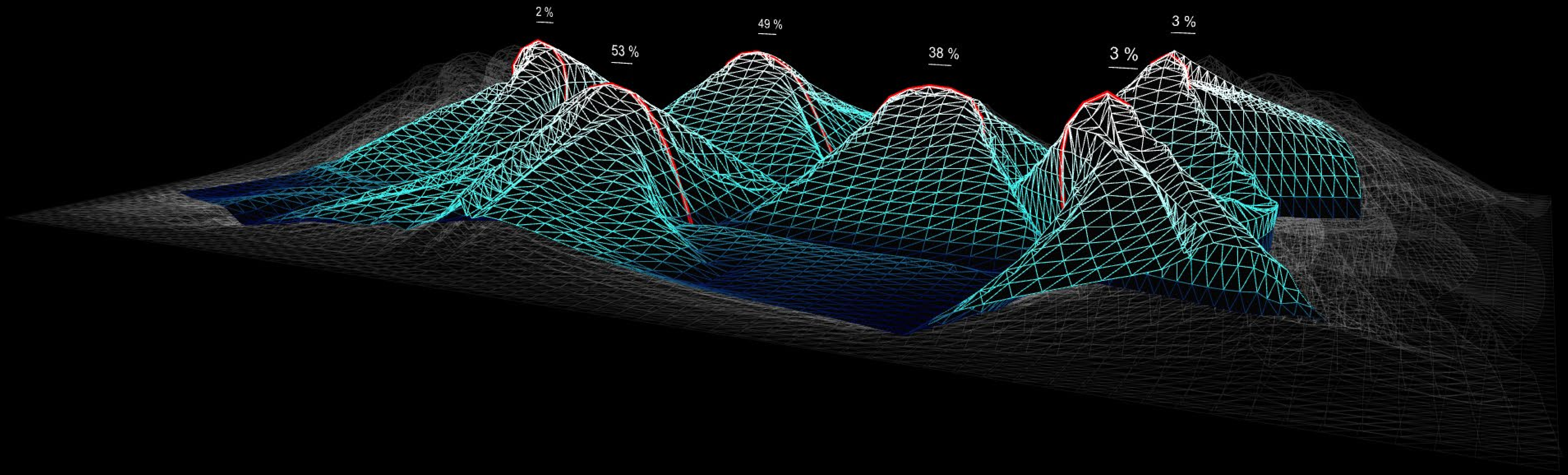
SHAPE CHANGING MATERIALS

FINDING CREATIVE GARMENT APPLICATIONS

8-10 APRIL 2016



THE TEAM

ARCHITECTS - DESIGNERS

NOUMENA

design. research. education

WEARSHOPS

design. interaction

LOCATION

NEW YORK CITY

PARSONS NEW SCHOOL OF DESIGN

MFA Design & Technology Department

PEOPLE

TUTOR + ASSISTANTS

EFILENA BASETA

tutor

architect Engineer / Master in Advanced Architecture / Noumena partner

Efilena is an architect engineer, studied in the National Technical University of Athens (NTUA), with a Master degree in Advanced Architecture from the Institute for Advanced Architecture of Catalonia (IAAC). Having developed several interactive projects, her current interest lies in exploring material properties in order to create real time responsive architectural structures.

GRACE JUN

assistant

designer / Founder of Wearshops / Parsons student

Grace Jun is researcher and designer at Parsons School of Design. Since working in the mobile IT industry, Grace is focused on user centered design and garment construction with electronics. She is Educational Director of MIT-based OpenStyleLab and founder of Wearshops.

JASKIRAT RANDHAWA

assistant

designer / Partner of Wearshops / Parsons student

Jaskirat is a polymath designer. His work focuses on the forefront of emerging technologies in interaction design. He is currently researching material technologies and physical interfaces at Parsons School of Design, NY. Jaskirat is interested in sharing meaningful technologies and experiences that open up discussion for creative endeavors amongst makers.

SCM

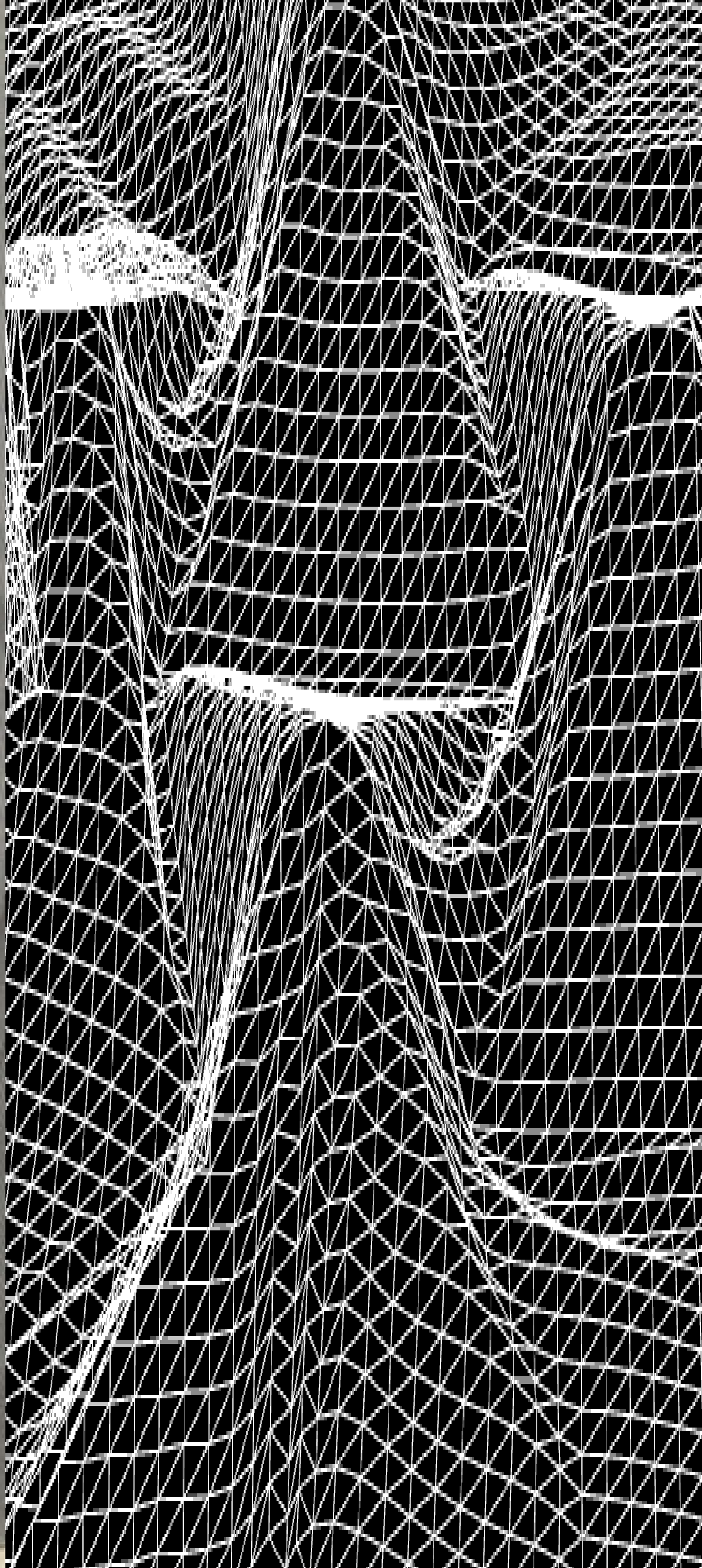
FINDING CREATIVE GARMENT APPLICATIONS

BRIEF

The Shape Changing Materials workshop is a threeday collaborative that explores the potential of shape changing clothing through alternative ways to integrate smart memory alloys (SMA) with fabric. The application of SMA to fabric was visualized through physical simulations using Rhino3D and Grasshopper. Kangaroo, a “live physics engine for interactive simulation, within Grasshopper,” was used to visualize the shape change. The contribution of this work can apply to the fields of wearable technology, material sciences, or textiles. Through a combination of hands-on making and digital simulations, participants were able to imagine shape changing garments or accessories.

INTRODUCTION

The field of design is changing along side technological advancements. Disciplines such as electrical engineering, human factors, or psychology have weaved into design fields and are providing experimental opportunities in wearable technology.
“Research and experimentation in the field of textiles and fashion in the last fifteen years have resulted to numerous projects and products conceived at the intersection of fashion, science and technology.” To explore experimentation in these emerging studies, the workshop was designed as an interdisciplinary collaboration with fifteen participants and three instructors. The workshop team came from different backgrounds of study such as design strategy, architecture, engineering, fine arts, and apparel design. As part of our vision for the future of transformable clothing, instructors and participants trained the SMA and studied its behavior when interacting with different kinds of natural fabric.



SCHEDULE

12 HOURS - 15 PARTICIPANTS

DAY 1

INTRODUCTION TO SMART MATERIALS AND APPLICATIONS

DEMONSTRATION OF SHAPE MEMORY MATERIALS AND SPECIFICATIONS

HANDS ON EXPERIMENTATION WITH DIFFERENT MATERIALS AND SMOCKING PATTERNS

* INDIVIDUALS

INTRODUCTION
MATERIALS & TOOLS

DAY 2

RHINO & GRASSHOPPER INTRODUCTION

EXPLANATION OF PRE-MADE KANGAROO DEFINITIONS

CONCEPT DEVELOPEMENT AND DIGITAL SIMULATIONS OF THE SYSTEM

PHYSICAL PROTOTYPES

* TEAMS OF 3 PARTICIPANTS

DIGITAL SIMULATIONS
OPTIMIZATION OF DESIGN

DAY 3

CONCLUDE TO THE BEST PATTERN FROM THE EXTRACTED DATA FROM THE SIMULATION

PRODUCTION OF THE OPTIMIZED PHYSICAL PROTOTYPE

DATA COLLECTION AND DOCUMENTATION FROM THE PHYSICAL PROTOTYPE

* TEAMS OF 4 PARTICIPANTS

PHYSICAL PROTOTYPES
FABRICATION & DATA COLLECTION

TOOLS/MATERIALS

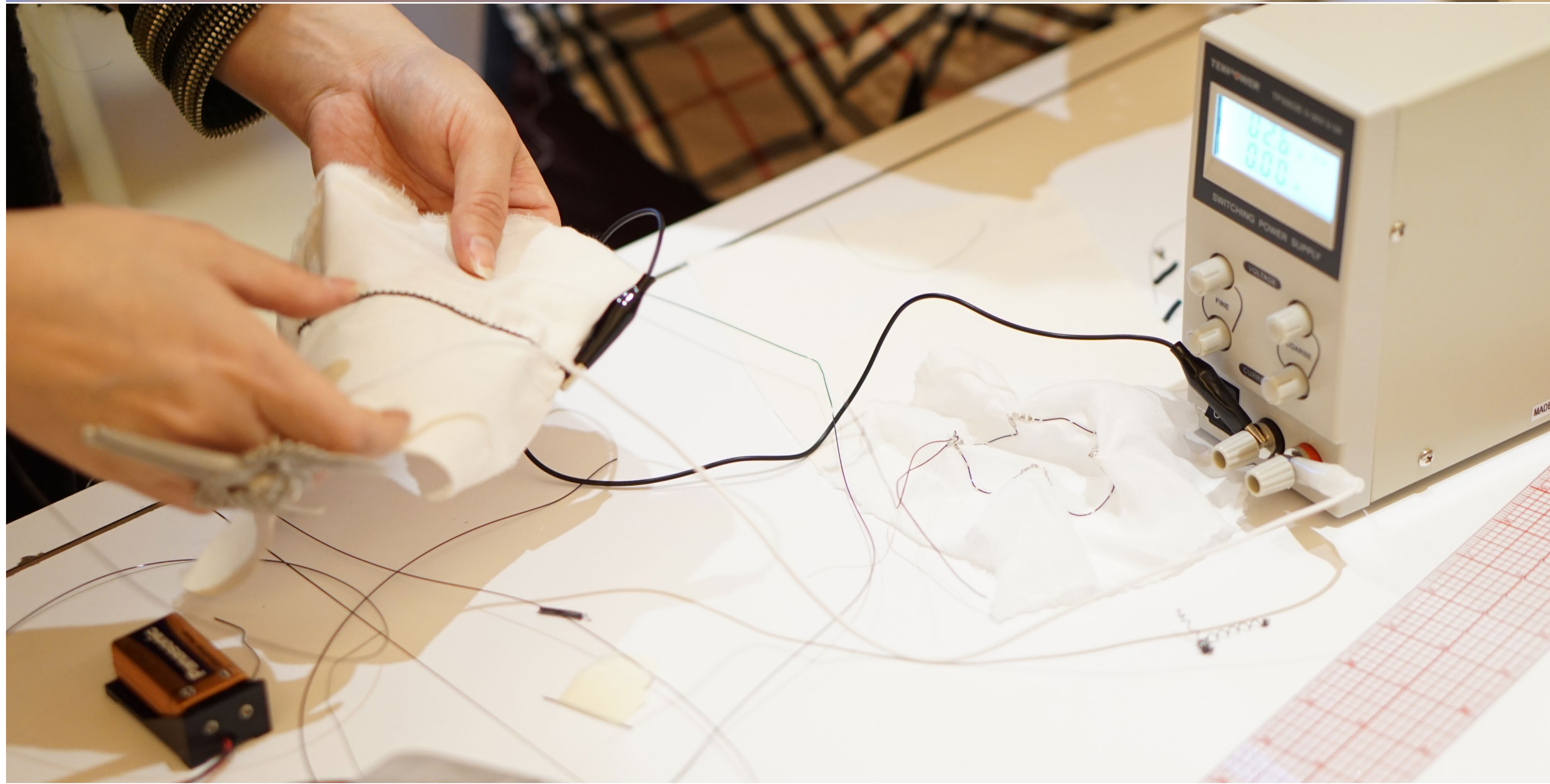
PREPARATION

PREPARATION

Preparation for the workshop included research and tests on different types of Shape Memory Alloy, best practices in connecting wires with fabric, and simulation using Rhino.
The instructors searched for 'ideal' natural fabrics like linen or cotton, and prepared a variety of thickness, weights, and colors. They also researched for the types of connectors. Connecting the SMA to fabric involved a trial and error process using heat-retardant thread and metal or silver crimps. The set of crimps had a diameter that was larger or nearly the same as the SMA wires.

GOALS

The learning goals for each day was to the following:
1. On the first day, participants prepared fabric swatches that embedded SMA using silver crimps, conductive thread, fabric, and alligator clippers. The shape of the swatch transformed when electric power was supplied to the SMA wire. The participants learned to control the transformations through iterative experimentation.
2. On the second day of the workshop, participants were grouped into teams to collectively experiment with hands-on practice with fabric and SMA. They were taught basics of Rhino and application of Grasshopper and Kangaroo for physical simulations. Participants were expected to deliver at least one simulation of their swatch behavior. The goal was to simulate the experiments in software before constructing the final swatches.
3. On the third and last day participants applied learning experiences from the previous two days to deliver final swatches with controlled transformations.



PHYSICAL

SHAPE-SHIFTING PROTOTYPES

TYPES

Many materials are sensitive to temperature and react to cold or heat, such as Shape Memory Materials (SMM). SMM react by changing into a prescribed shape and “can be seen in a variety of materials such as alloys, ceramics, polymers and gels”. This workshop explored two types of nickel/titanium (NiTi) alloy wires.

1 MUSCLE WIRE (d=0.006”)

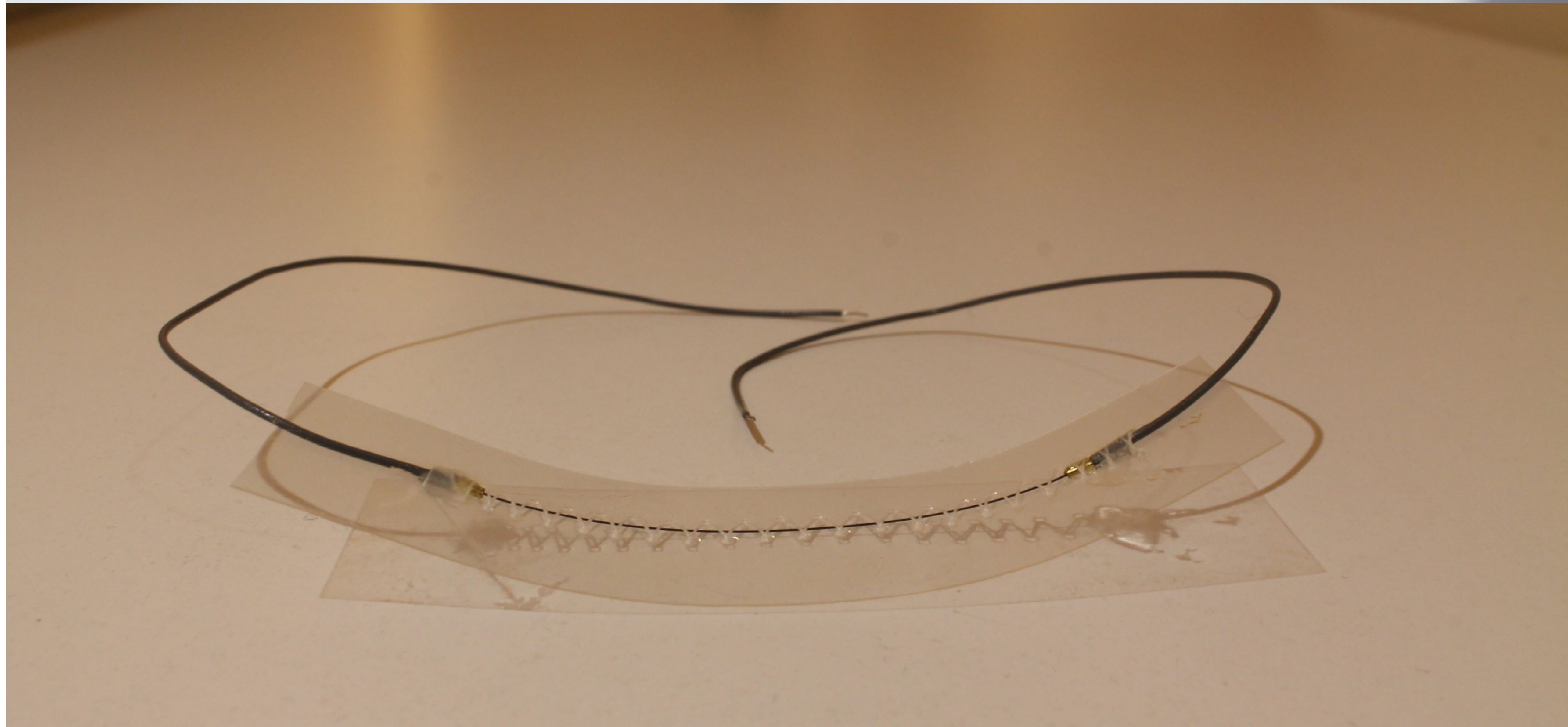
Participants used muscle wire or actuator wire (FLEXINOL® actuator wire) which can be electrical activated or thermally heated to change shape. “These alloys contract by several percent of their length when heated and can then be easily stretched out again as they cool back to room temperature”. The participants used “LT”- Low Temperature type actuator wires and springs of 0.006 inch diameter. Participants were able to sew the wire into fabric through a sewing machine, The Brother CS 6000i. By rapidly sewing on the wire, participants did several tests with different stitch length and pattern combination. The sewing machine has independent controls for the length and width of stitch. Compared to 0.006 inch diameter wires, the 0.008 inch wires were too thick for the machine to handle and created rigid knots that restricted any transformation when the wire were electrically activated. Because the sewing machine has different control panels for the length and width of stitch, it was easy to create many samples using the 0.006 inch actuator wire. The 0.008 inch wires were too thick for the machine to handle and created many knots.

PHYSICAL

SHAPE-SHIFTING PROTOTYPES

2 MUSCLE WIRE (d=0.008” PREMADE BENDSOFT)

However, the 0.008 inch worked best in the pre-made Bendsoft™Demo. BendsoftTMDemo, is 2 inches in length made of high temperature type or (HT) wire. In Bendsoft, the actuator wire is secured to a plastic strip along its length and is anchored using metal crimps at each end. Participants found it was convenient to test several prototypes with a standard product.The electrical power needed per Bendsoft was 2- 2.8 volts. For example, one participant created a visor cap using three Bendsofts placed on the rim. Coin cell batteries worked best for this wearable concept. Because the wire was secured within a plastic frame and already came with anchored crimped wires on each end, participants discovered it was easy to quickly use and apply to other forms. For example, one participant created a visor cap using three Bendsofts placed on the rim. Coin cell batteries worked best for this wearable concept.

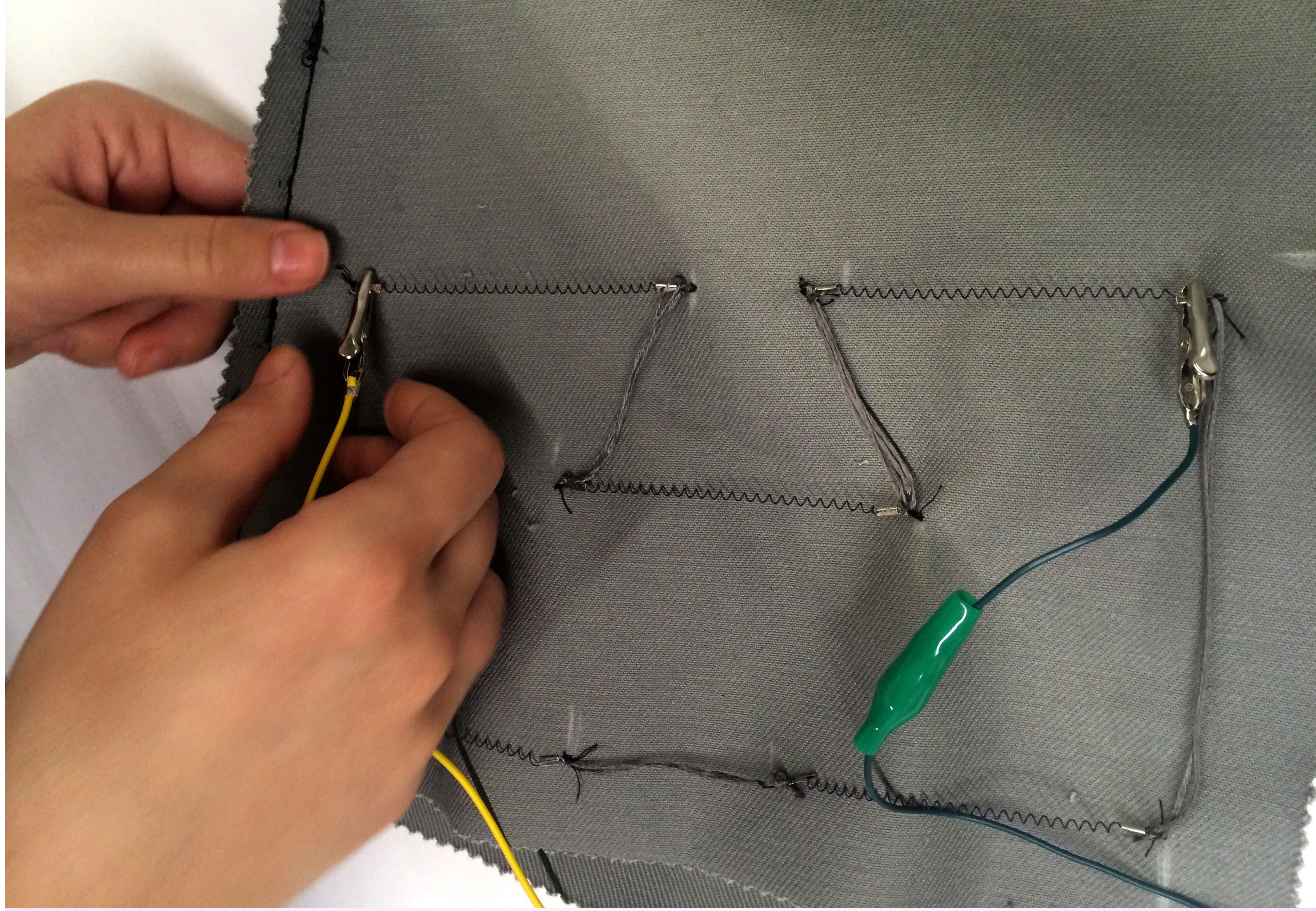


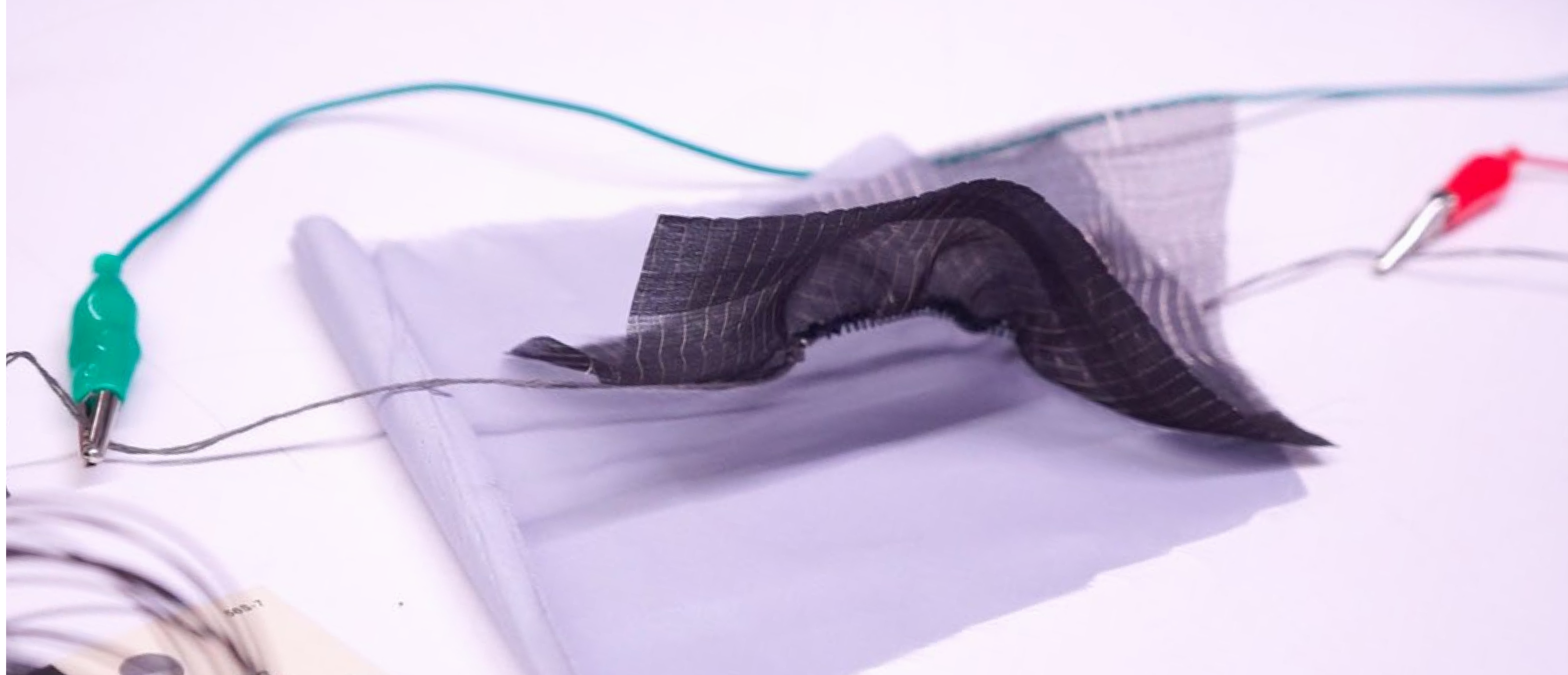
PHYSICAL

SHAPE-SHIFTING PROTOTYPES

3 MUSCLE WIRE (SPRINGS)

Next, workshop applicants worked with the FLEXINOL® springs. The 0.015 inch diameter springs were successfully used in two group projects. The first project, “Animated Wearable” stretched the springs into a straight wire and attached conductive thread at the end with crimps. The concept demonstrated a transformation in material reflection that contracted in 2D plane. The sample piece used a 0.38 mm spring on a sandwiched layer of synthetic black fabric with blue-gray silk. The spring was tied to two acrylic squares that provided weight and aesthetics. The heating time was 1-2 seconds and the cooling time was 8.8 seconds.
The next project aimed to make a vest. The piece used the thickest type of spring actuators, 0.020” (0.51mm), to make a contraction behavior to one of the halves of the vest. With a combination of traditional pattern making and apparel construction techniques, the coils were embedded on the inside of the vest, interlinked using conductive thread. The placement of the springs created pleats on the surface of the vest, when the power was applied to them. The experiment aimed to create self-automated garments which could open and close on it’s own. The potential application for such garments is for people with physical disabilities. “One of the most visible areas of change caused by integration of technology is in garment silhouette and contour: bulky, solid shapes integrated into a flexible textile garment create noticeable bulges and stiff areas in a garment”. The half bodice exemplified the potential of shape change for wearables.



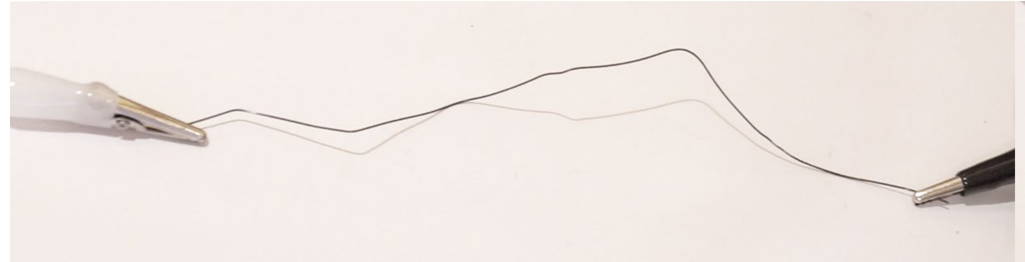


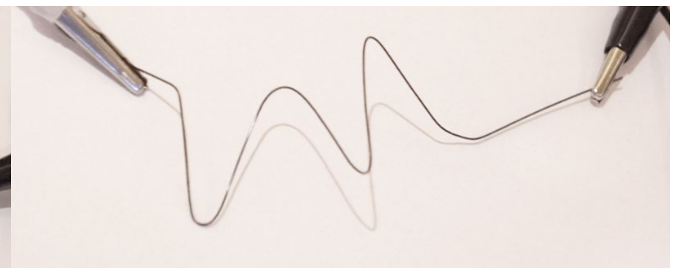
PHYSICAL

SHAPE-SHIFTING PROTOTYPES

4 MEMORY WIRE

The second type of NiTi alloy wire, also known as Memory Wire initially ‘remembers’ a shape when treated with heat. “It simply has to be held in the desired shape and then heated to 500°C in a small oven for a few minutes”. When Memory wire is electrically powered, it retracts back to its original state.
One group of participants conducted an experiment in which one end of the swatch contracted and simultaneously the opposite end expanded across a 2D resting plane. The 0.5mm Memory Wire was treated to follow the triangular contours of the gray viscose fabric. The team successfully created a simulation of its change in Rhino. One group conducted an experiment that used both ends of a fabric swatch to move in opposite directions. The 0.5mm Memory Wire created a wave-like behavior in the gray viscose fabric. The team successfully created a simulation of it’s change in Rhino. They witnessed a 20% contraction effect on the total length of their 60cm wire.
Another team created a simulation and prototype of an interactive wearable shoe, “The R2DShoe.” The team’s concept envisioned a flap that automates expansion of the opening of the shoe to help the wearer easily wear it. The team attached the Memory Wire onto a 1mm thick lambskin fabric and conducted a contraction analysis using the pattern of the shoe flap.





DIGITAL

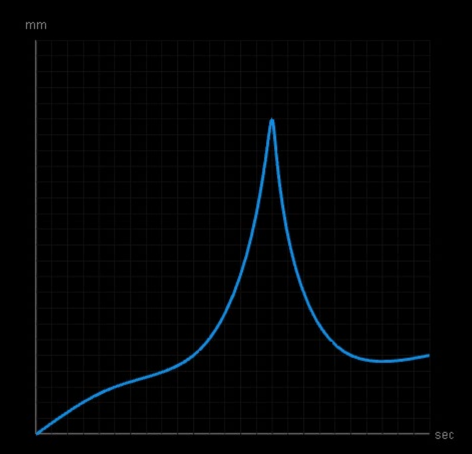
SIMULATIONS

ENVISIONING SHAPE CHANGING WEARABLES

The potential to imbue clothing with emerging technologies and functionality, was examined through hands-on experience of embedding SMA into fabrics, skillfully envisioned through digital simulations. The second half of the workshop explored those visualizations and simulations to predict the behavior of the experiments with high fidelity. The second half of the workshop explore visualization and simulation techniques for these behavior changes.

SOFTWARE USED

In order to optimize and inform the shape shifting prototypes, we simulated beforehand their movement digitally. For the simulations, Rhinoceros3D and its plug-in Grasshopper have been used. Because Rhinoceros3D is an accurate 3D modeler that supports mesh design.The different types of textiles have been represented by mesh geometries with less or more polygons according to their flexibility. Grasshopper, is a visual programming software where the creation of computational algorithms allow real time interactivity between the user and the design. Finally, the add-on Kangaroo enabled physics simulations.



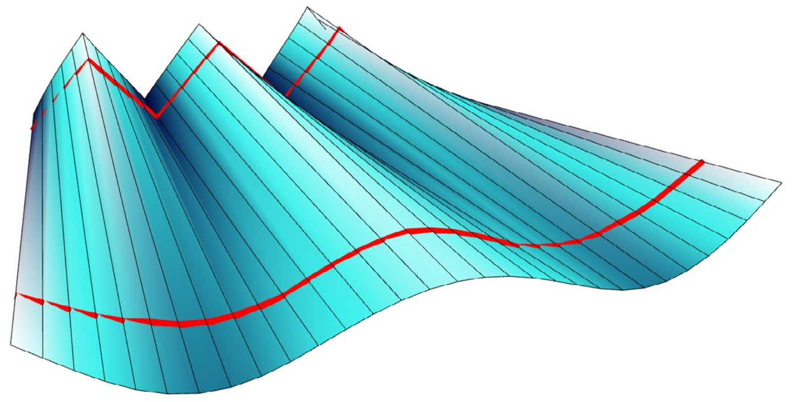
DIGITAL

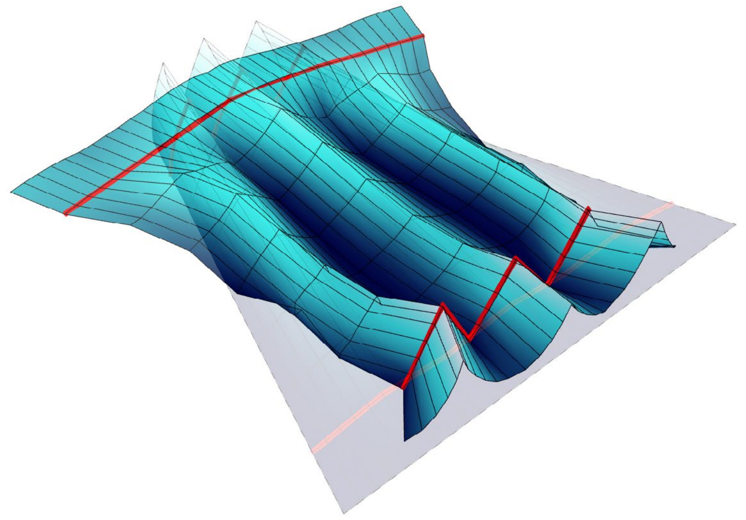
SIMULATIONS

KANGAROO PHYSICS

Kangaroo is a real time, interactive engine, which allows the manipulation of the time parameter and the introduction of other possible external factors, such as wind, or human interference. Using Kangaroo, the forces applied by the smart alloys onto the textiles were used as input data for the digital deformations. Another input parameter was the flexibility and the elasticity of the fabric, represented by Kangaroo Springs with different stiffness. Internal forces cause shape-shifting in these kinetic material systems. According to the written algorithm, we could automatically extract data as an numeric output such as the following: a) Shape memory alloy contraction, b) Textile contraction, c) Time needed, d)Energy consumed

The participants discovered realistic simulations and numeric data could be achieved by using the aforementioned software. Simulating the material system behavior before developing the prototypes gave them the opportunity to optimize their design in terms of desired deformations and efficiency in a short amount of time. However, there was no direct connection between the input parameters of the physical prototypes (Voltage, Current) or for the digital simulation (Unary forces, Springs).



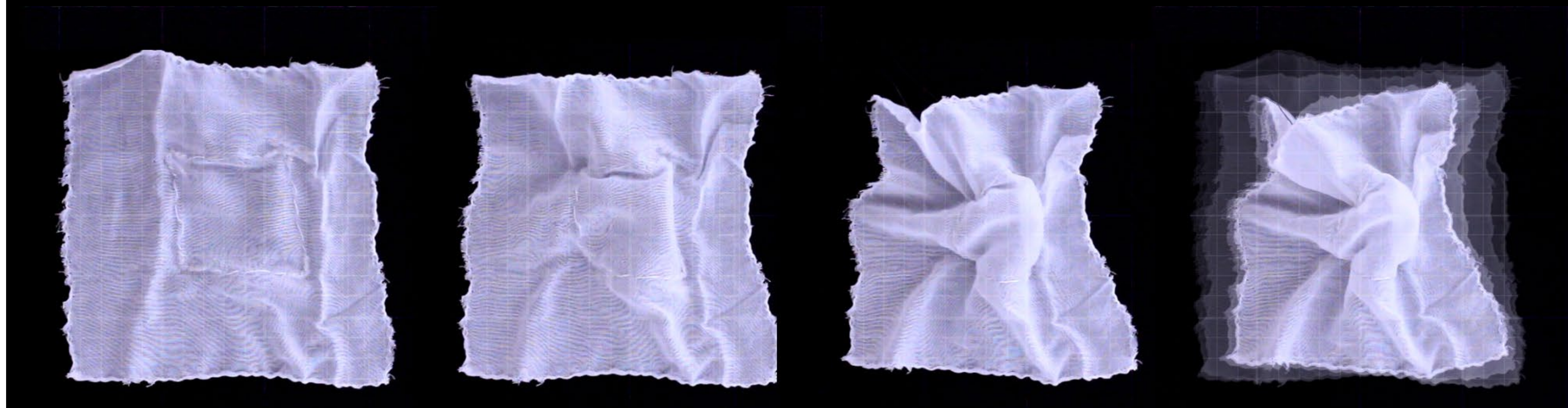


DIGITAL

SIMULATIONS

SIMULATION RENDERING AND RETOUCH

The digitalization of material behaviors of a kinetic system (wearable, fabric, smart material etc.) can add various values to the design, both during the design process and towards the final product. As mentioned before, digital simulations support designers to optimize their compositions according to different parameters. Extracting numeric data, designers can minimize the amount of material used, the material waste, energy consumed and simultaneously maximize the desired shape-shifting. A digital simulation of a kinetic product can inform the users about its behavior and also can be used as a visual manual and demonstration.



LINKS

NOUMENA

workshop webpage:http://noumena.io/?page_id=12431
workshop video: https://vimeo.com/164613734
noumena website: http://noumena.io/

THANK YOU

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