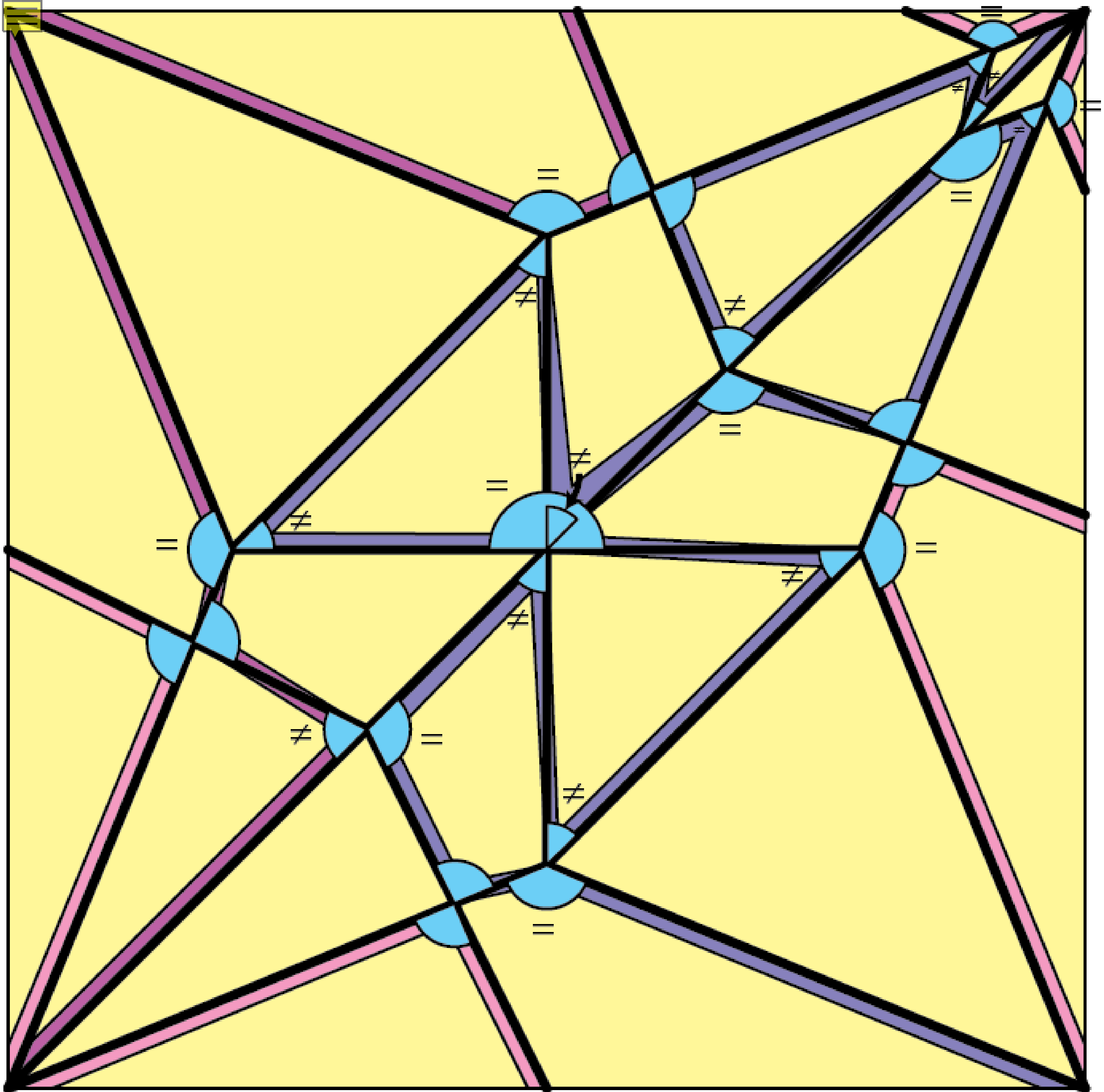



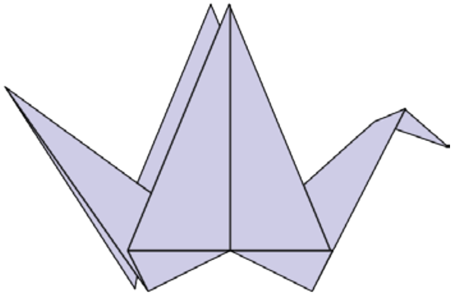




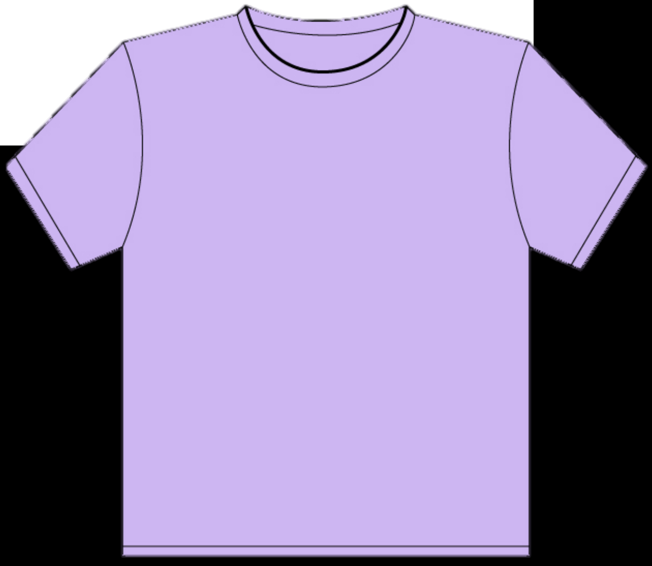








>360° cones could be made by fabric — perhaps you want to fold a garment along its seams, but the seamed sections meet in a point and the sum of the angles is greater than 360° (e.g., underarm of a shirt)



“Japanese way of folding T-shirts!” mushk45 June 2006 youtu.be/b5AWQ5aBjgE

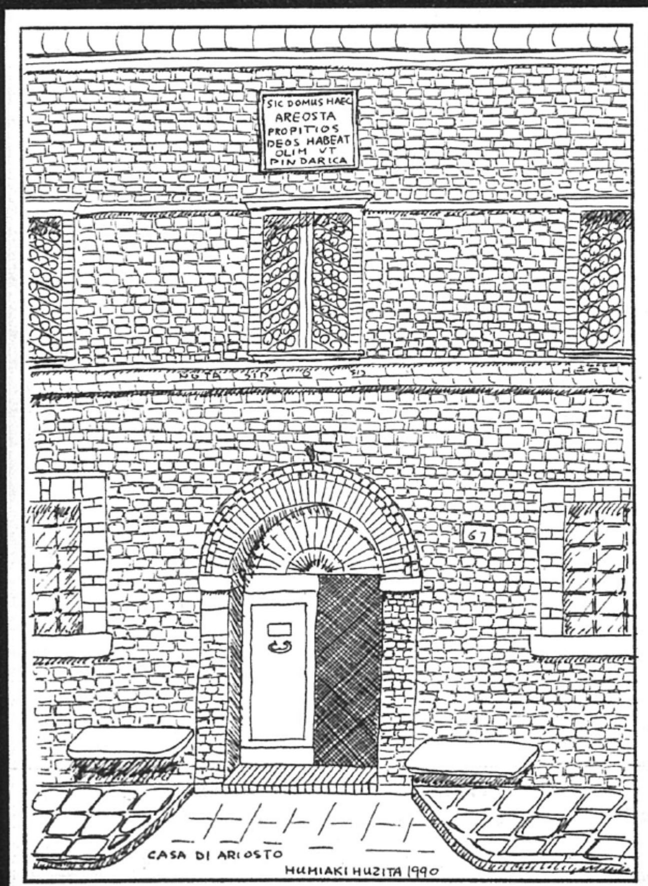
“T-Shirt Folding Machine” gotcsin February 2008 youtu.be/rMnNHA_GrT8

If flat foldability is to fold a 2D sheet of paper in 2 dimensions, are there results for "flat foldability" in higher dimensions, i.e. to fold a *d*-dimensional sheet of paper in *d* dimensions? Can the result be generalized to higher dimensions?

Proceedings of the First International Meeting of

ORIGAMI SCIENCE and TECHNOLOGY

Ferrara, Italy, December 6 - 7, 1989
Casa di Lodovico Ariosto



Dipartimento di Fisica Galileo Galilei dell'Universita` degli studi di Padova
Dipartimento di Matematica dell'Universita` degli studi di Padova
Dipartimento di Matematica dell'Universita` degli studi di Ferrara
Comune di Ferrara and Centro Origami Diffusion

On High Dimensional Flat Origamis

By

Toshikazu Kwasaki

§0. Notation.

Let X be the real euclidian line $\boldsymbol{R}$, plane $\boldsymbol{R}^2,\cdots$, n-dimensional space $\boldsymbol{R}^n$, unit circle $\boldsymbol{S}^1$, unit 2-sphere $\boldsymbol{S}^2,\cdots$,or unit n-sphere $\boldsymbol{S}^n$. Let $\mathrm{Isom}(X)$ be the group of isometric automorphisms. For a segment ℓ(if $X=\boldsymbol{R}$), a face f (if $X=\boldsymbol{R}^2$),$\cdots$,a hyperplane σ (if $X=\boldsymbol{R}^n$), we denote by $R(\ell)\in \mathrm{Isom}(\boldsymbol{R}^2)$, $R(f)\in \mathrm{Isom}(\boldsymbol{R}^2),\cdots$, $R(\sigma)\in \mathrm{Isom}(\boldsymbol{R}^n)$, the reflection whose axis is the line including ℓ, whose milor is the plane including f,$\cdots$, whose milor is the hyperplane including σ (Fig.0).

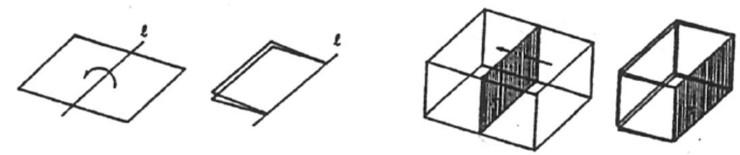


Fig.0 (reflection)

§1. Flat origamis of $\boldsymbol{R}^2$,$\boldsymbol{S}^2$ and $\boldsymbol{R}^3$

1.1. Flat origamis of $\boldsymbol{R}^2$

Definition 1.1 (flat origamis of $\boldsymbol{R}^2$): Let X be $\boldsymbol{R}^2$. A locally finite cell decomposition K of X is called a flat origami if for an arbitrary closed curve γ in X such that γ does not pass through any vertex of K and intersects 1-celles (edges) $\ell_1,\ldots,\ell_r$ of K transversally in this order, the following condition (We call this condition by "flat condition") holds:

$$R(\ell_1)\cdots R(\ell_r)=\text{identity}.$$

Remark: A flat origami K represents the "development chart" of an origami though its valley creases and its mountain creases are not distinguished.

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ORIGAMI SCIENCE and TECHNOLOGY

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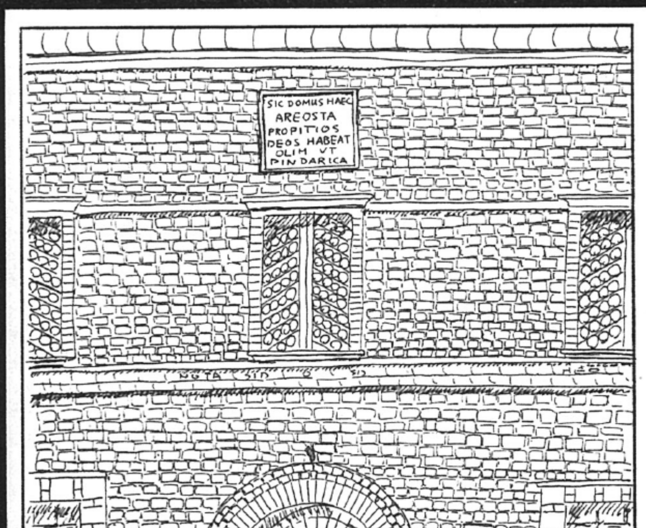
Casa di Lodovico Ariosto



On High Dimensional Flat Origamis

By

Toshikazu Kwasaki

§ 0. Notation.

Let X be the real euclidian line $\boldsymbol{R}$, plane $\boldsymbol{R}^2$,$\cdots$, n-dimensional space $\boldsymbol{R}^n$, unit circle $\boldsymbol{S}^1$, unit 2-sphere $\boldsymbol{S}^2$,$\cdots$,or unit n-sphere $\boldsymbol{S}^n$. Let Isom(X) be the group of isometric automorphisms. For a segment ℓ(if $X=\boldsymbol{R}$), a face f (if $X=\boldsymbol{R}^2$),$\cdots$,a hyperplane σ (if $X=\boldsymbol{R}^n$), we denote by $R(\ell)\in \mathrm{Isom}(\boldsymbol{R}^2)$, $R(f)\in \mathrm{Isom}(\boldsymbol{R}^2)$,$\cdots$, $R(\sigma)\in \mathrm{Isom}(\boldsymbol{R}^n)$, the reflection whose axis is the line including ℓ, whose milor is the plane including f,$\cdots$, whose milor is the hyperplane including σ (Fig.0).

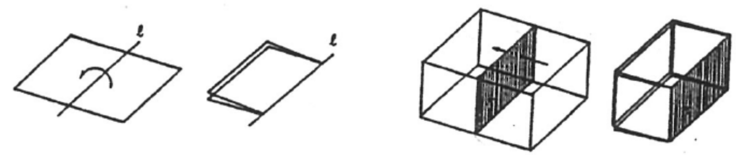


Fig.0 (reflection)

§ 1. Flat origamis of $\boldsymbol{R}^2$,$\boldsymbol{S}^2$ and $\boldsymbol{R}^3$

1.2. Flat origamis of $\boldsymbol{R}^3$

Definition 1.2 (flat origamis of $\boldsymbol{R}^3$): A locally finite cell decomposition K of X is called a flat origami if for an arbitrary closed curve γ in X such that γ does not pass through any 0 or 1 −cell of K and intersects 2-celles $\sigma_1,\ldots,\sigma_r$ of K transversally in this order,the flat condition holds:

$$R(\sigma_1)\cdots R(\sigma_r)=\mathrm{identity}.$$

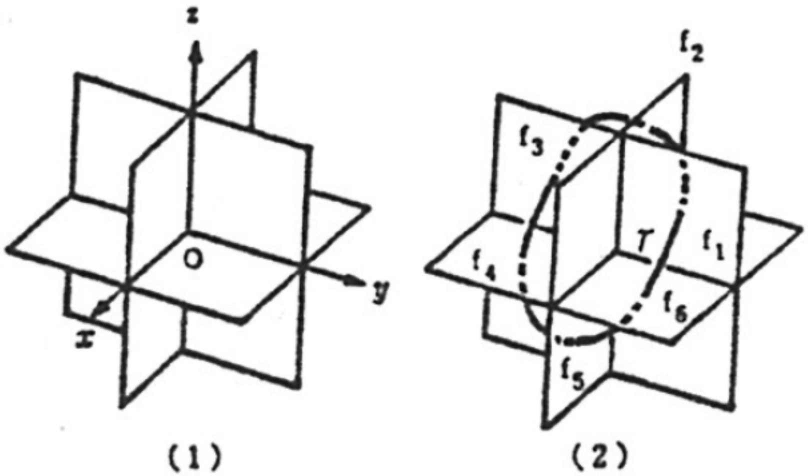


Fig.1.1 (a flat origami of $\boldsymbol{R}^3$)

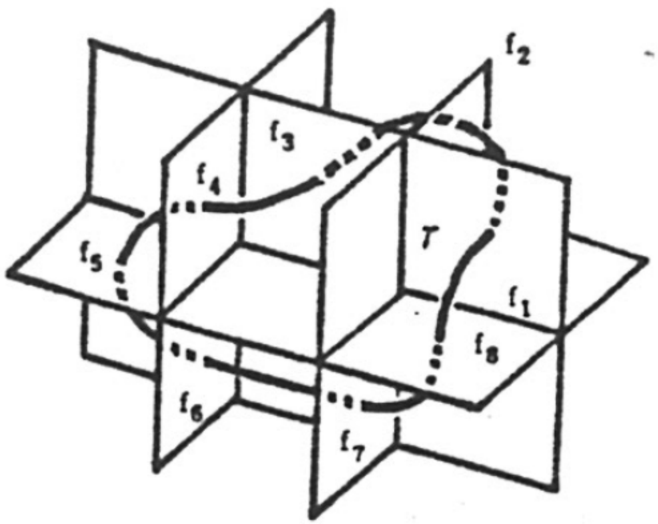


Fig.1.2 (a flat origami of $\boldsymbol{R}^3$)

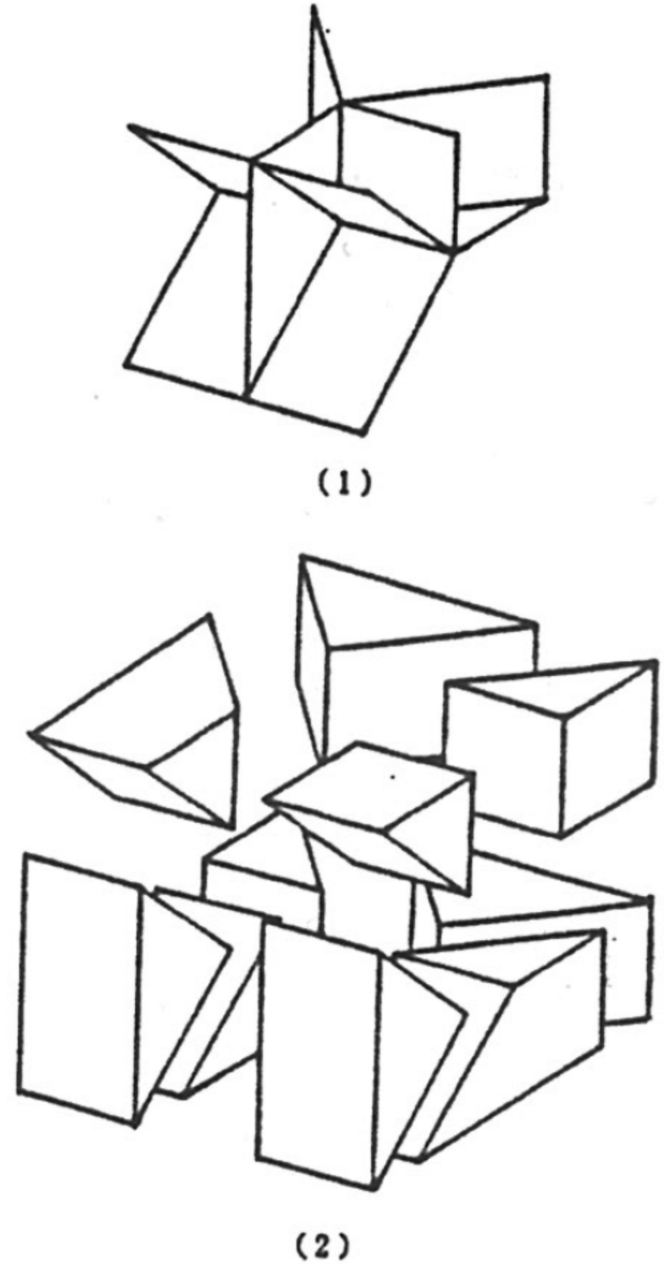


Fig.1.3 (a flat origami of $\boldsymbol{R}^3$)

芸術科学会論文誌 Vol.4 No.4 pp.151-158

CG Image Generation of Four-Dimensional Origami

Akira Inoue Ryouko Itohara Kuniaki Yajima Keimei Kaino
Sendai National College of Technology
yajima@cc.sendai-ct.ac.jp kaino@cc.sendai-ct.ac.jp

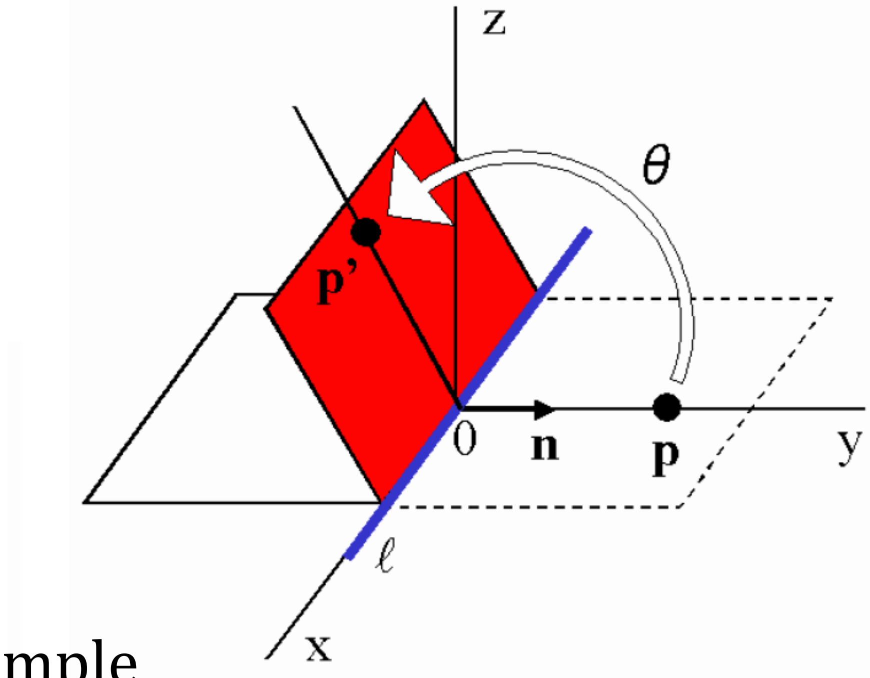
Abstract

To produce four-dimensional (4-D) origami, we fold a solid material along flat planes in a 4-D space. A 4-D space has a fourth axis that is perpendicular to a three-dimensional space. Because a computer graphics (CG) image of a 4-D origami must be drawn on a three-dimensional screen to visualize it, we will produce its CG image using a 4-D painter's algorithm with a stereogram. First, we will show how to fold a solid material in a 4-D space. After defining front and a back sides of this solid in a 4-D space, we will make mountain and valley folds and thereby produce a "4-D Noshi" CG image. Secondly, we will show how to fold a regular tetrahedron flat by bisectors of its dihedral angles and make a 4-D bird base from a double tetrahedron. Finally, we will produce CG images of this 4-D bird with opened wings using a stereogram.

Keywords: Four-dimensional origami, Four-dimensional painter's algorithm, Four-dimensional space, Stereogram, View space

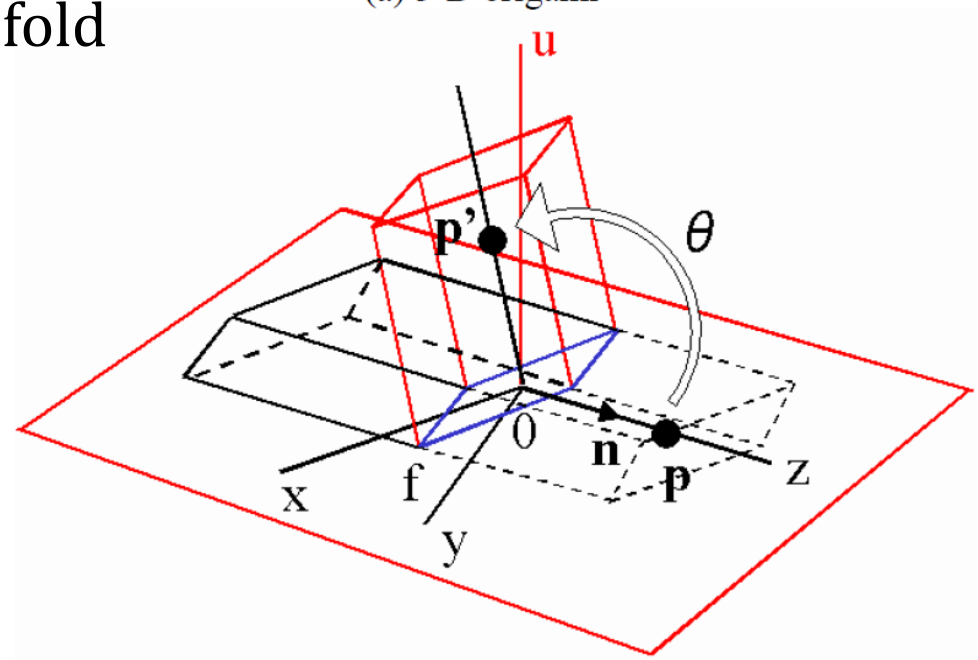
４次元折り紙の CG 画像生成

井上亮 糸原良子 矢島邦昭 海野啓明
仙台電波工業高等専門学校



(a) 3-D origami

simple fold



(b) 4-D origami

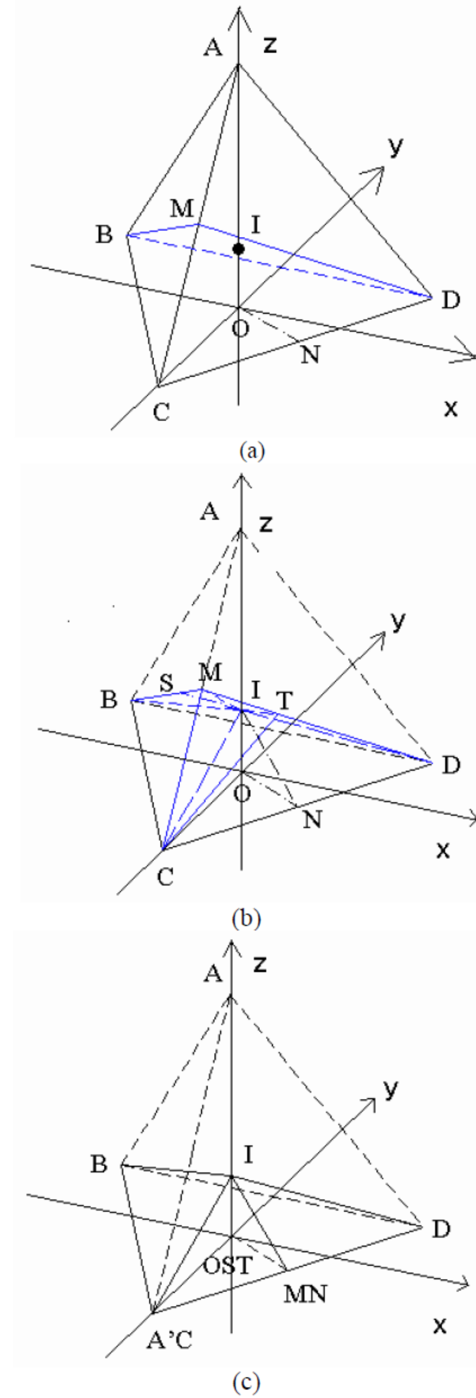
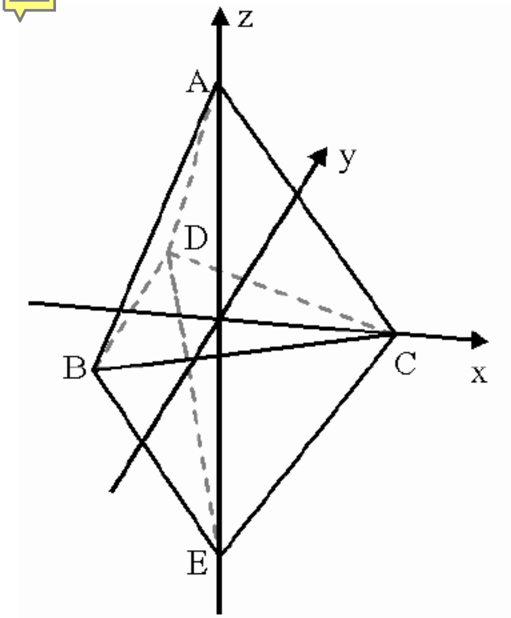


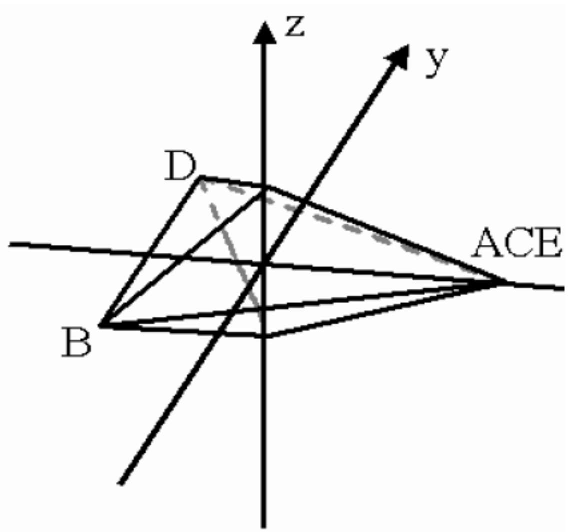
Figure 10: Folding of regular tetrahedron

simple fold

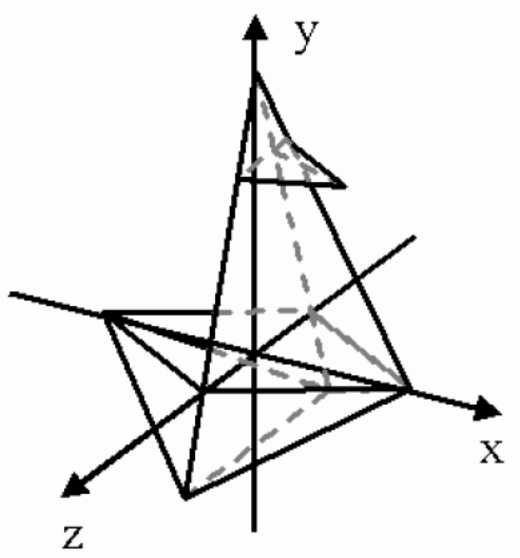
inside reverse fold



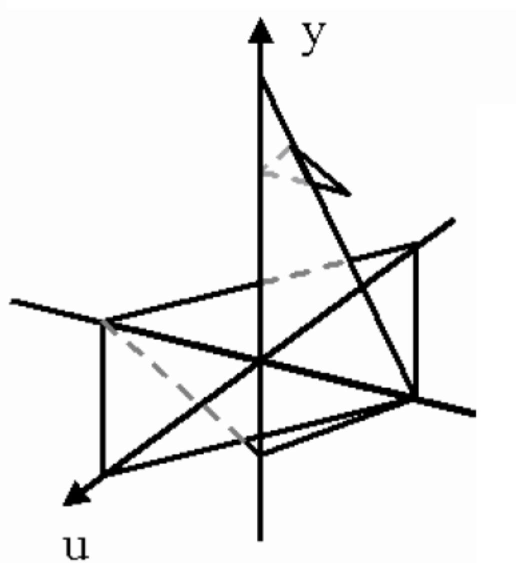
(a) Double tetrahedron



(b) Bird base

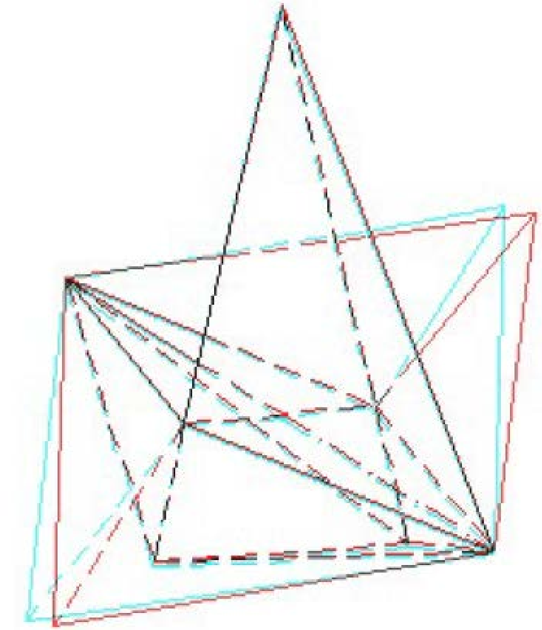


(c) Projection on u=0

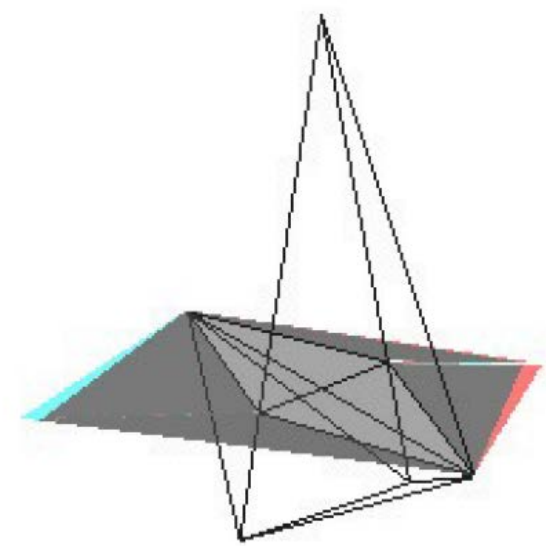


(d) Projection on z=0

Figure 12: Four-dimensional bird



(a) Wire frame model



(b) Solid model

We've spent a good chunk of time talking about flat foldability. What is the significance to this? Why is so much work done coming up with proofs and algorithms regarding this?

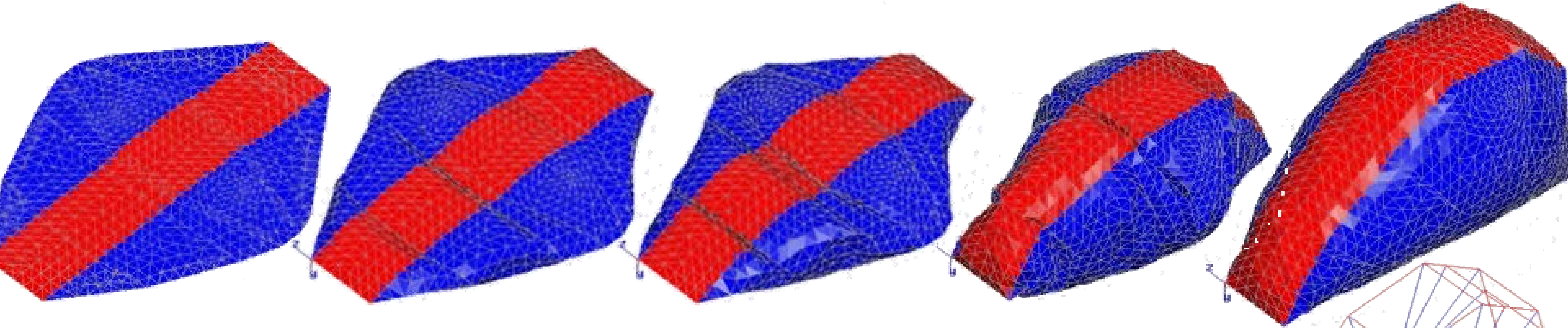
“Ralf Konrad's Rubik's Cube Tessellation”

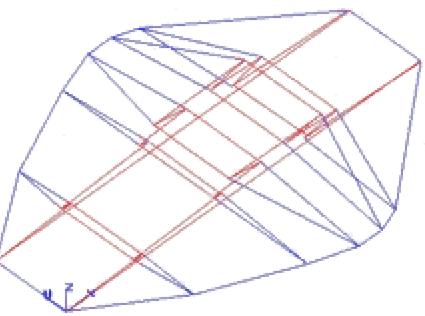
Jorge Jaramillo / georigami

January 2007

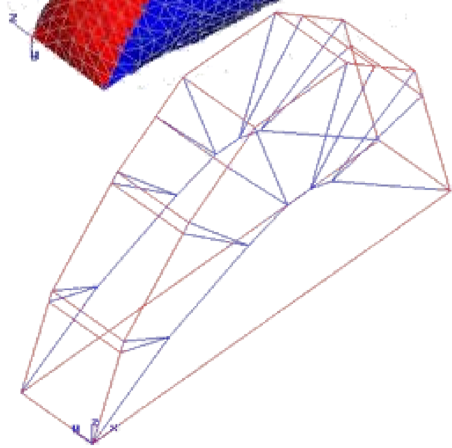
Airbag Folding

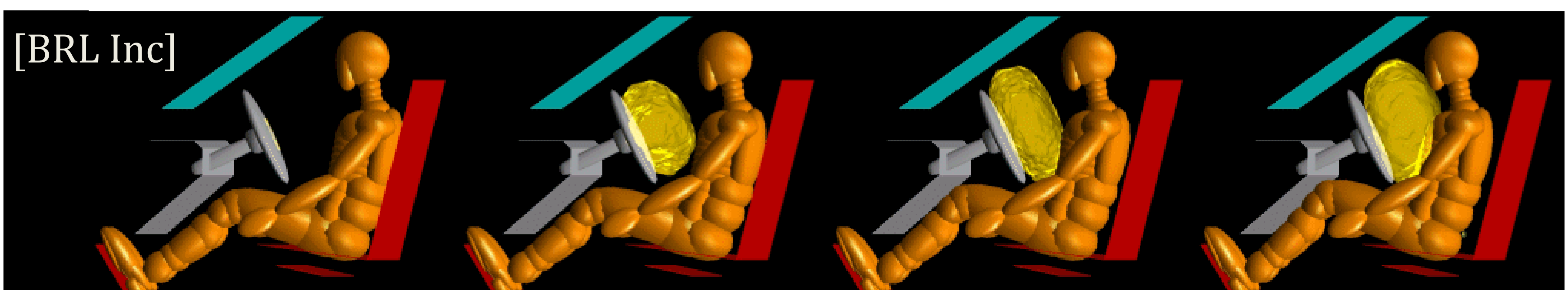
[EASi Engineering]





creases based on
computational origami design





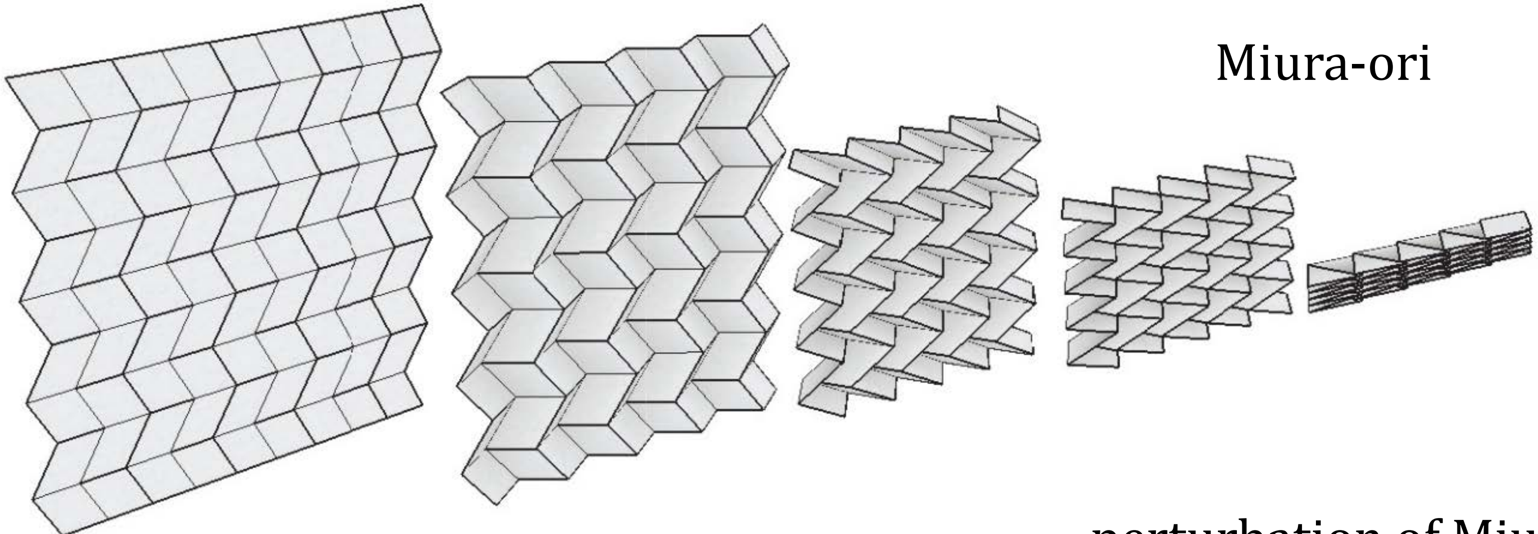
Proceedings of the International Association for Shell and Spatial Structures (IASS) Symposium 2009, Valencia
Evolution and Trends in Design, Analysis and Construction of Shell and Spatial Structures
28 September - 2 October 2009, Universidad Politecnica de Valencia, Spain
Alberto DOMINGO and Carlos LAZARO (eds.)

Generalization of Rigid Foldable Quadrilateral Mesh Origami

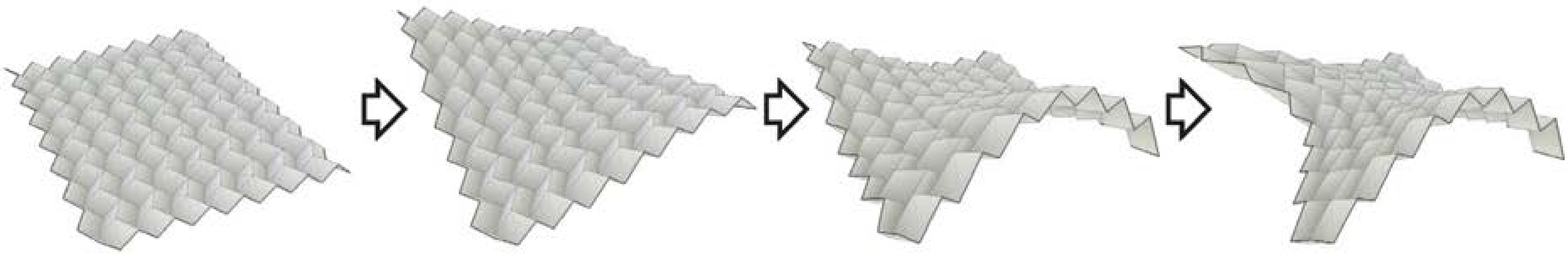
Tomohiro TACHI*
* The University of Tokyo
7-3-1 Hongo , Bunkyo-ku, Tokyo 113-8656, Japan
ttachi@siggraph.org

Theorem 2 *Any flat-foldable planar-quad mesh origami has rigid-folding motion if and only if there exists a non-trivial valid state, i.e., every foldline is folded* ($\rho \neq 0$) *but not completely folded* ($\rho \neq \pi, -\pi$).

Miura-ori



perturbation of Miura-ori



freeform Miura-ori