COLLAPSIBLE

As we venture onto new journeys, our needs for luggage change constantly. How can one luggage be adapted to all our different needs?

Collapsible aims to explore the potential of shape-morphing structures that not only can be reconfigured easily but also remain strong. It draws inspiration from origami, the traditional method that bridges between flat and three-dimensional structures. Made of a zig-zag pattern, the luggage can be collapsed into any height while the the alternating direction of the zig-zags sustains the strength. As it is compressed, the color changes from transparent to solid, creating a different look at each different height.

CONTENTS

Motivation

We have duffle bag for spontaneous weekend get-away, carry-on for week-long trip, and larger suitcase for the long-awaited summer vacation. Instead of having multiple luggages for different kinds of trips, could we have one that can be reconfigured for multiple purposes?

While expandable luggages do exist already, the morphing part of them usually is the weakest or softest part of the luggage, allowing easy reconfiguration. This project stems from the desire to achieve easy deployment as well as to maintain the integrity of the structure.

BELLOWS BY BENJAMIN HUBERT FOR NAVA / Dezeen

PETIT PLI BY RYAN MARIO YASIN/ Dezeen

TRIPP TRAPP ® BY STOKKE / stokke.com

Changing Form for Changing Need

Reconfigurable design can be found in various fields. The backpack Bellows designed by Benjamin Hubert for Nava and switch between a regular laptop bag for work and an expanded version for weekend trips. In fasion, Ryan Mario has designed clothes that grows with the child, reducing the need to buy new clothes for child who outgrows them quickly. Similarly, the Tripp Trapp ® chair by Stokke can be reconfigured as the child grows up.

ISSEY MIYAKE TRUNK PLEATS BAG / isseymiyake.com

LITTALA X ISSEY MIYAKE HOME COLLECTION / isseymiyake.com

ISSEY MIYAKE IN-EI / isseymiyake.com

Origami Details in Design

When we talk about shape-changing, origami is an important technique that has been around for almost two thousand years. It connects between 2D and 3D structures with folding. It shows up frequently in Issey Miyake's design, including bags, home goods, and light fixtures. It is not only a functional technique, but also an elegant design language.

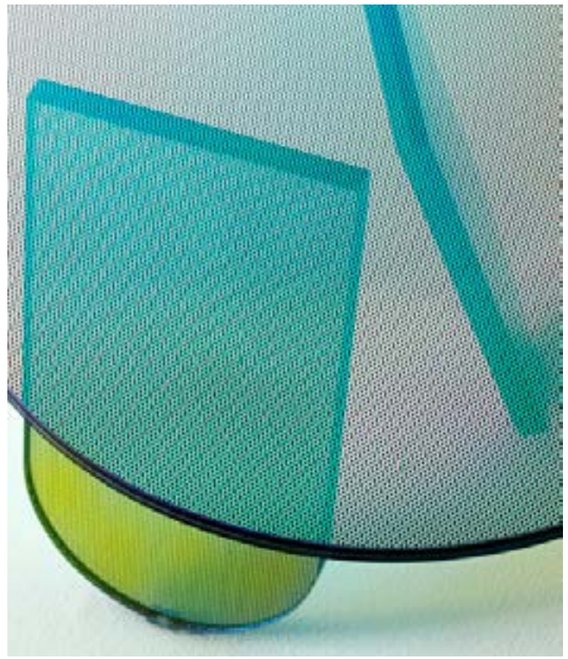
CMY PAVILLION / shift-au.com

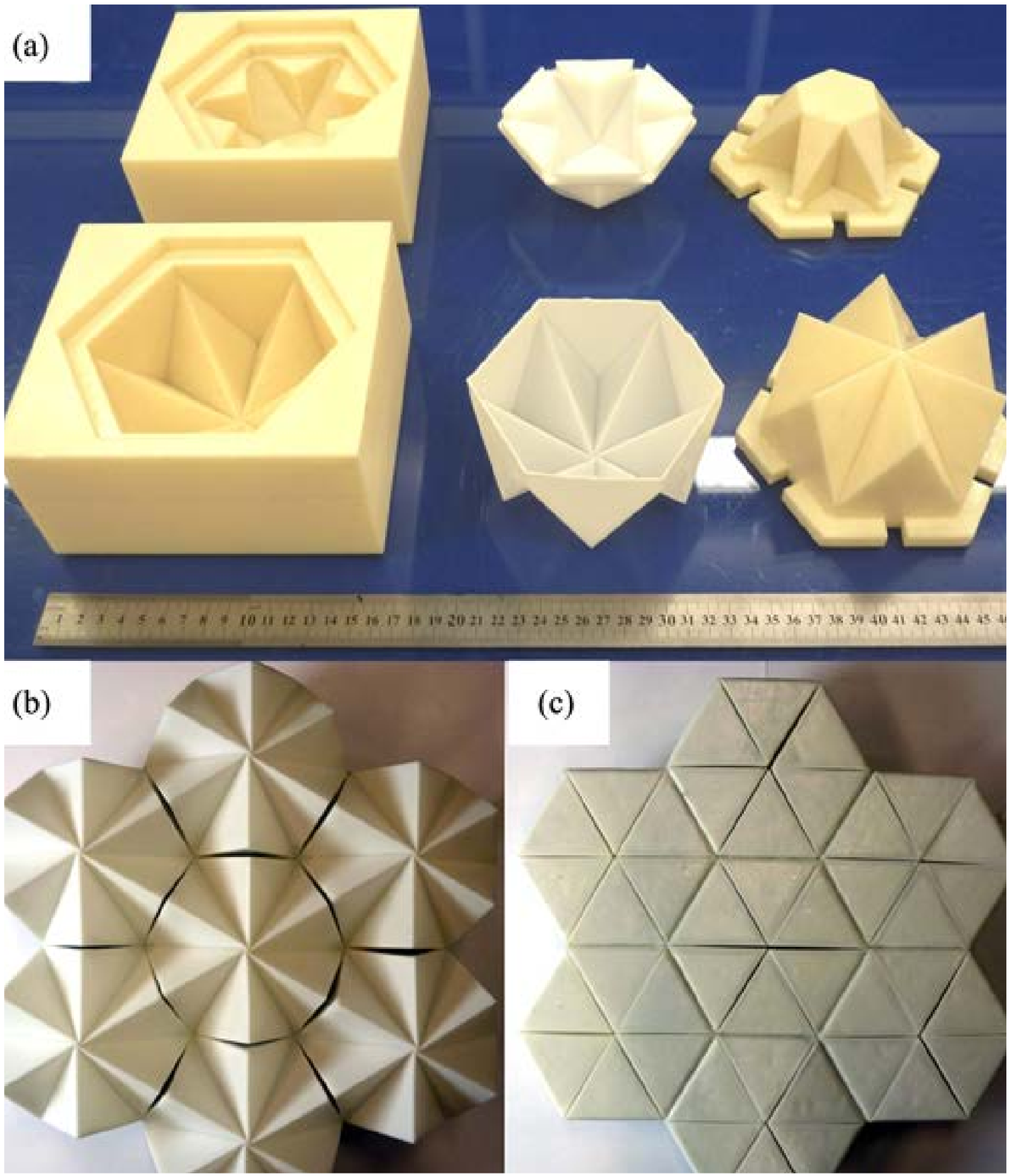
Tinted Light

For the visual of the luggage, I was interested in using transparent colored material to play with light. The colored enclosure of CMY Pavilion creates a boundary between the outside and the inside while maintain the connection between them. Glithero's tinted windows and Urquiola's iridescent glass both cast mesmerizing shadow on the surroundings. I was curious to see how the light changes as the luggage takes on different shapes.

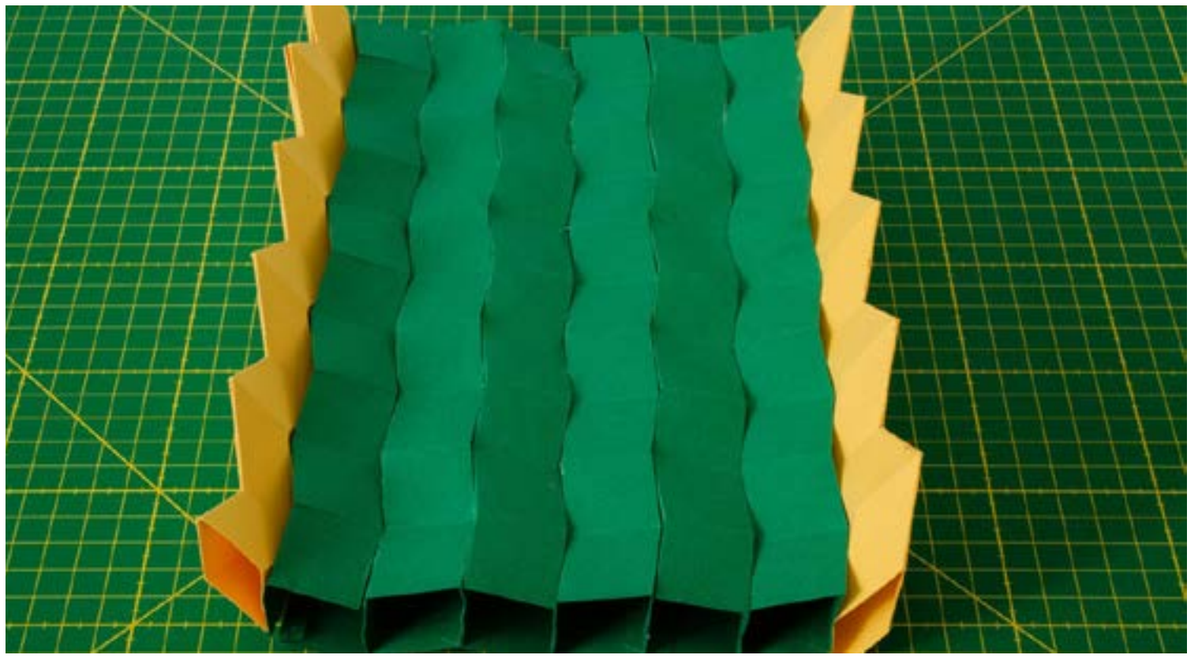
NEZ-À-NEZ BY GLITHERO / glithero.com

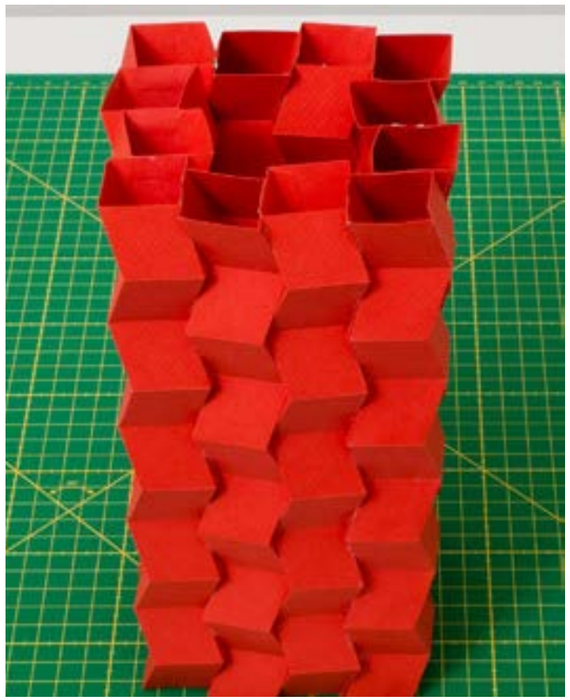
IRIDESCENT FURNITURE BY PATRICIA URQUIOLA / Dezeen



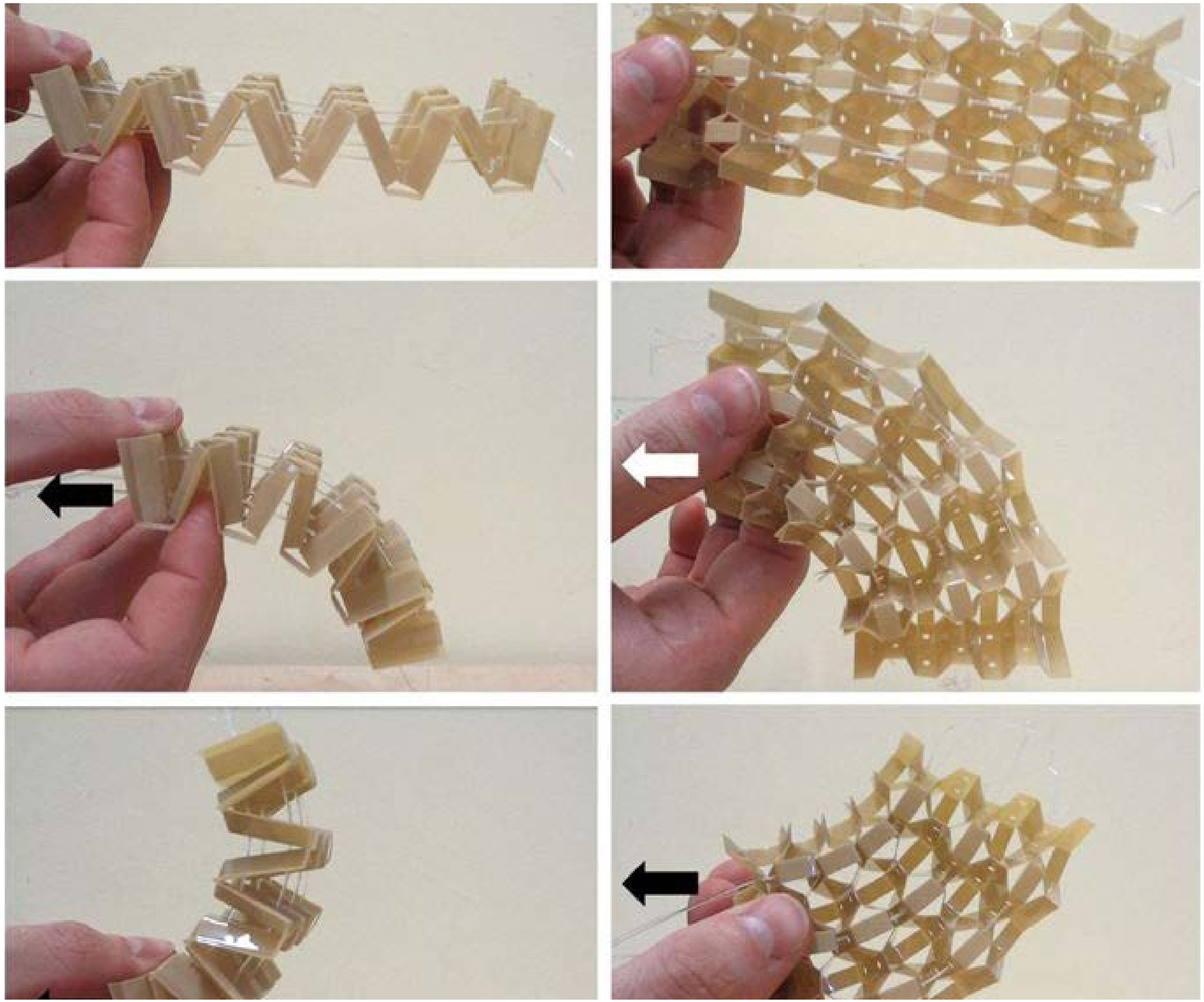


BIO-INSPIRED BISTABLE MATERIAL BY DAYNES ET AL. / IOPScience





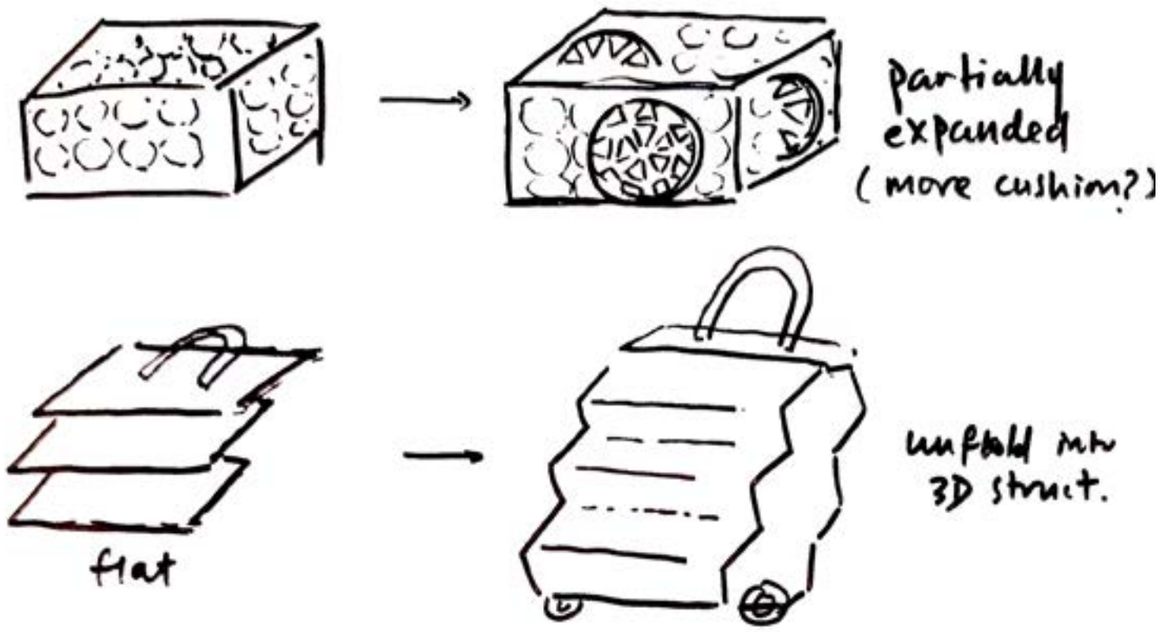
ZIPPER TUBES BY FILIPOV ET AL. / Proceedings of the National Academies of Sciences

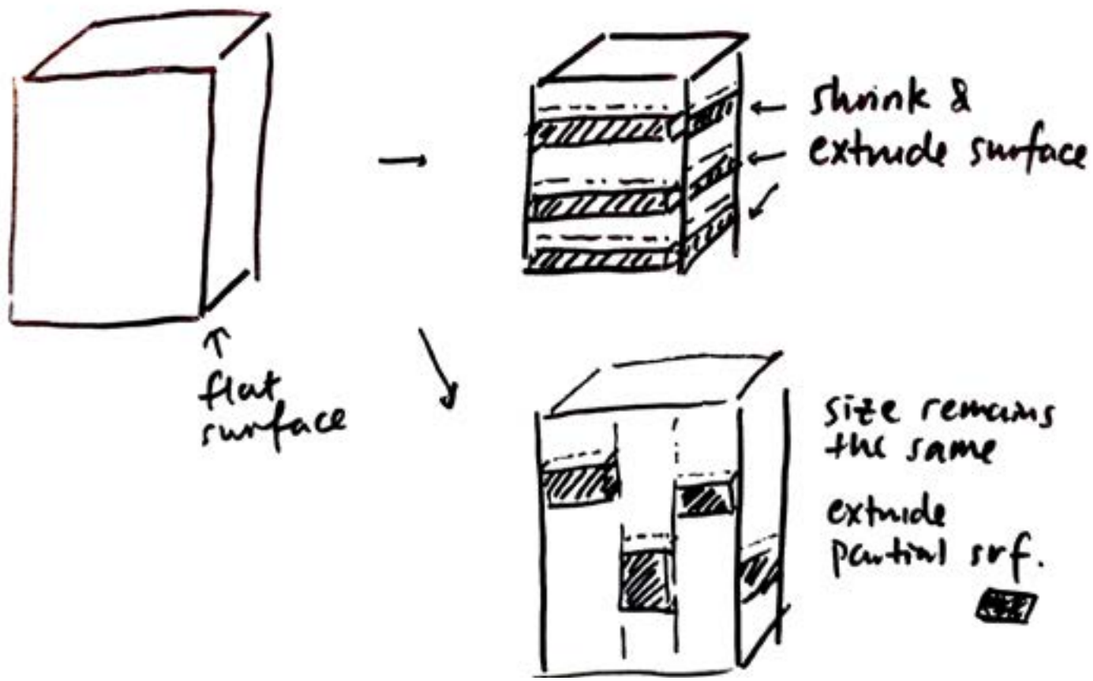


SHAPE MORPHING KIRAGAMI BY NAVILLE ET AL. / Nature

Metamaterial

A metamaterial is an engineered material that has properties not found in natural materials, usually made of repeating elements. Daynes et al. designed a bistable structure that can be folded flat and expanded into a spiky structure. Filipov et al.'s research focused on origami-based zipper-tube that can be assembled into different configurations. They are easy to deploy and can sustain an incredible amount of force. Kiragami is another the method for creating 3D structure out of paper through cutting and folding. Naville et al. used this technique to create shape-morphing structures as seen on the left.

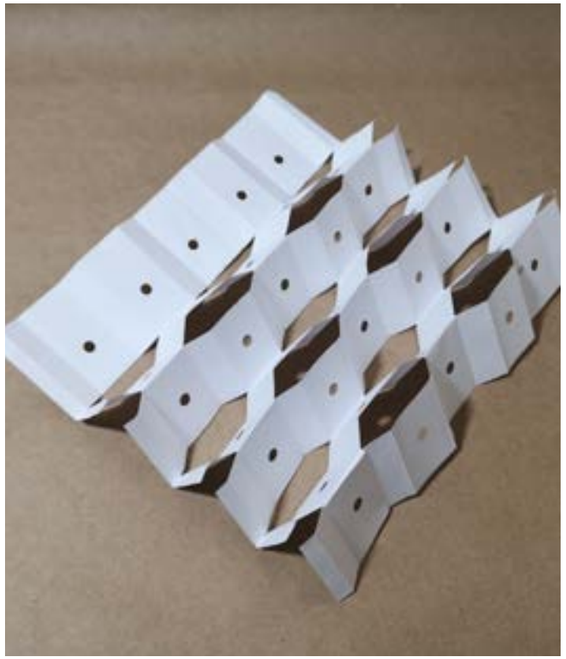




INITIAL CONCEPT SKETCH

Expansion and Contraction

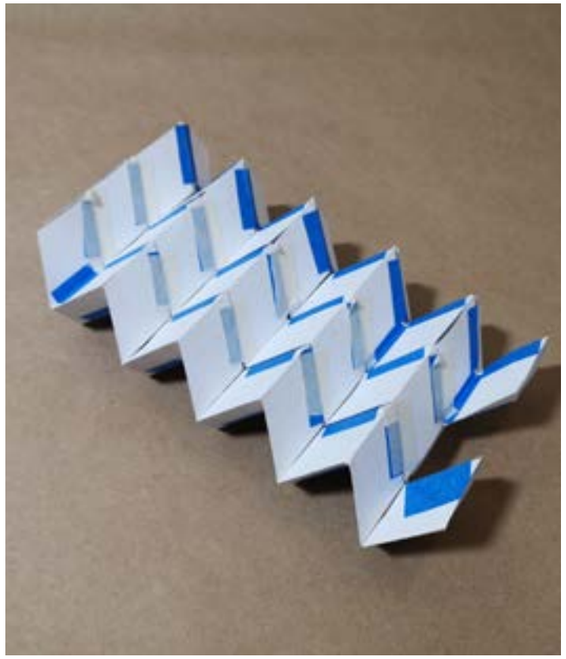
I started exploring the most foundational ways of shape-morphing, expansion and contraction. My initial ideas are all based on ways to expand or contract either part or all of the luggage. In order to narrow down to a direction, I then moved on testing different shape-morphing techniques based on the research phase.



KIRAGAMI COMPRESSED

KIRAGAMI EXPANDED

MIURA ZIPPER TUBE COMPRESSED



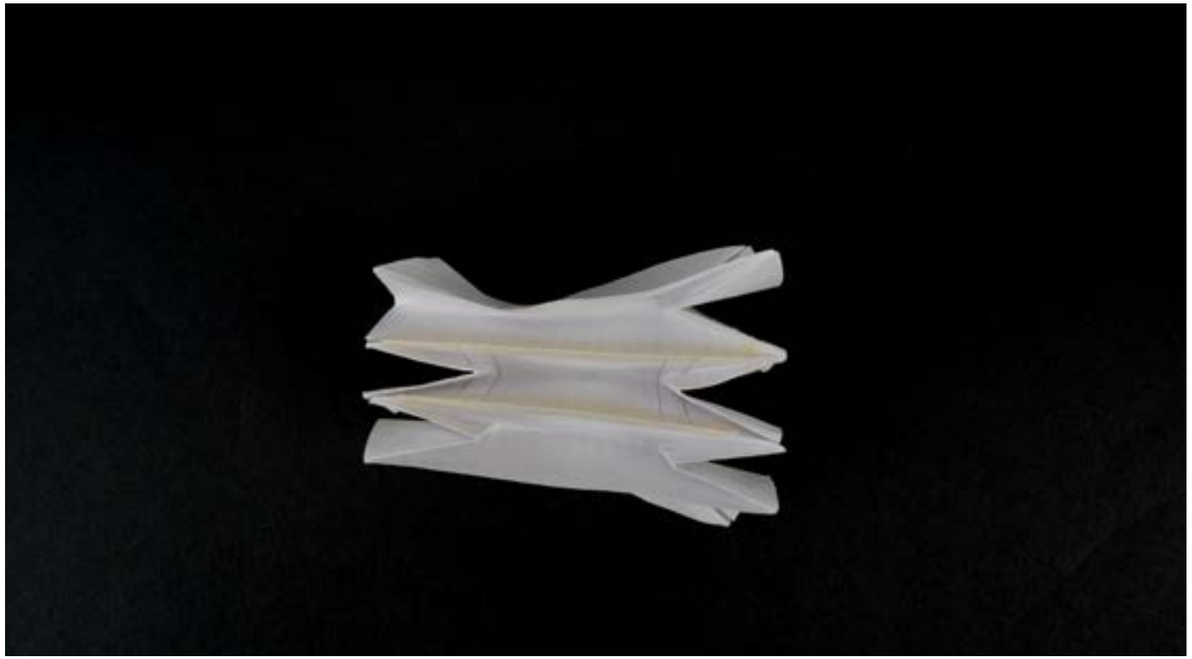
MIURA ZIPPER TUBE EXPANDED

KIRAGAMI FLAT

KIRAGAMI EXPANDED AND 3D

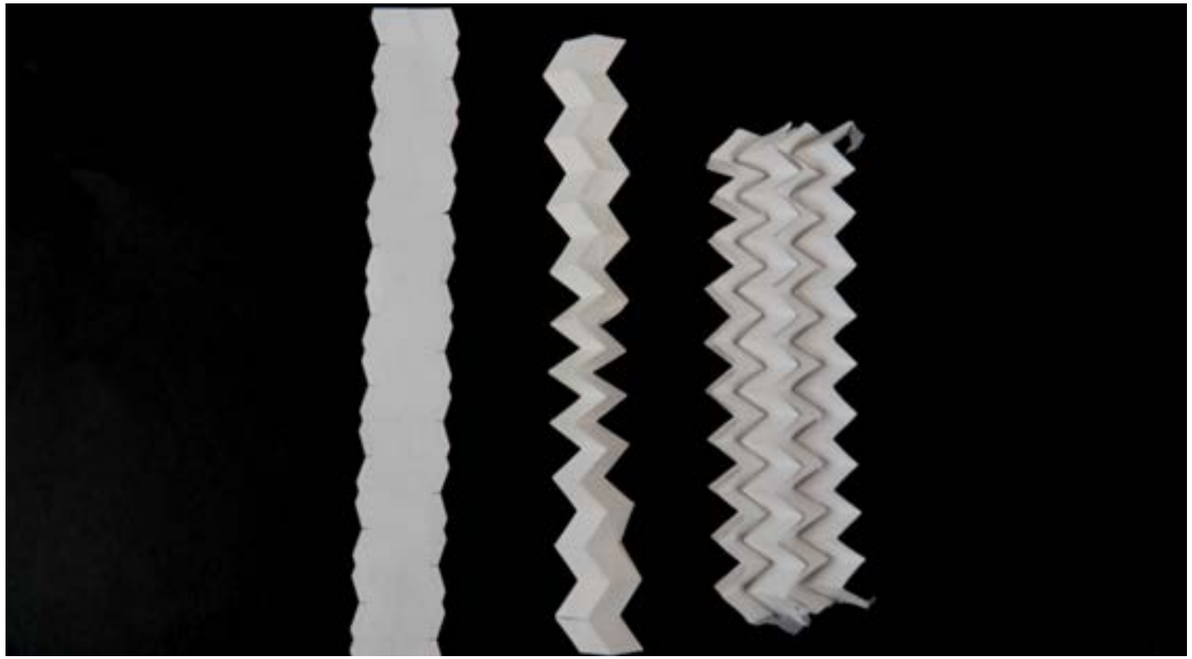
Mechanism Testing

After testing different origami and kiragami techniques, origami was more appealing because it creates an enclosed volume that can be manipulated. In particular, the zipper tube concept created stronger structure that a single-colum of collapsible origami.

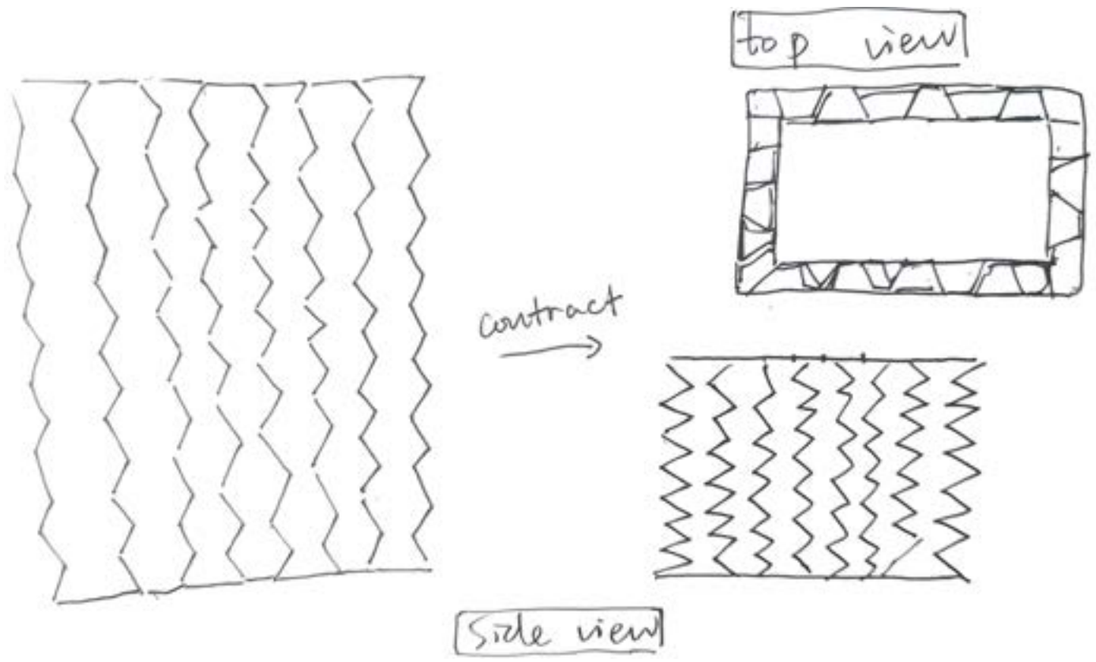


SECTIONAL CONTRACTION

TOP SECTION EXPANDED

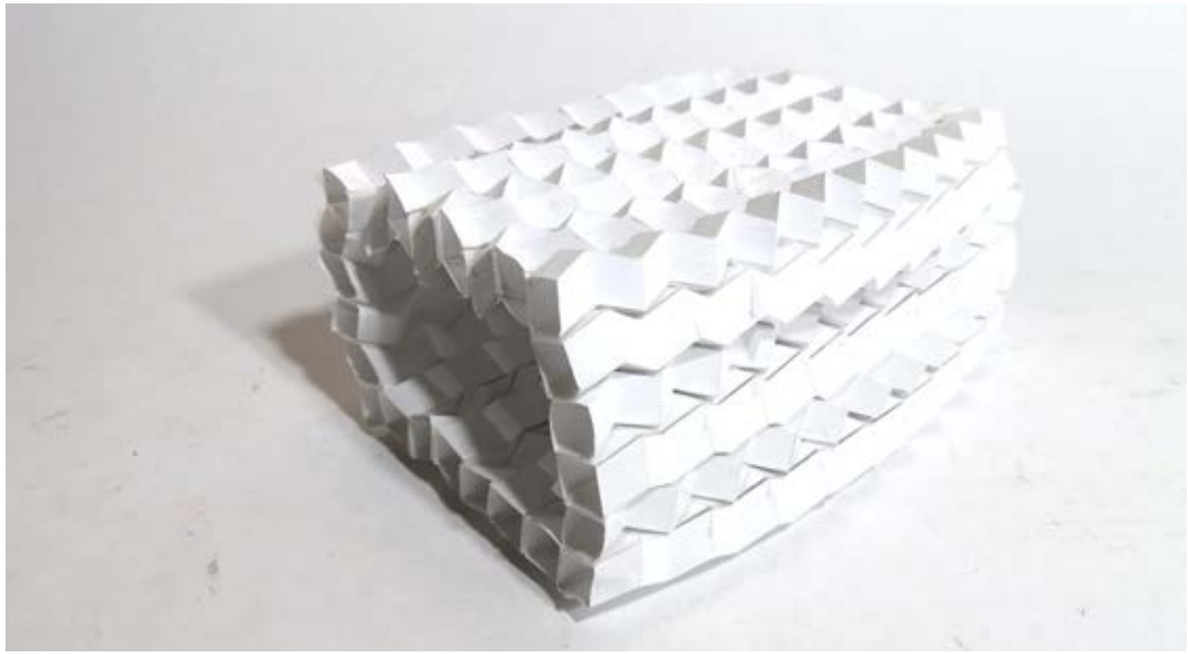


ZIPPER TUBE ASSEMBLY



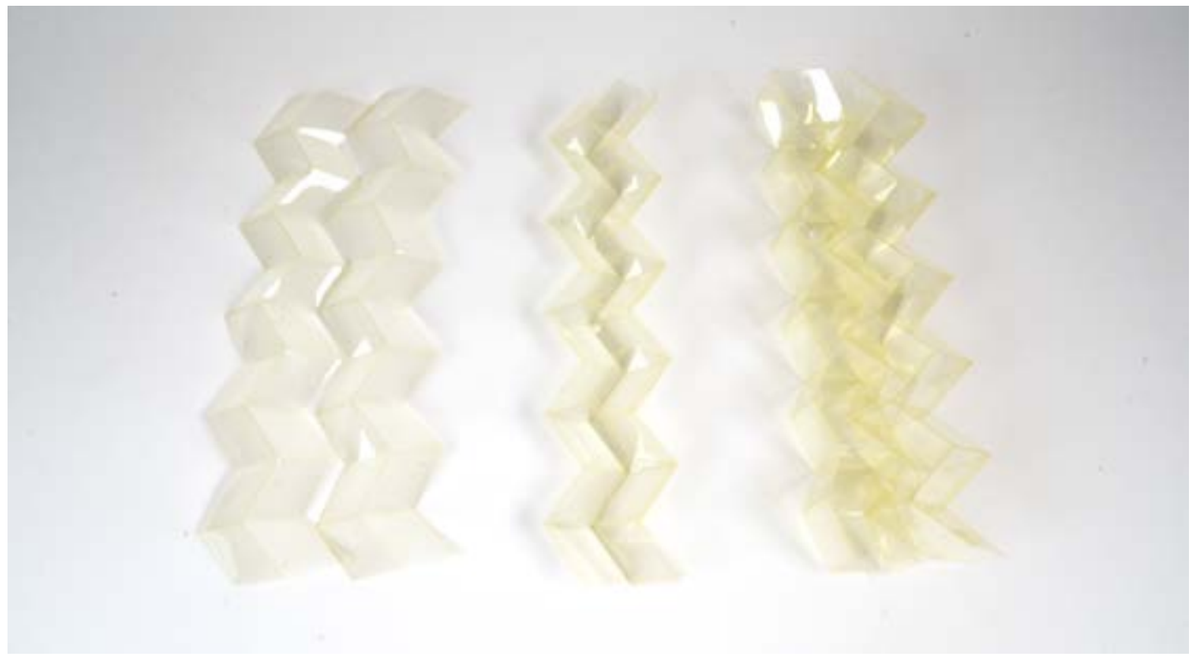
FINAL CONCEPT

HALF-SCALE MODEL OF FINAL CONCEPT

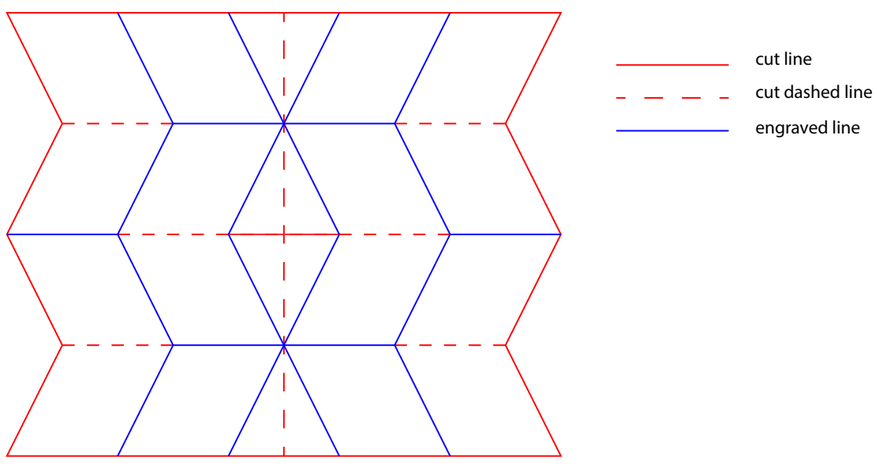


WALL DETAILS

TOP DETAILS

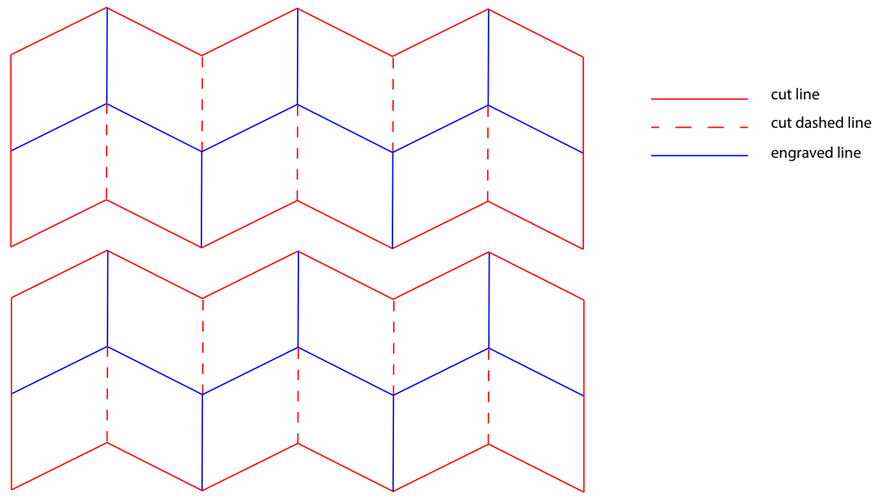


ZIPPER TUBE MADE OF ONE PIECE



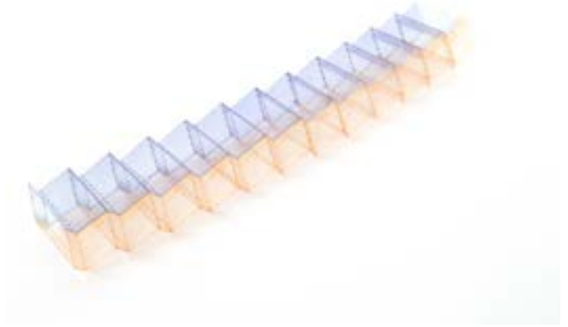
ONE PIECE ZIPPER TUBE LASERCUT PATTERN

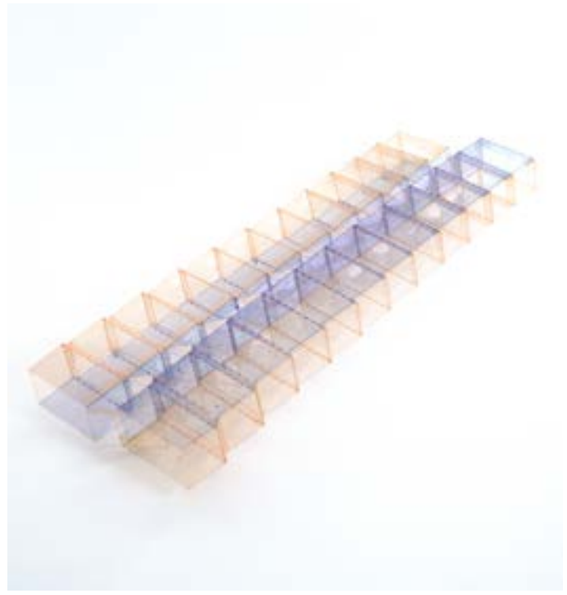
TWO-PIECE ZIPPER TUBE ASSEMBLY



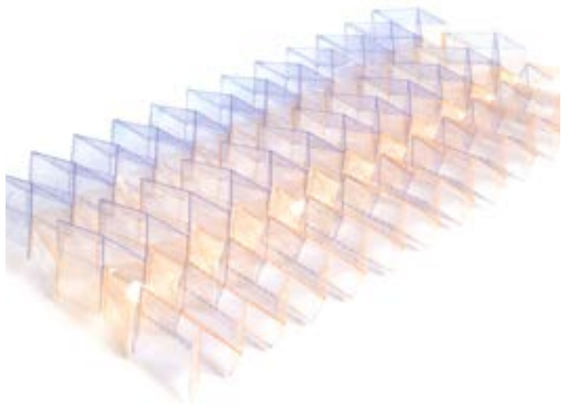
TWO-PIECE ZIPPER TUBE LASERCUT PATTERN

SINGLE DIRECTION ZIPPER TUBE

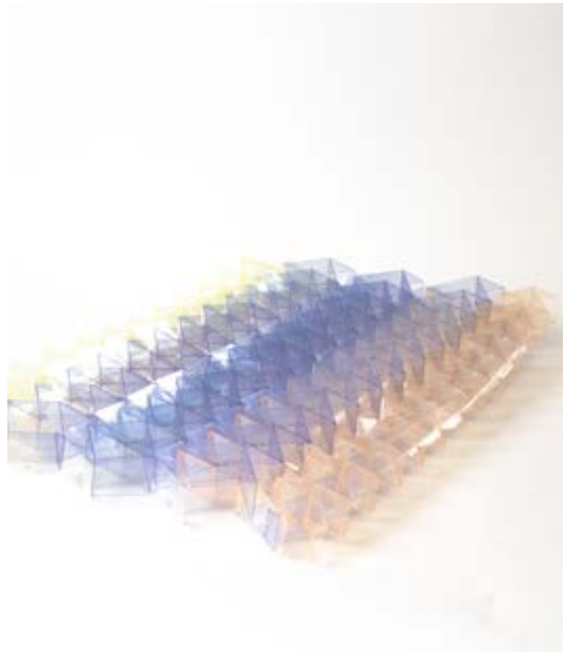


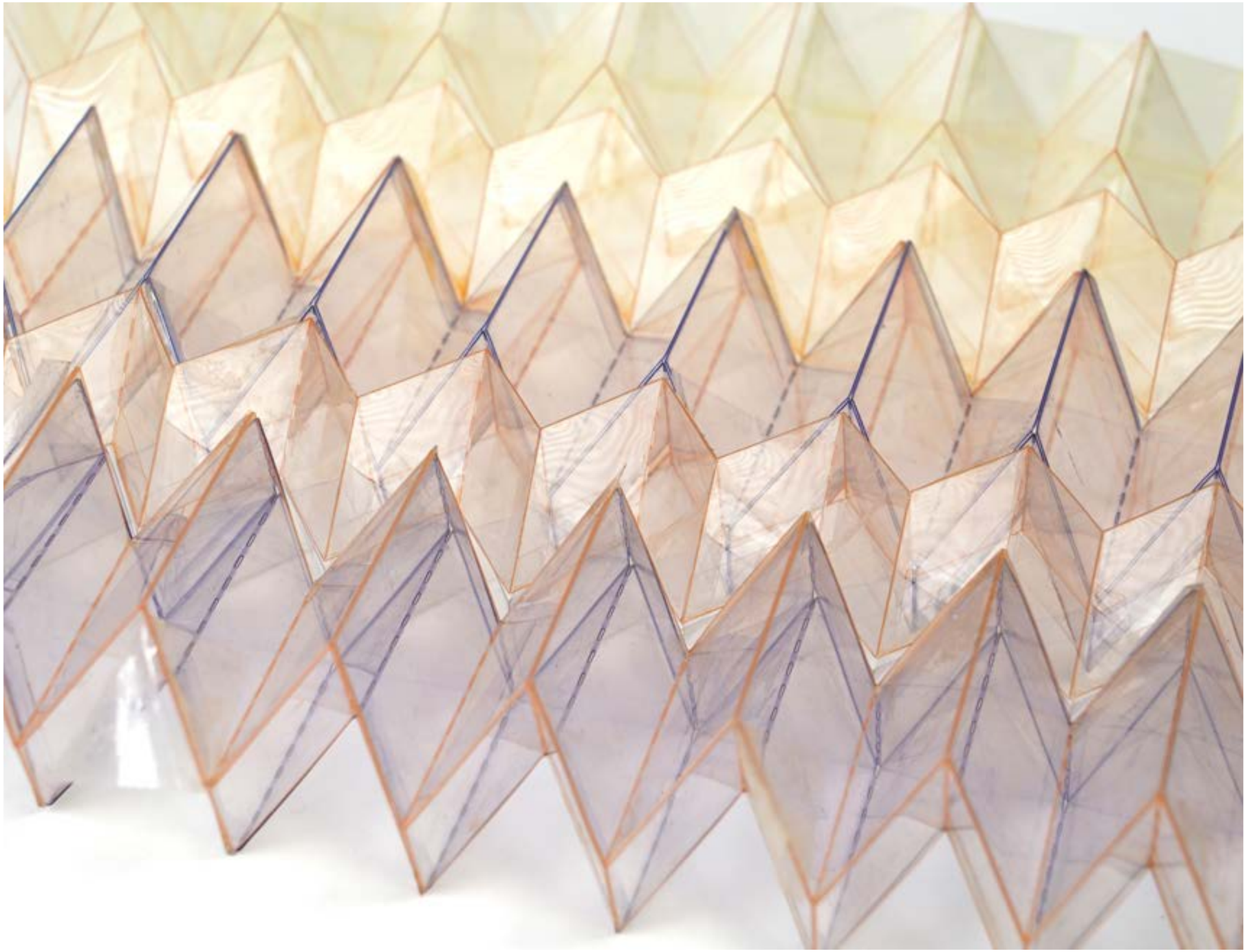


MUCH STRONGER ALTERNATING ZIPPER TUBE



ZIPPER TUBE ASSEMBLY PROCESS



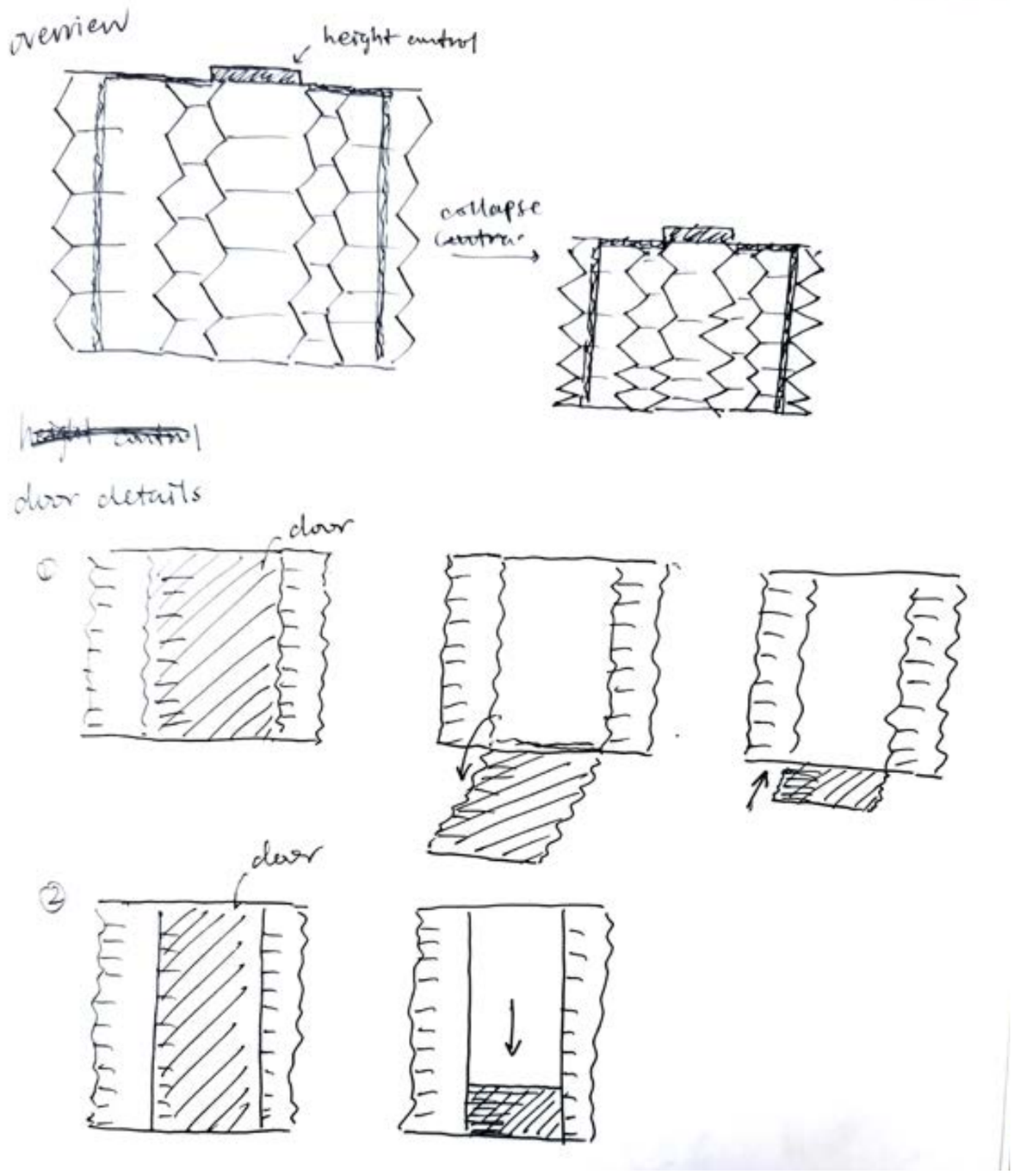


CLOSE-UP DETAILS

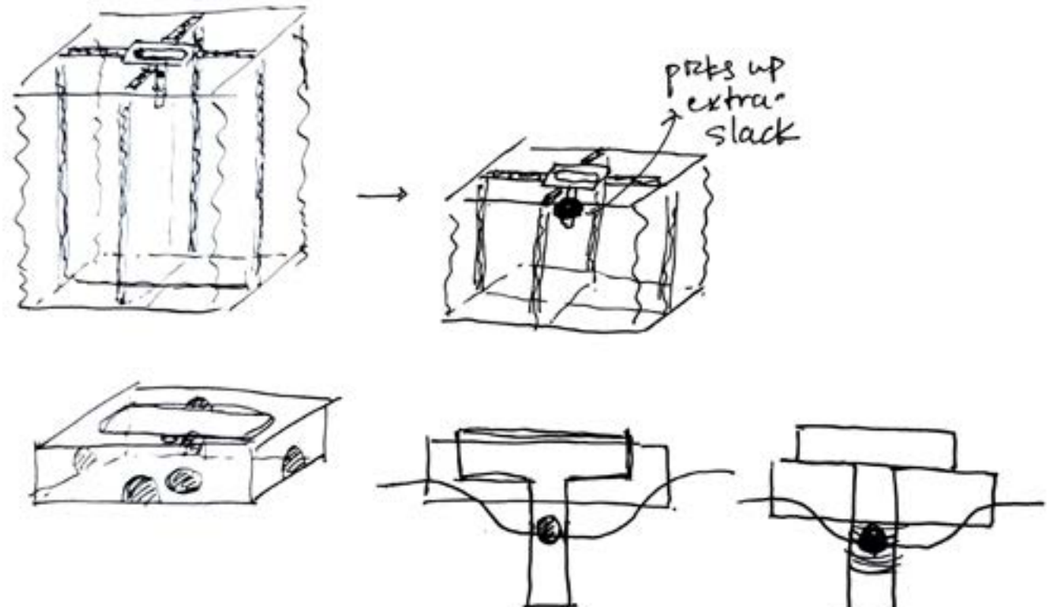
Process and Challenges

After settling on the final concept of using zipper-tube to make strong collapsible luggage, I made the half-scale model out of paper. I lasercut the two pieces for each zipper tube and glued the tubes together. In this process, I discovered that the assembly is very labor-intensive. Thus, when I moved to polyester for the final material, I wanted to come up with a design that can make the zippuer out of one piece. However, after testing, the extra tab required for connecting the two pieces into one turned out to be a issue; it gets in the way when the tube is compressed. Eventually, I switched back to the two-piece design for a single zipper tube. In order to increase efficiency, I tested out different ratio for the height and width of each section of the zipper tube, finding the largest width that can still sustain considerable amount of force.

Each zipper tube was lasercut out of flat sheets of polyester film. Then they were dyed to create the tinted color. Afterwards, they were assembled together to create the shell of the luggage.



FINAL DESIGN SKETCH



HEIGH CONTROL SKETCH

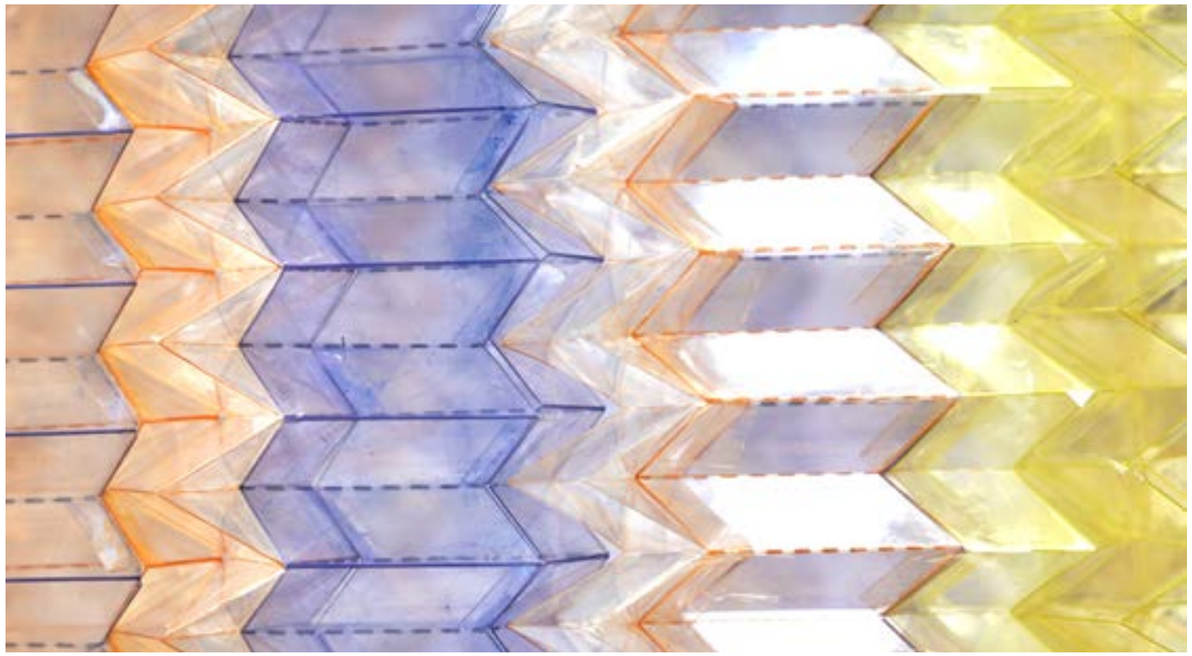
HEIGHT CONTROL 3D MODEL

FINAL DESIGN DEMO

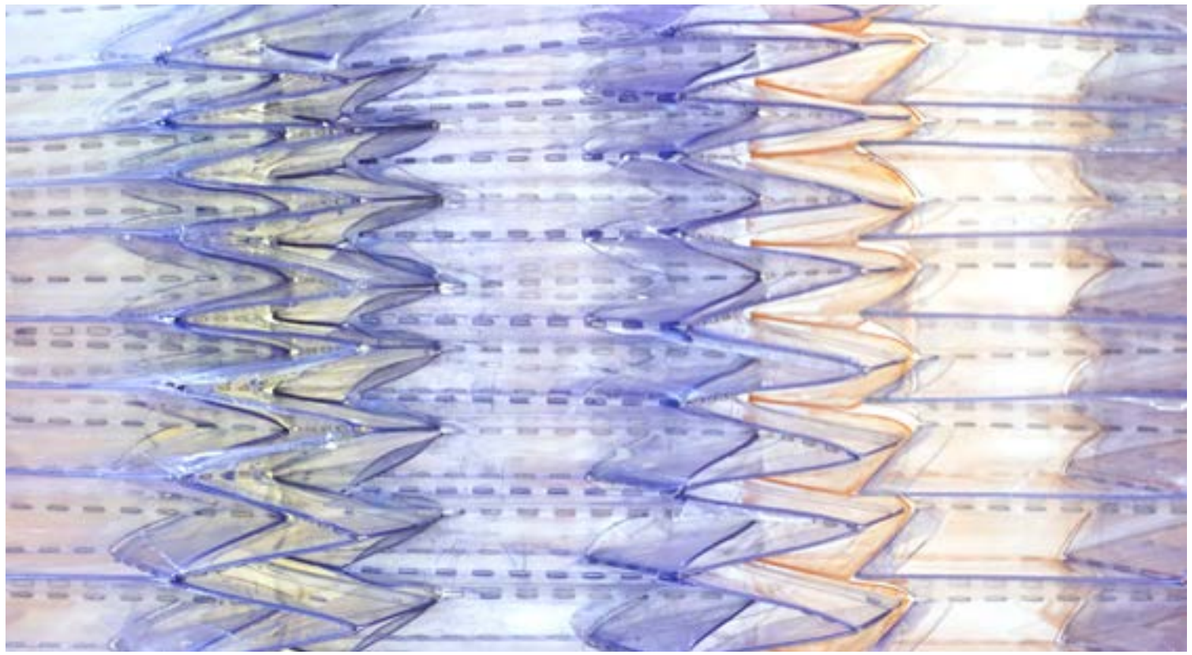
FINAL DESIGN WITH CONCEPTUAL HANDLE

FINAL DESIGN

FINAL DESIGN



UNCOMPRESSED WALL DETAIL

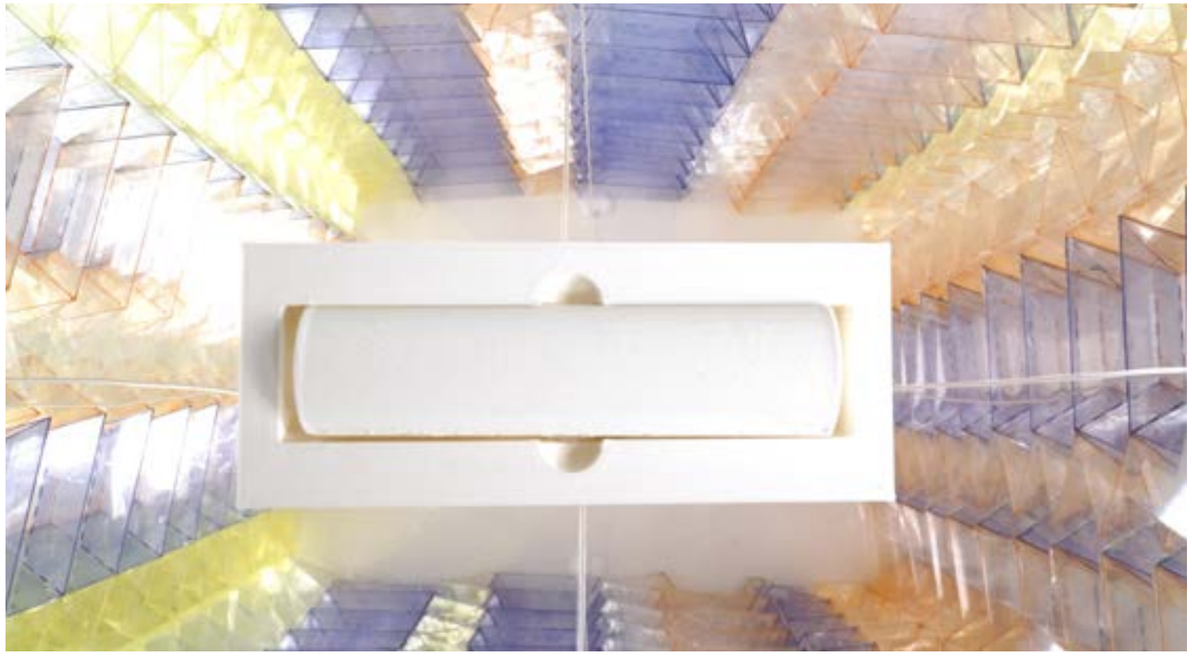


COMPRESSED WALL DETAIL

Image caption / image source

Before collapsed, the luggage is more transparent.

As the luagge is compressed, its color becomes more solid.



Close up of the top handle.

Top handle in action.