MAKING THAT MATTERS: A COMPUTATIONALLY KNITTED WOODEN TECTONIC

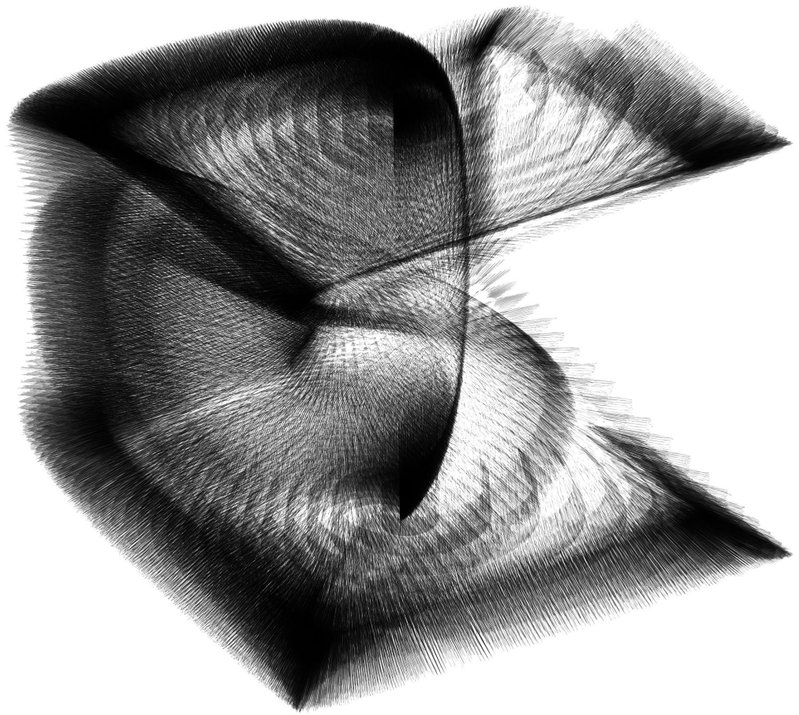
This research project seeks to leverage a local traditional craft with a local natural material through the use of advanced computational methods. The future of building is not derivative of or subservient to the advancement of technology, but is embedded within a larger knowledge-based rooted in cultures of making. The 2022 TAB Installation Competition is not located in a marshmallow desert (or cloud) within a siteless software environment. The site for the installation is Tallinn, Estonia—a place filled with a rich history, heritage and culture of making. Instead of naively applying our own autonomous vision on the site, we strive to understand site as culture. We begin by asking, "What can we learn from Estonia and what can Estonia learn from us?"

Knitting is a traditional craft that Estonia is very well known for. In particular, knitted garments and clothes from Estonia are easily identifiable because of their rigorous and exceptionally detailed execution of geometric patterns. These patterns often visually challenge foreground background reversals while simultaneously being carefully placed in a proportionally-driven composition. Some of the knitted garments even give the visual illusion of three-dimensional surfaces with double-curvature. Fortunately, much of this traditional craft is documented through numerous books, which transparently share knitting patterns and techniques through visual diagrams.

As a result, our research for this project primarily asks the question: "How can knitting advance wood construction?" For starters, knitting is fundamentally a computational craft—making through rules and utilizing constraints as opportunities. When an individual knits, they follow a visual diagram as a set of instructions.

However, those instructions usually focus on a particular detail or portion of the garment, leaving the craftsperson to improvise and make their own design decisions along the way. The process of combining or "algorithmically" breeding various patterns is intuitive and tacit for someone fluent in this particular craft. Instead of the conventional workflow of design then build, we aim to design a framework for builders to improvise and contribute to the final built artifact. How can we design an installation or pavilion through a similar series of instructions that allow the builders onsite to improvise and contribute to the structure's final form? How can machine learning be used to computationally understand the knitting patterns historically developed in Estonia? How can actively bending wooden elements be combined with numerically controlled joinery to emulate some of the knitting structural logic? Think light, not heavy timber. Somewhere between gridshell structures, soap bubbles and knitting lies a new ultra-lightweight wooden tectonic. Not just any tectonic, but a tectonic born out of Estonia's cultural heritage—and radically developed through advanced computation.

When speaking of cultures of making the notion of learning collapses time. Slowness is not a value to seek but an inherent status-quo that goes beyond iterative processes found in machine "learning." This status-quo approaches the intersection between craftsmanship and high-tech construction beyond the slow-fast binary. It is more about a narrower or wider scope of understanding time and learning from it.



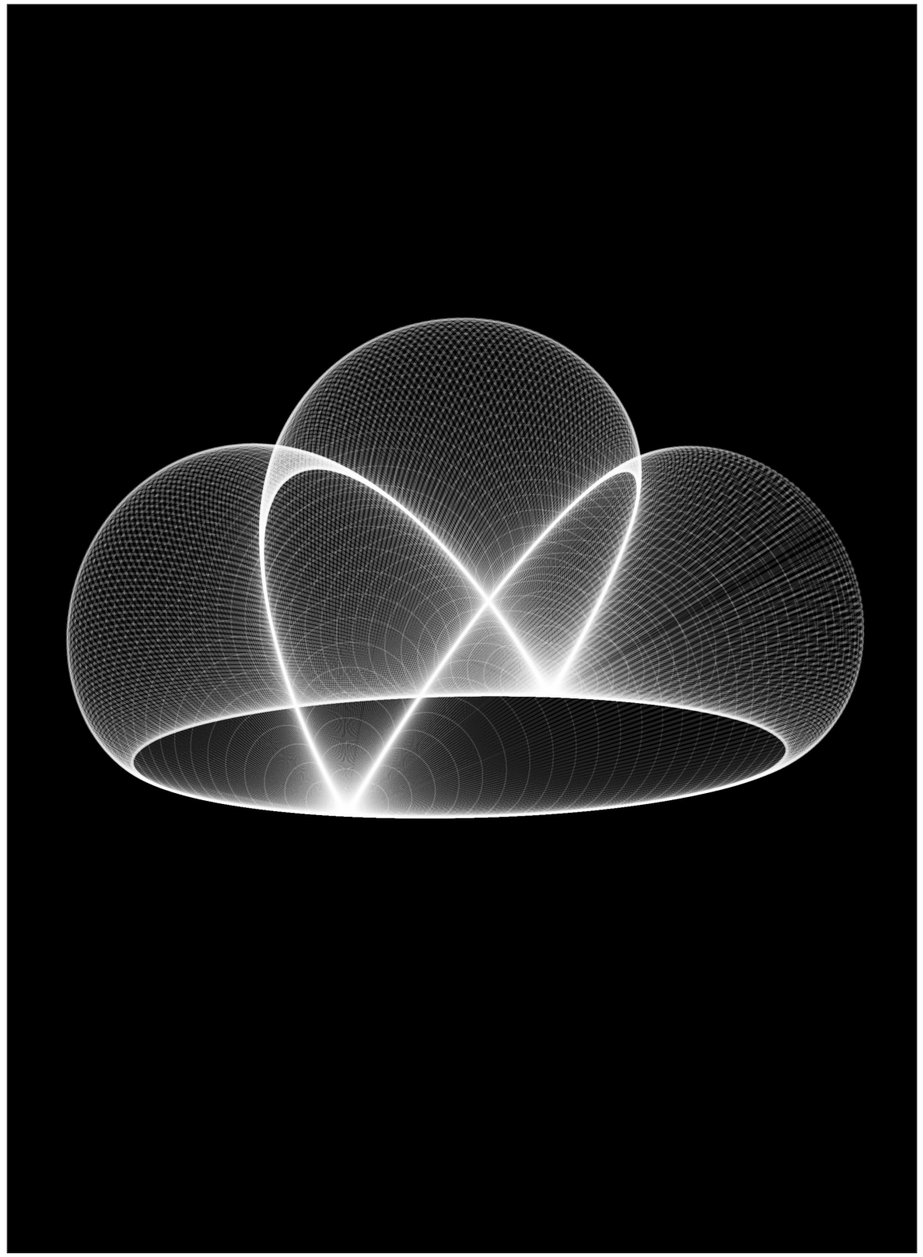
Joseph Choma is the Founder of the Design Topology Lab and an Associate Professor of Architecture at Clemson University. He is the author of three books: *Morphing: A Guide to Mathematical Transformations for Architects and Designers* (Laurence King Publishing, 2015), *Études for Architects* (Routledge, 2018), and *The Philosophy of Dumbness* (ORO Editions, 2020). As a researcher, his interests lie at the intersection of mathematics, folding, structure and materials. He has received awards from both the American Institute of Architects and the American Composites Manufacturers Association. His recent material explorations have been noted by CompositesWorld Magazine as "spearheading research into the use of foldable composites." In 2018, he was a keynote speaker at the Future of Architecture and Building Biennale in Mumbai, India. In 2019, he was a keynote speaker at FAB15 in Egypt. Recently, he was selected for the 2019-20 NCCR Digital Fabrication Researcher in Residence at the ETH Zurich.

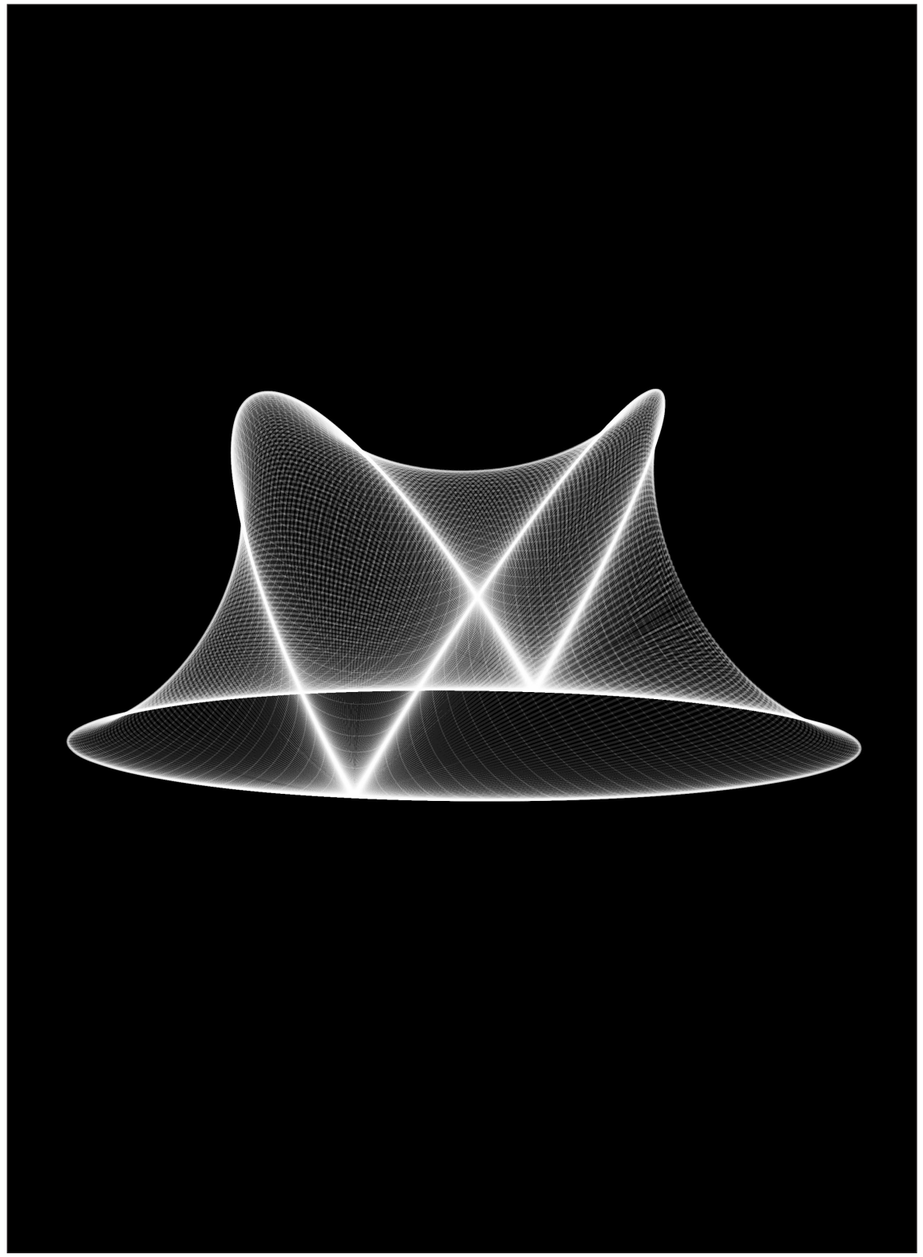
Jefferson Ellinger is an Architect and Associate Professor at University of North Carolina at Charlotte in the School of Architecture and Director of the Design Computation Program. With his architecture practice he has built several projects throughout North America and won several international competitions, including being a MoMA Young Architects finalist. His work has been featured in multiple international publications, exhibited at the Museum of Modern Art in New York and was the subject of his TED Talk. He authored the book *Philosophical Difference and Advanced Computation in Architectural Theory: From Less to More* forthcoming from Routledge. He is additionally a partner in FABS (Fresh Air Building Systems) dedicated to designing and producing next generation air filtering systems for the built environment. He holds a Master of Architecture from Columbia University in New York City and a B.S. in Architecture from the Ohio State University.

Wesam Al Asali is an architect and research associate at the Centre for Natural Material Innovation at University of Cambridge. Wesam researches Critical Fabrication: the intersection between material and building technologies with cultural and social studies. His work investigates and proposes possible grassroots design practices in the context of climate emergencies. Wesam is a design and innovation lead at his co-founded practice (IWlab) and co-founder of the social enterprise CERCAA in Spain- Valencia, a centre for learning and innovation in building crafts and natural material in Spain-Valencia. His work and research have been reorganised with awards Morgan Snidal Sustainable Construction Award, Tiles of Spain Award for Innovation in Ceramic Architecture, and Tamaouyz Award for Excellence of Architecture Practice in the Middle East (Nomination). Wesam is a guest lecturer at the Università IUAV di Venezia's master's programme Resilience Spaces and taught both undergraduate and graduate programmes at the University of Cambridge, Clemson University, and Damascus University.

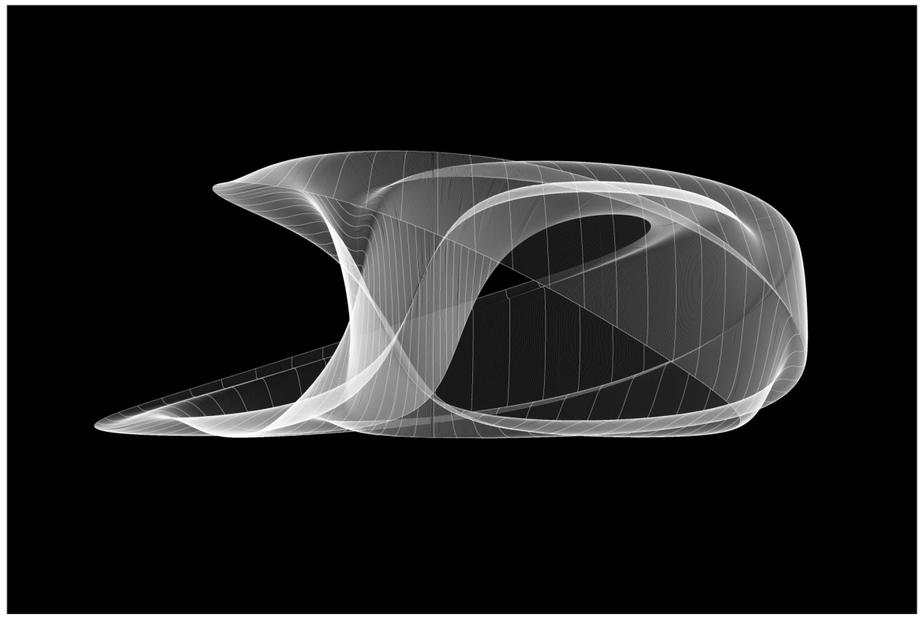
FROM DESIGNING WITH MATHEMATICS TO FOLDABLE STRUCTURES AND MATERIALS

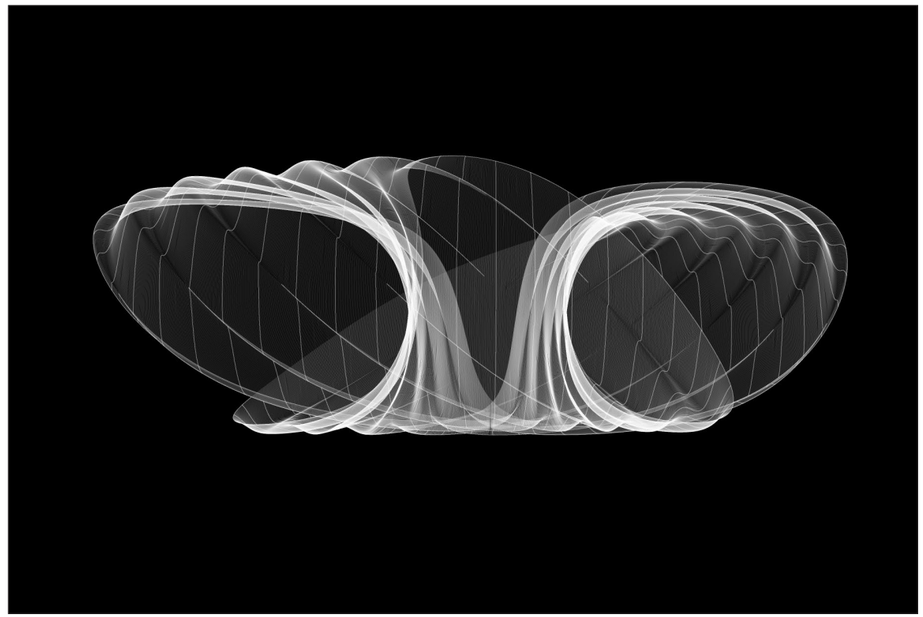
JOSEPH CHOMA

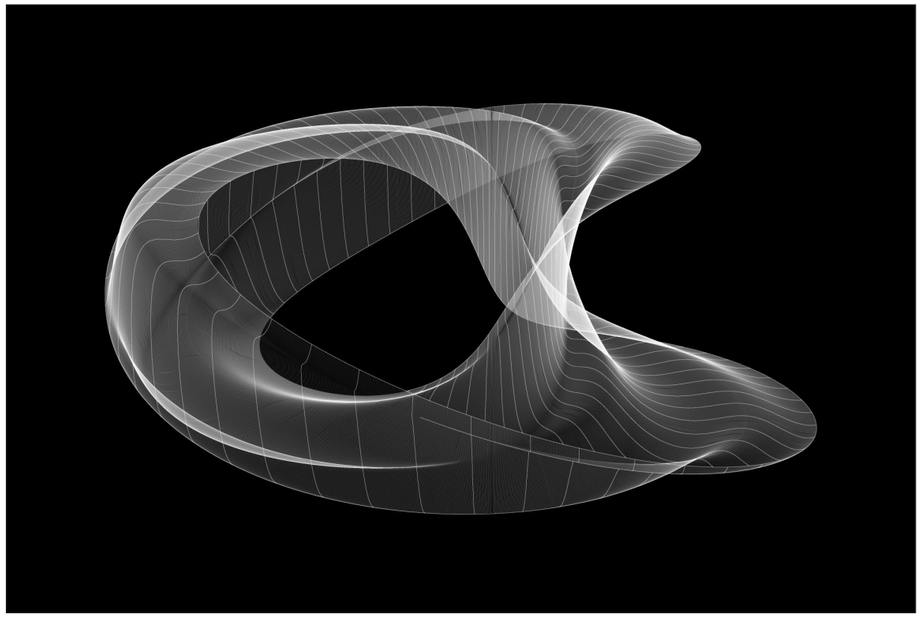


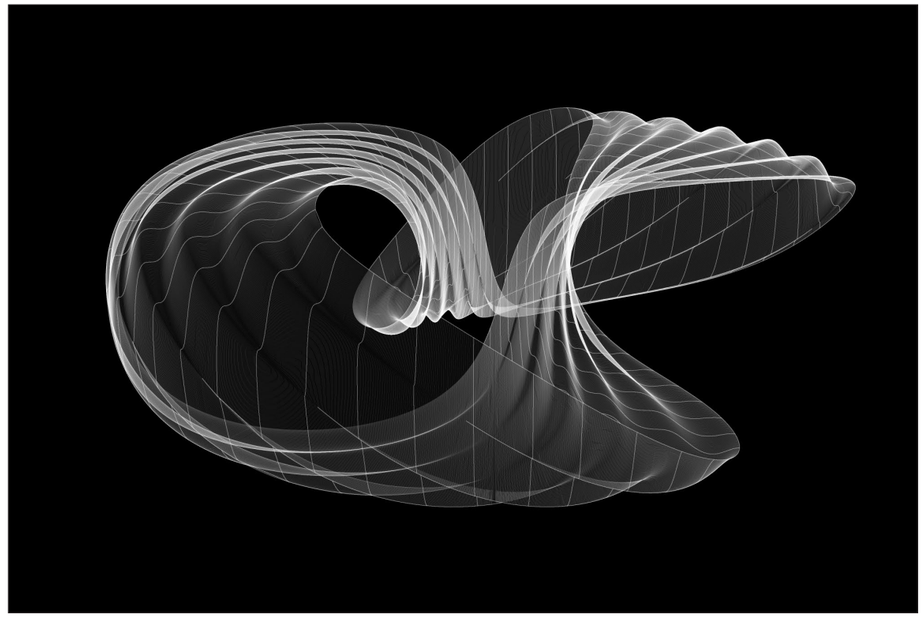


Materializing Mathematics by Joseph Choma (2020)

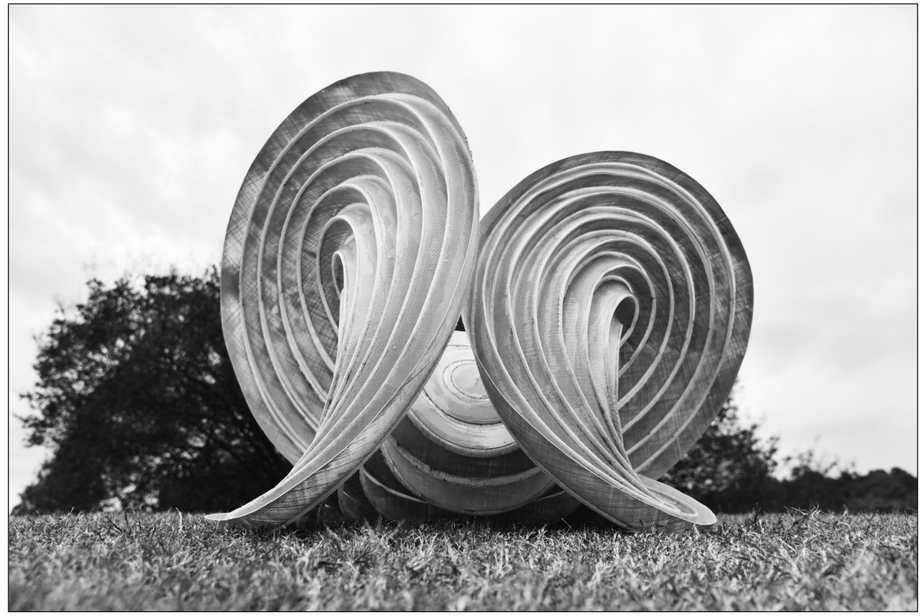




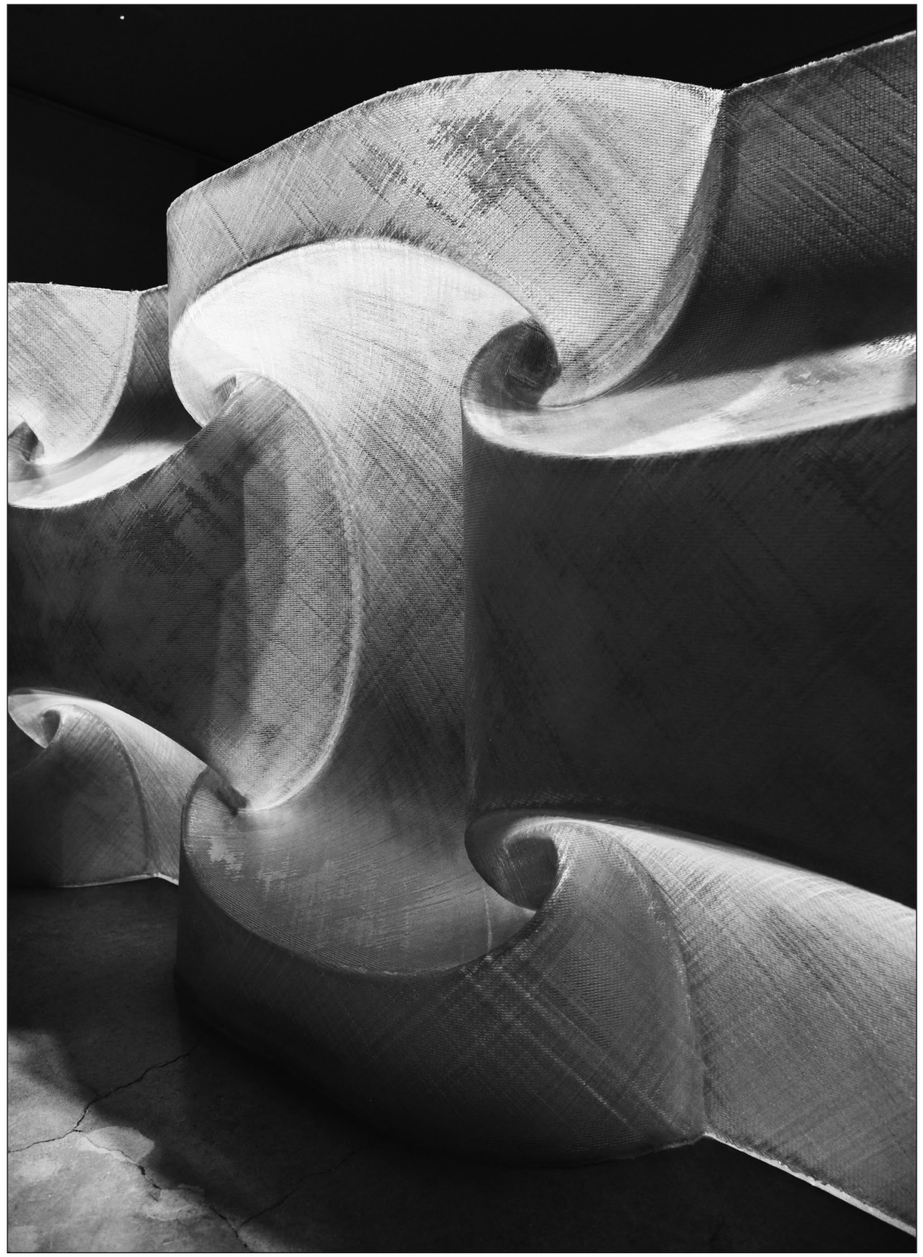


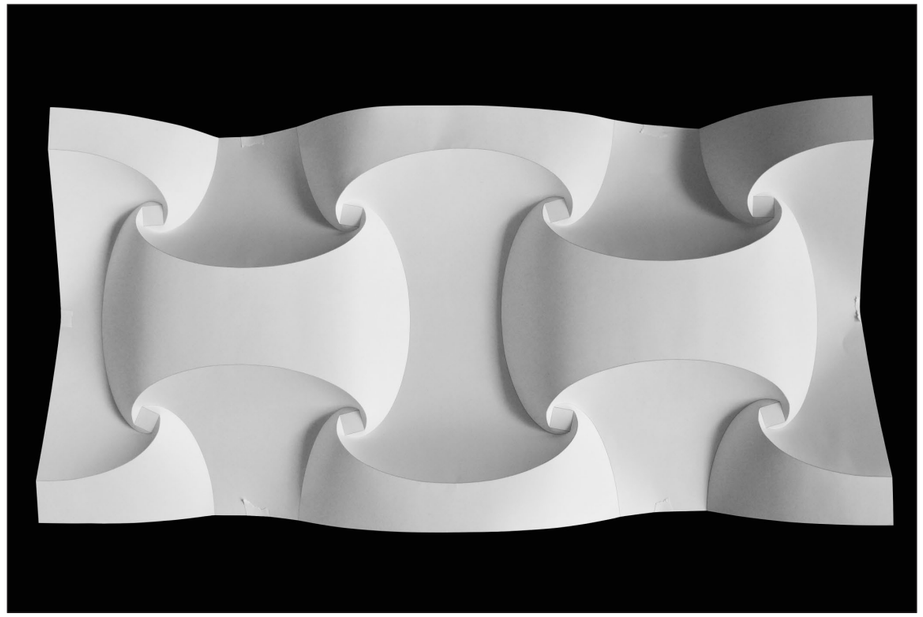


Sketching with Mathematics: Variations of a Dancing Torus by Joseph Choma (2017)

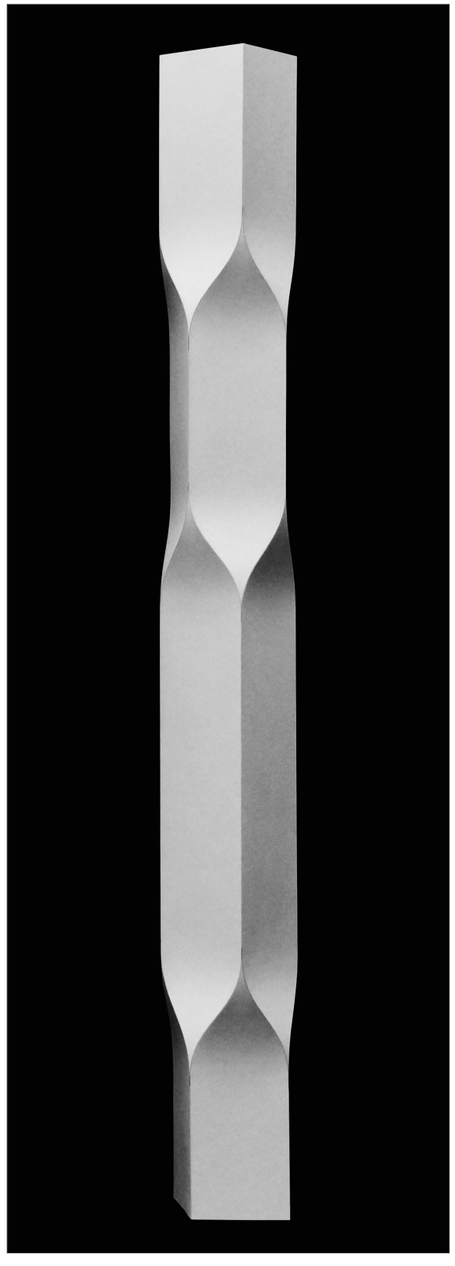


Folding fiberglass along curved creases. The 8ft in diameter saddle is composed of twenty concentric circles.
Principal Investigator: Joseph Choma, Clemson University (2018)

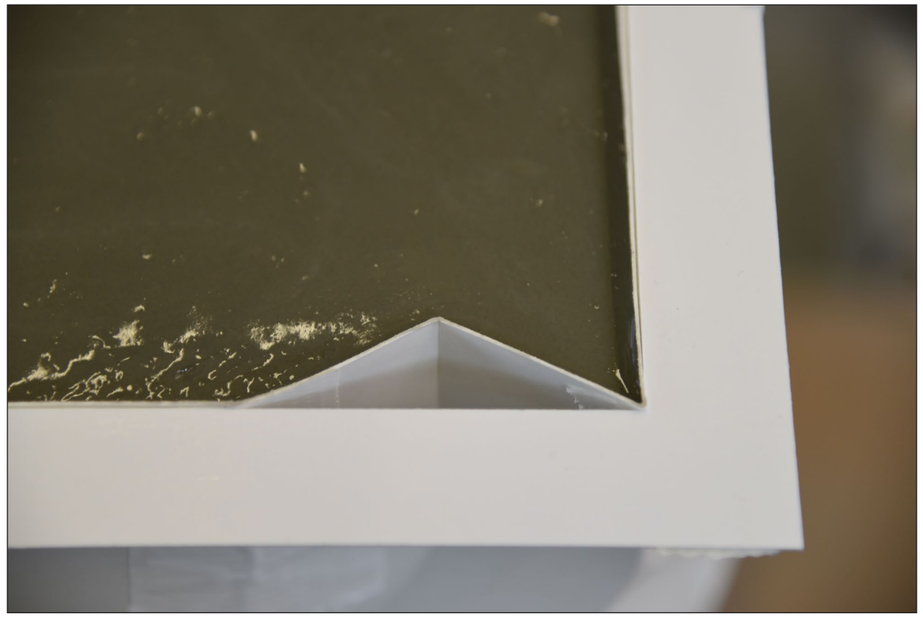




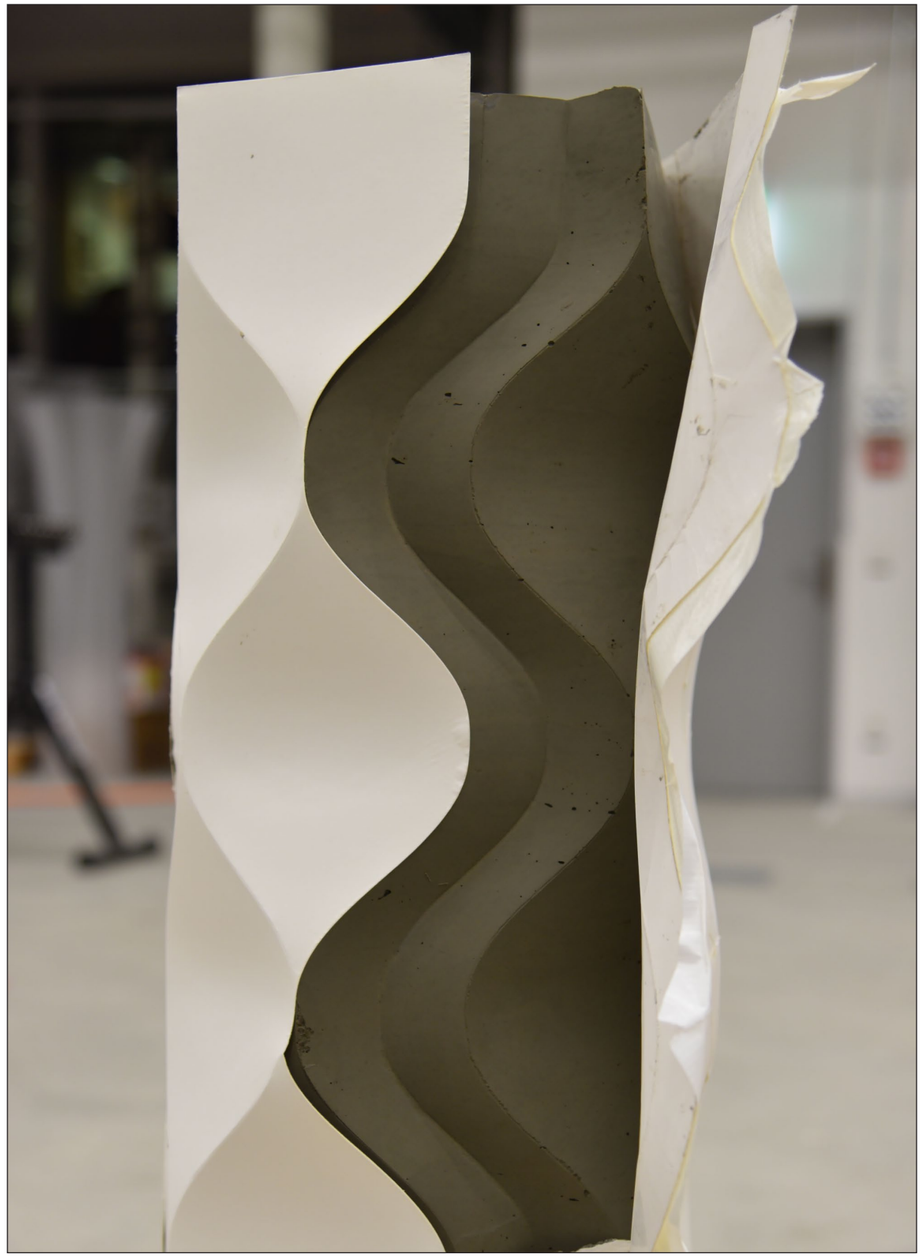
The 8ft long wall has a structural depth of approximately 1ft.
The tesselated crease pattern folded out of paper (above) and out of fiberglass (left and below).
Principal Investigator: Joseph Choma, Clemson University (2018)



Small-scale column folded out of paper (far left) and full-scale column folded out of fiberglass (right).
Principal Investigator: Joseph Choma, Clemson University (2018)



Ultra-thin folded paper formwork (0.5 mm thickness) with set on demand concrete casting (2019 - Present)
Principal Investigators: Joseph Choma, Clemson University and Ena Lloret-Fritschi, ETH Zurich
Collaborators: ETH Zurich (Ena Lloret-Fritschi, Fabio Scotto, Anna Szabo, Robert Flatt)



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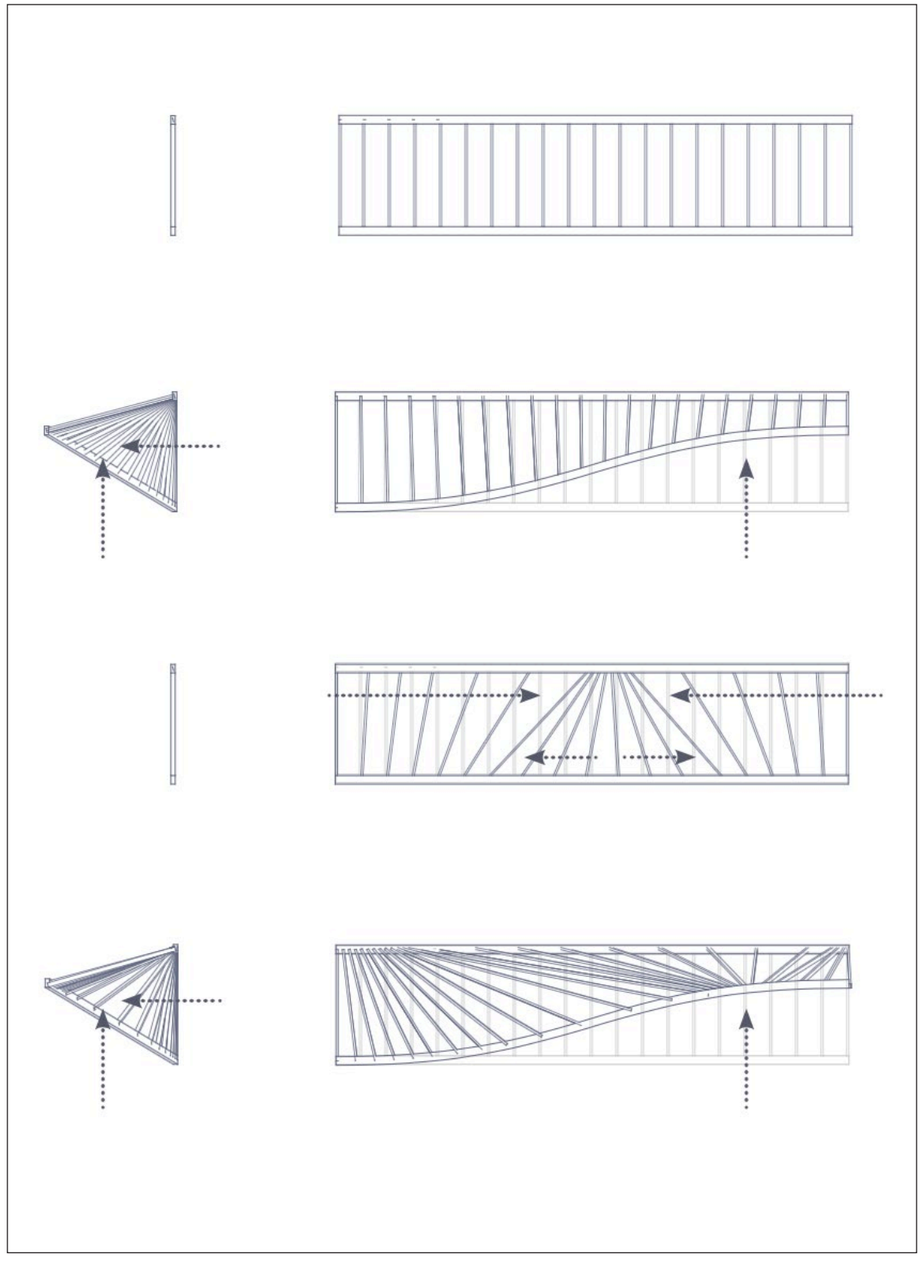
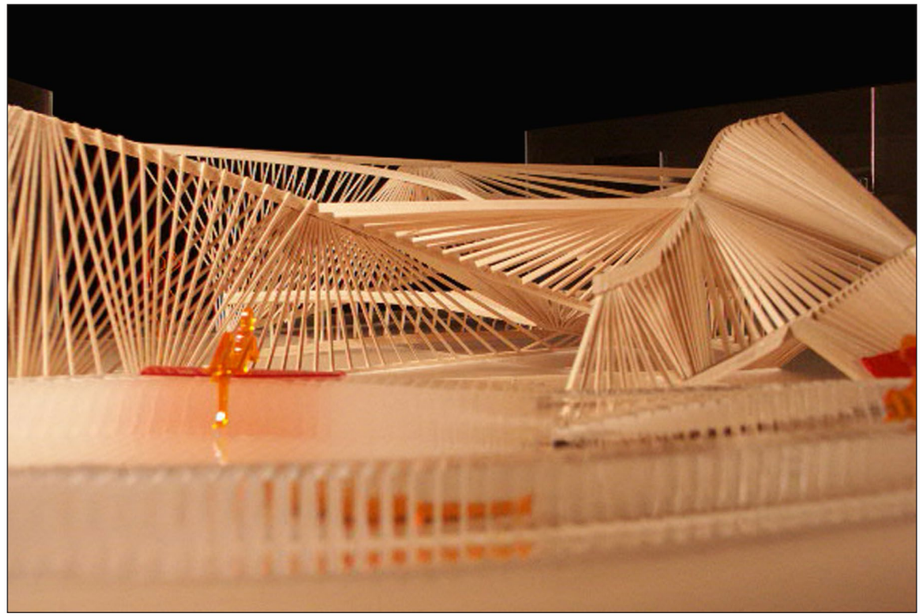
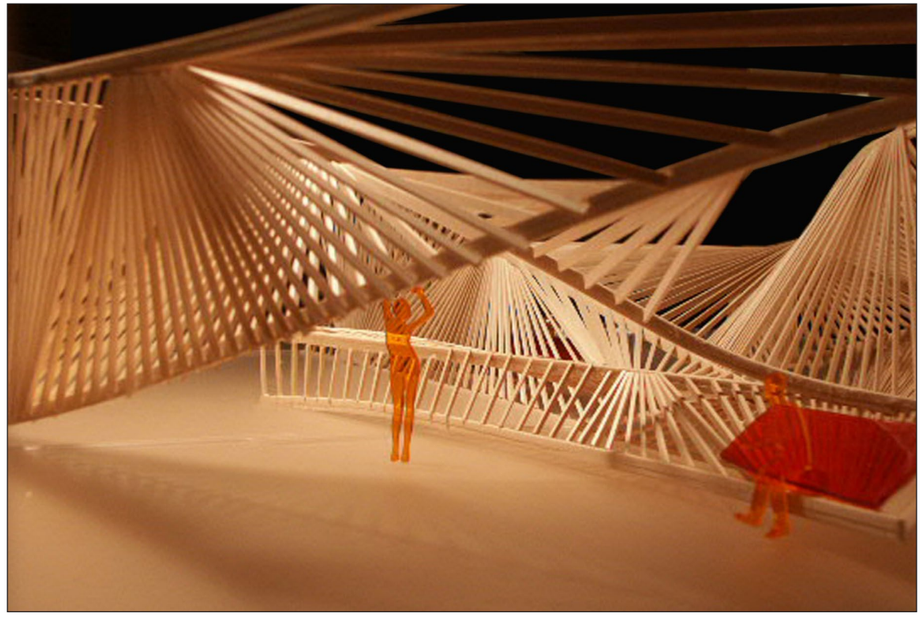
FROM RULED SURFACES TO ADVANCED ARCHITECTURAL MANUFACTURING

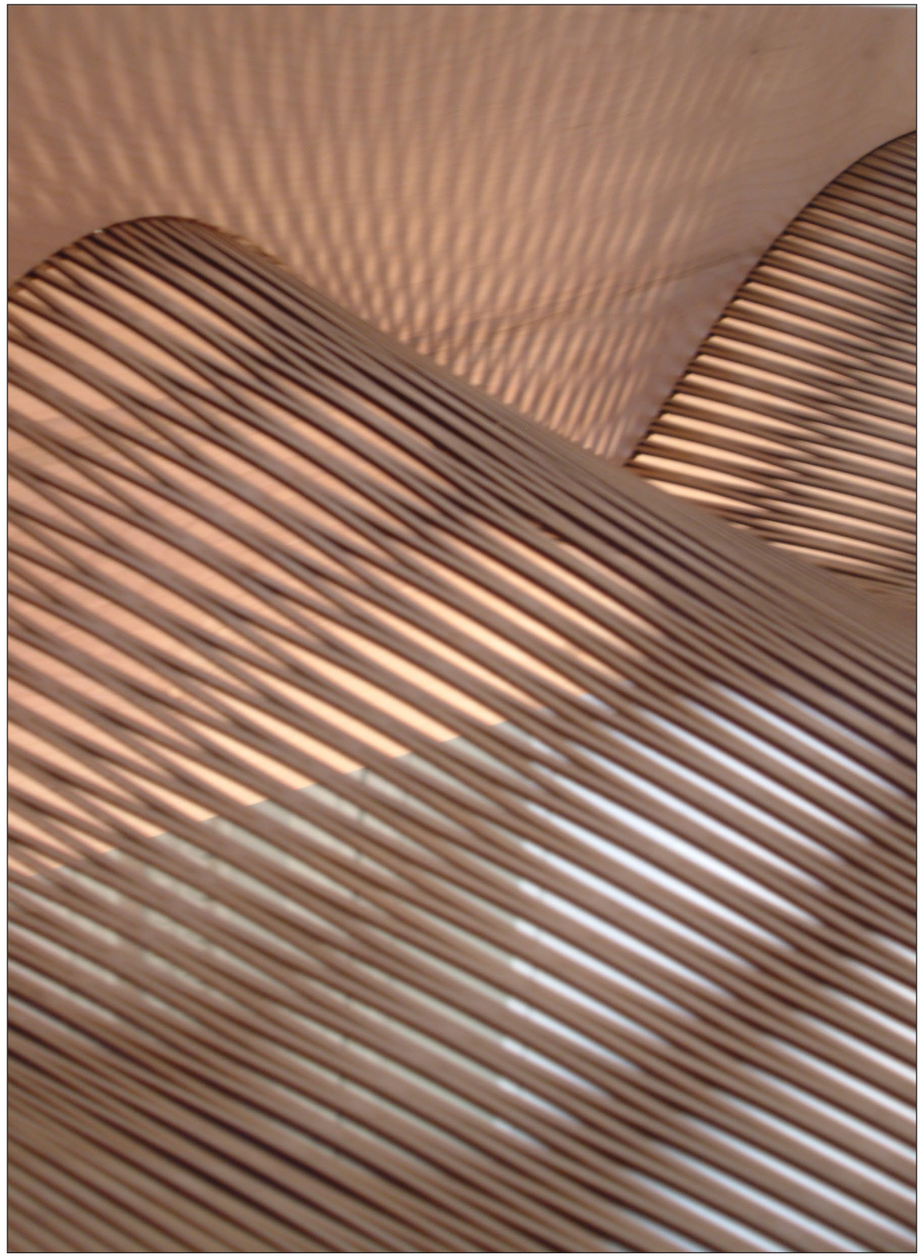
JEFFERSON ELLINGER

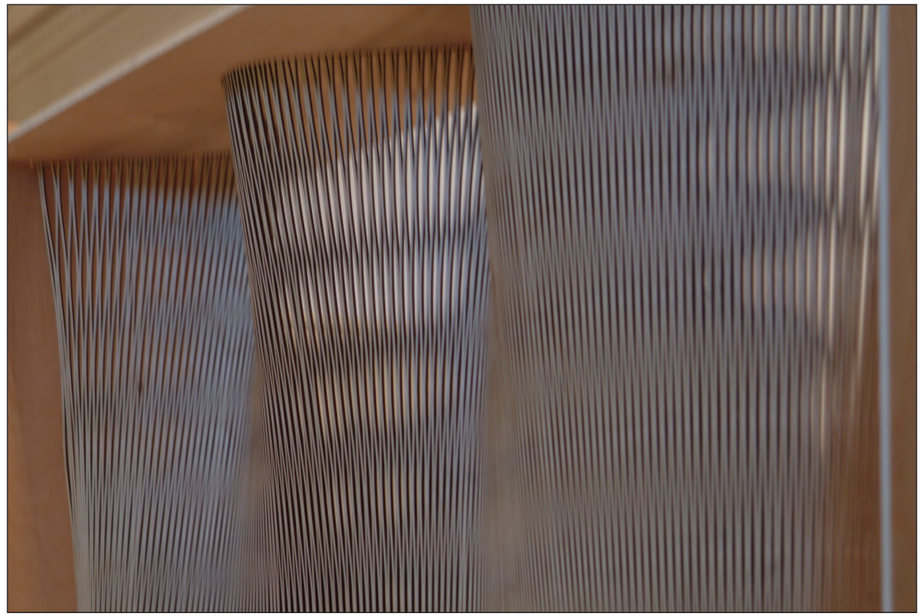




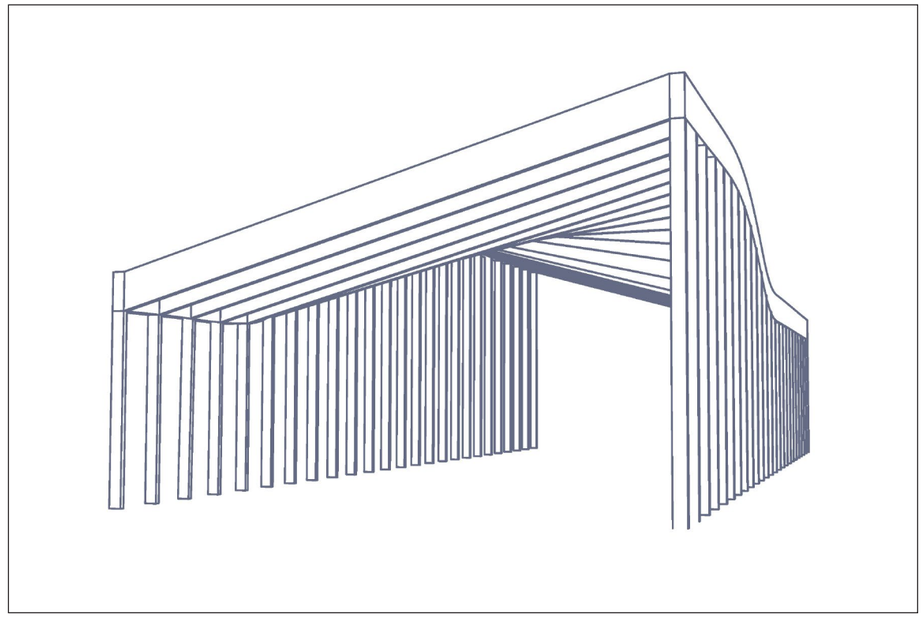


Swells: MoMA PS-1 Young Architects Program Finalist by Ellinger/Yehia Design (2003)

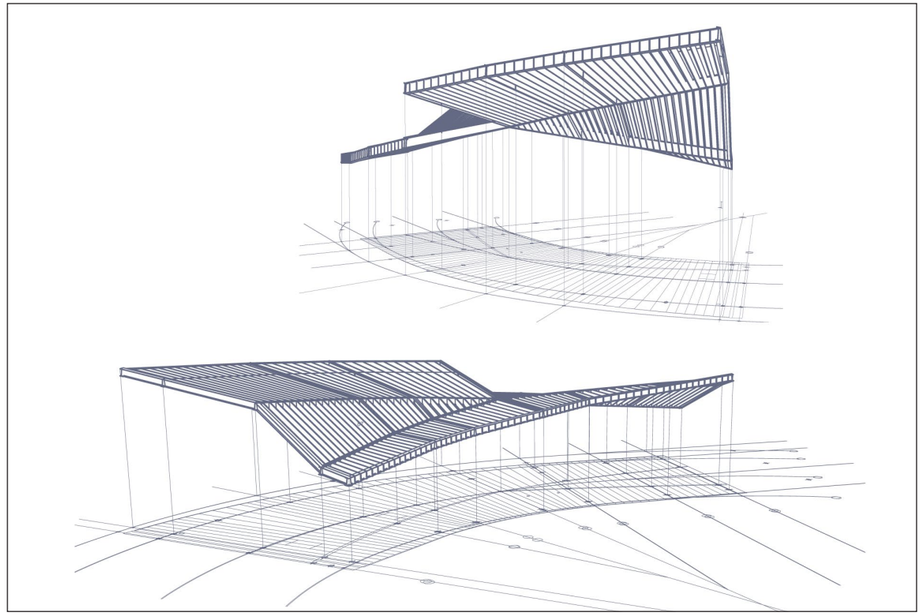




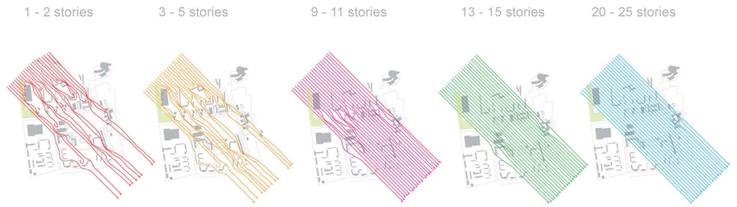
PlyScreen: Expanded Plywood by Jefferson Ellinger and David Riebe (2004)

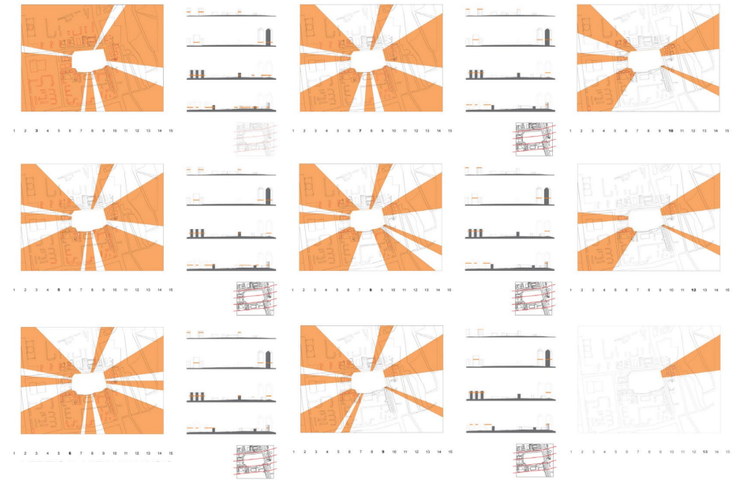


Uni/Care Systems Headquarters by Ellinger/Yehia Design (2005)

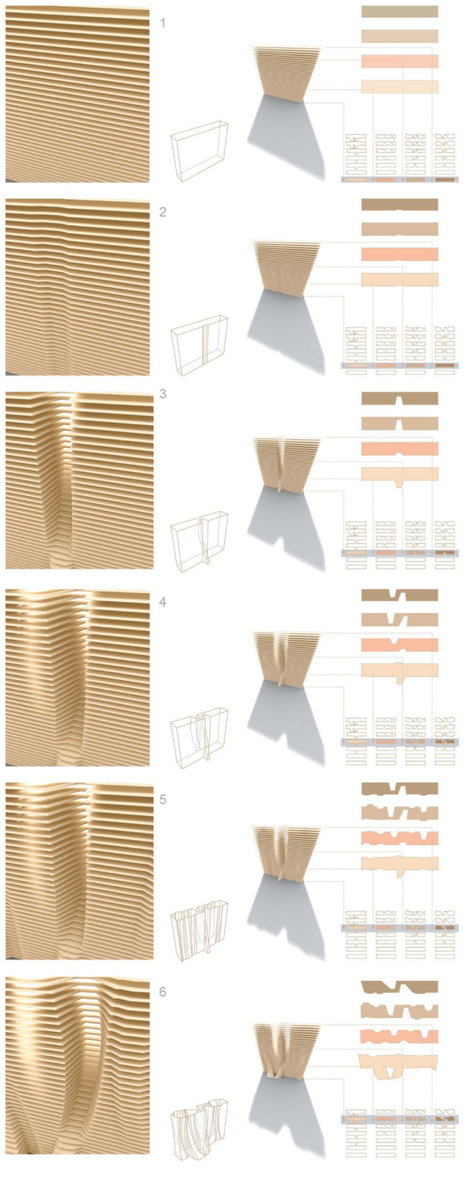


W-House by Ellinger/Yehia Design (2006)





Dostyk Business Center by Ellinger/Yehia Design (2007)



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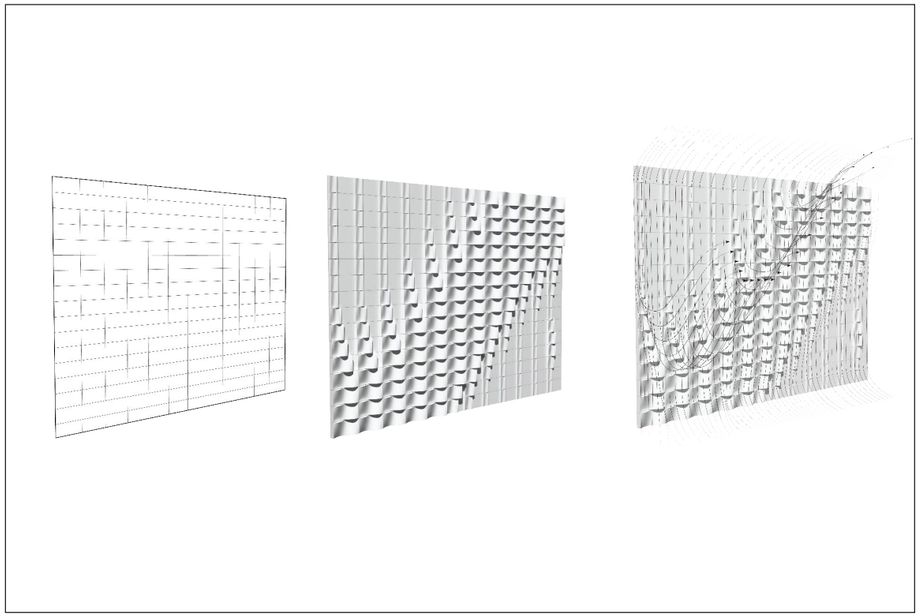
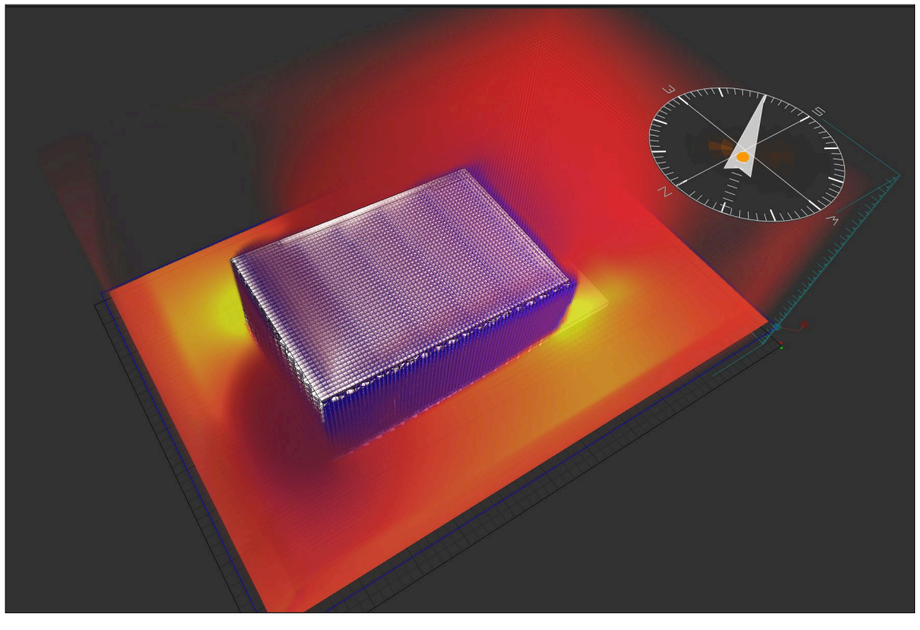
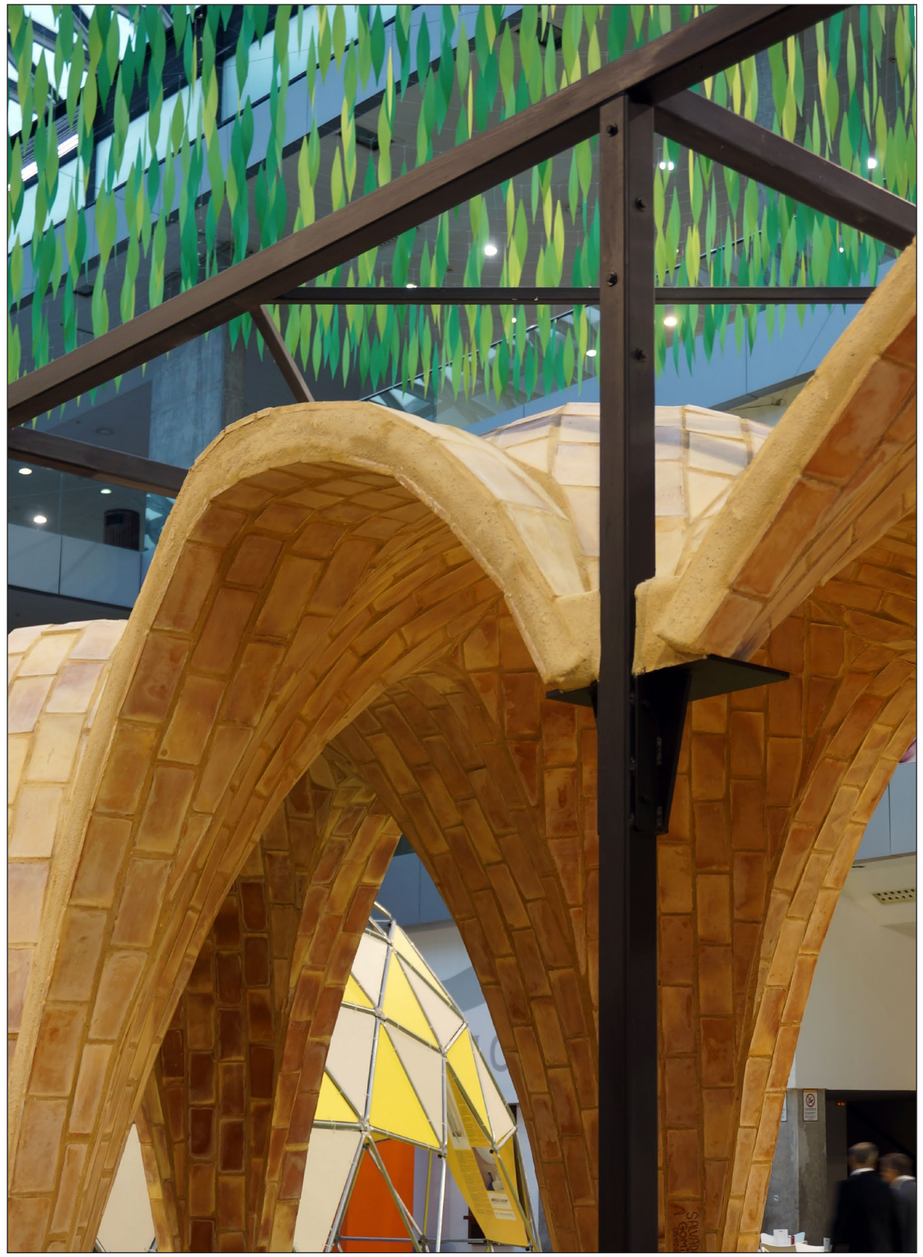




Laitsos Residence by Ellinger/Yehia Design (2012)

FROM THIN-TILE VAULTING TO NATURAL MATERIAL INNOVATIONS

WESAM AL ASALI



Fabricarte by Wesam Al Asali with Light Earth Designs (2018)

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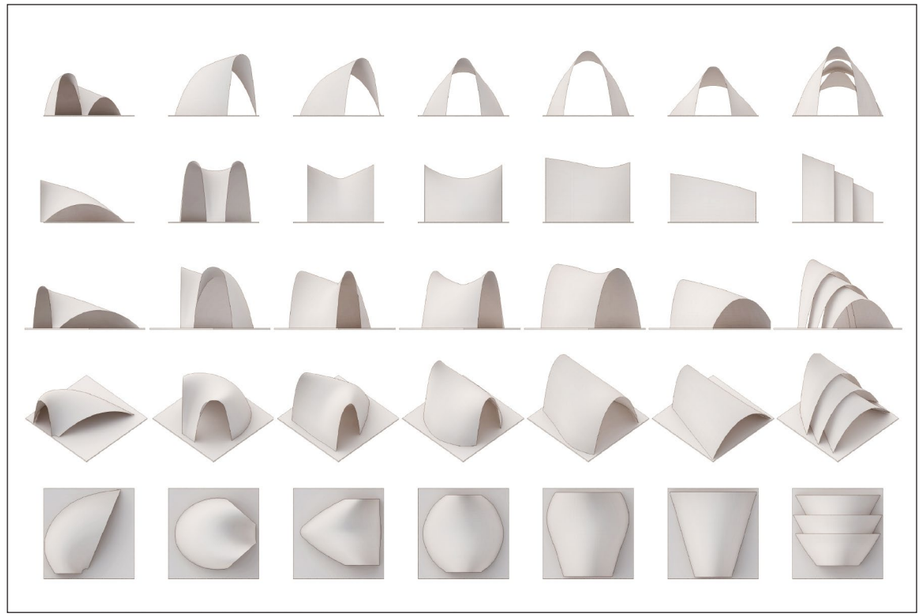

In Situ by Wesam Al Asali (2017)

Ceramic Tile Pavilion in Art and Culture Centre in Santa Pola by Wesam Al Asali (2019)
Coordinated with master artisans Salvador Gomis and Jesus Gomis.

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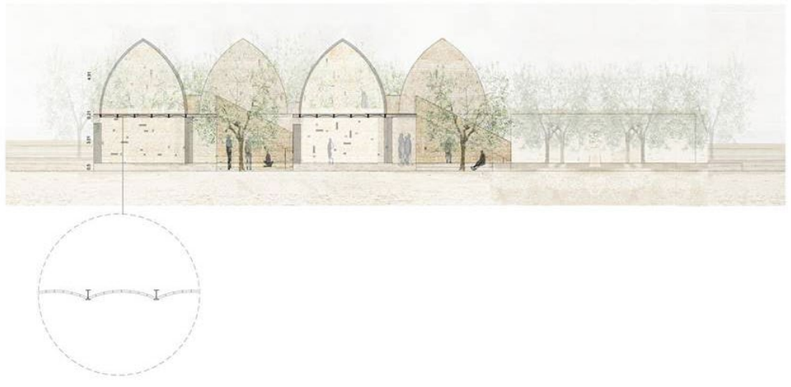
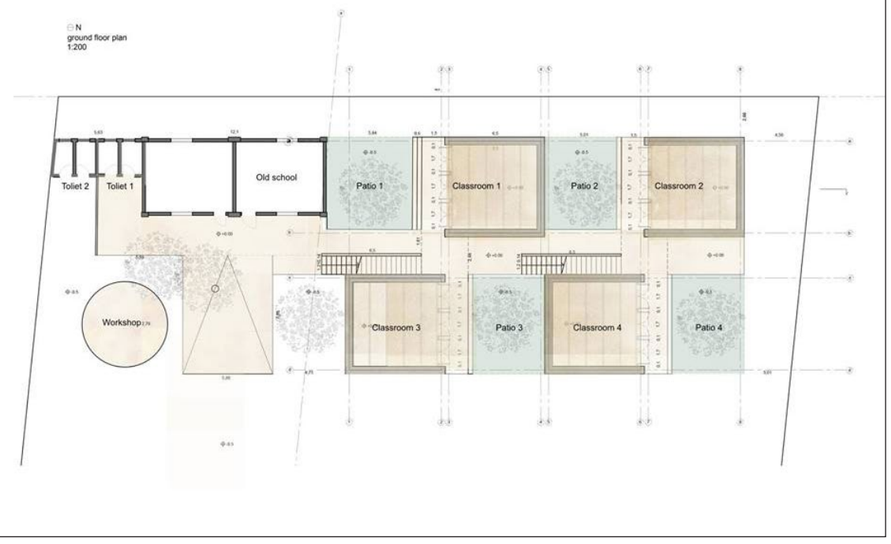
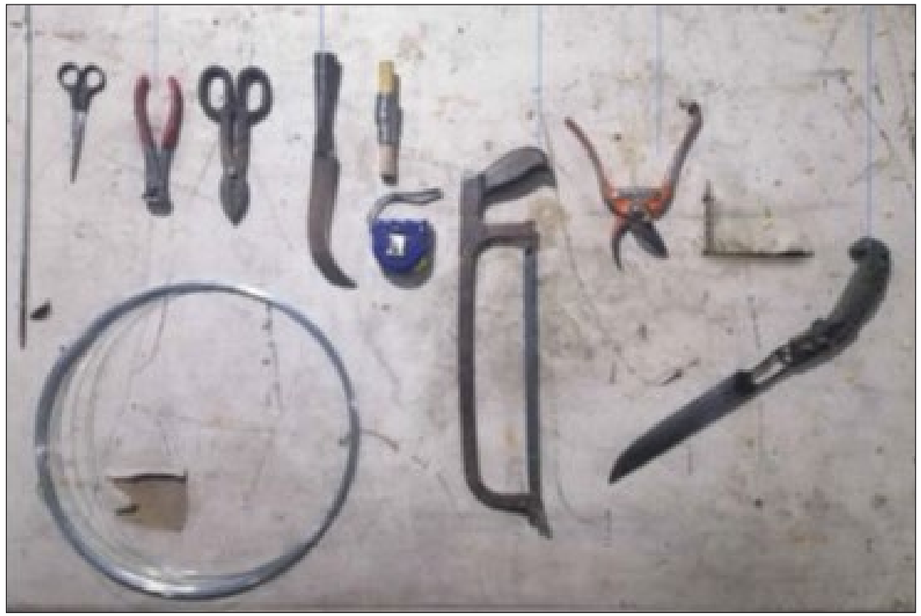
longitudinal section
1:200





School in Azraq by Wesam Al Asali with Emergency Architecture and Human Rights (2018)



Weaving Barada by Wesam Al Asali with local artisans in Damascus (2019)