

PINO TROGU – SAN FRANCISCO STATE UNIVERSITY, USA

BIO-INSPIRED MODELS OF ROTATIONAL GEOMETRY AND DESIGN OF METAMATERIALS

7th GLOBAL INTELLIGENT INDUSTRY CONFERENCE

SHENZHEN INTERNATIONAL CONVENTION AND EXHIBITION CENTER

SUNDAY, MARCH 31, 2024 – 13:30

ROOM CCI01C, FLOOR 1, HALL 18

[go to last slide](#)

ORIGINS AND INFLUENCES: ART.

GIORGIO SCARPA (1938-2012)

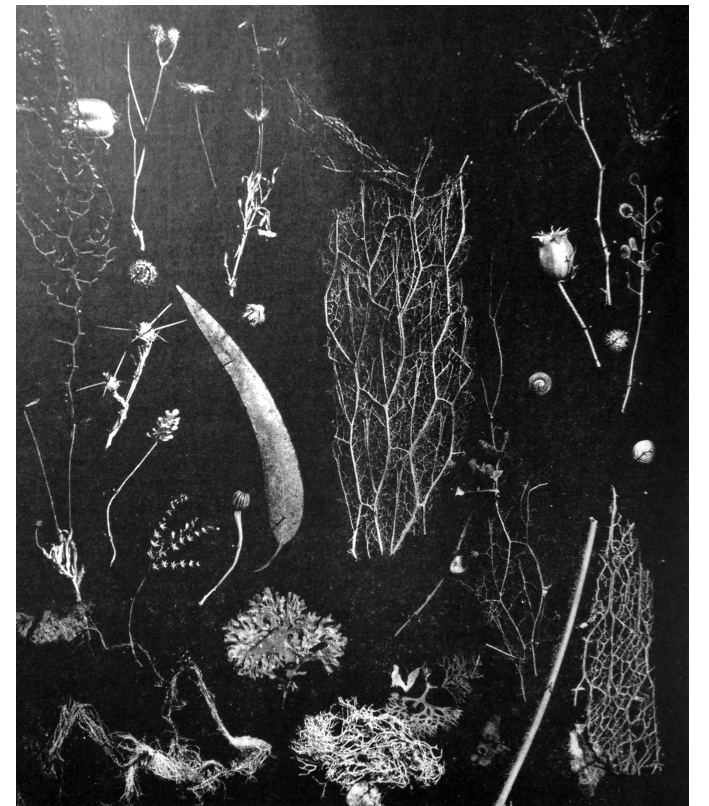
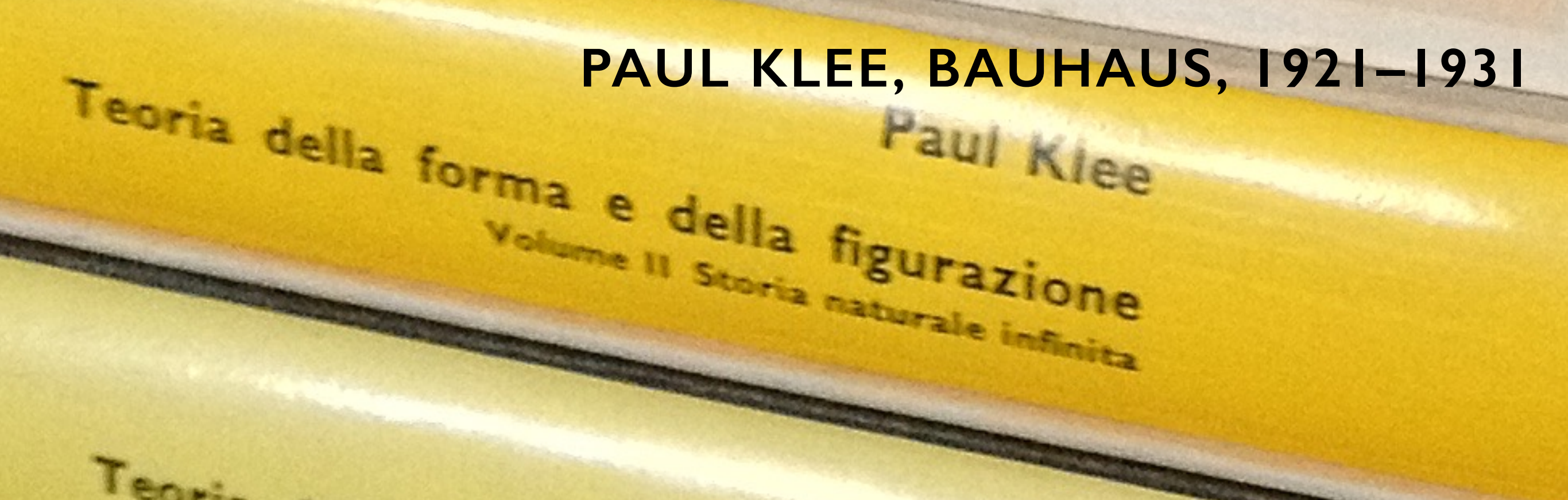
“Year 1950, my first project.”

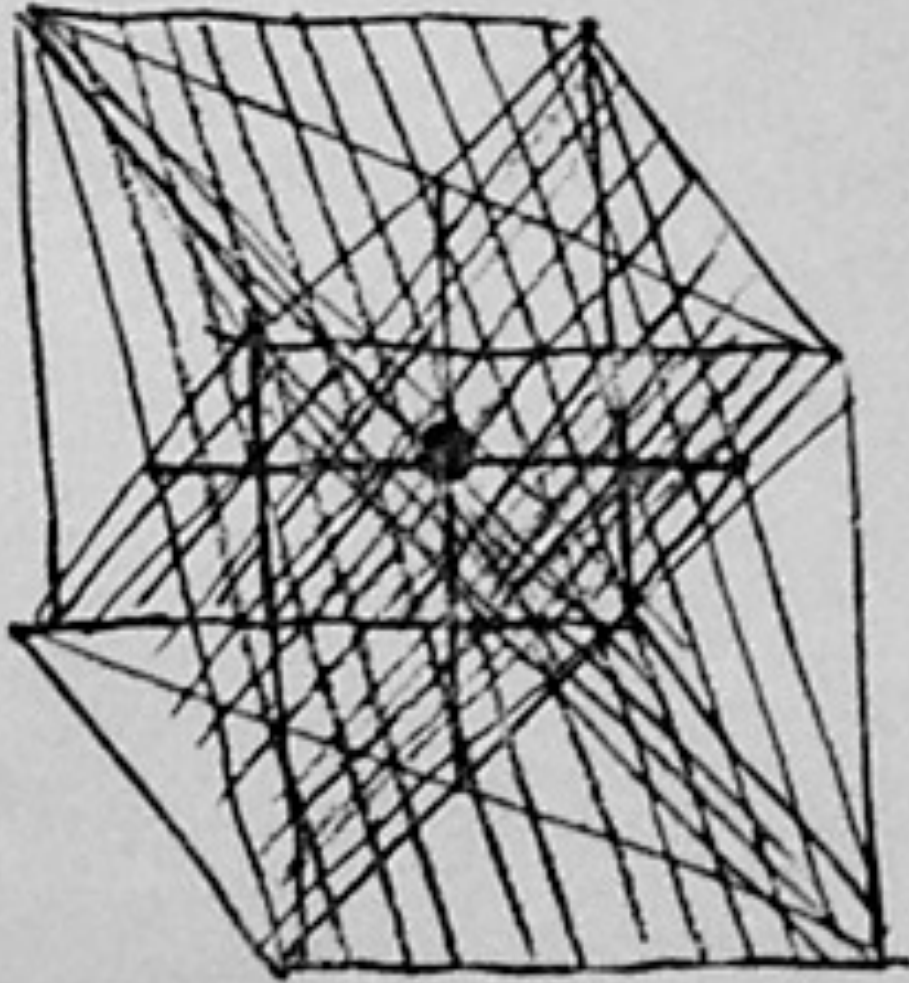






PAUL KLEE, BAUHAUS, 1921–1931





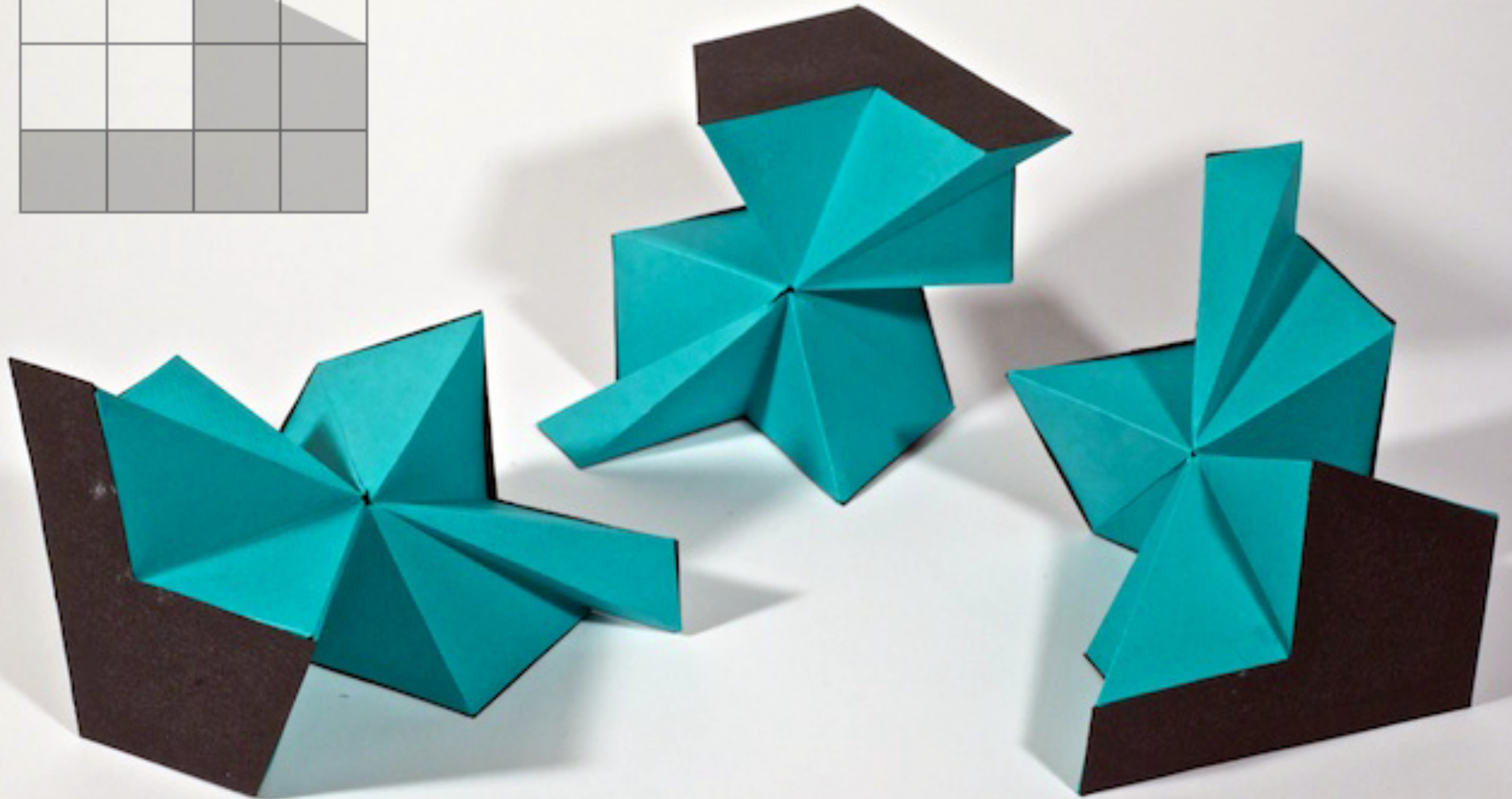
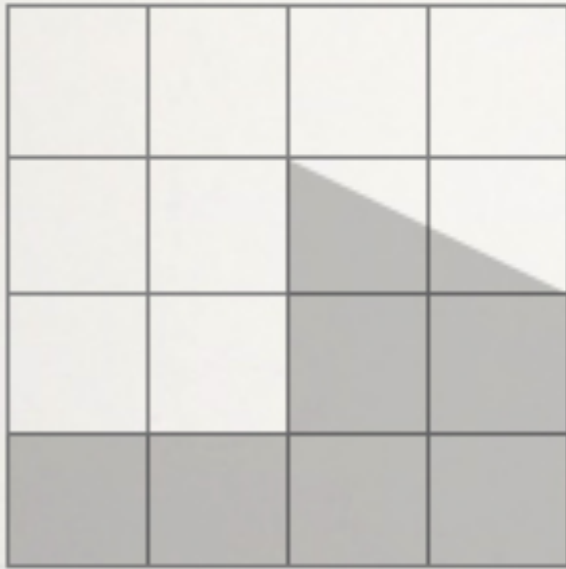
The inward
plays the dominant part.
The whole inward territory
designated by the word 'content'

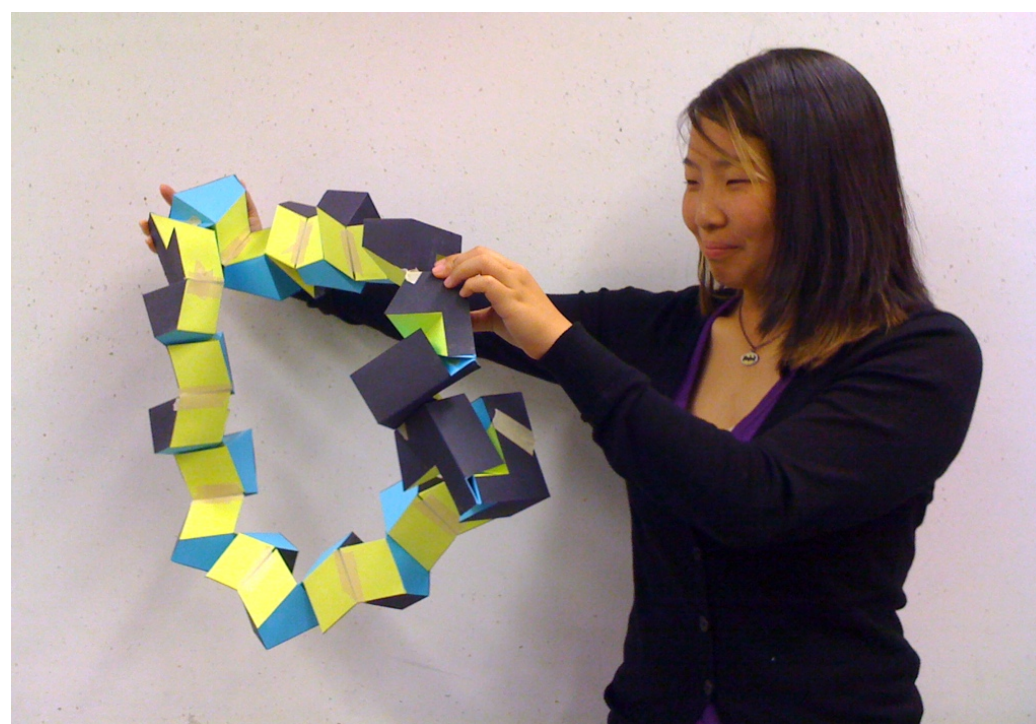
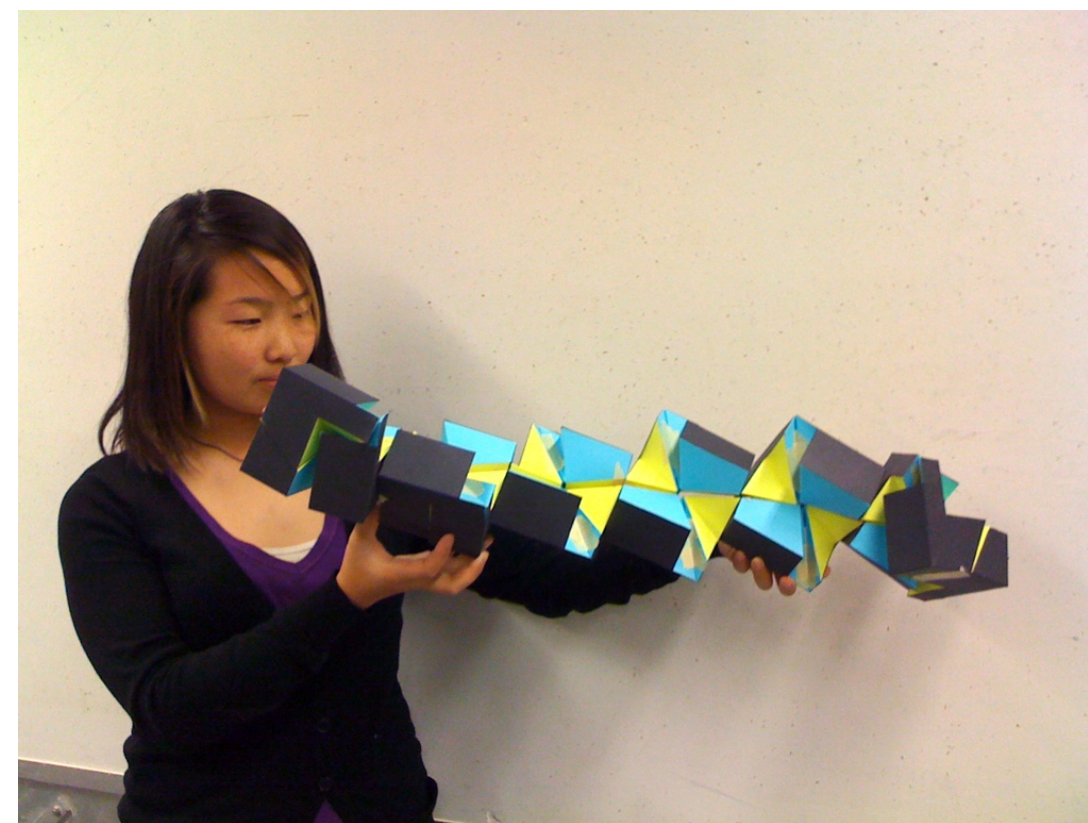
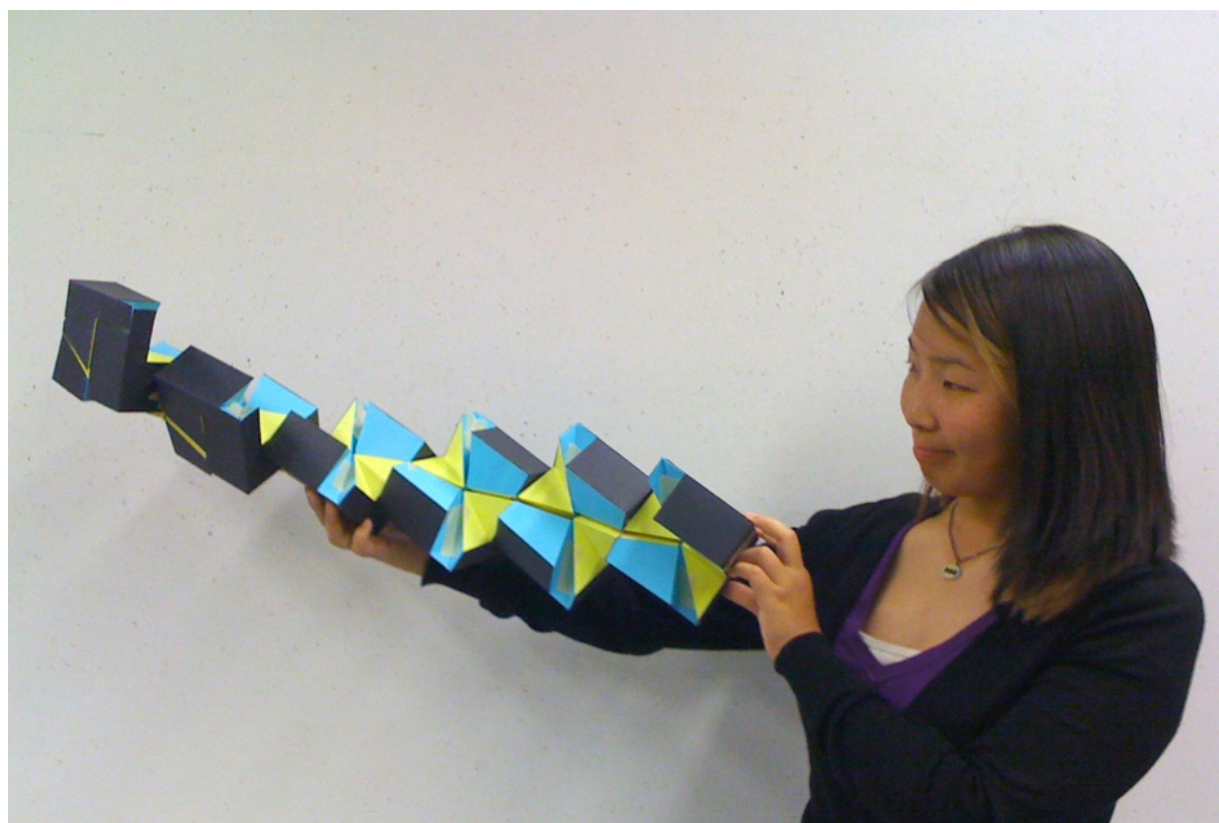
TEACHING: TECHNICAL DRAWING & PERSPECTIVE.

GIORGIO SCARPA'S CLASSROOM, ITALY, C.1975



CUBE SECTION PROJECT





24-MODULE CLOSED CHAIN
FLORENCE YUEN
SAN FRANCISCO STATE UNIVERSITY
2012

NATURE:
BIONIC MODELS:
SEA URCHIN & DNA.



SCARPA – BIONICS

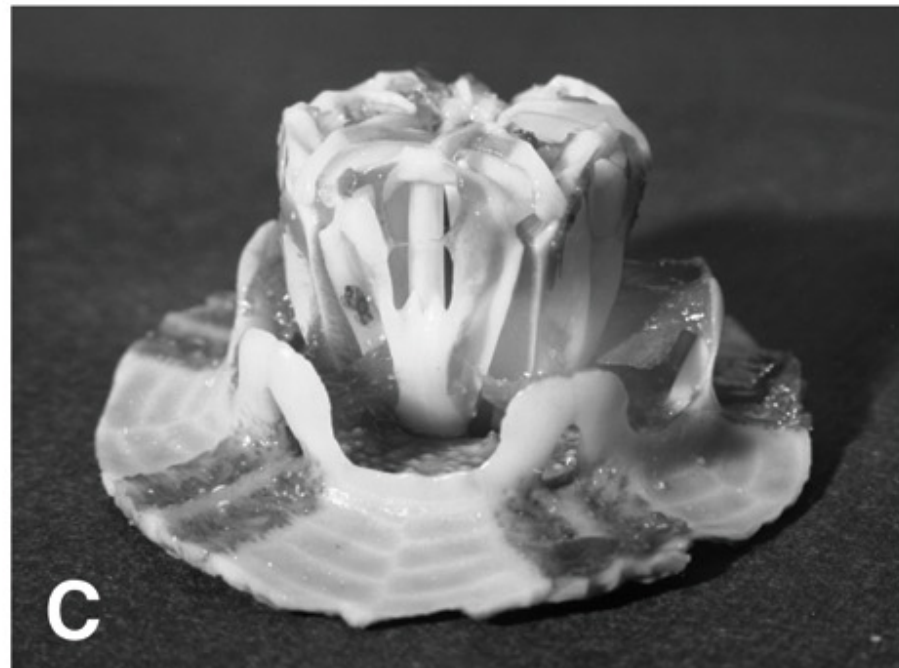
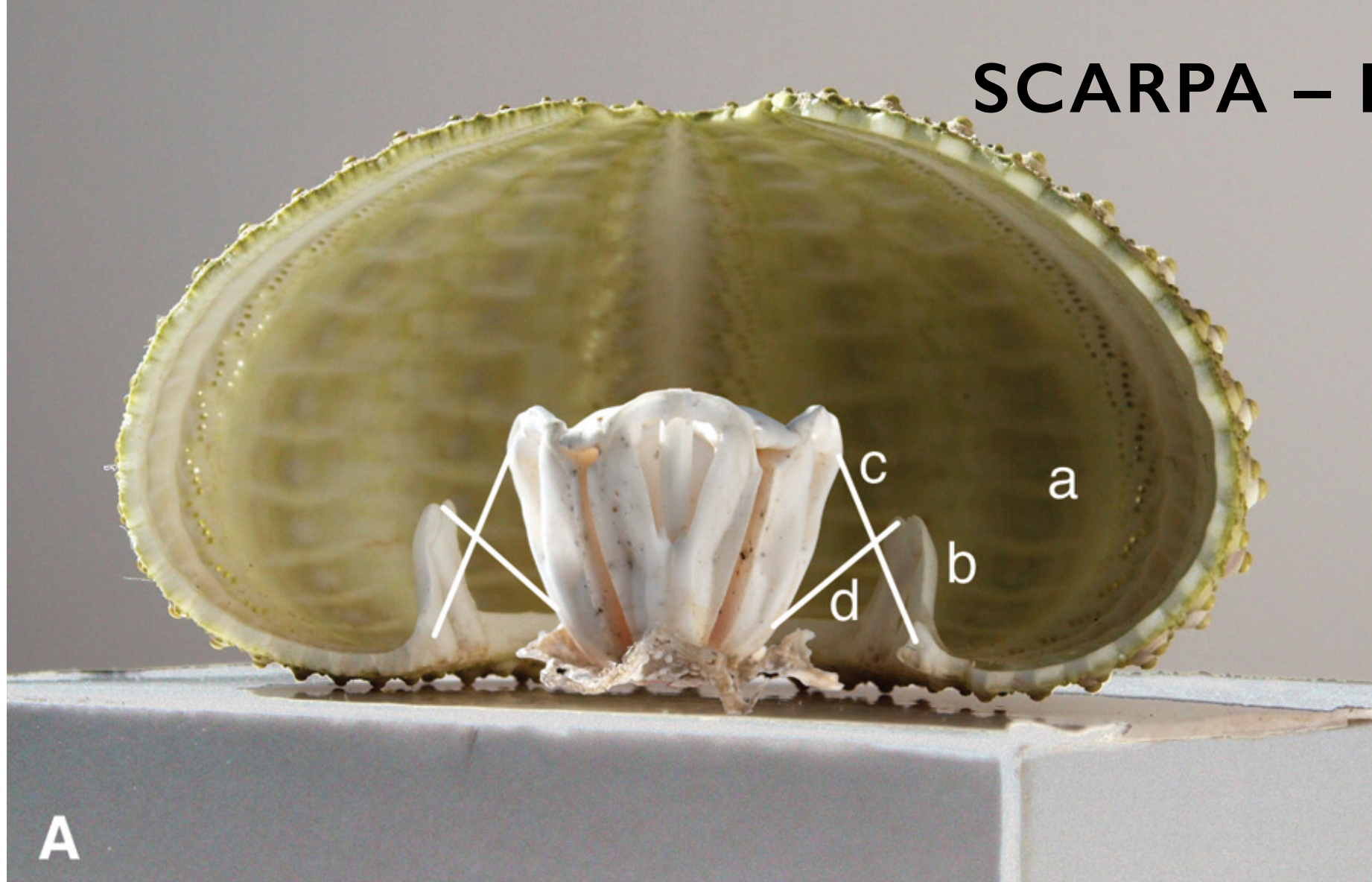


Photo: Giorgio Cireddu

SCARPA, ARISTOTLE'S LANTERN



Faenza, Italy, c. 1980

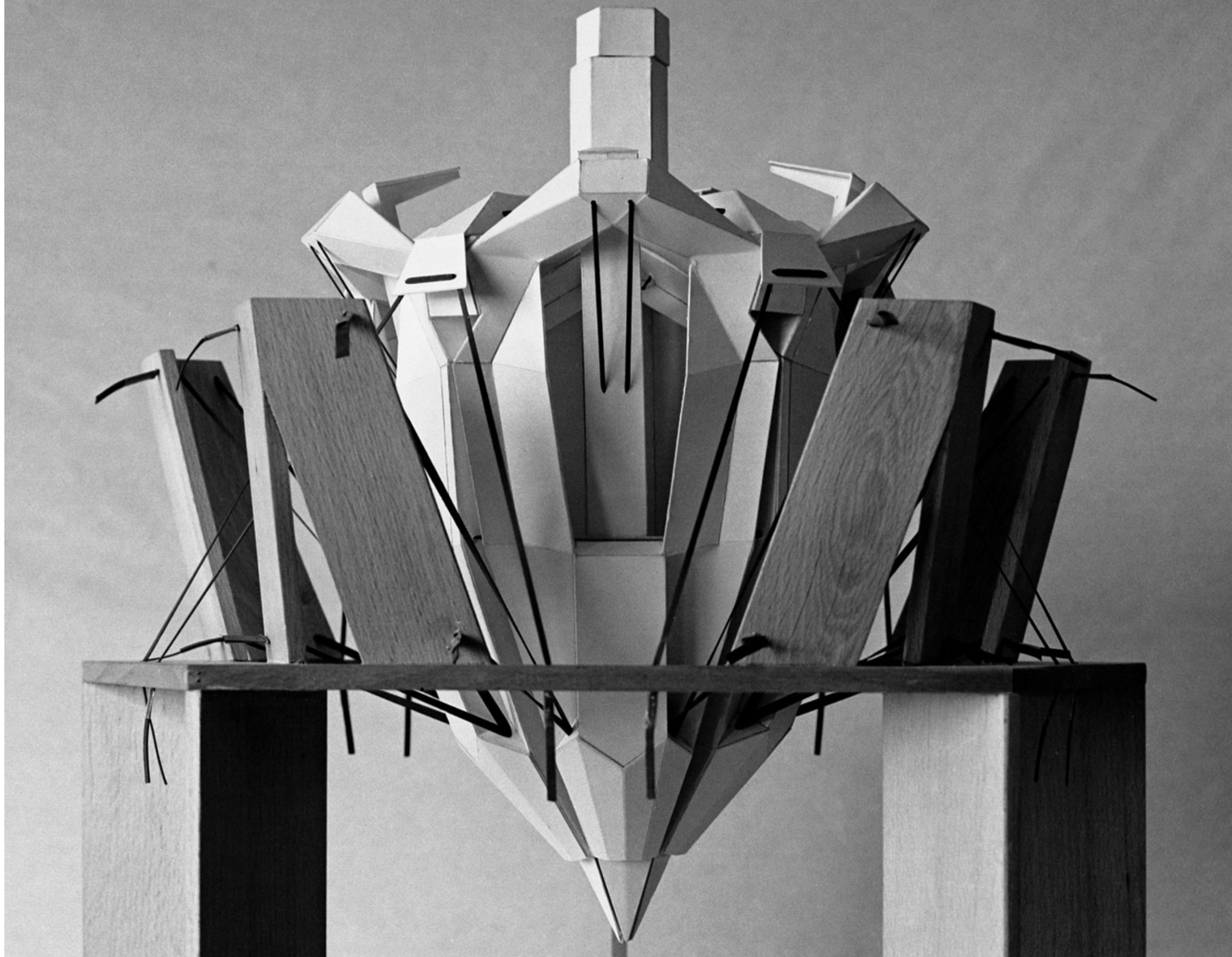
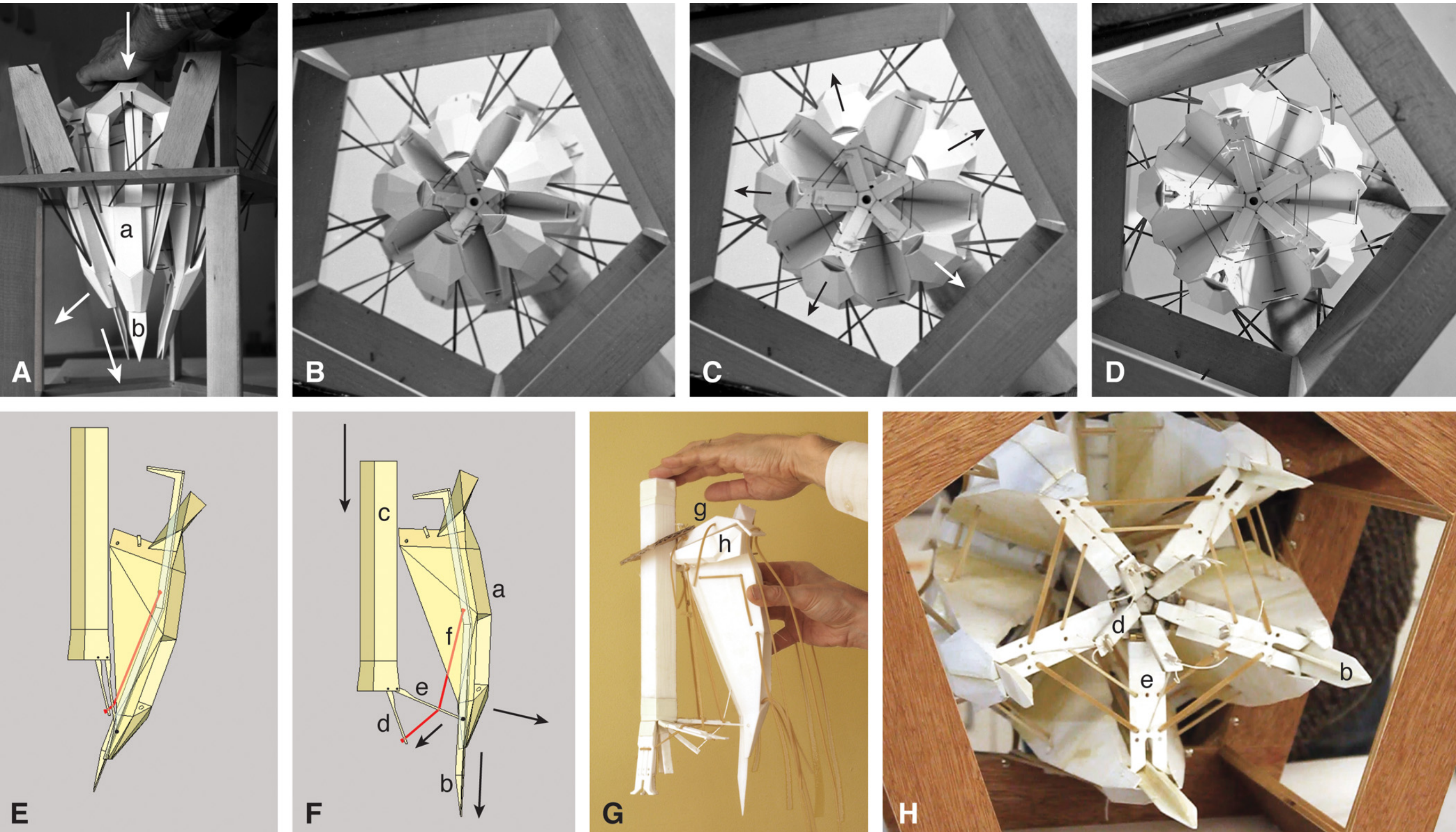
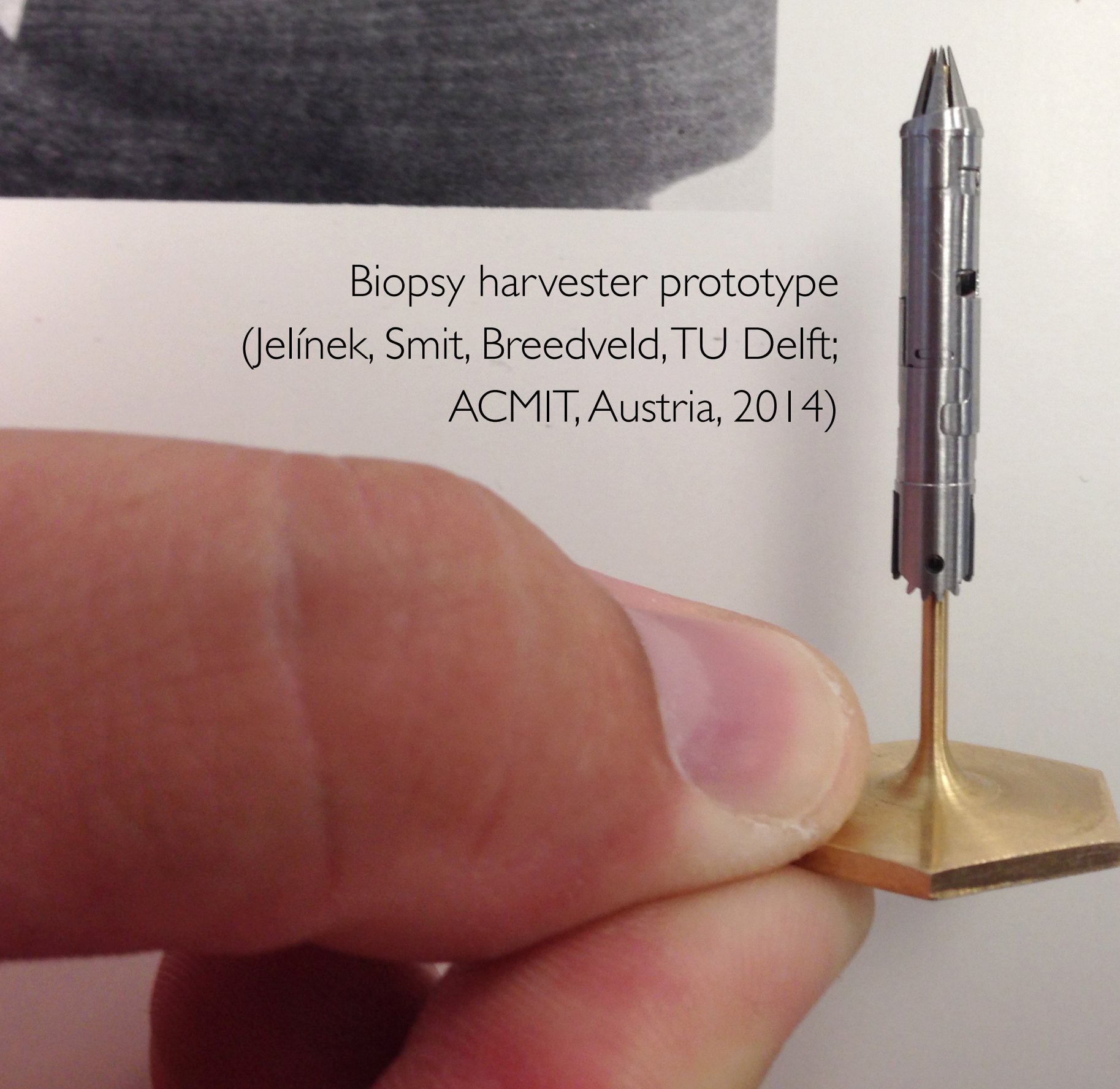


Photo: Giorgio Cireddu

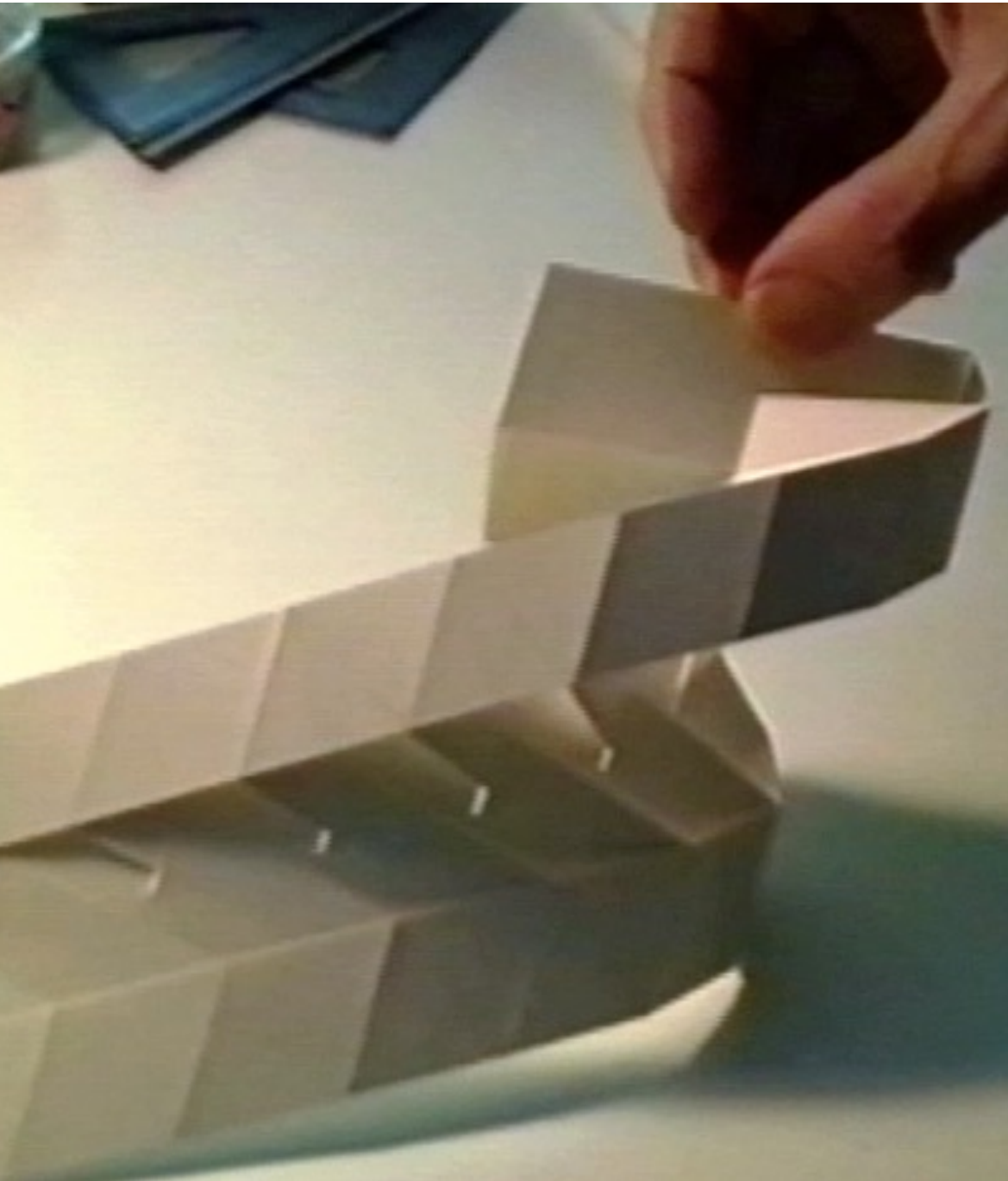


Pino Trogu, replica of Scarpa's Aristotle's Lantern, 2015

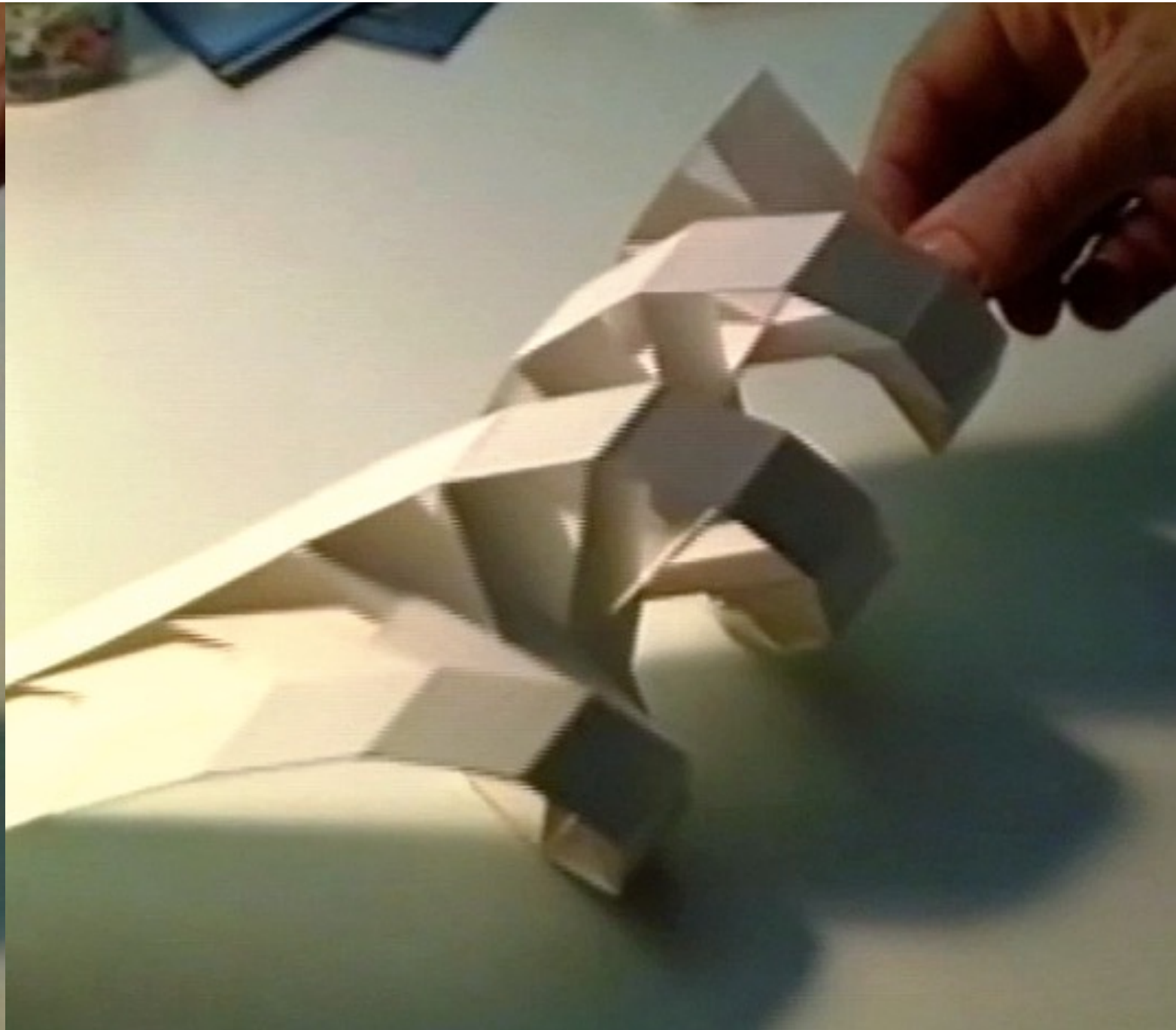
Biopsy harvester prototype
(Jelínek, Smit, Breedveld, TU Delft;
ACMIT, Austria, 2014)



SCARPA



DNA MODEL, C. 1985



ROTATIONAL GEOMETRY

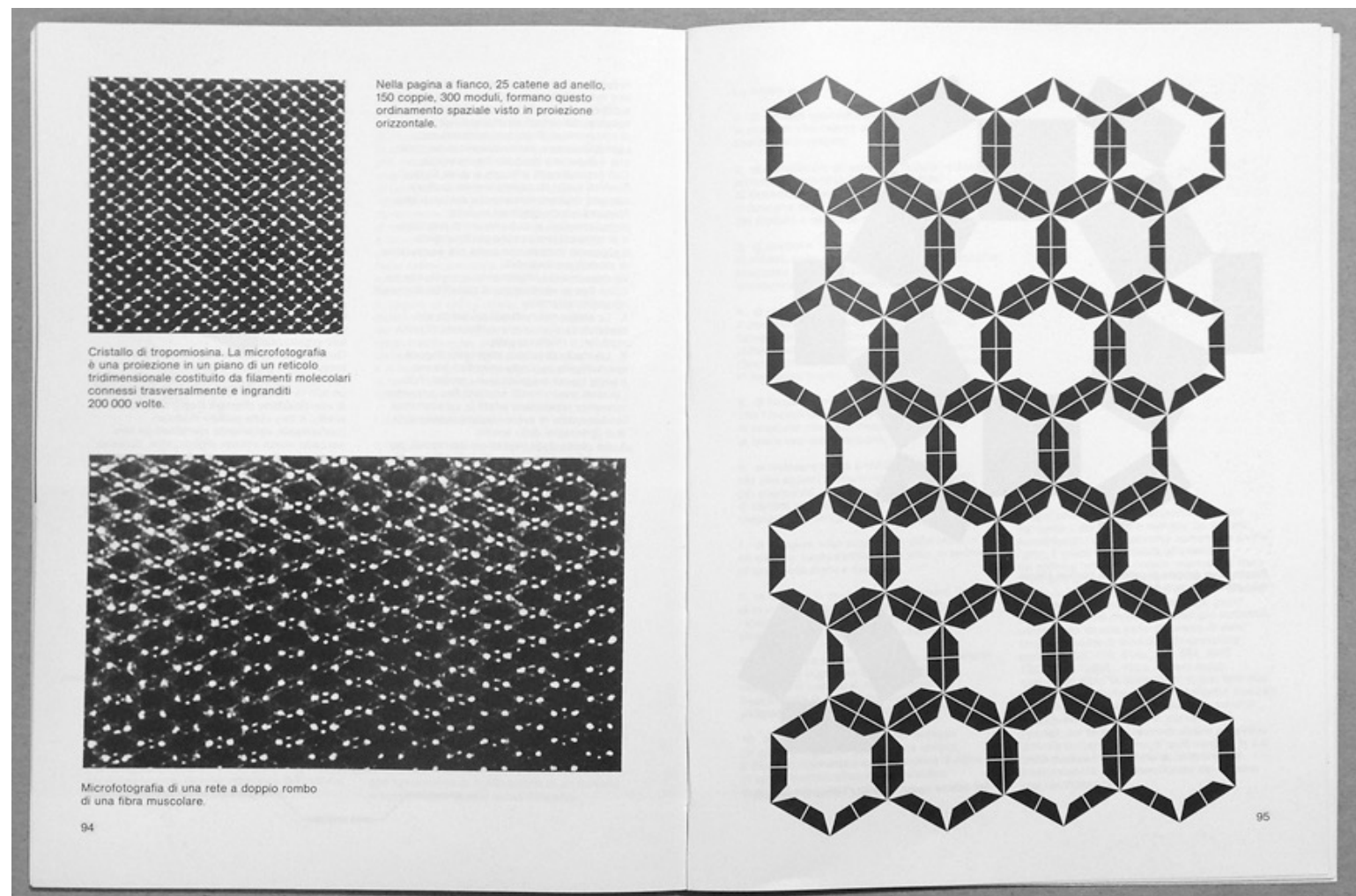
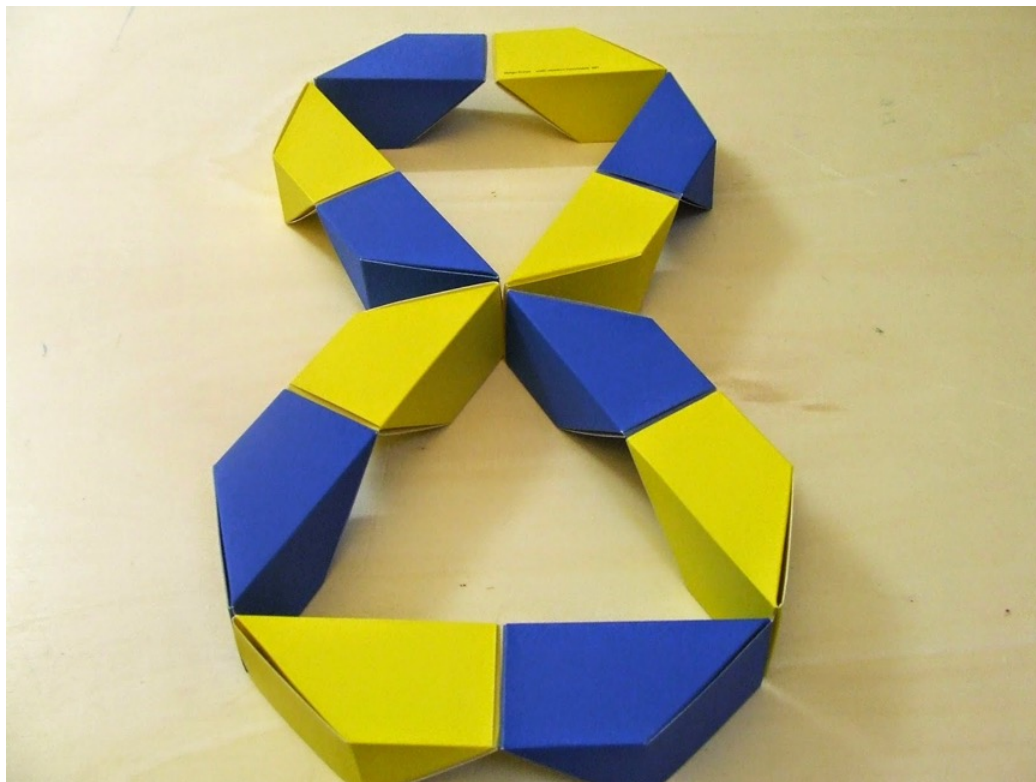
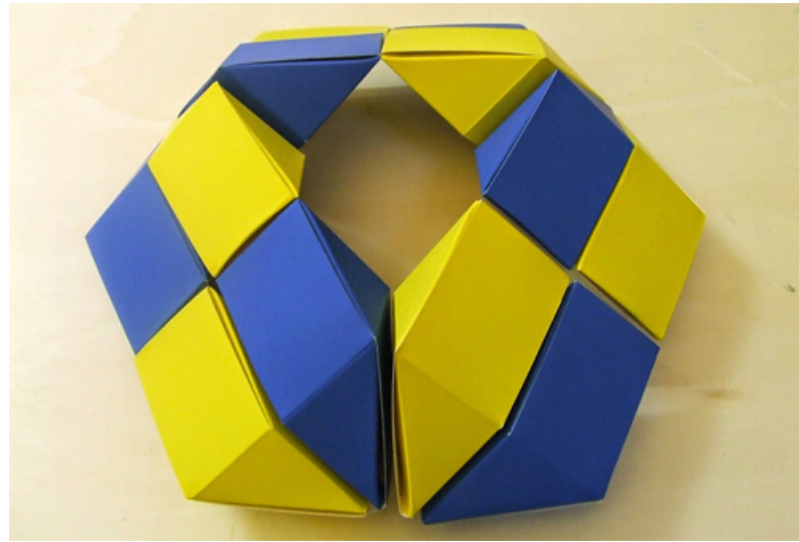
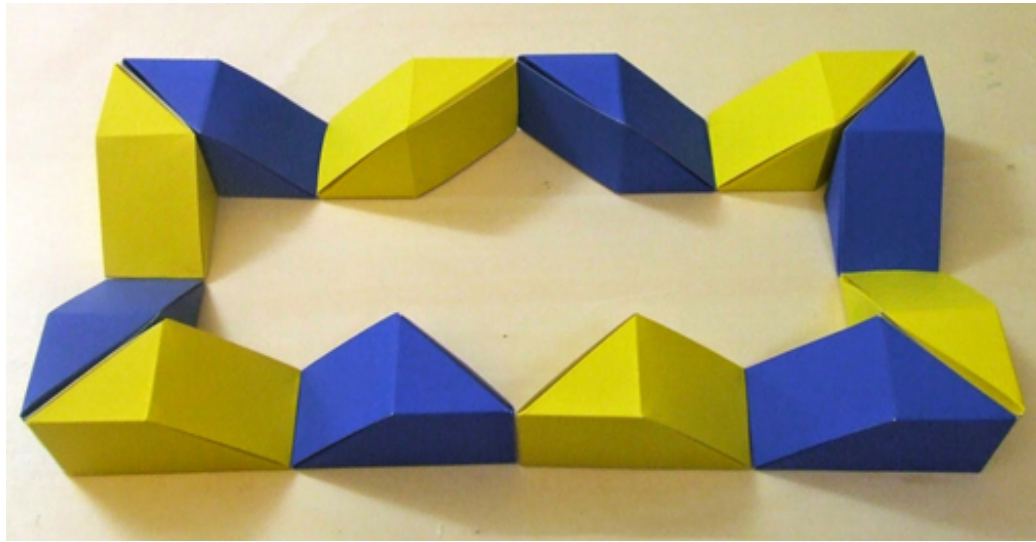
MODELS:

TRANSFORMABLE FABRICS

& POLYHEDRA.

SCARPA

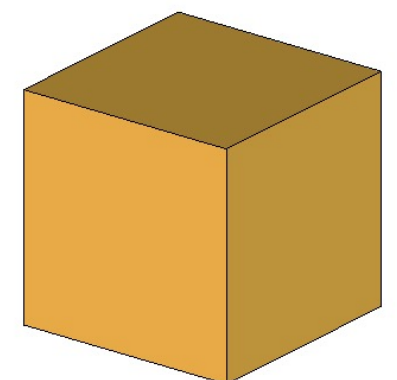
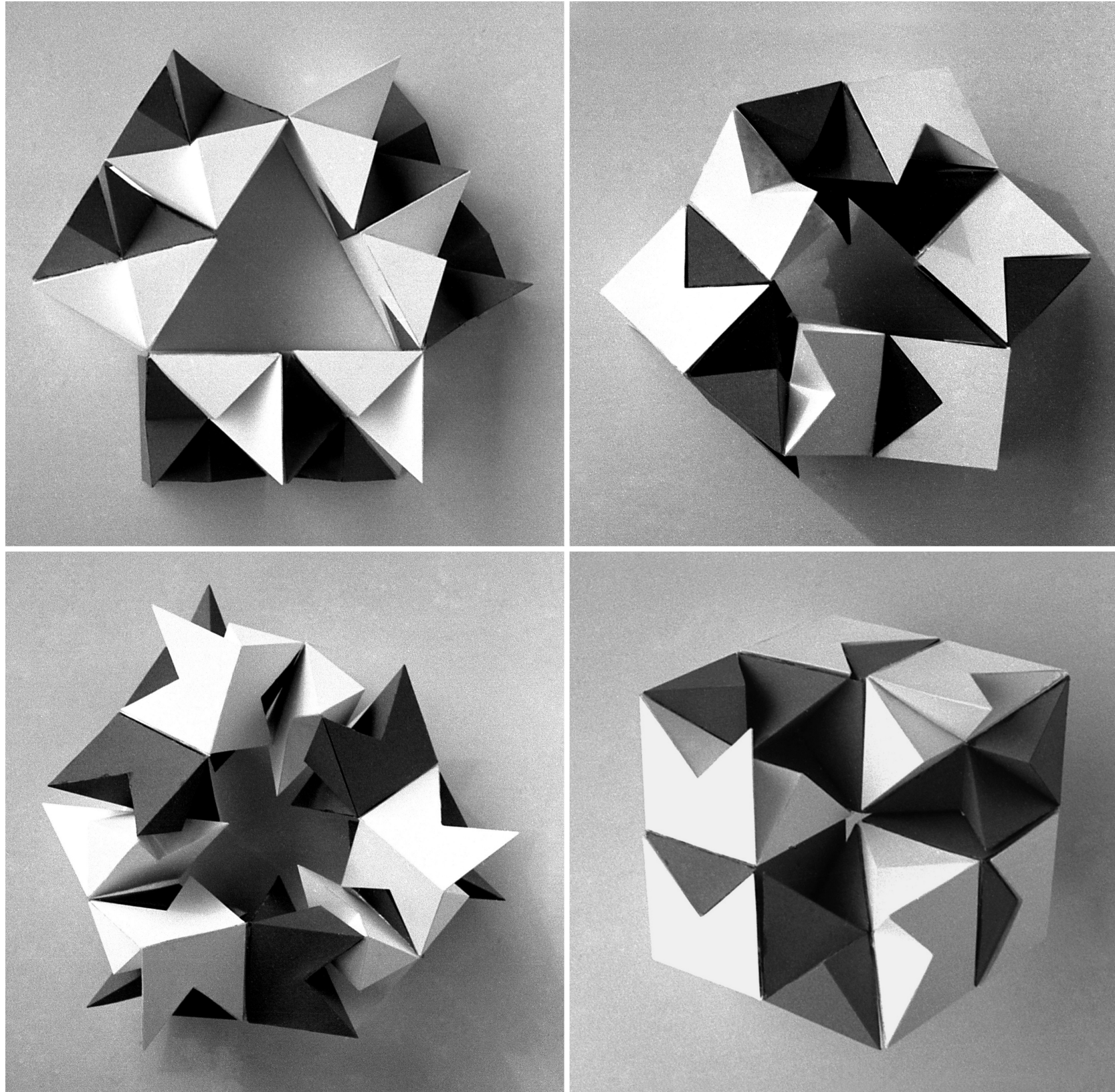
TRANSFORMABLE FABRICS, 1978



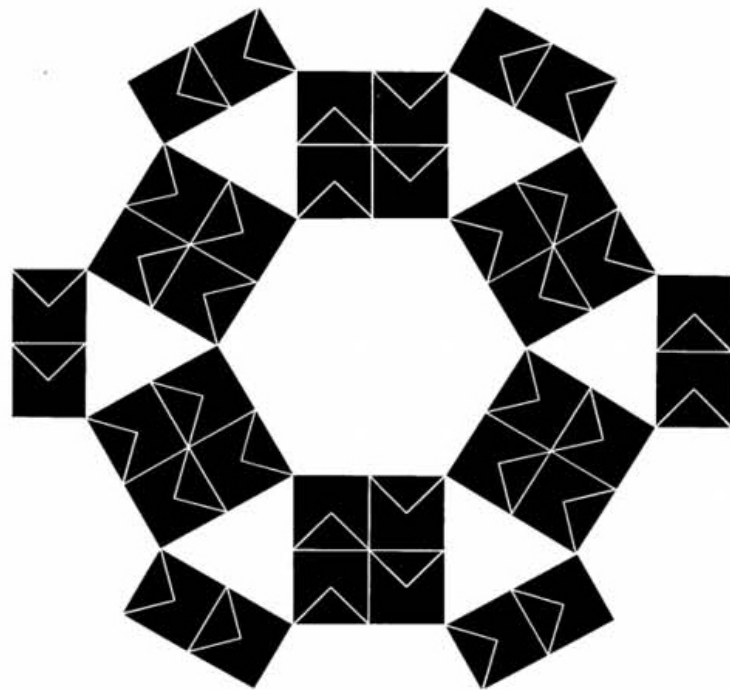
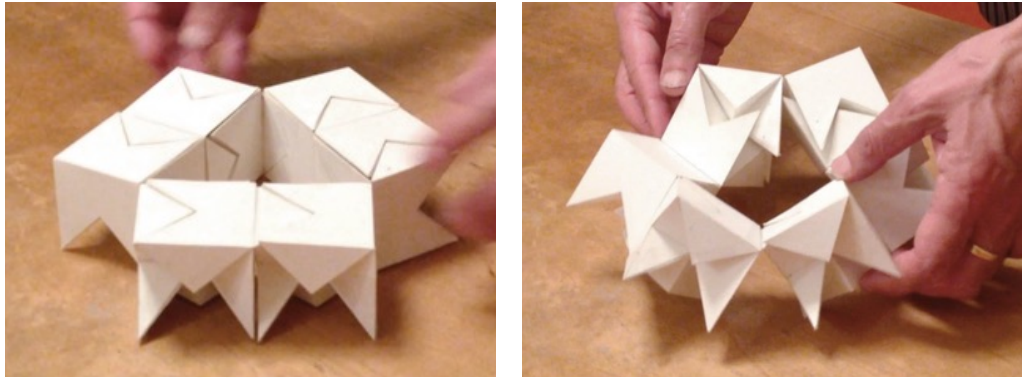
(G. Scarpa, Models of Rotational Geometry, 1978)

SCARPA

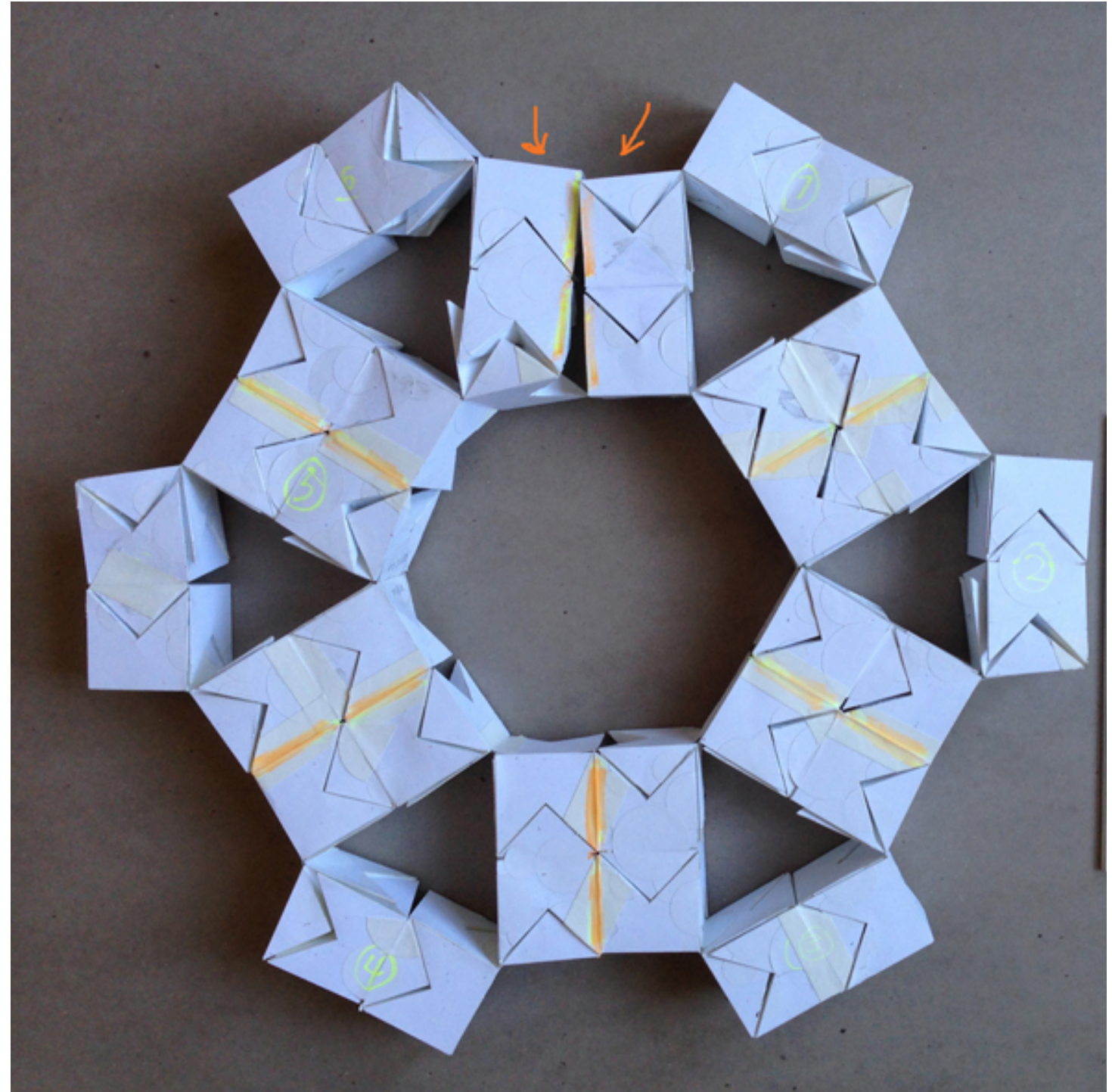
HEXAHEDRAL CHAIN, 1978



SCARPA



HEXAHEDRAL CHAIN, 1978



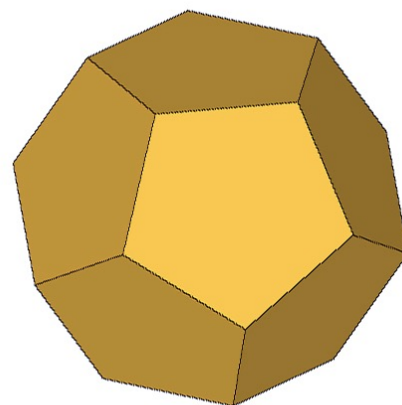
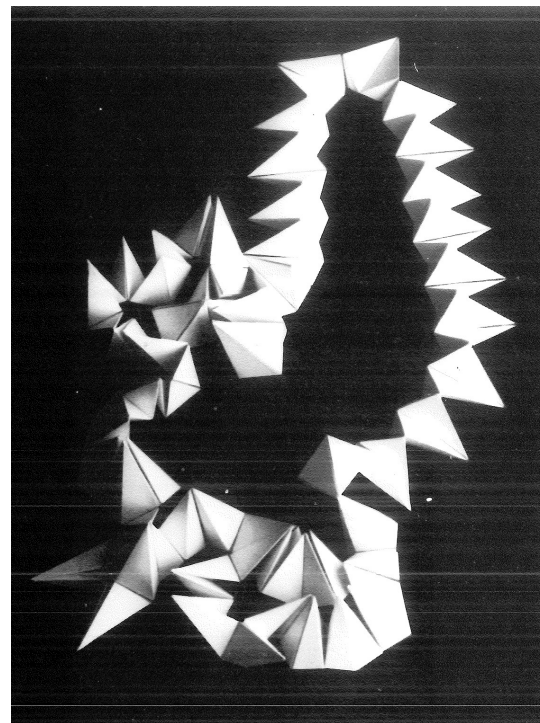
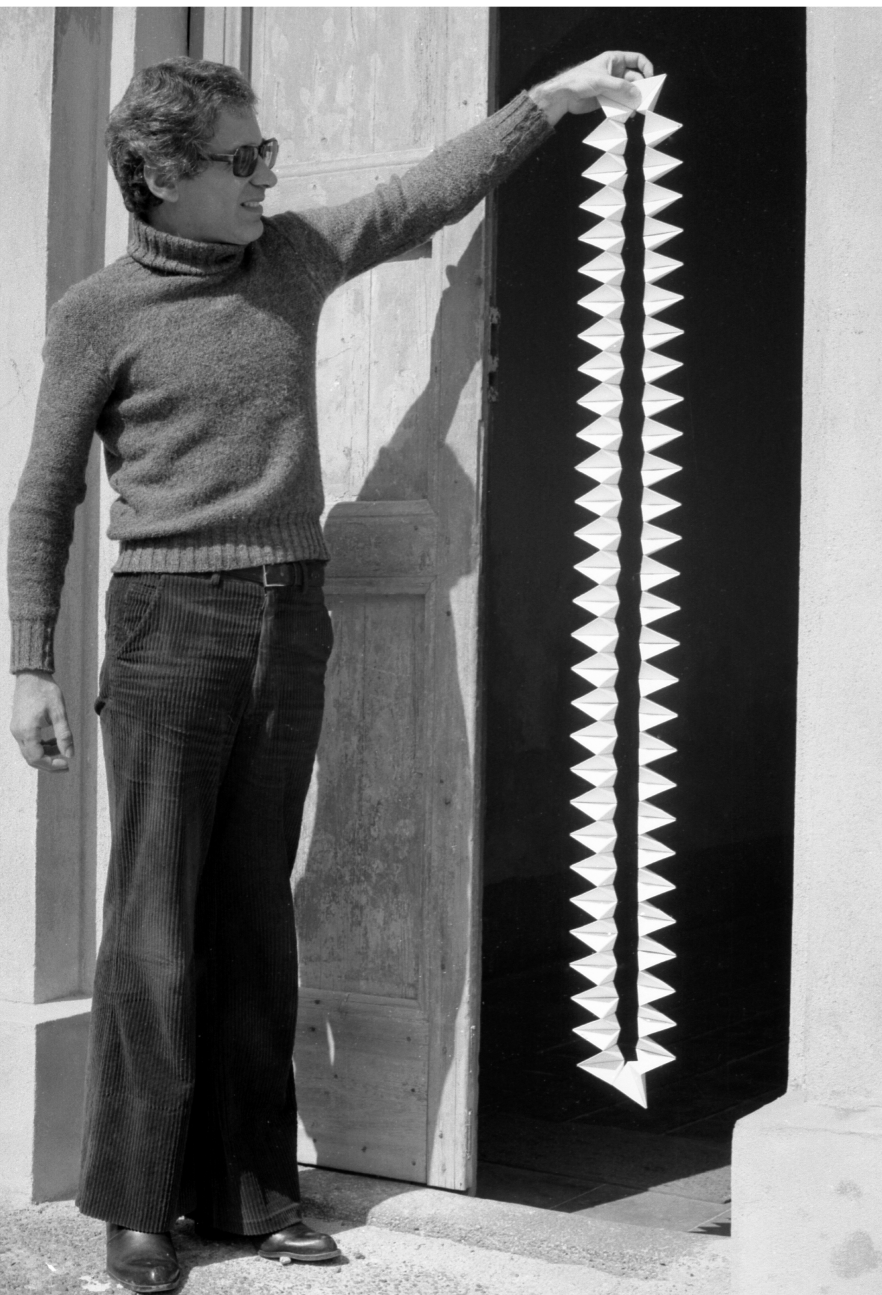
(Trogu & Nies, prototype, 2015)

**PROTOTYPE OF TRANSFORMABLE CHAIN BY GIORGIO SCARPA.
MODEL CONSTRUCTION BY PINO TROGU & CLIFF NIES**

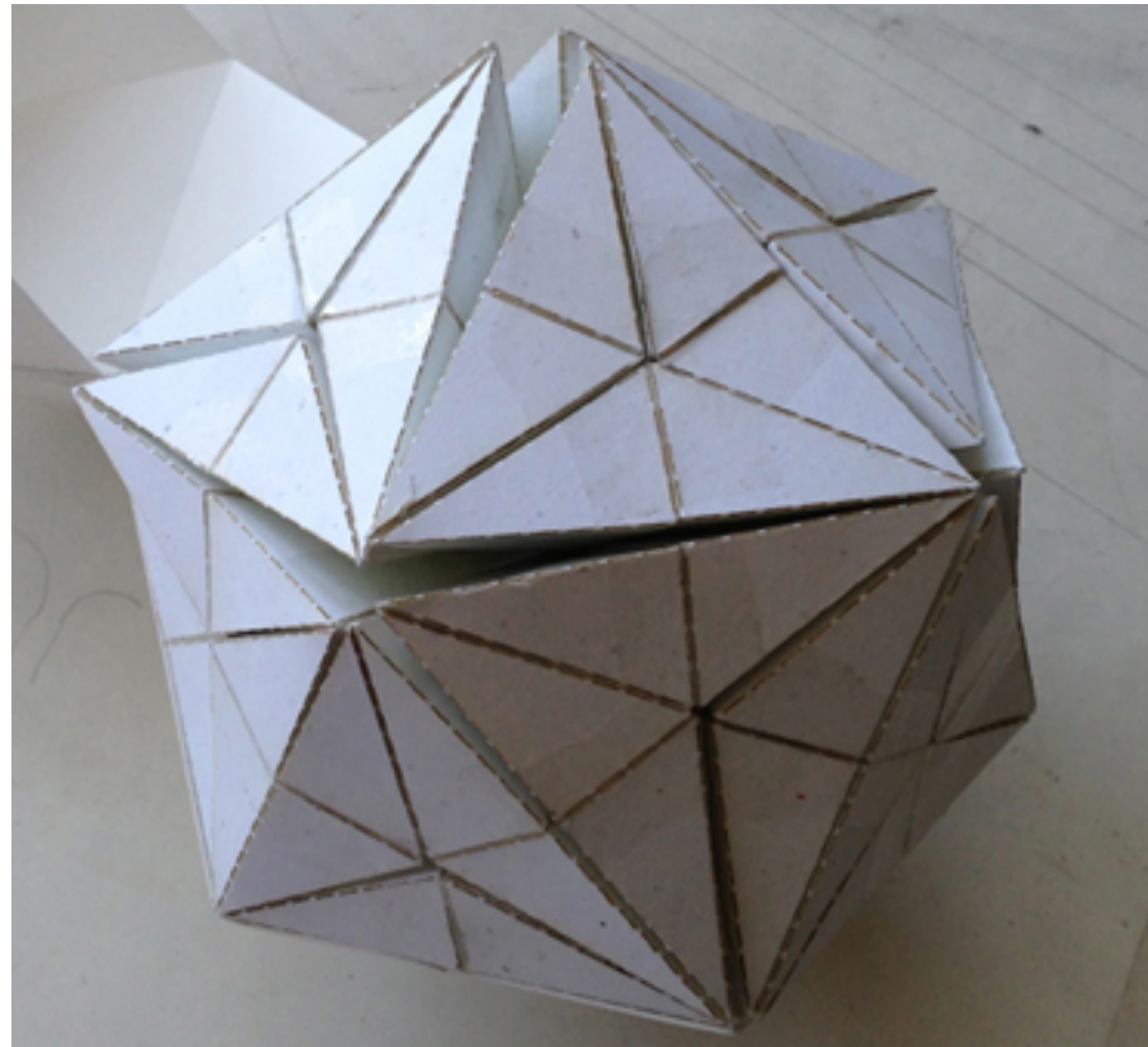
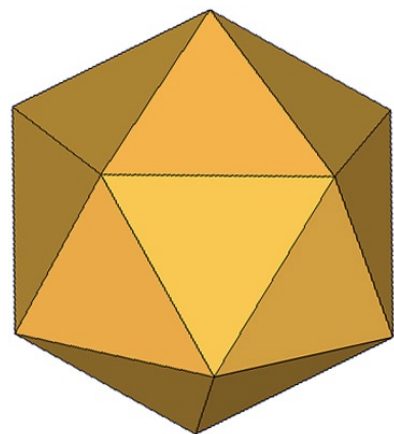


SCARPA

DODECAHEDRAL CHAIN, 1978



120 RIGHT-ANGLE PYRAMIDS

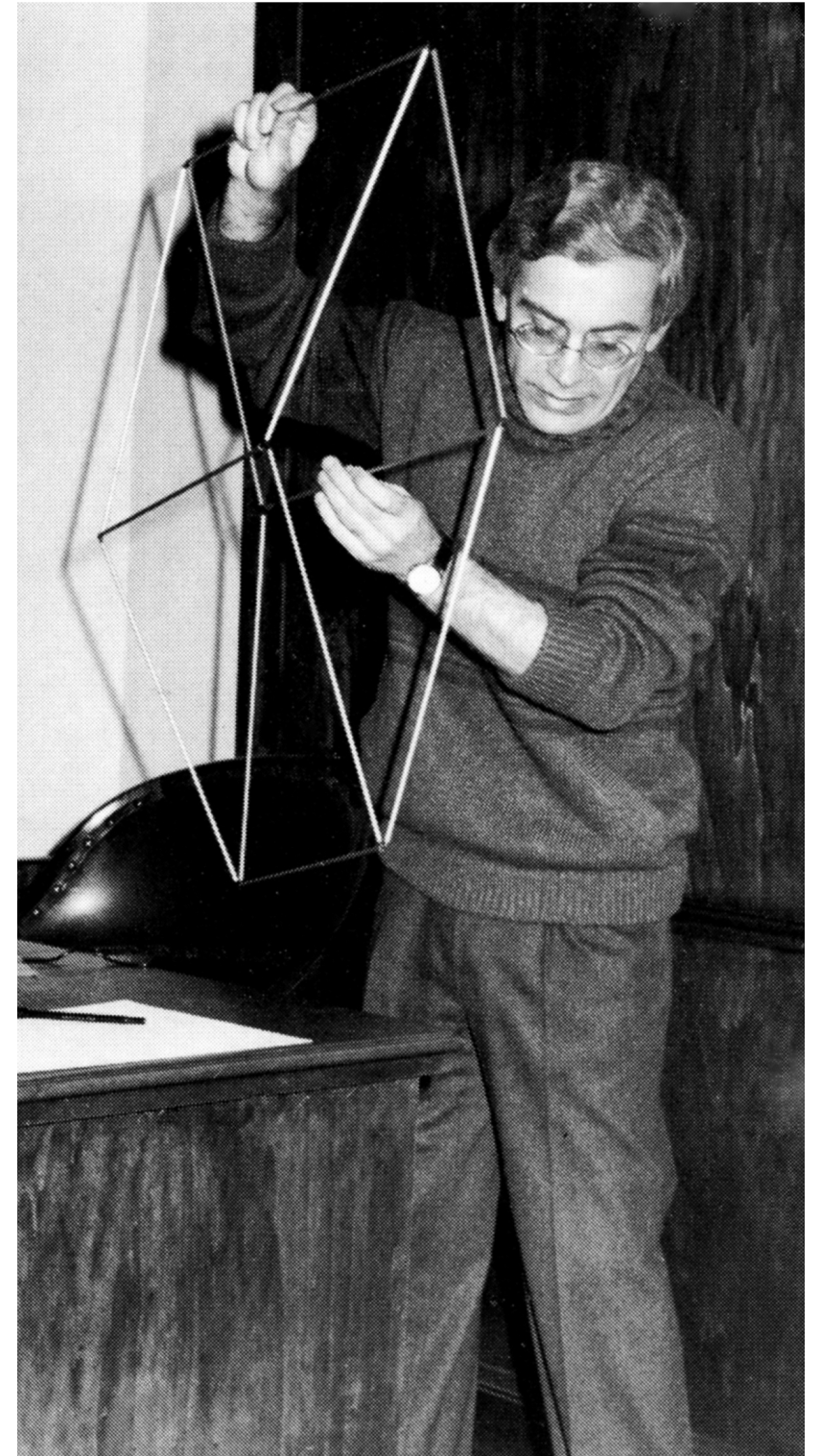
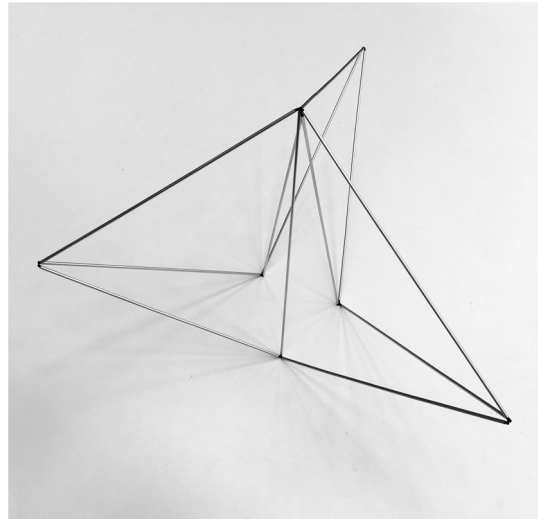
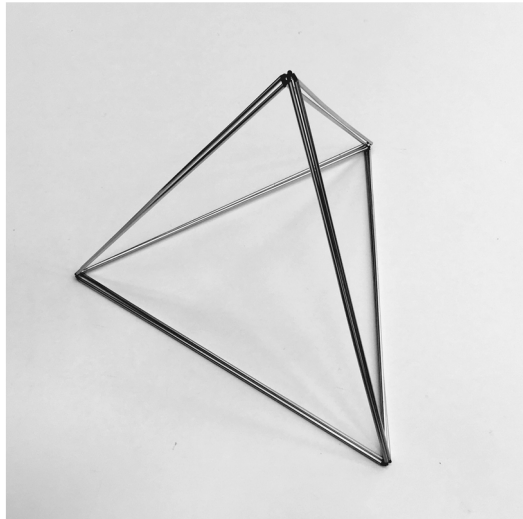
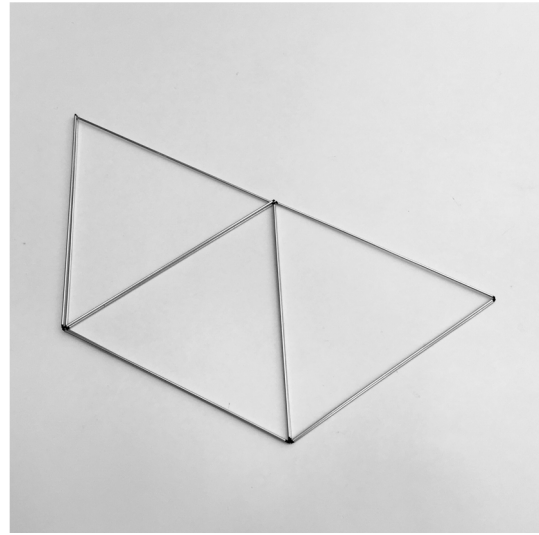
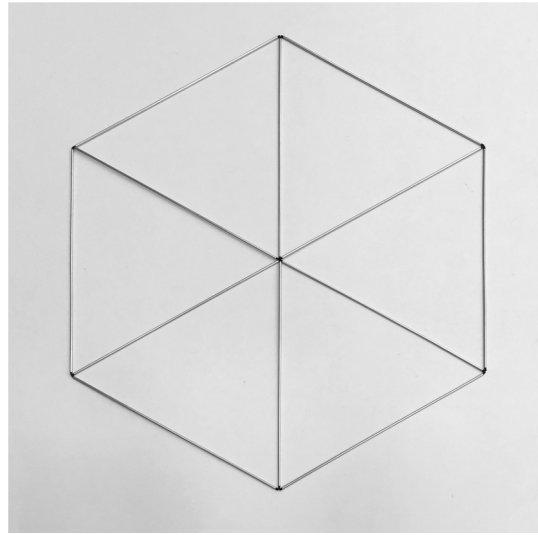
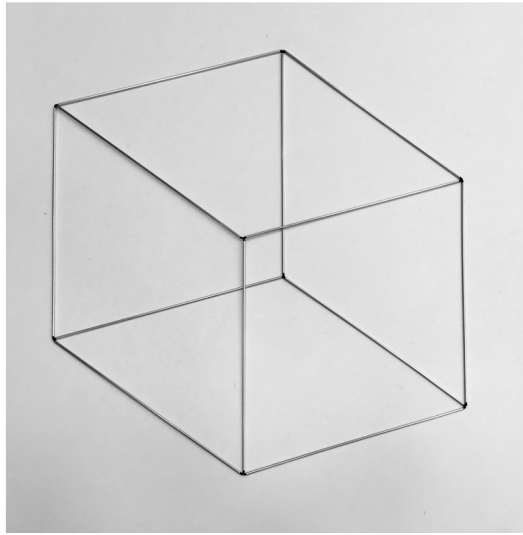


(Trogu & Nies, model based on Scarpa, 2015)

120 RIGHT-ANGLE PYRAMIDS

SCARPA

TRANSFORMABLE CUBE, 1965

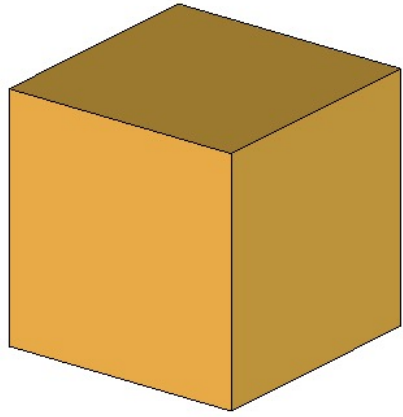


TWO

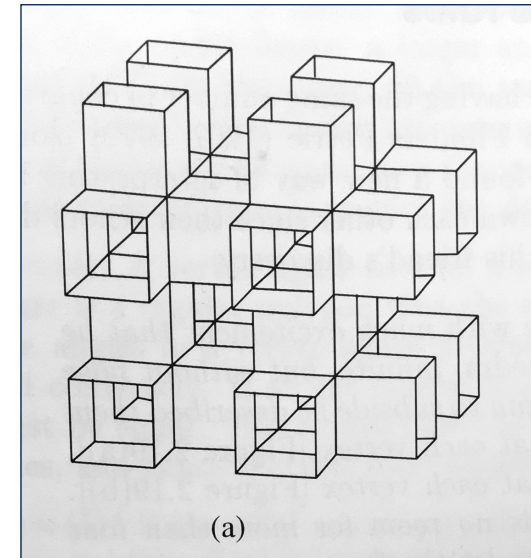
TRANSFORMABLE SHAPES:

“FIGURE TRASFORMABILI”

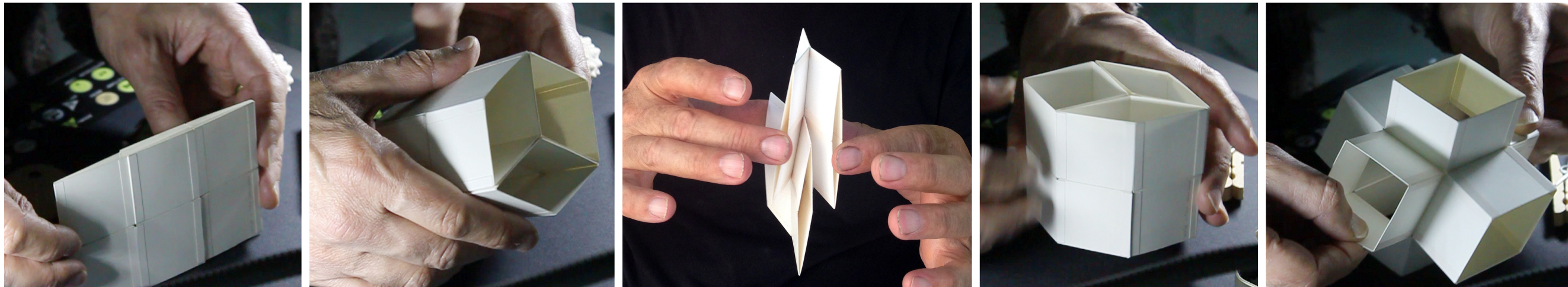
1996.



J. F. PETRIE REGULAR HONEYCOMB, 1926



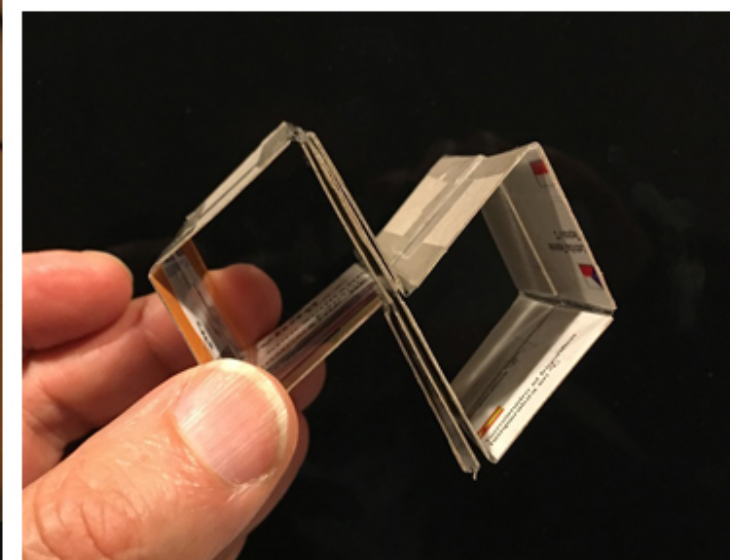
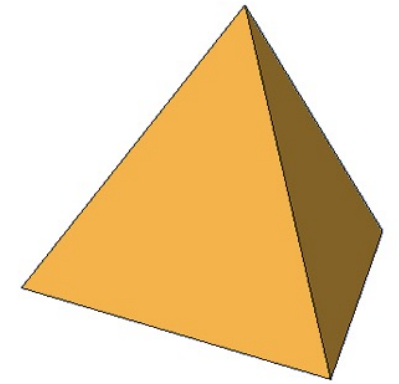
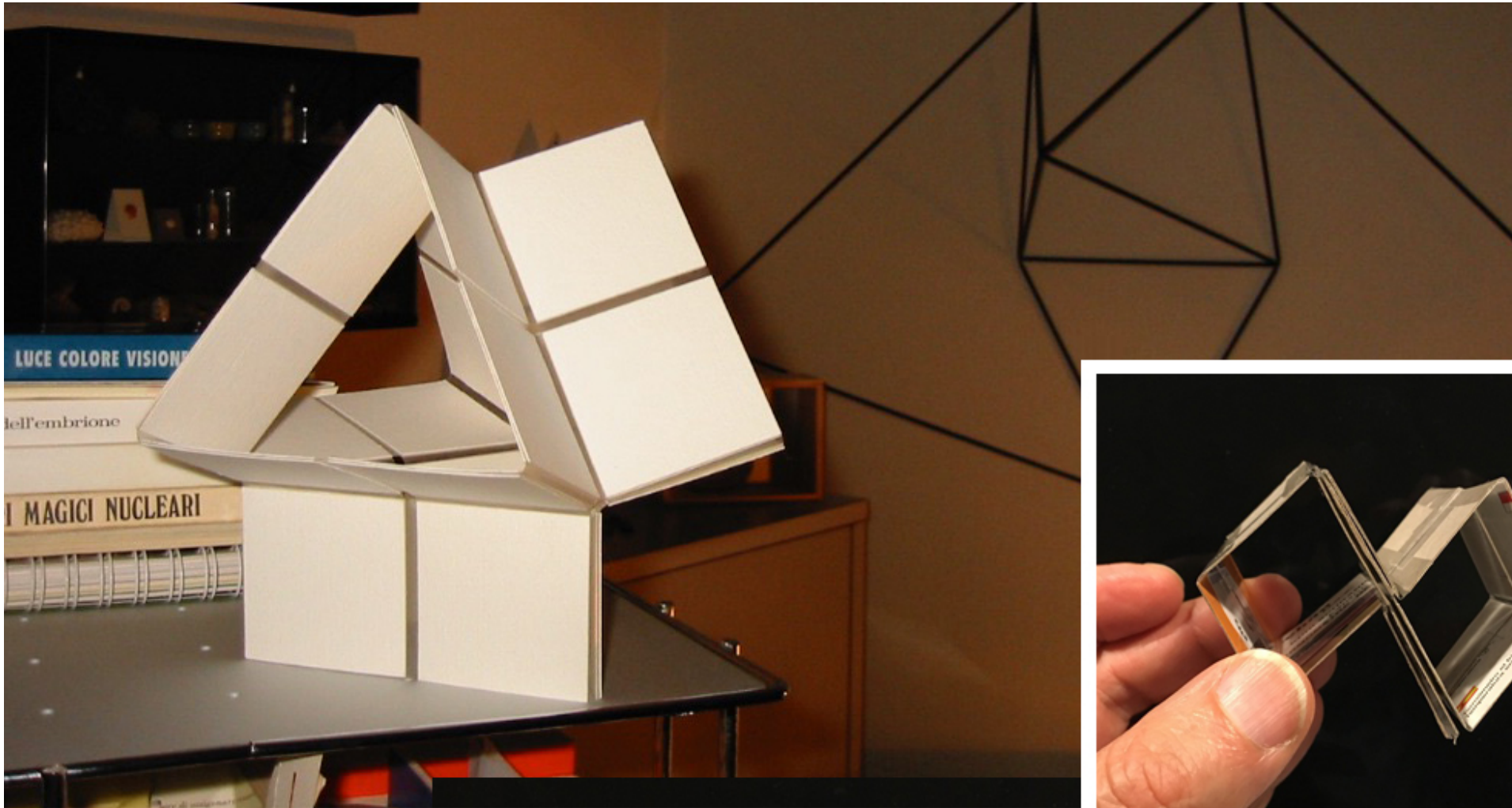
G. SCARPA, 1996



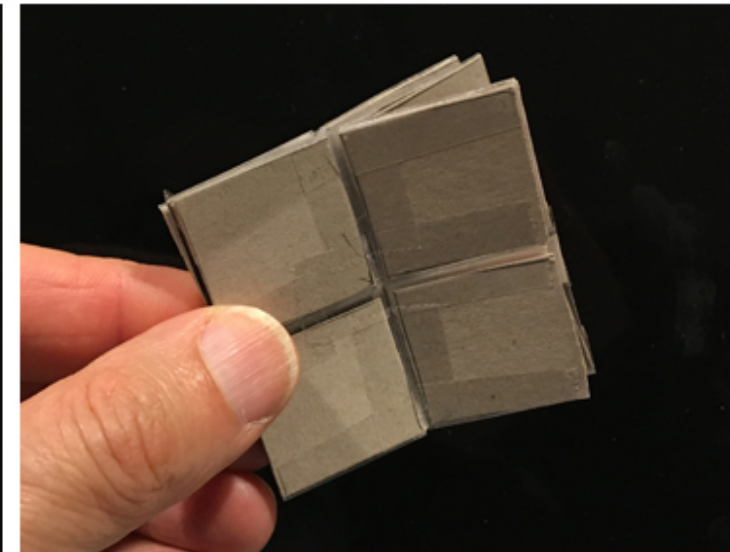
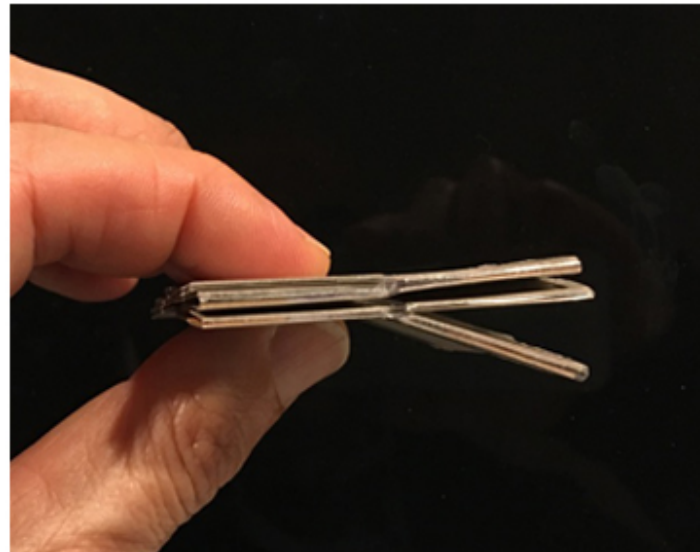
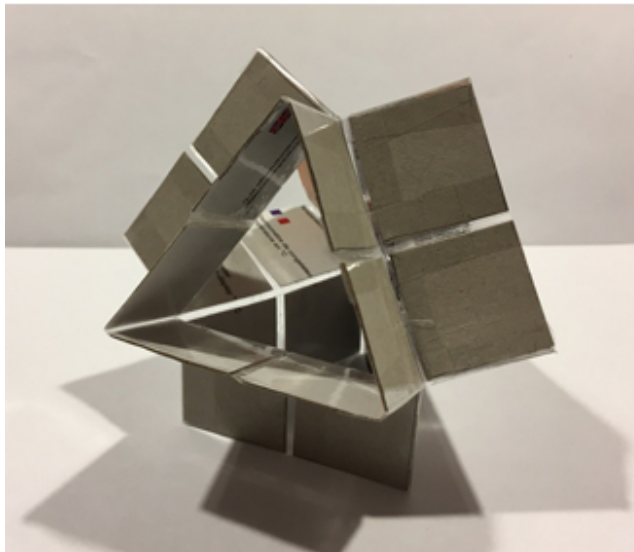
B. OVERVELDE, 2016



G. SCARPA – SPLIT EXTRUSION TETRAHEDRON – 1996



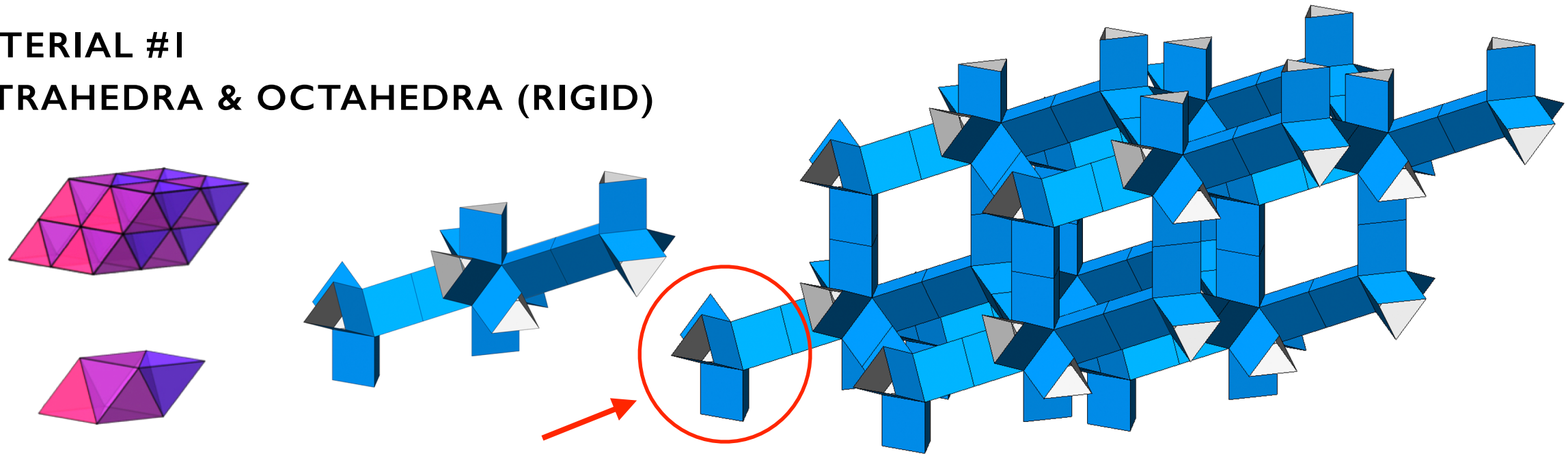
**(REPLICA)
PINO TROGU
2017**



METAMATERIALS:
RIGID,
NON-RIGIDLY FOLDABLE,
& RIGIDLY FOLDABLE.

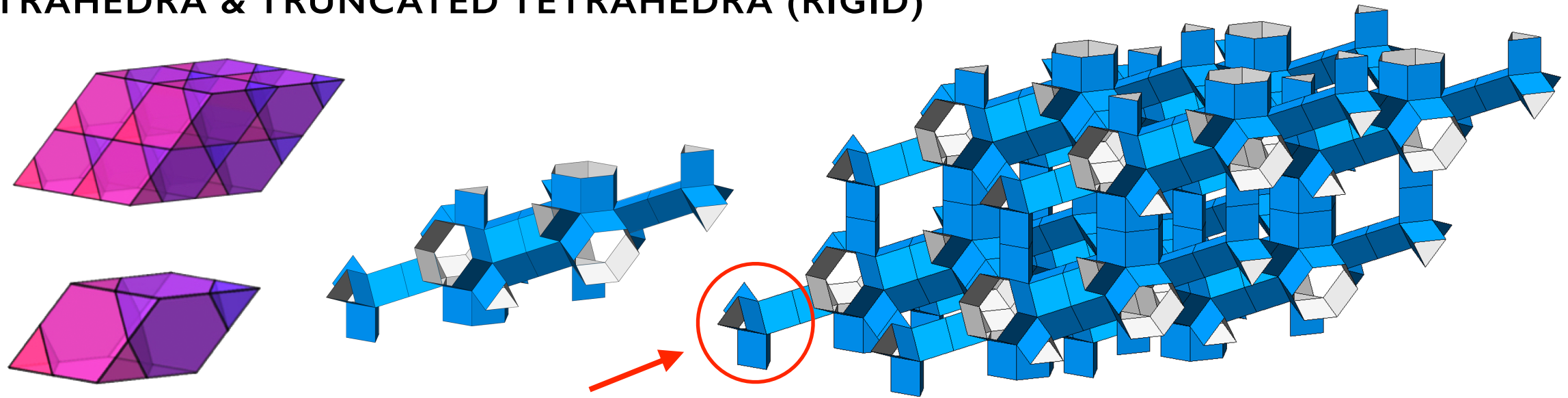
MATERIAL #1

TETRAHEDRA & OCTAHEDRA (RIGID)



MATERIAL #6

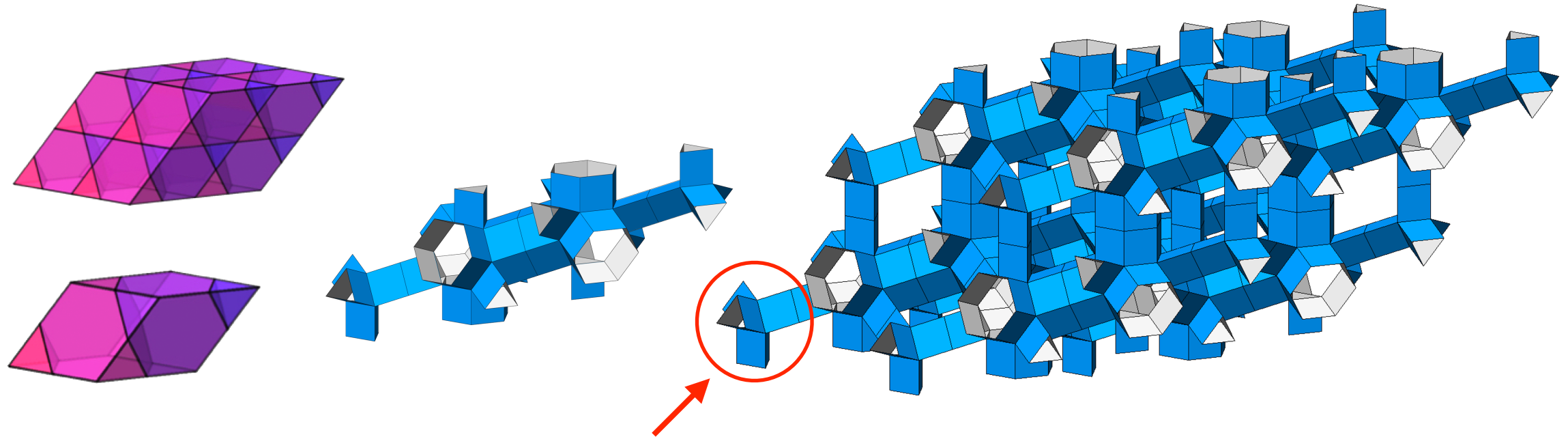
TETRAHEDRA & TRUNCATED TETRAHEDRA (RIGID)



OVERVELDE *ET AL*, 2017

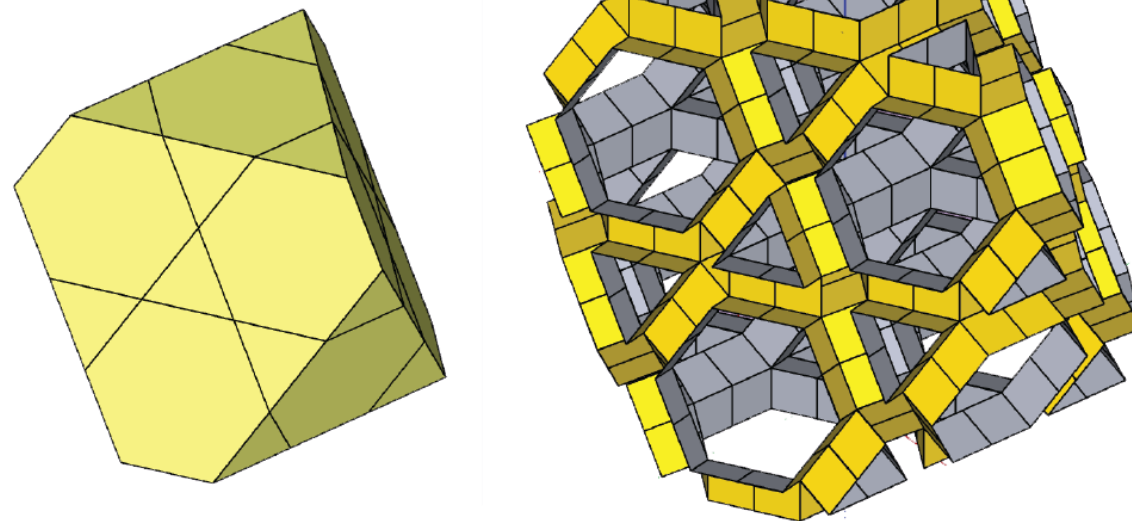
MATERIAL #6

TETRAHEDRA & TRUNCATED TETRAHEDRA (RIGID)

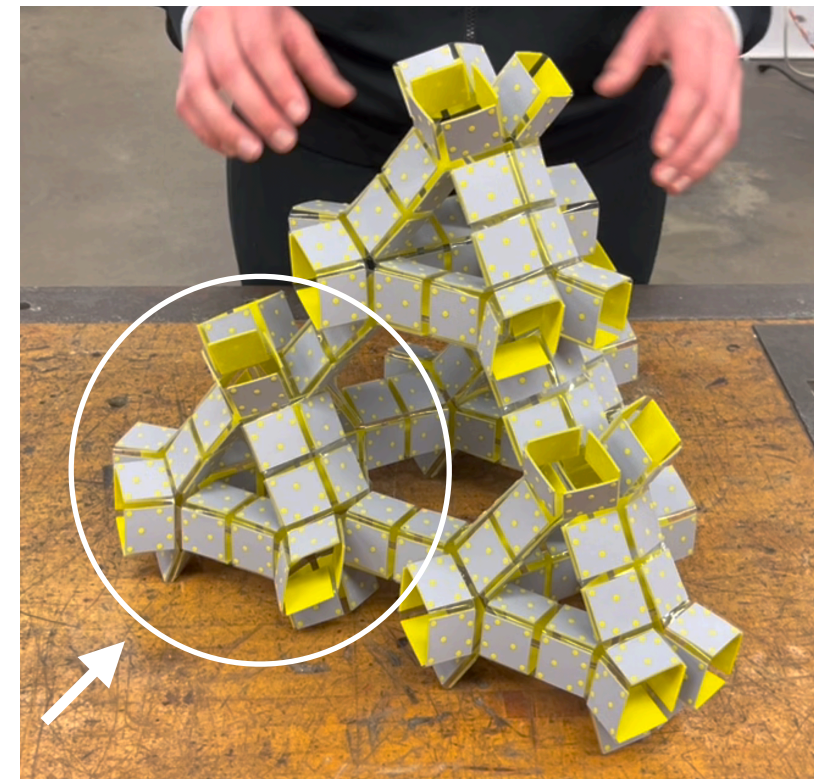


TROGU, 2023

MATERIAL #6 – FLAT-FOLDABLE

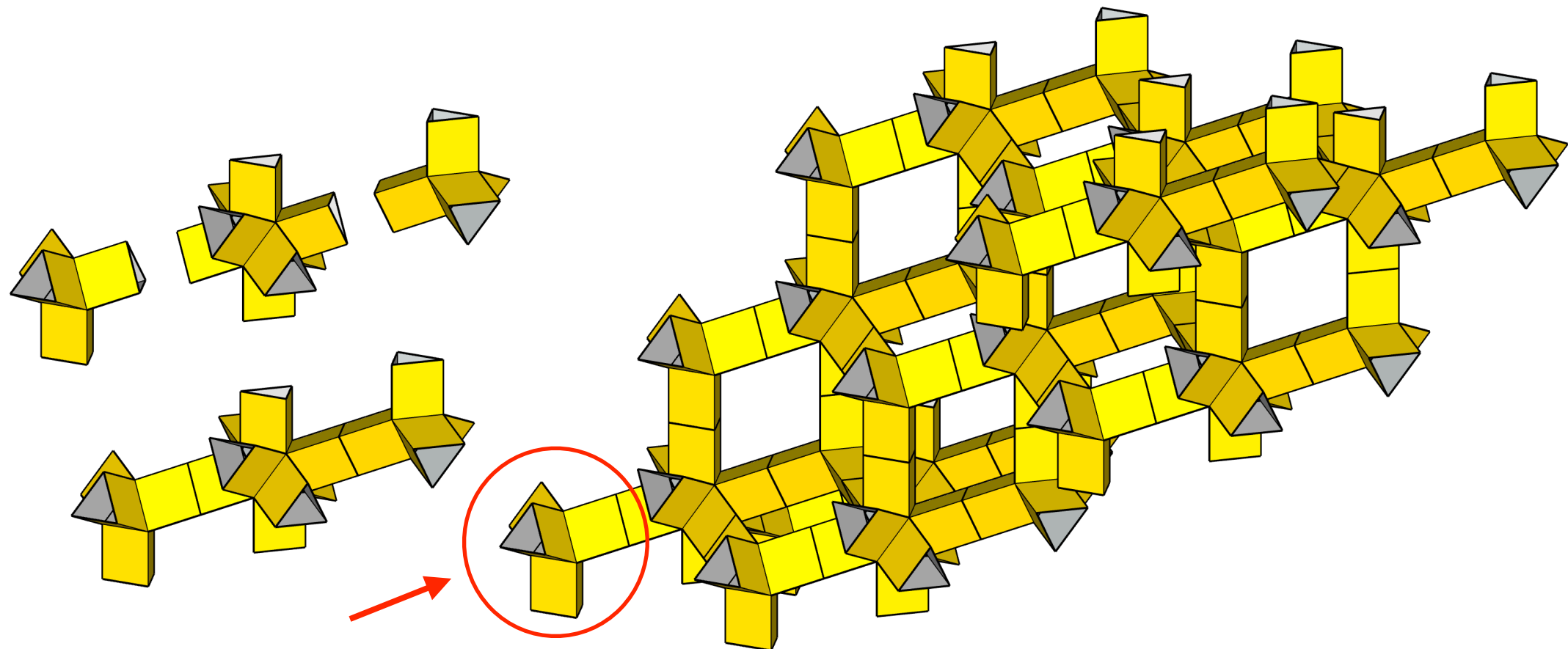
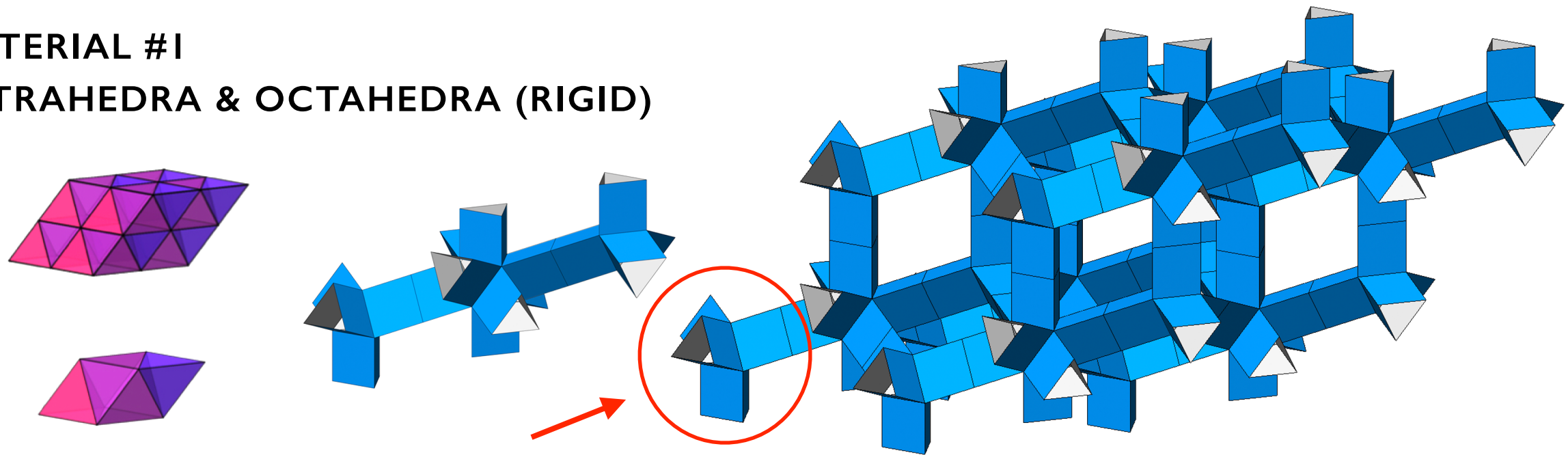


(Model fabrication: E. Montano, J. Minnick, D. Munechica, J. Cuellar, P.Trogu, 2023)



MATERIAL #1

TETRAHEDRA & OCTAHEDRA (RIGID)

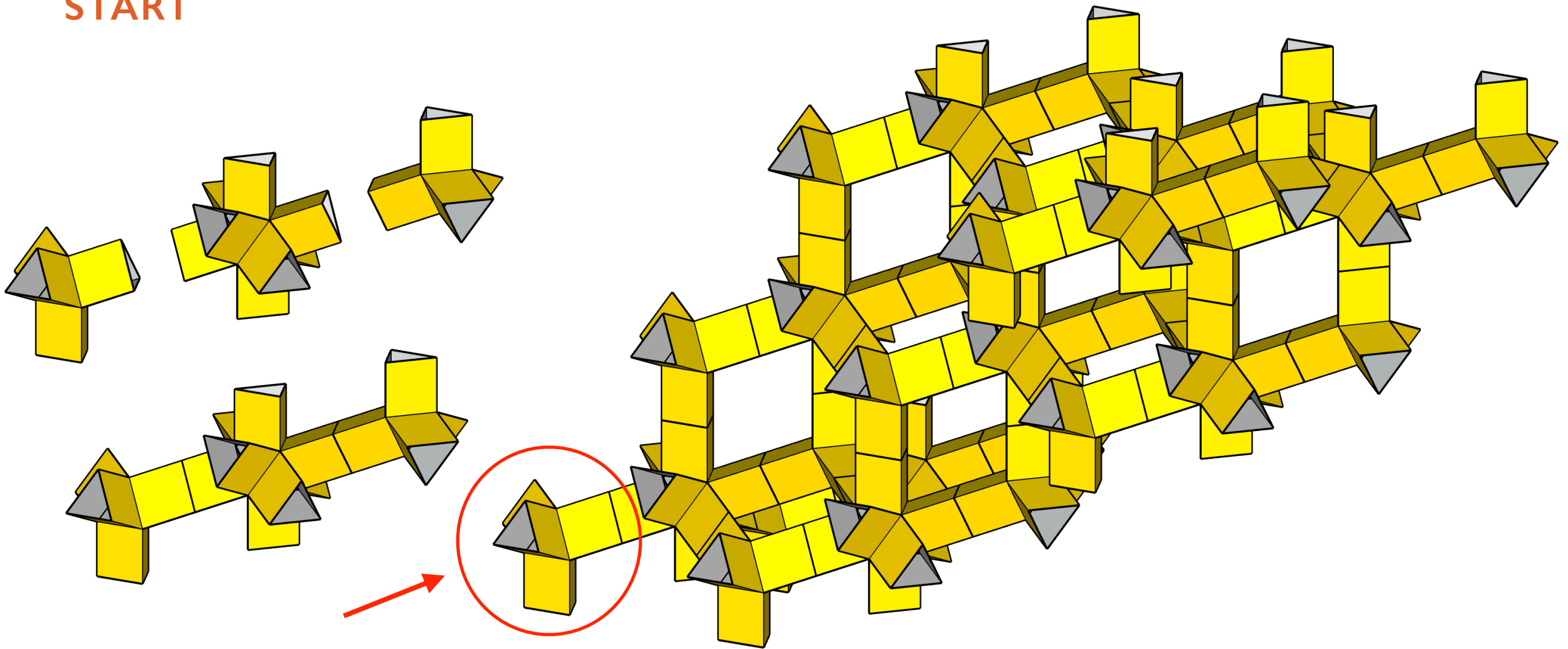


TROGU, 2023

MATERIAL #1

TETRAHEDRA & OCTAHEDRA (FLAT-FOLDABLE)

START

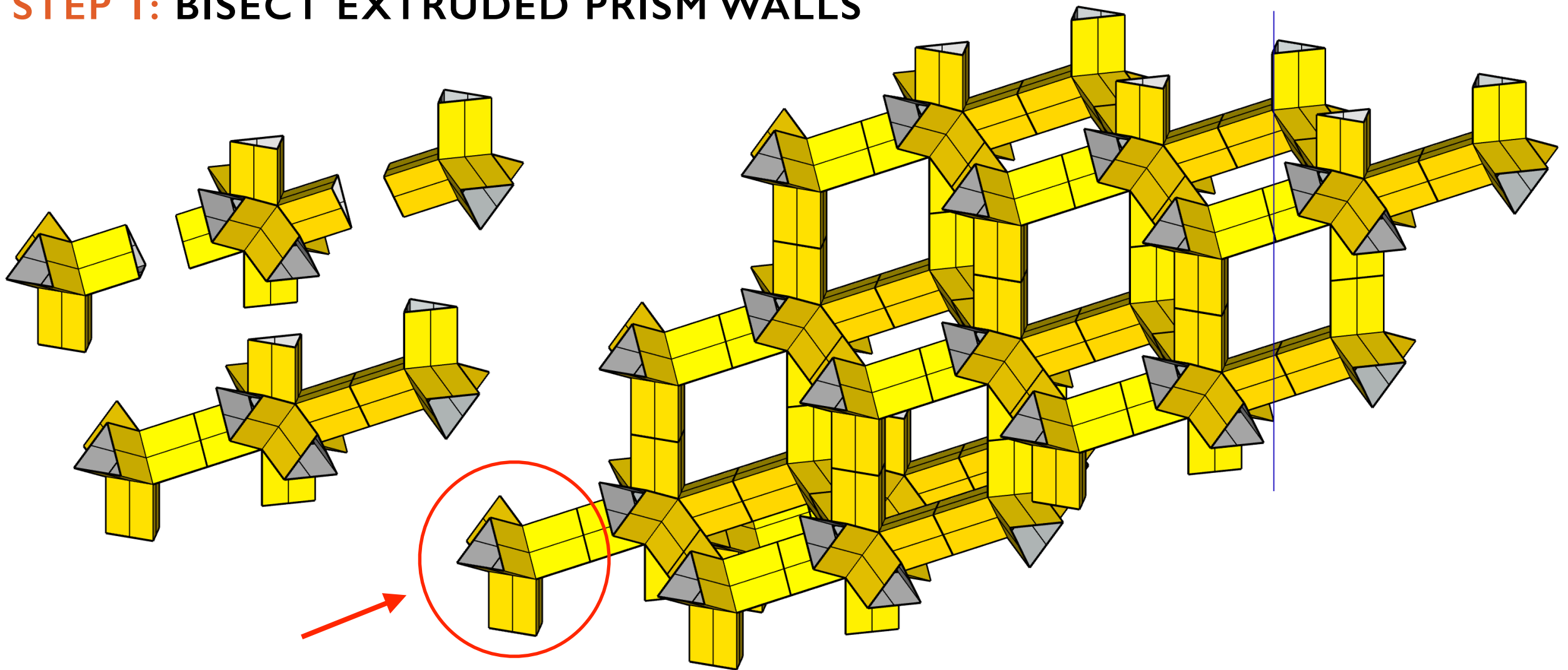


TROGU, 2023

MATERIAL #1

TETRAHEDRA & OCTAHEDRA (FLAT-FOLDABLE)

STEP 1: BISECT EXTRUDED PRISM WALLS

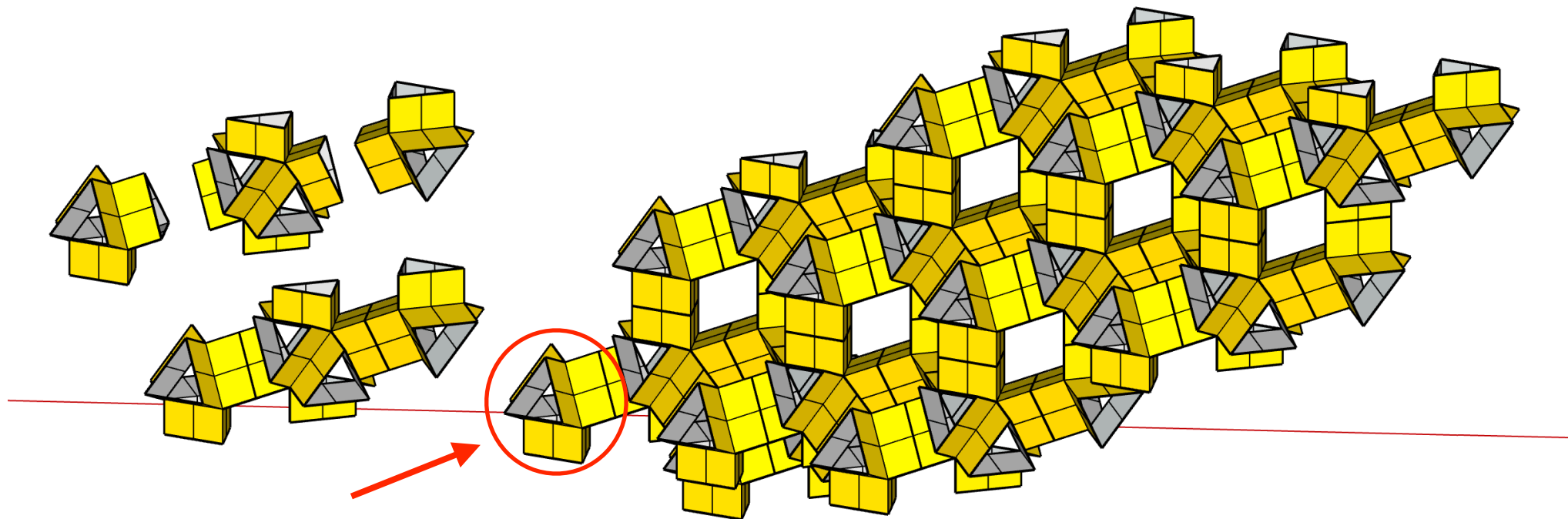


TROGU, 2023

MATERIAL #1

TETRAHEDRA & OCTAHEDRA (FLAT-FOLDABLE)

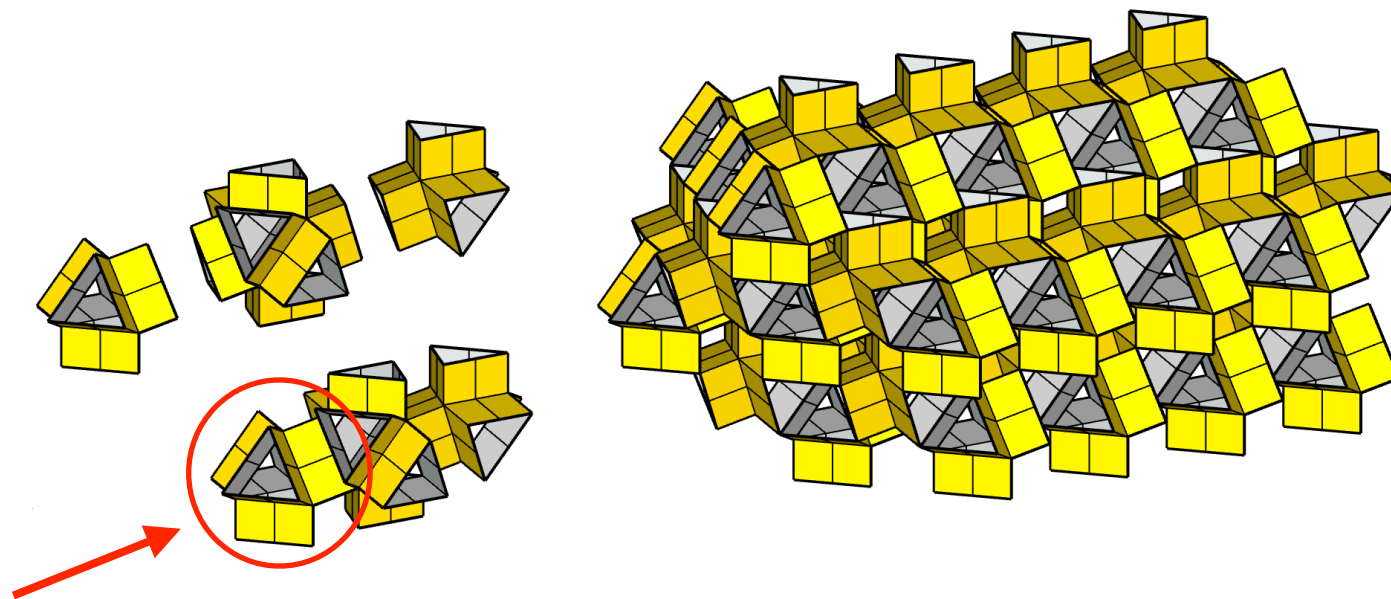
STEP 2: HALVE THE EXTRUSION LENGTH



MATERIAL #1

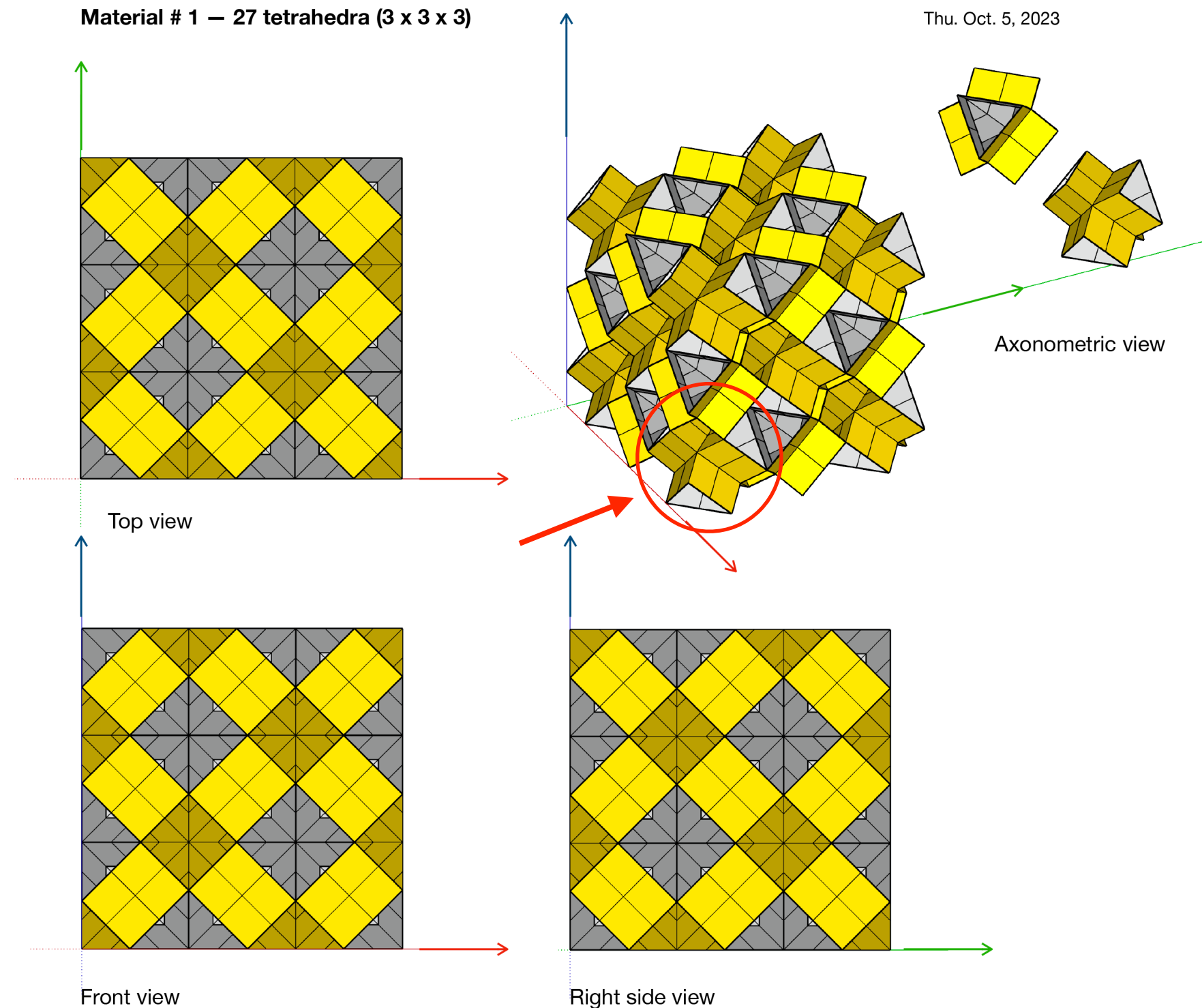
TETRAHEDRA & OCTAHEDRA (FLAT-FOLDABLE)

STEP 3: “PUSH-FIT” THE EXTRUDED PRISMS



MATERIAL #1 TETRAHEDRA & OCTAHEDRA (FLAT-FOLDABLE)

ORTHOGRAPHIC AND AXONOMETRIC VIEWS

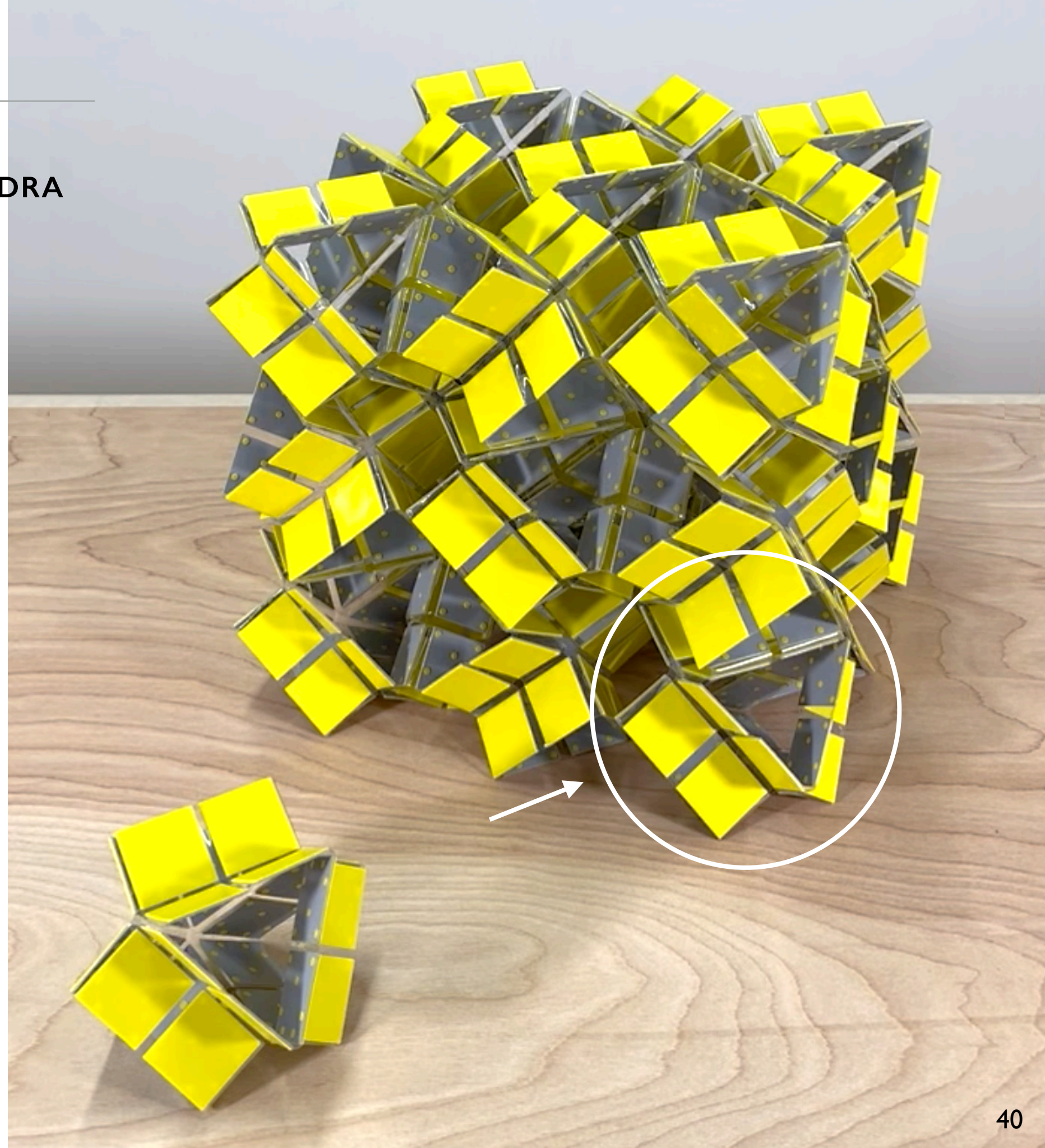


TROGU, 2023

MATERIAL #1
TETRAHEDRA & OCTAHEDRA
(FLAT-FOLDABLE)

PHYSICAL MODEL

(Model fabrication:
E. Montano, J. Minnick,
D. Munechica, J. Cuellar,
P.Trogu, 2023)

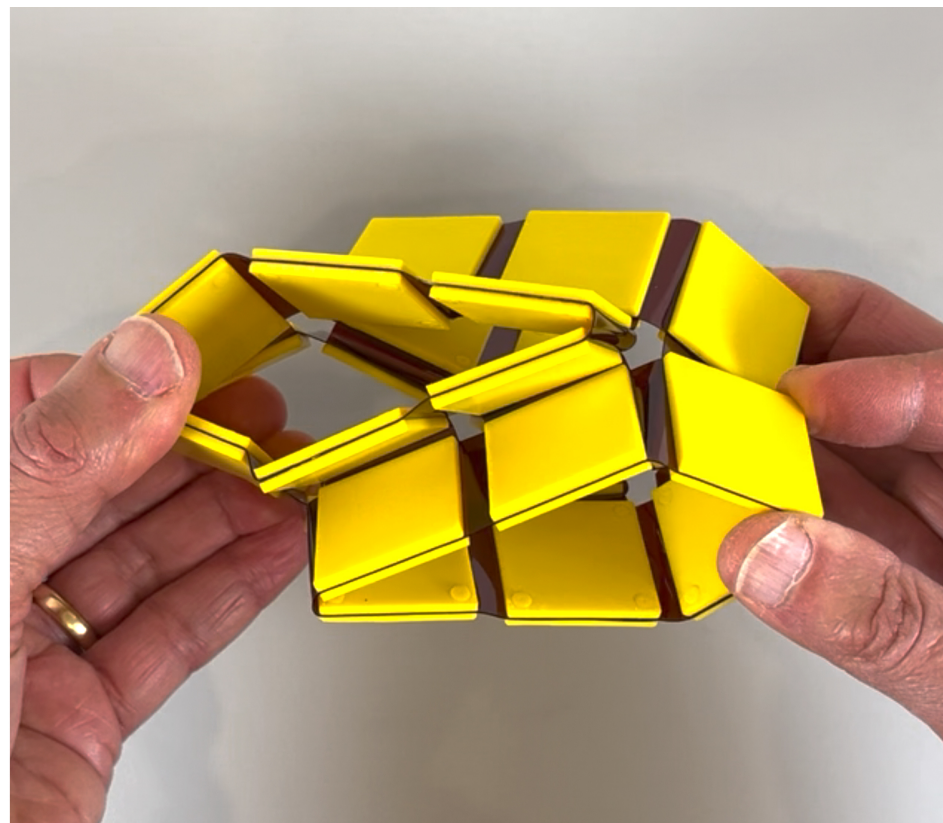


FENG, SHI, TROGU & DAI, 2024

MATERIAL #1

EXTRUDED BISECTED TETRAHEDRON

SCARPA'S ORIGINAL SHAPE: NON-RIGIDLY FOLDABLE



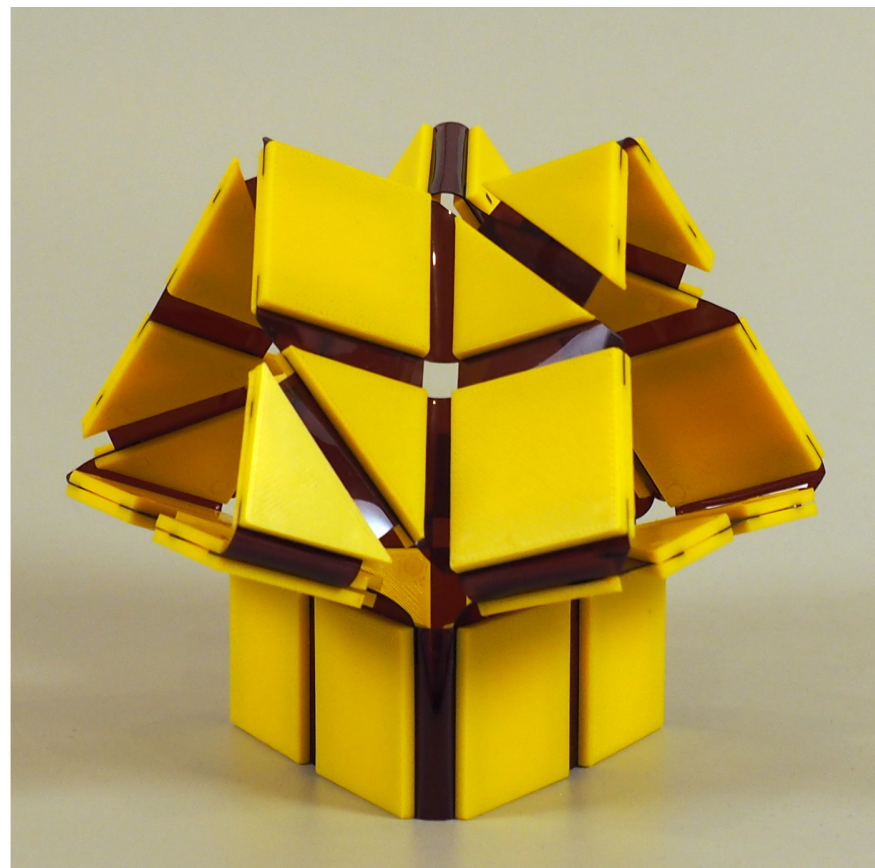
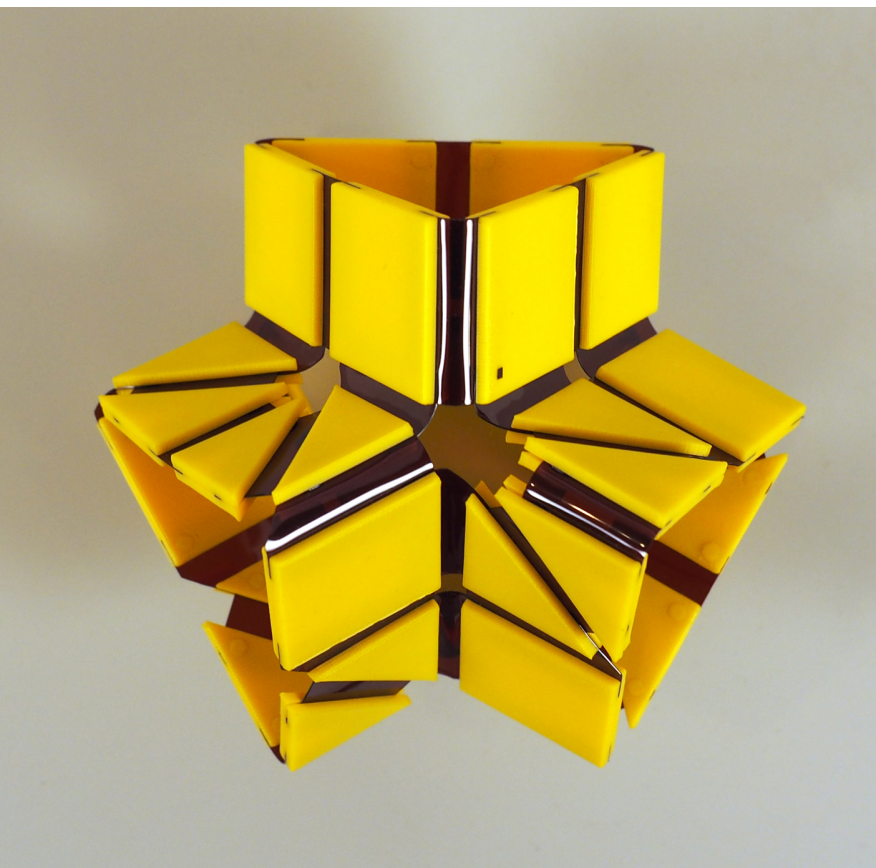
(Model fabrication: H. Feng, W. Shi, P.Trogu, E. Montano, J. Minnick, G. Montalvo, T. Casanova, 2023)

FENG, SHI, TROGU & DAI, 2024

MATERIAL #1

EXTRUDED BISECTED TETRAHEDRON

MODIFIED SHAPE: RIGIDLY FOLDABLE WITH ADDITIONAL CREASES



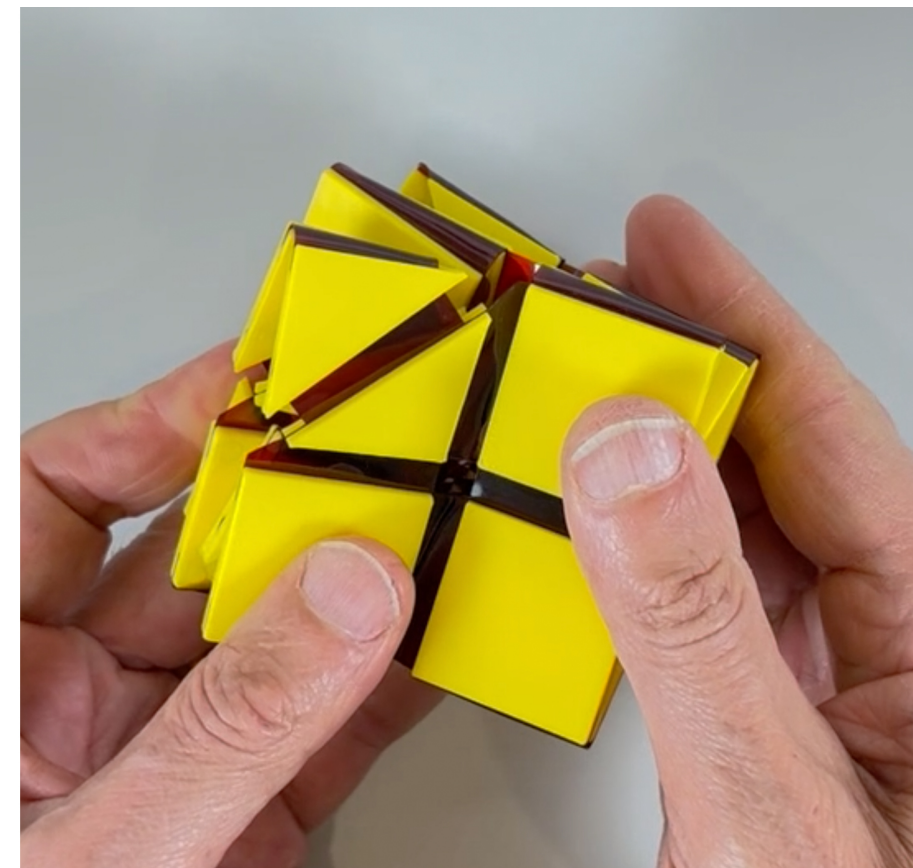
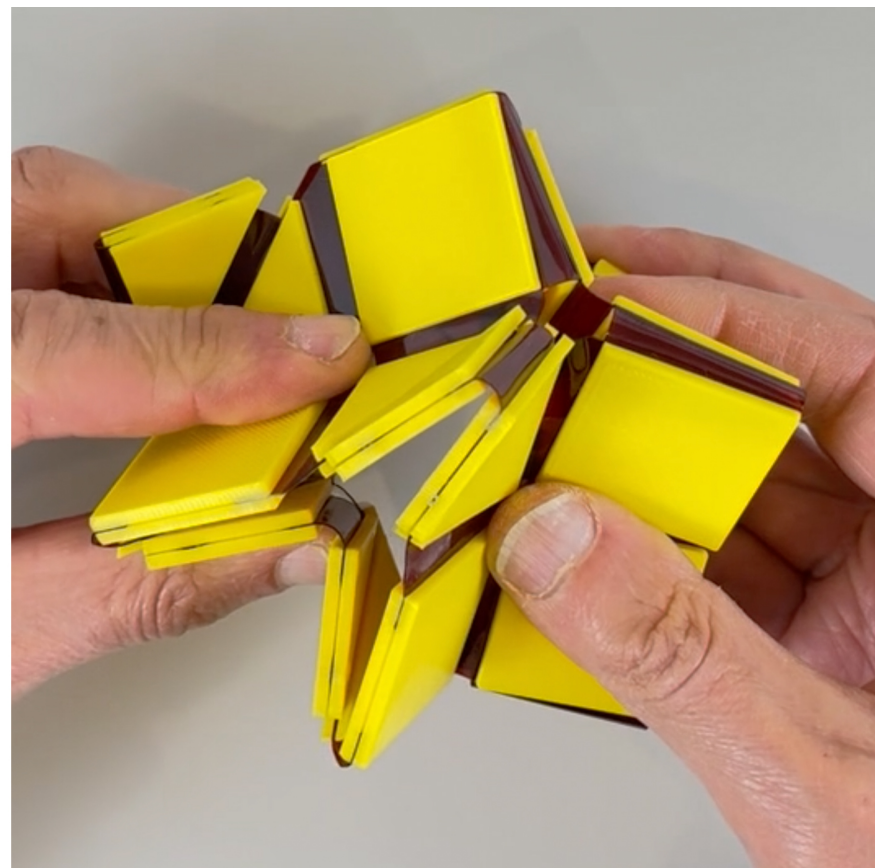
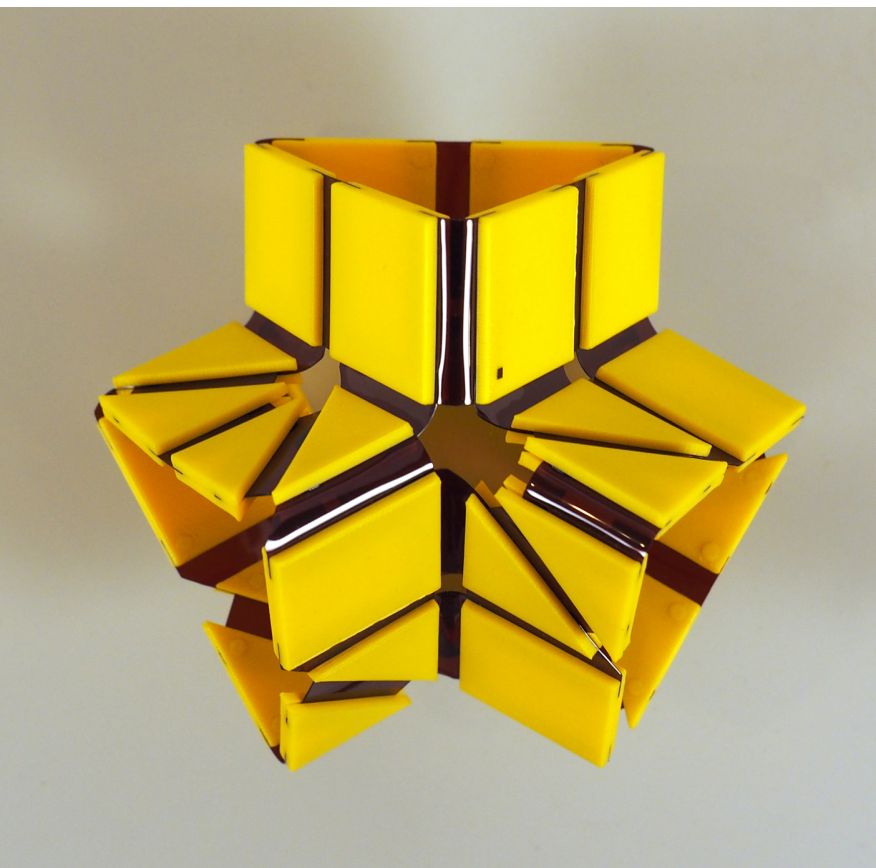
(Model fabrication: H. Feng, W. Shi, P.Trogu, E. Montano, J. Minnick, G. Montalvo, T. Casanova, 2023)

FENG, SHI, TROGU & DAI, 2024

MATERIAL #1

EXTRUDED BISECTED TETRAHEDRON

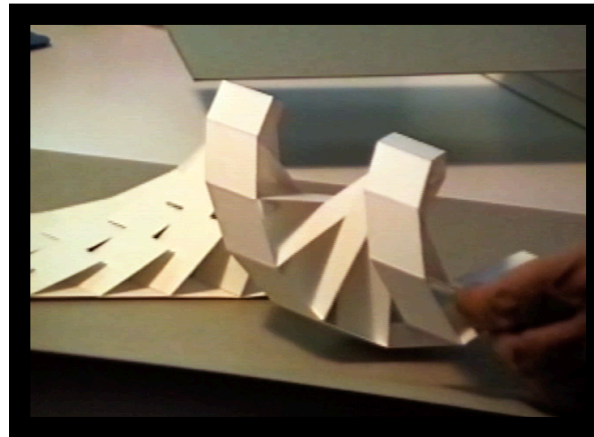
MODIFIED SHAPE: RIGIDLY FOLDABLE WITH ADDITIONAL CREASES



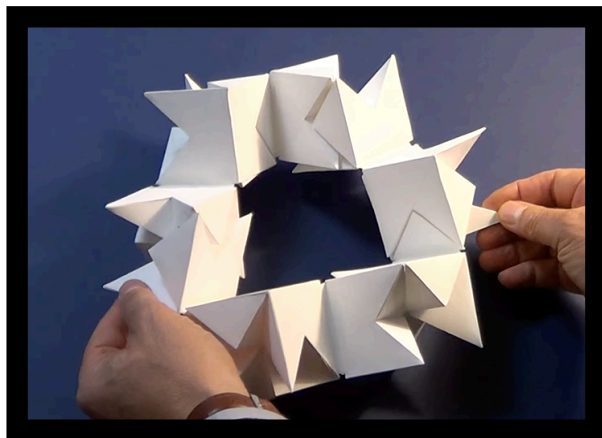
(Model fabrication: H. Feng, W. Shi, P.Trogu, E. Montano, J. Minnick, G. Montalvo, T. Casanova, 2023)



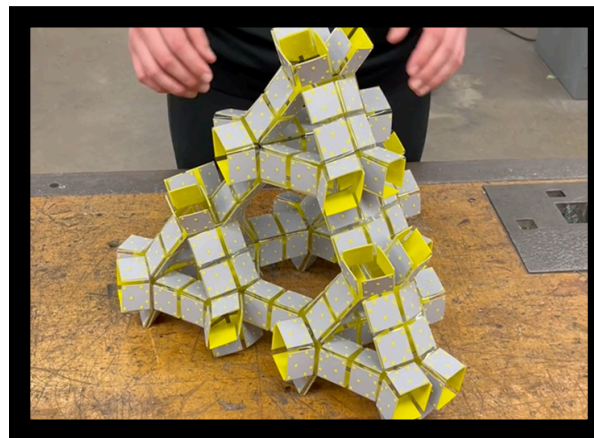
[Scarpa: Aristotle's Lantern](#)



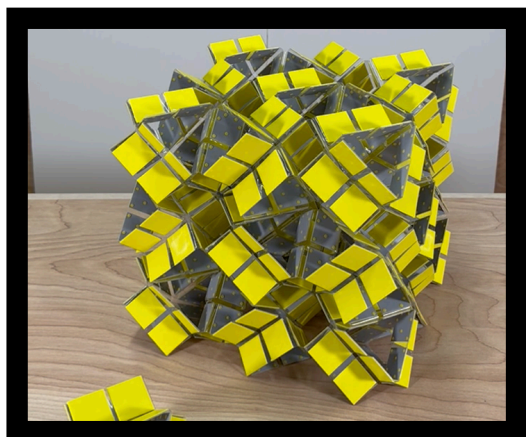
[Scarpa: DNA Model](#)



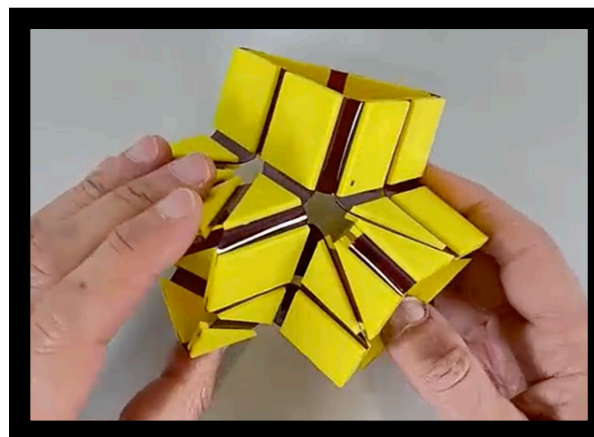
[Scarpa: Hexahedral Chain](#)



[Trogu: Material #6](#)



[Trogu: Material #1](#)

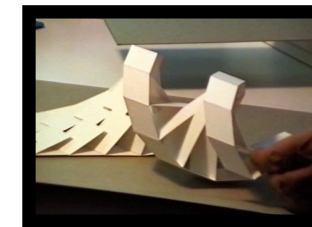


[Feng, Shi, Trogu, & Dai: Auxetic Metamaterial](#)

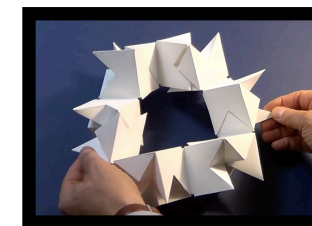
VIDEOS (online/local)



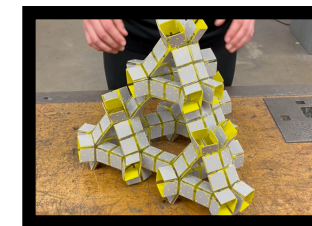
[Scarpa: Aristotle's Lantern](#)



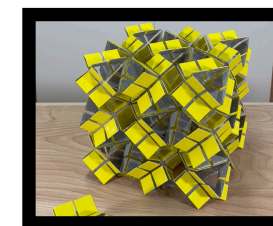
[Scarpa: DNA Model](#)



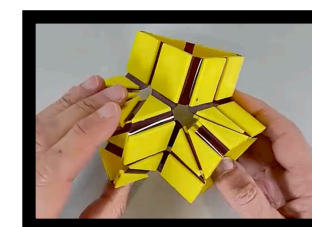
[Scarpa: Hexahedral Chain](#)



[Trogu: Material #6](#)



[Trogu: Material #1](#)



[Feng, Shi, Trogu, & Dai: Auxetic Metamaterial](#)

Giorgio Scarpa

Italian designer, bionics and topology researcher, teacher, and artist.

Profile and videos by **Pino Trogu**, San Francisco State University [trogu at sfsu dot edu]

The short videos below refer to the topics of Scarpa's two books. The first is a bionic study of the mouth apparatus of the sea urchin, also known as Aristotle's Lantern, after the first detailed study of it by the Greek philosopher. Recently new prototypes of a biopsy harvester and a ground sampler were inspired by Scarpa's model of the urchin. This new instrumentation is described in an article published in 2016 by the journal Leonardo (MIT). Click links below to download those articles. The PDFs of the bionics books are at right. The English is an unpublished draft translation; the Italian is the original text and images.

The second video shows one of the many modular chains described in the rotational geometry book, which focuses on rotational movement as a basic form generating process. Scarpa dissects the five Platonic solids and other solids into chains of hinged triangular pyramids that fold back into their enclosure cells. The PDFs of the geometry books are at right. The English is an unpublished draft translation; the Italian is the original text and images.

Both bionics and geometry books were published as part of a now out-of-print series called Design Notebooks, edited by the late Italian designer Bruno Munari. The covers of the books in that series are shown below. The other videos show more topological and bionic studies by Scarpa, including DNA models and studies of muscle cells.

This page was last updated on Sunday Feb. 6, 2022.

On July 29, 2021, the website was moved from <http://online.sfsu.edu/trogu/scarpa/> to <https://res.trogu.com/scarpa/>



Bionic Model of Aristotle's Lantern
Video length: 1:12 | Video: Pino Trogu, 1994.

Interviews

Leonardo Book Club: Live discussion with Pino Trogu, author, "Giorgio Scarpa's Model of a Sea Urchin Inspires New Instrumentation"
Length: 58:30 | April 24, 2019.

Articles

Pino Trogu
Giorgio Scarpa's Model of a Sea Urchin Inspires New Instrumentation,
Leonardo Journal, 52.2, 2019.
Free article download from MIT Press website:
[doi:10.1162/LEON_a_01384](https://doi.org/10.1162/LEON_a_01384).



Download PDF of complete Bionic Models book.
Unpublished English translation of Italian Edition: Modelli di Bionica, 1985.
Translated by Pino Trogu. 120 pages. File size: 38MB.



Scarica PDF completo del libro Modelli di Bionica Zanichelli, Bologna, 1985. 120 pagine. File size: 50MB.

LINKS

res.trogu.com/scarpa

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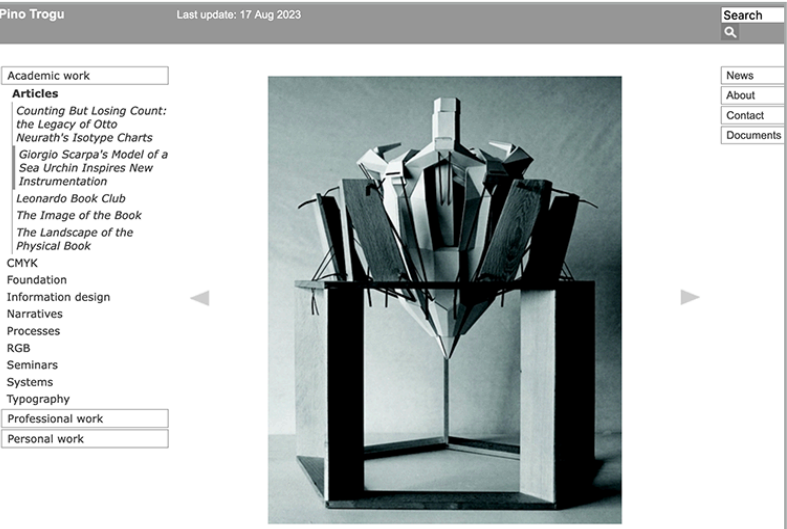
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Giorgio Scarpa

Giorgio Scarpa (Brisghella 1938, Castel Bolognese 2012) frequenta l'Istituto d'Arte di Faenza pensando di diventare pittore e ceramista, ma nel 1962 ottiene la cattedra di Disegno Architettonico e Geometria Descrittiva all'Istituto d'Arte di Oristano sorto in quell'anno. Accetta e la sua vita prenderà una direzione di studi che lo accompagnerà per sempre. Negli anni '60 farà parte del Gruppo V di Rimini, diretto da Pino Parini, che collabora con il Centro di Cibernetica di Milano diretto da Silvio Ceccato. In seguito a questa fondamentale esperienza, comincia a studiare le figure topologiche e realizza le prime figure trasformabili. Nel '71 Bruno Munari vede una sua opera alla Galleria Sincron di Brescia e decide di scrivergli; nasce così una amicizia duratura che vedrà molti dei modelli progettati da Scarpa nei testi pubblicati da Munari. In seguito, ispirato da alcuni disegni di Paul Klee, inizierà lo studio sulla sezione del cubo creando catene esodriche trasformabili. Si applicherà allo studio della bionica realizzando un modello inerente il riccio di mare che ispirerà, tra l'altro, uno strumento medico. Da queste esperienze



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THANK YOU!

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