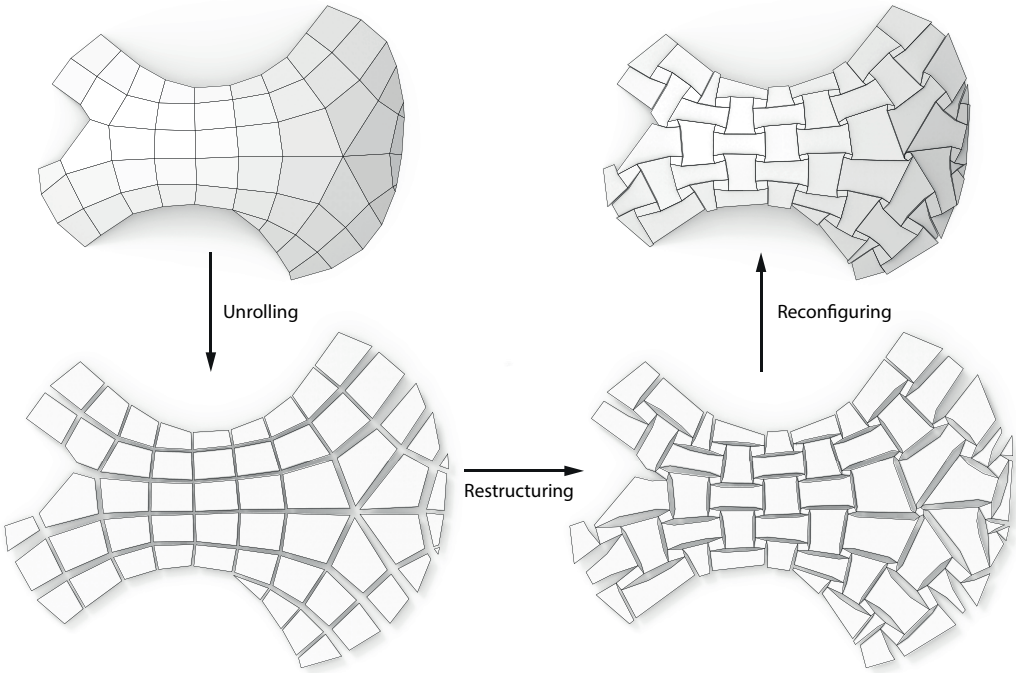
Integrating Robotic Assembly Strategies with Design-to-Robotic-Production

Keywords: Digital Fabrication, Reconfigurable Mechanism, Shell Structure, Free-Form Construction, Programmable Material

Architectural Engineering + Technology / Architectural Engineering / Robotic Building

Area of Research: Computation & Performance, Digital Fabrication



Research Summary: Advances in architectural geometry make complex free-form architecture explicitly definable and economically manufacturable. To further enhance the efficiency of fabrication, this research investigates how to form a free-form surface from a flat programmed auxetic bi-stable mechanism. The mechanism consists of numerous blocks connected by hinges. The hinges are designed and positioned to allow blocks to rotate around each other, and hence be reconfigurable from a flat configuration to the desired double curved surface. During the bi-stable mechanism is reconfigured from the first stable state to another, the blocks are temporarily deformed. After the elasticity brings the blocks back to the original dimensions, the mechanism reaches its second stable state. The geometrical challenge lays in the process to identify the specific set of the hinges which satisfy the condition and bridge the desired two stable states. This ongoing research is going to develop the algorithm to translate an arbitrary surface to its flat configuration and investigating the applicability in architectural scale.

Research Methodology: This research employed methods in discrete differential geometry to identify the existence of the bi-stable flat-to-curved reconfigurable mechanism. The ongoing research will integrate numerical solvers to apply the methods to free-form designs and carry out physical experiments to validate numerical predictions.

Key Publications:

Chiang, Y.-C. (2018). *Programming Flat Materials to be Synclastic Surfaces*. Manuscript submitted for publication.

Chiang, Y.-C., Mostafavi, S., & Bier, H. (2018). Assembly of Shells with Bi-Stable Mechanism. In *Advances in Architectural Geometry 2018*. Gothenburg.

Chiang, Y.-C., Bier, H., & Mostafavi, S. (in press). Design to Robotic Assembly: An Exploration in Stacking. *Frontiers in Digital Humanities, 5(23).*

Yu-Chou Chiang

PhD started in: 2017

Master of Science in Hydraulic Engineering 2012

Bachelor of Science in Civil Engineering 2010

Promoter:
Prof.ir. Peter G. Luscuere

Co-Promoter:
Dr.ir. Henriette H. Bier

Daily Supervisor:
Sina Mostafavi

Email:
Y.Chiang@tudelft.nl
Chiang.YuChou@gmail.com

Phone:
+31- 658922369

Main Question:
How can robotic assembly and reconfigurable assembly be integrated into Design-to-Robotic-Production processes? What is the benefit of the integrated approach?

Deliverables:
Methods and tools to generate the tessellation of a shell for shape reconfiguration.
Expressive exemplar in the form of workshops involving designers and users co-designing a structure then co-assembling structure with robots.

Link:
http://www.roboticbuilding.eu
https://ChiangYC.wordpress.com

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