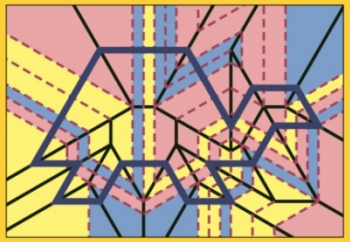
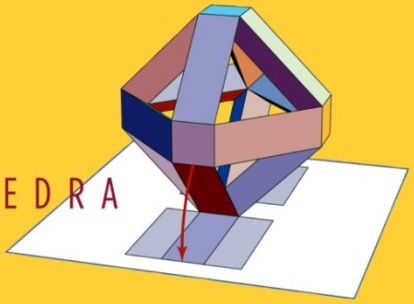
Geometric Folding Algorithms

Linkages, Origami, & Polyhedra





Erik D. Demaine & Joseph O'Rourke

幾何的な Geometric Folding Algorithms 折りアルゴリズム

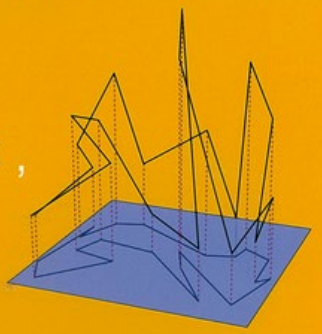
リンケージ，折り紙，多面体

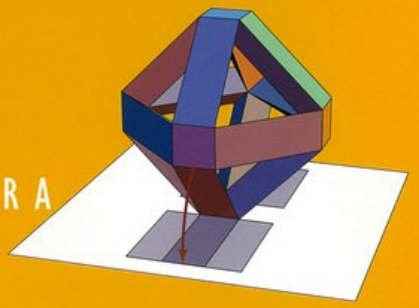
エリック・D・ドメイン＆ジョセフ・オルーク著

Erik D. Demaine & Joseph O'Rourke

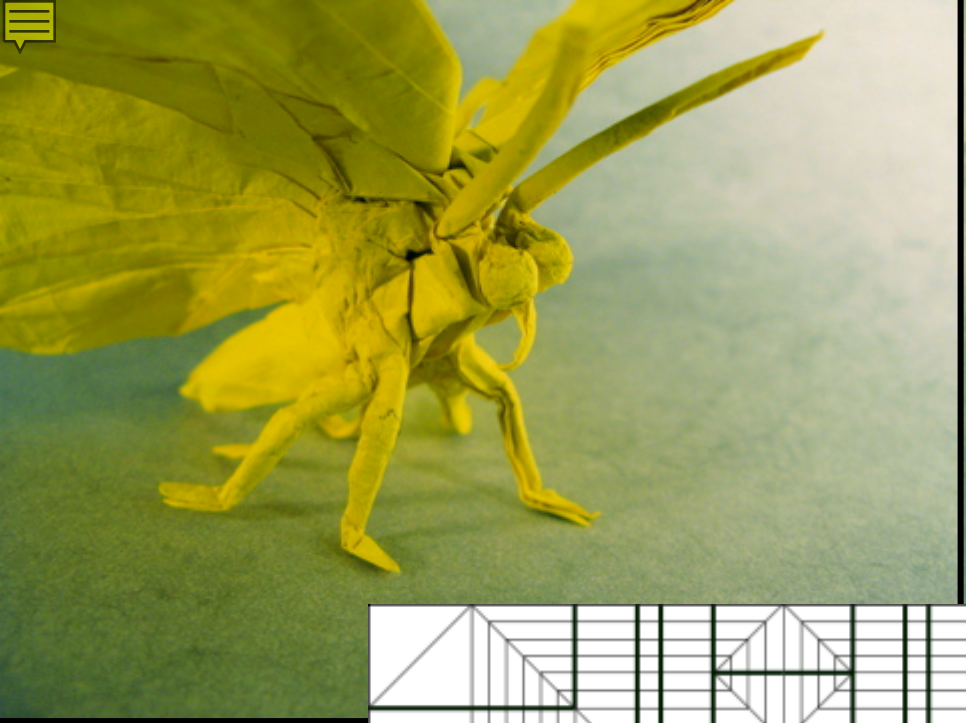
上原隆平訳

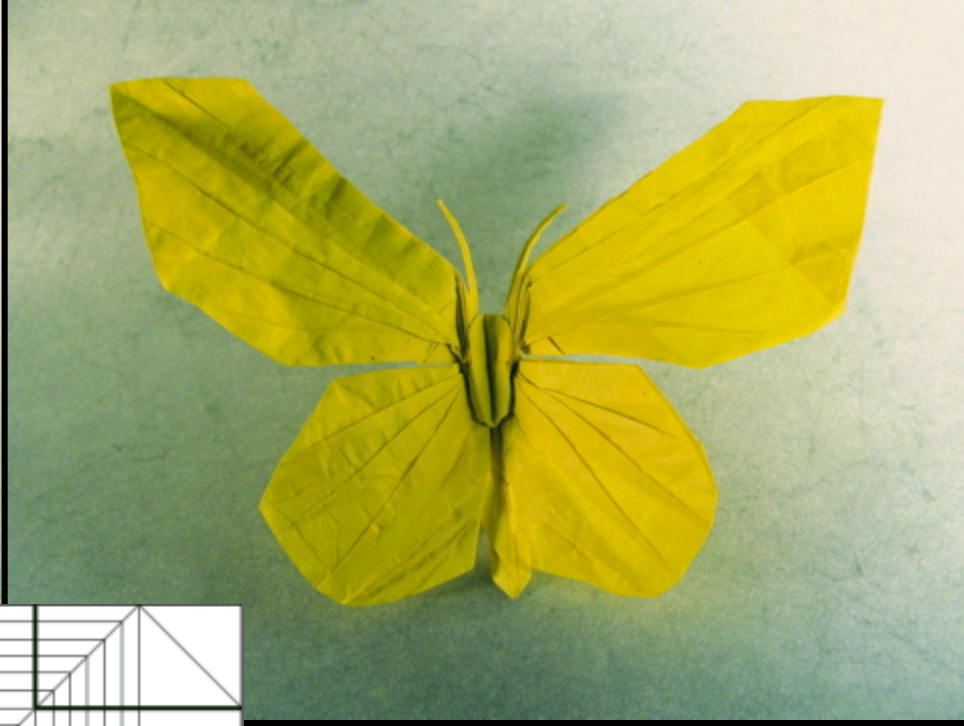
Linkages, Origami, Polyhedra



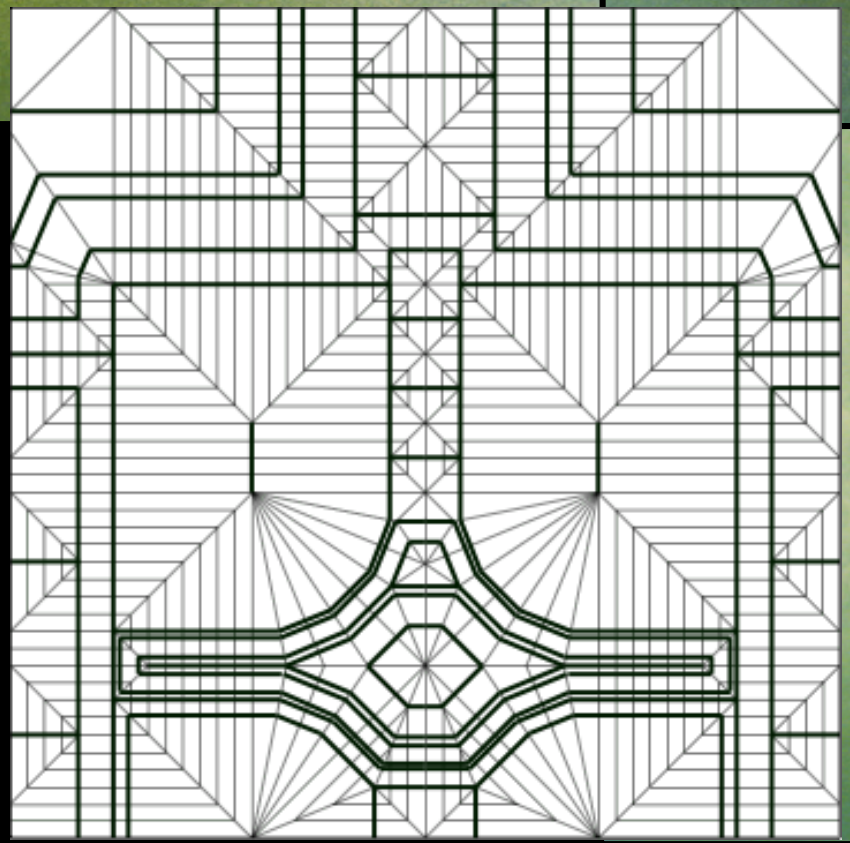


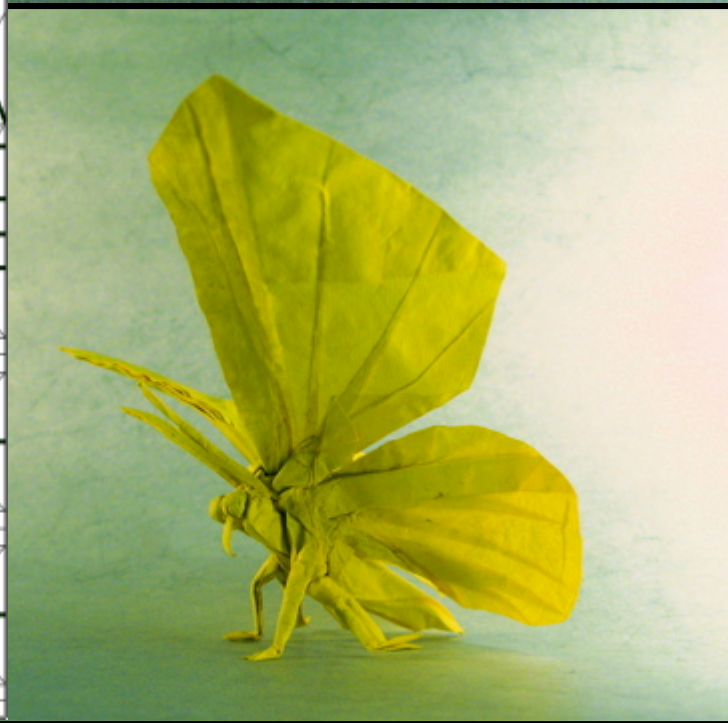
近代科学社





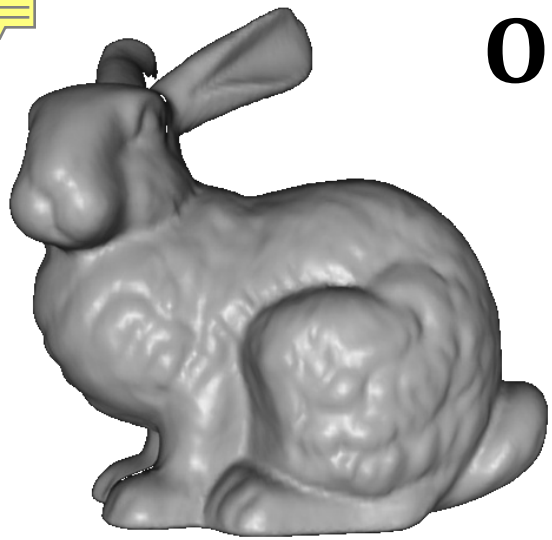
Butterfly 2.2
Jason Ku

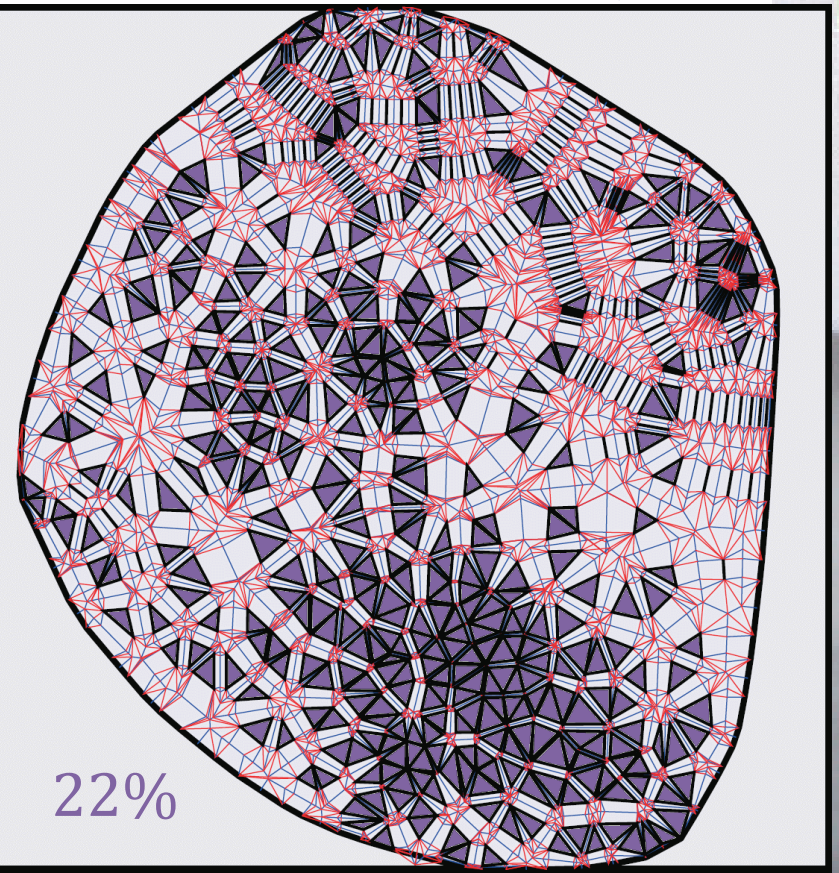




Origamizer

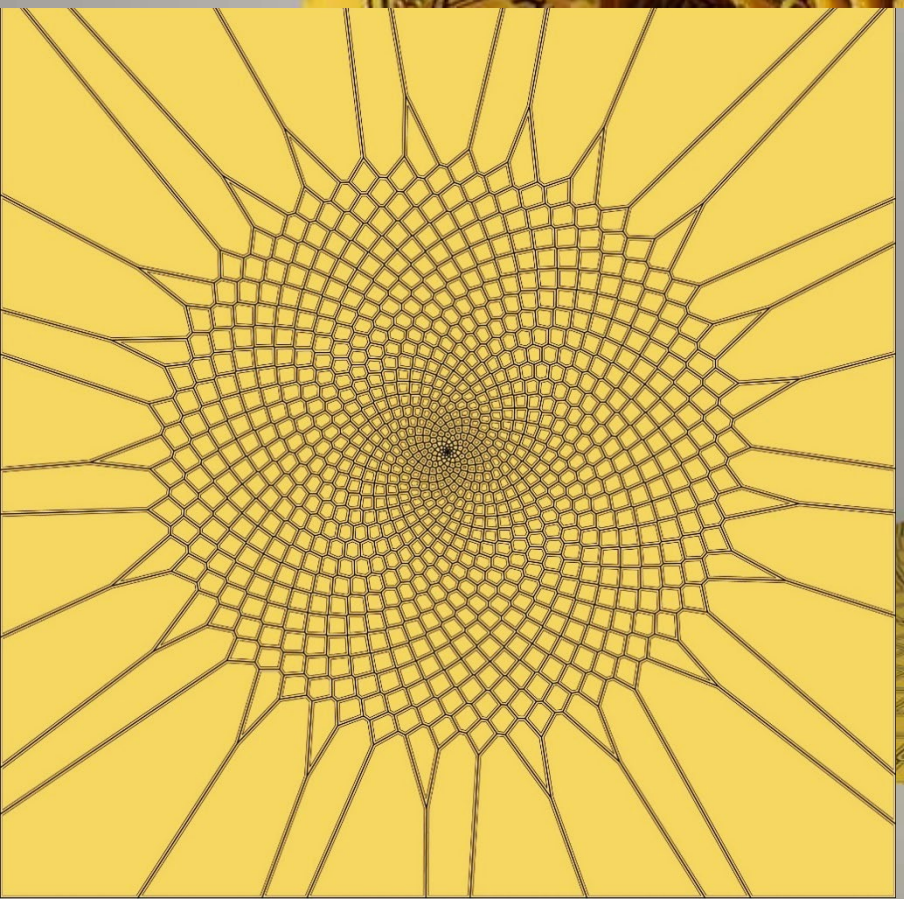
[Tachi 2006; Demaine & Tachi 2017]





Tomohiro Tachi

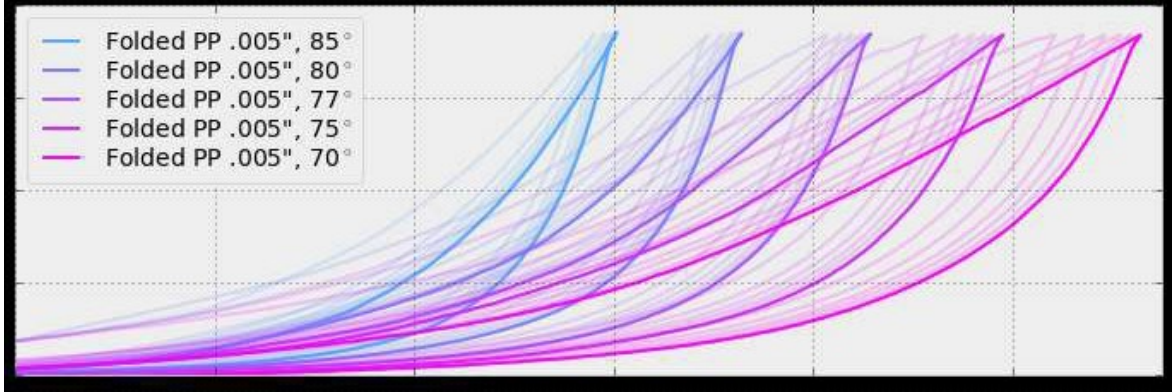
American Craft
photo by Cary Wolinsky

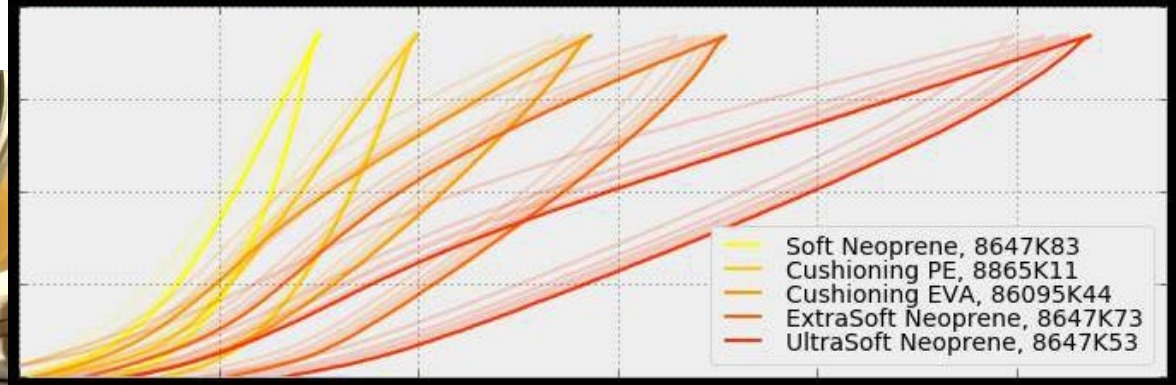


“**Voronoi Sunflower**”
Demaine & Demaine
2018

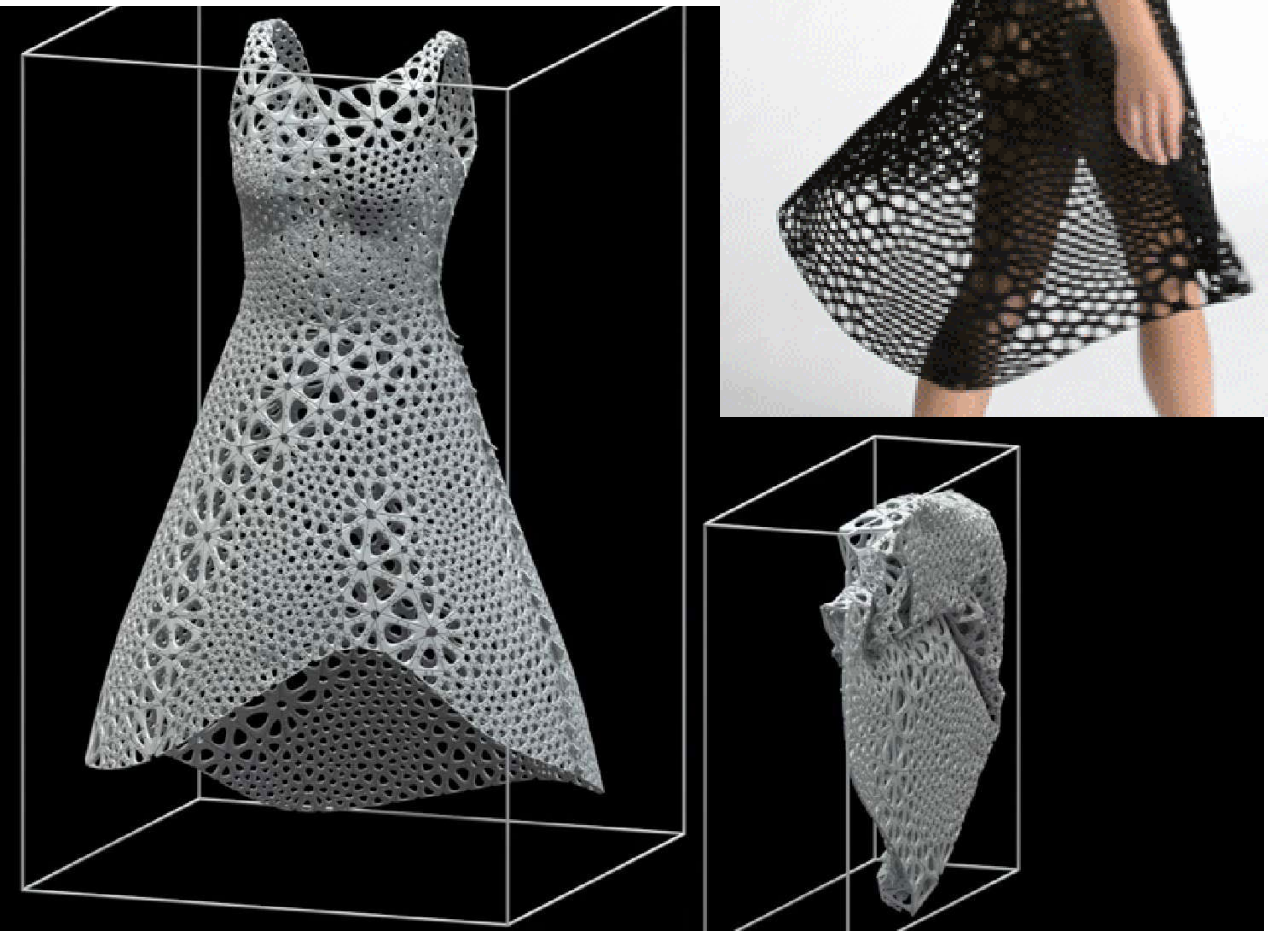
Shoe Soles

[Calisch & Gershenfeld 2018]





Nervous System
3D Printed Dress
2014



https://n-e-r-v-o-u-s.com/projects/albums/dress-in-motion/

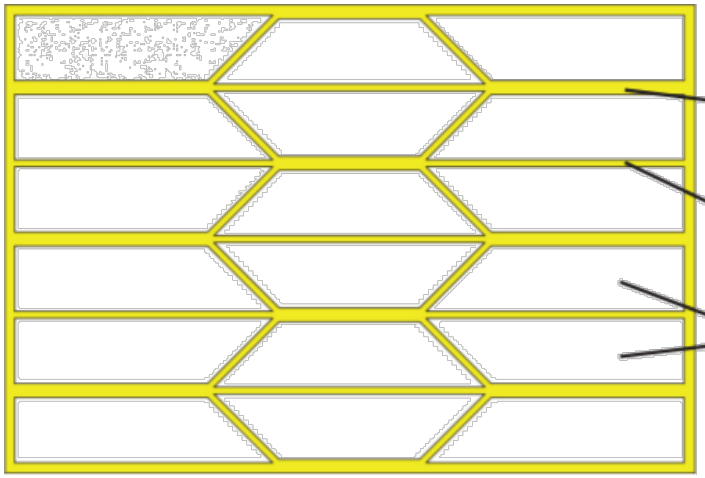
Deployable Origami Structures

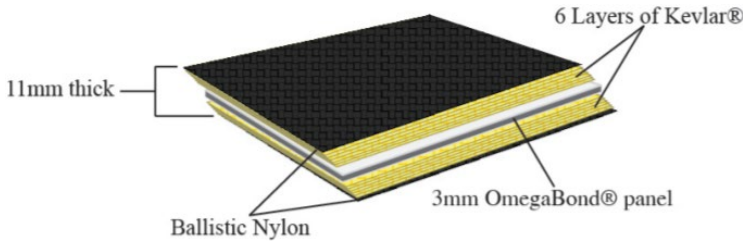
5m prototype of 100m
space telescope lens
[Lang & LLNL 2002]

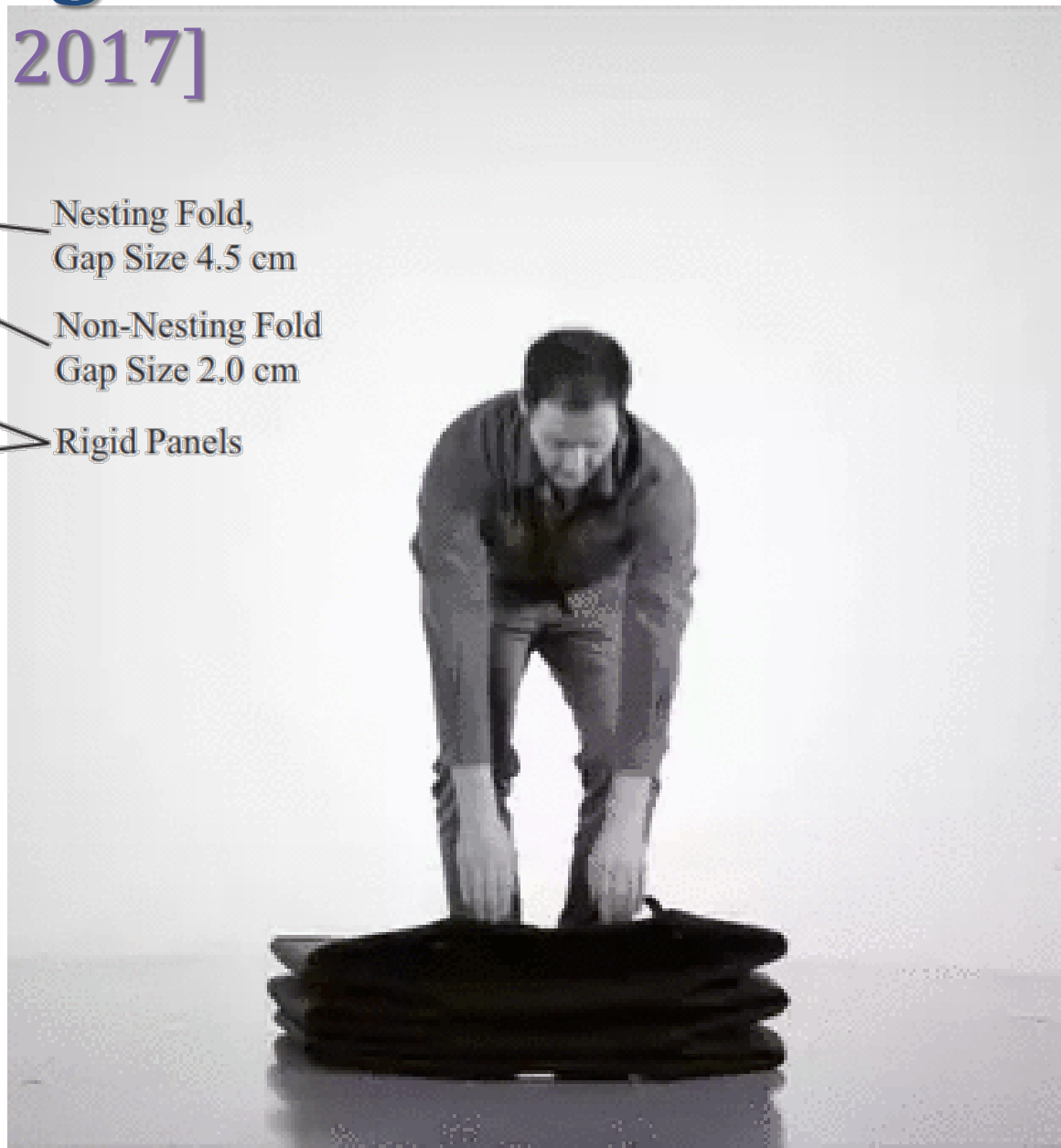
Origami stent
[You & Kuribayashi 2003]

Deployable Origami Shield

[Howell et al., BYU 2017]

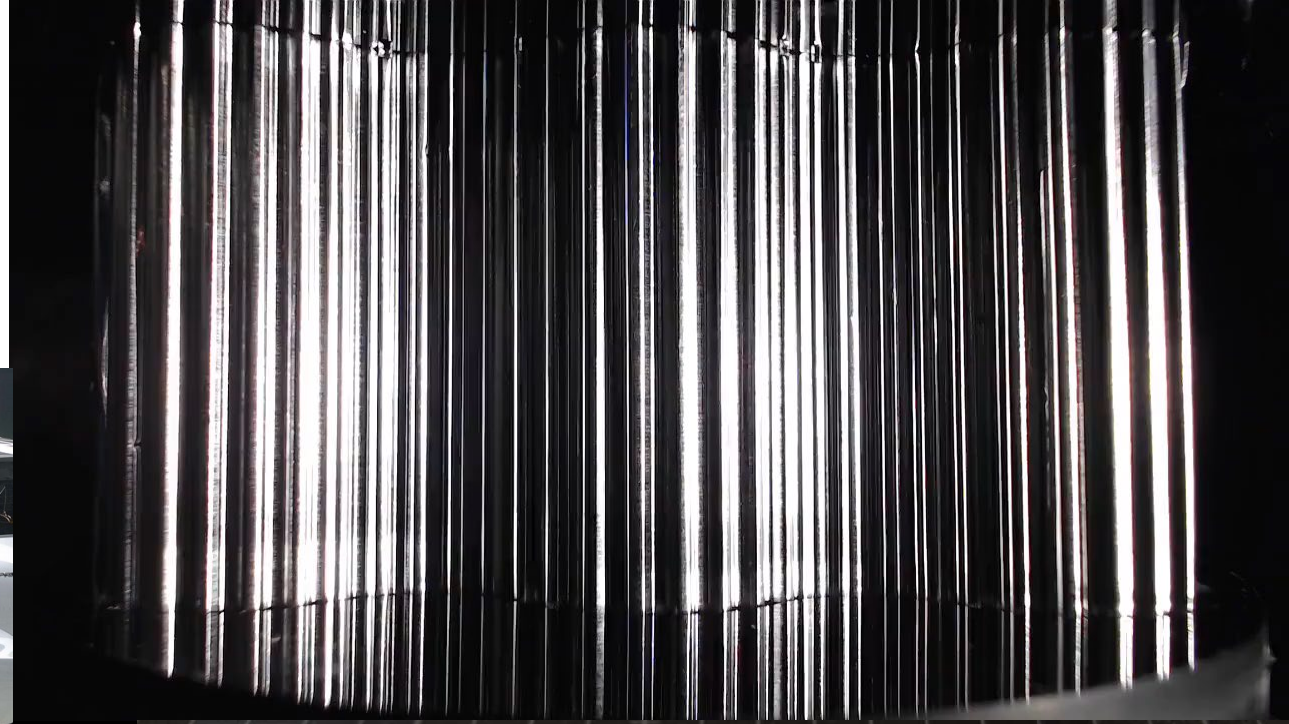


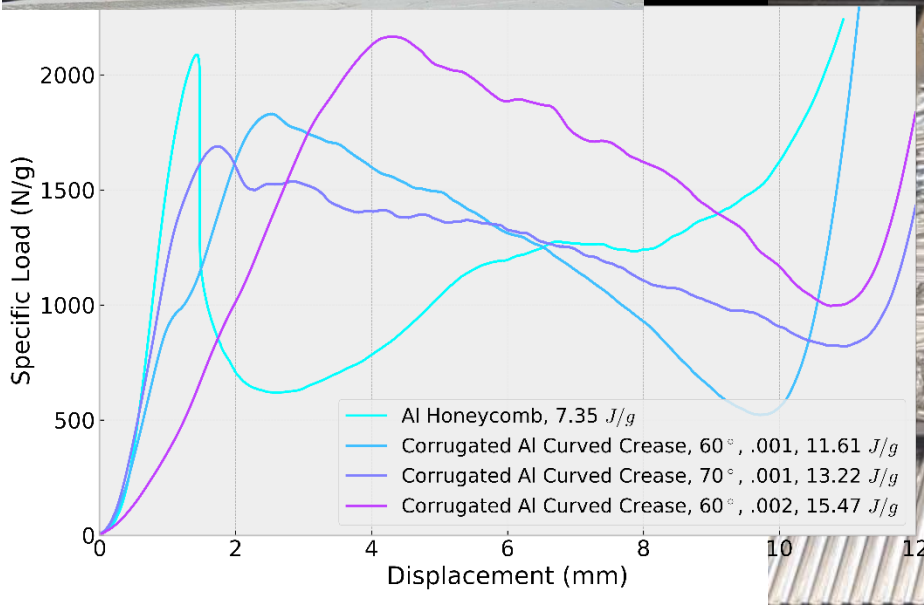




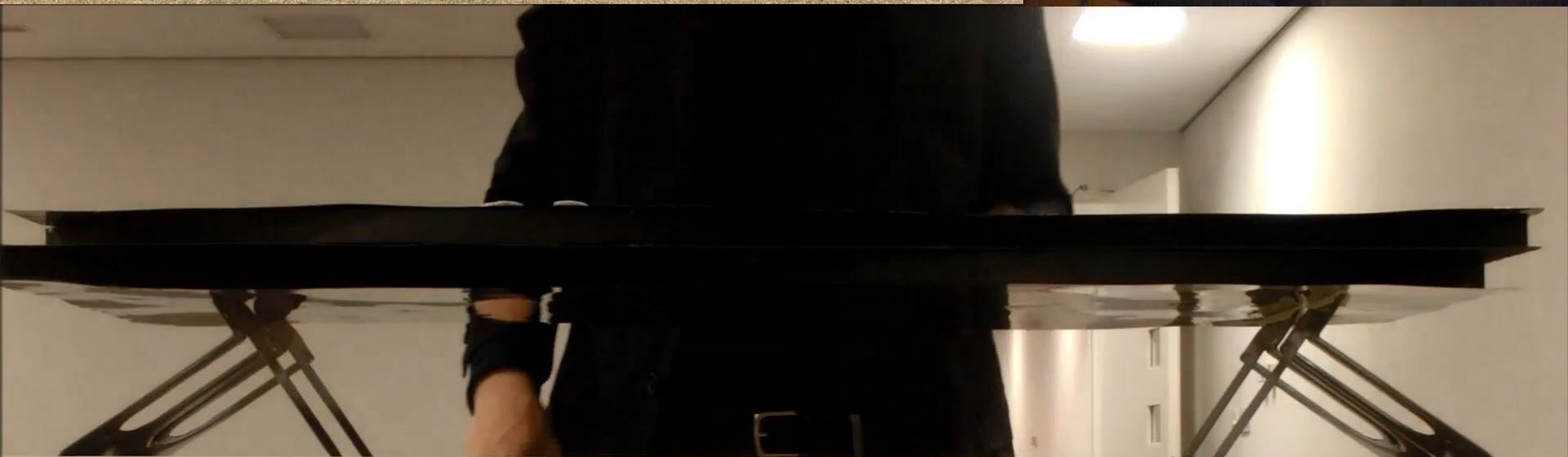
Energy Absorbtion

[Calisch 2019]

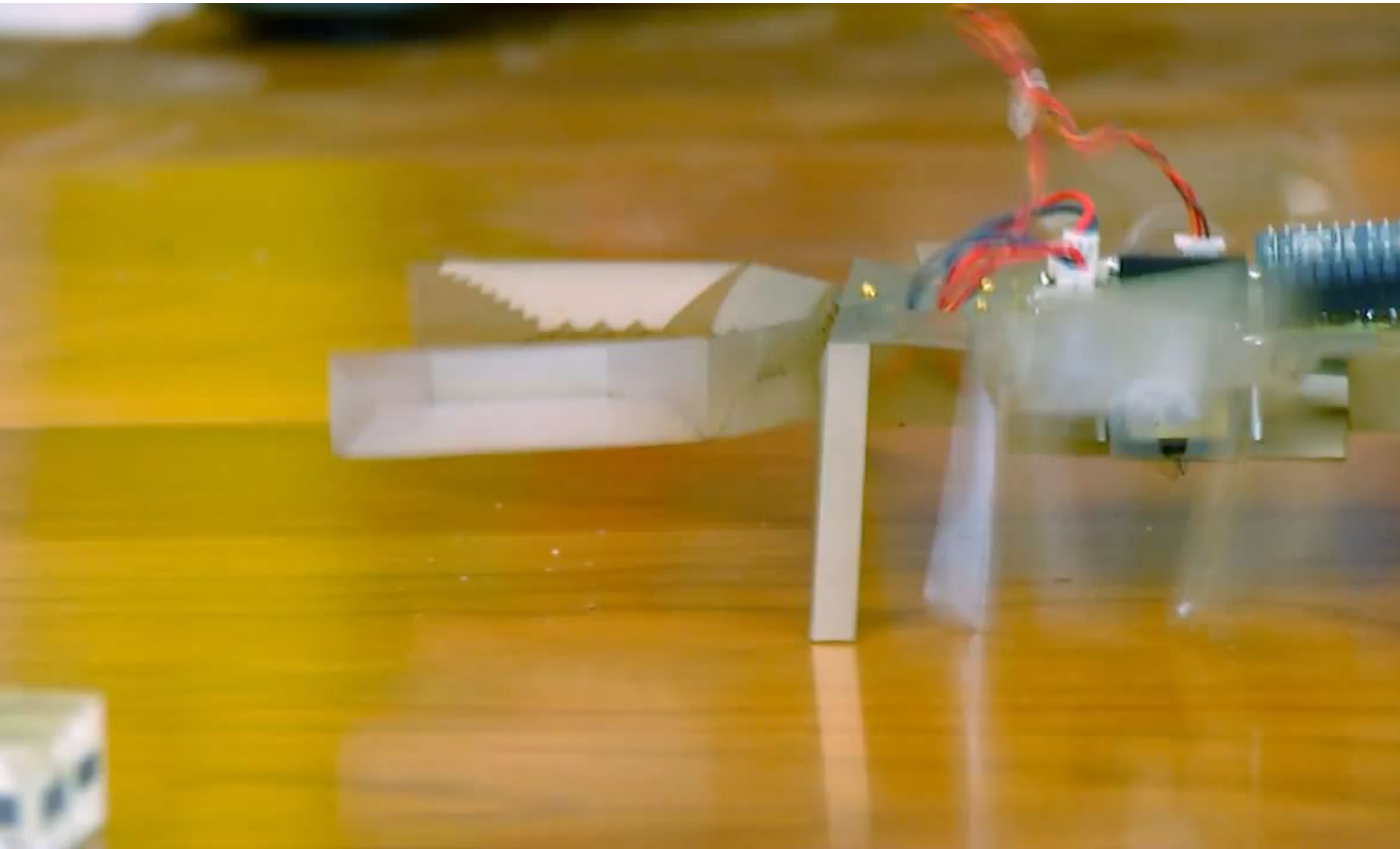





Tomohiro Tachi



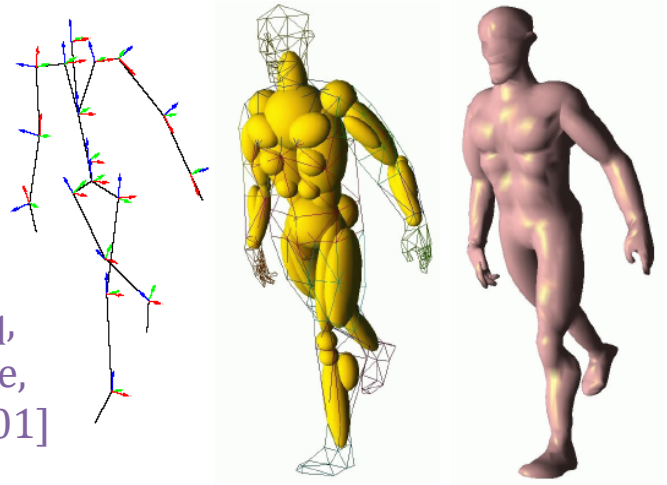
Printable Robots [MIT, Harvard, Penn]



Applications of Linkage Folding

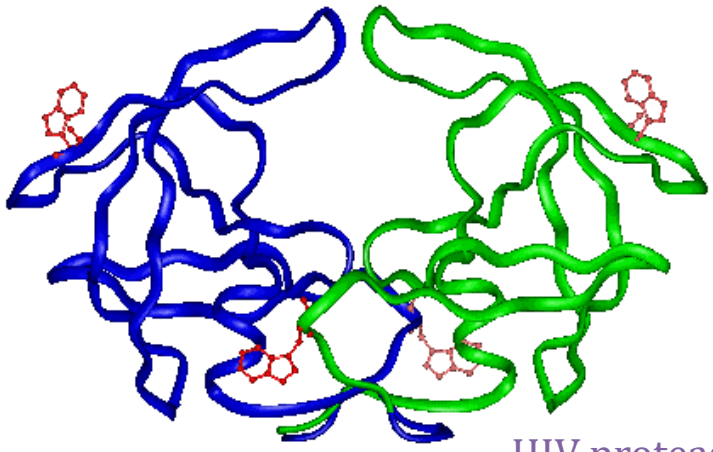
Mechanics

Robotics



[Leclercq, Akkouche, Galin 2001]

Graphics

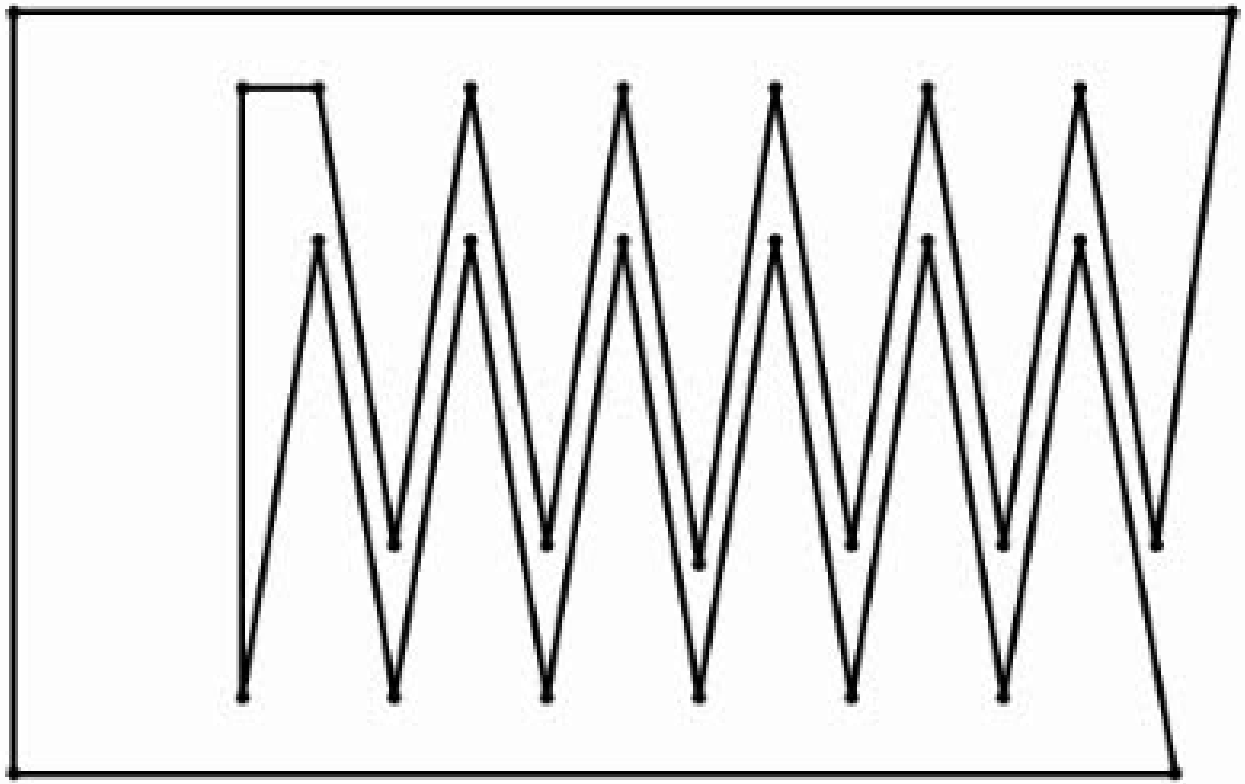


HIV protease

Biology

Carpenter's Rule Theorem

[Connelly, Demaine, Rote 2000]



[Cantarella, Demaine, Iben, O'Brien 2004]

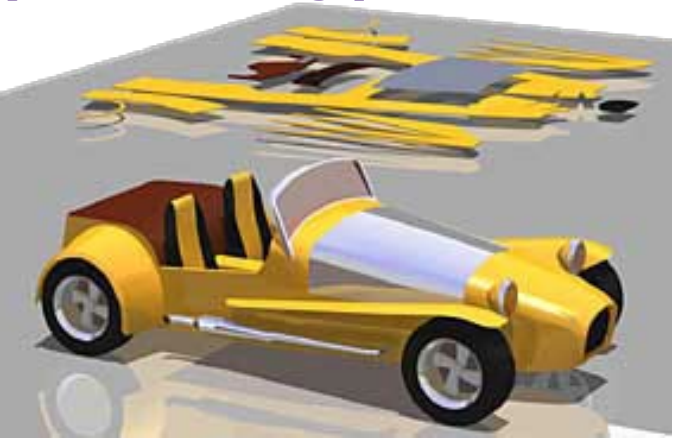
Hoberman Associates

2002

Hoberman Arch
2002 Winter Olympics, Salt Lake City, UT

Applications of Polyhedron Folding

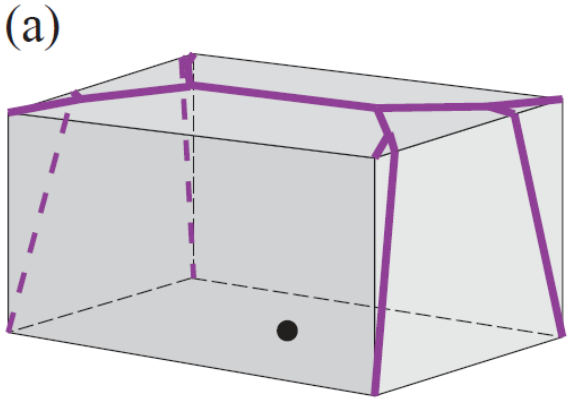
[Lundström Design]



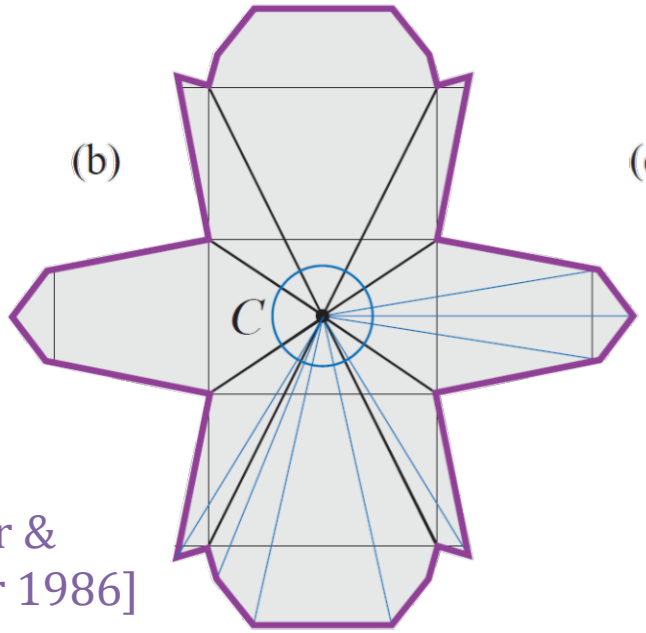
Sheet-metal manufacturing

Theory of Unfolding Polyhedra

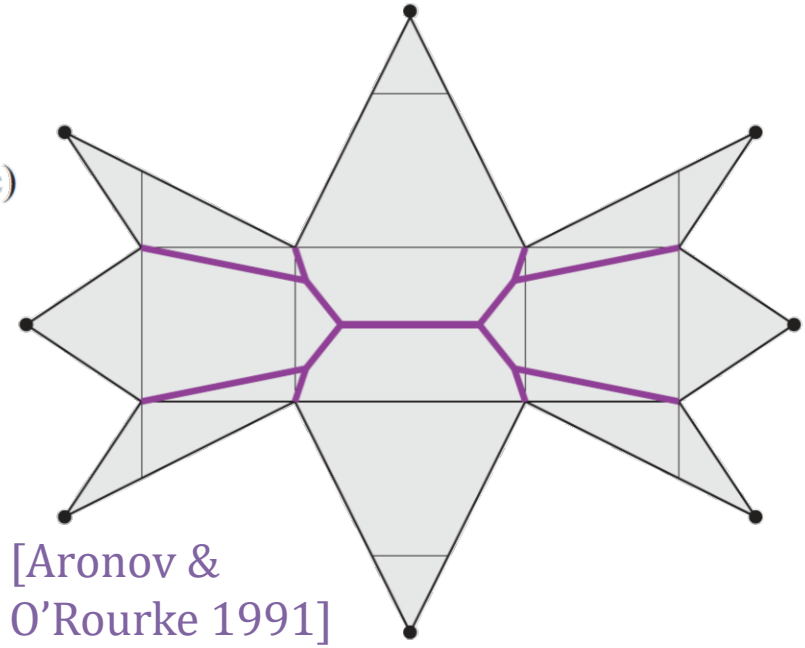
- **Convex** polyhedra always have a one-piece unfolding
- <u>OPEN:</u> Do **general** polyhedra?



[Demaine & Lubiw 2011]



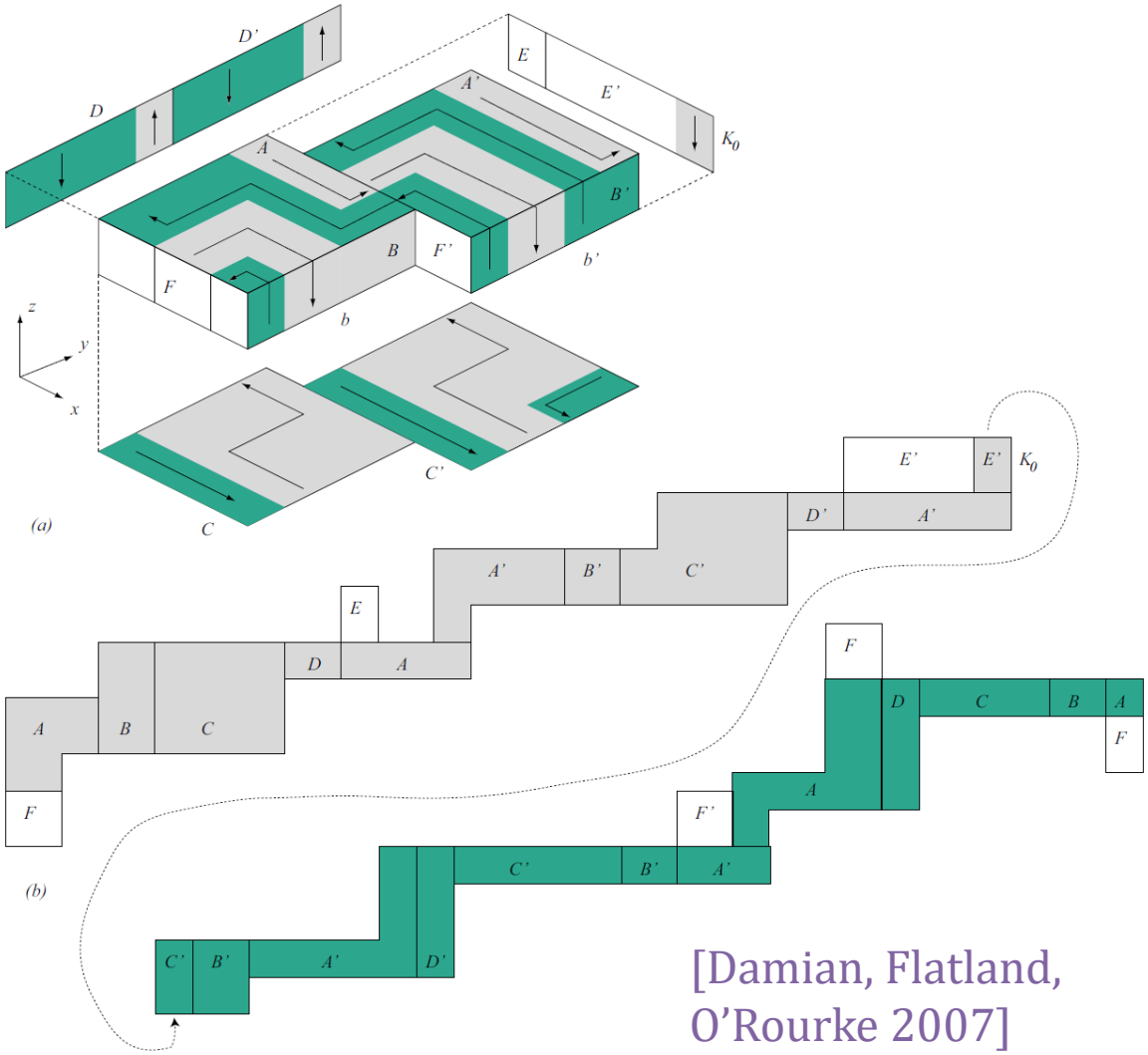
[Sharir & Schorr 1986]



[Aronov & O'Rourke 1991]

Theory of Unfolding Polyhedra

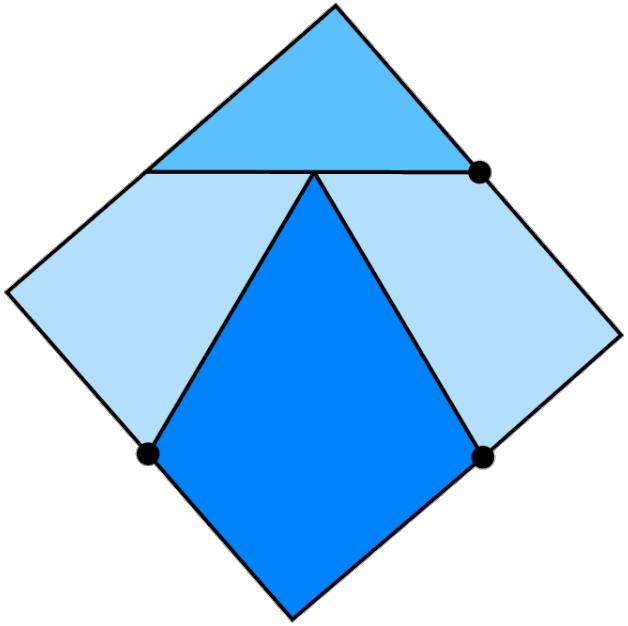
- **Orthogonal** polyhedra always have a one-piece unfolding
- <u>OPEN:</u> Do **general** polyhedra?

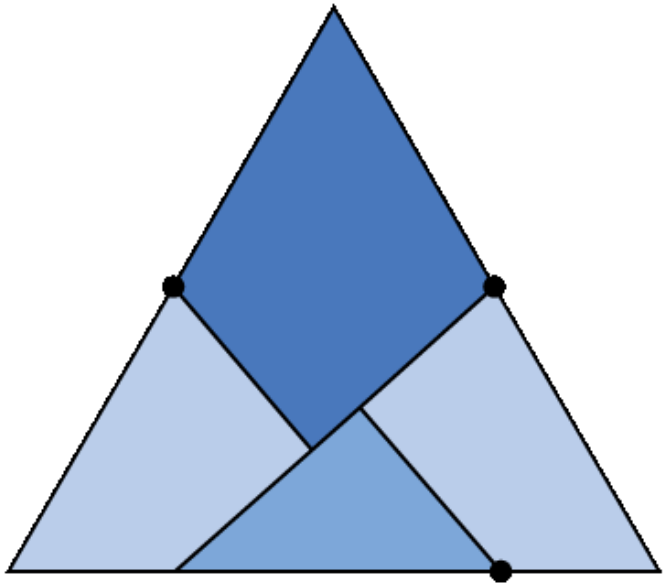


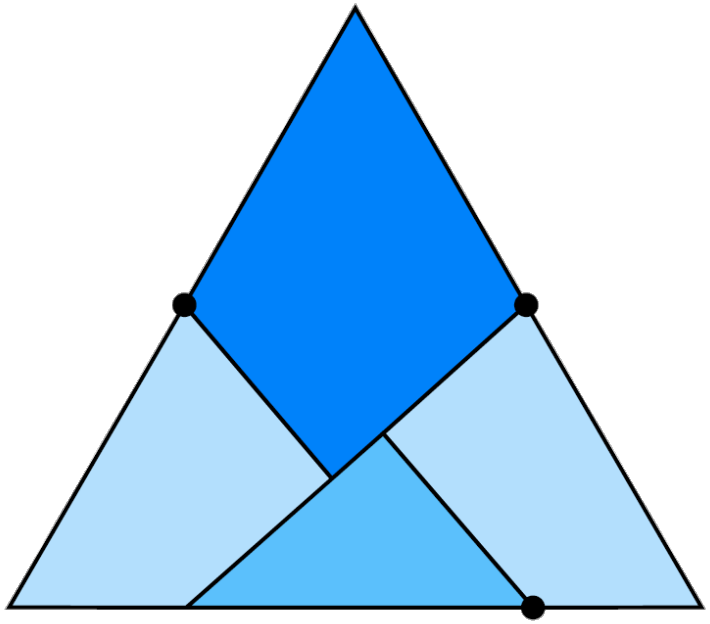
[Damian, Flatland, O'Rourke 2007]

Hinged Dissections

- Any two polygons of the same area have a **hinged dissection**
  [Abbott, Abel, Charlton, Demaine, Demaine, Kominers 2008]







[Dudeney 1902]

http://courses.csail.mit.edu/6.849/fall20/

Specifics

Synchronous Class Time:	Mondays at 4:00pm–5:30pm Eastern **and/or** Thursdays at 7:00–8:30pm Eastern (For-credit students must attend at least one. You are encouraged to attend both if possible.)
Synchronous Class Room:	online, using custom software (Fill out the sign-up form and join the mailing list (see below) to get the link to the class.)
First Class:	Thursday, September 3, 2020 at 7:00–8:30pm Eastern
Second Class:	Tuesday, September 8, 2020 at 4:00–5:30pm Eastern
Professor:	Erik Demaine, edemaine *at* mit.edu
Co-lecturer:	Martin Demaine, mdemaine *at* mit.edu
TAs:	Yevhenii Diomidov, diomidov *at* mit.edu Klara Mundilova, kmundil *at* mit.edu
Staff Email:	6849-staff *at* csail.mit.edu
Units:	3-0-9
Prerequisites:	6.046 or equivalent background in discrete mathematics and algorithms. Alternatively, permission from the instructor.
Credit:	H-level and AAGS credit
Requirements:	• Watch all video lectures, measured by filling out Completion Forms. • Watch recorded portions of synchronous classes that you didn't attend. • Participation in synchronous classes, at least one per week (email 6849-staff about exceptions). • Participation in discussion, measured as posting or being @mentioned in at least one Coauthor post each week • Project write-up and presentation. • Problem sets roughly weekly.
Grading scheme:	The *approximate* breakdown of your grade is 50% project, 20% project presentation, 15% psets, and 15% partic But you cannot pass the class without participating (according to the fairly minimal requirements above).

Project

http://courses.csail.mit.edu/6.849/fall20/

The project is the most important requirement of the course. It can take several forms:

- **Design/create** artwork, furniture, architecture, sculpture, tool, illustration, or other object based on the ideas in the class. Your work should be both aesthetically compelling and technically grounded (though the latter need not be explicitly visible). You may use any medium you wish, including virtual; the challenge of working with your format will be taken into consideration.
- **Theoretical contribution** to the field: tackle/solve a problem, formulate interesting open problems or conjectures, etc. You should not feel pressure in terms of grades to produce results, but you should spend substantial time thinking and trying to solve the problem. On the other hand, from past experience, we expect many such results to be produced during class time, and you are encouraged to turn those results into your project(s).
- **Survey** a few papers on a related topic (not already well-covered by the class or textbook).
- Design a possible new **lecture** for a future edition of this class.
- Write/record an accessible **tutorial** for teaching folding to a broad audience.
- Substantially improve the **Wikipedia** articles for several topics related to the class. Recommended only if you have existing experience editing Wikipedia and with its guidelines. In this case, your project write-up and presentation should summarize the changes you made, why you made the decisions you did, and any challenges you ran into, in addition to linking to new articles and change diffs.
- **Implement/visualize** one or more algorithms or results, or make a tool to help explore an open problem, from this class or on related topics. We encourage such implementations to be designed as web pages, with code written in CoffeeScript (see our guide for Python programmers) or JavaScript.

You are encouraged to relate the final project to your research interests, and you will not be limited to the topics discussed in class.