PORTFOLIO

DESIGN INNOVATION

MATERIAL DRIVEN

Francesca Perona

2017

TEXTILE CHEMISTRY

Leading scientists in the research for circular fibres solutions and non-toxic chemical treatments for the textile industry

LIQUID FACTORIES

A new paradigm for textile fibers production and post-consumer waste recycling

RESPONSIVE HYDROGELS

Designing bio-inspired macro and micro-patterned sensing materials for future skin-care products

SHAPE MEMORY POLYMERS

Collaborating with industry to identify and test smart materials to enhance packaging solutions and manufacturing processes

CERAMICS FABRICATION

Igniting innovation in the local industry by blending robotics and traditional craftmanship

ARTIFICIAL MINERALISATION

Harnessing biomineralisation through microfluidics to sequester CO_2 and produce safe materials

TEXTILE CHEMISTRY

Deep Science Ventures
5 months project
2017

Only designer in a community of top scientists and engineers brought together to rapidly explore huge challenges in industry, discover opportunities and build the next generation of high growth science-based ventures.

I teamed up with polymer chemist Dr. Sandra Amaral and synthetic biologist Dr. Vivek Raj Senthivel to leverage their scientific know-how for the design of more sustainable textile fibres.

I reached out to industry leaders to discuss feasibiity of the proposed solutions and understand challenges in the adaptation of the supply chain.

1 Problem framing

Fire Retardant chemicals are applied to home furniture, children products, bedding, mattresses and children nightwear to improve fire safety and meet strict regulations.

However, various studies have demonstrated that chemicals sprayed on and embedded in these products, since not chemically bound to the substrates, can mobilise and escape into the local environment and accumulate in house dust.

Once in the dust, these toxic chemicals are ingested and build up in the body. They have carcinogenic and neurotoxic effects, act as endocrine disruptors, and are linked to decreasing male and female fertility.

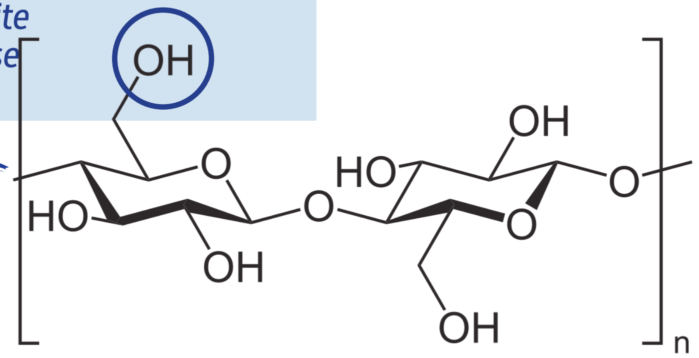
2 Research

We researched:

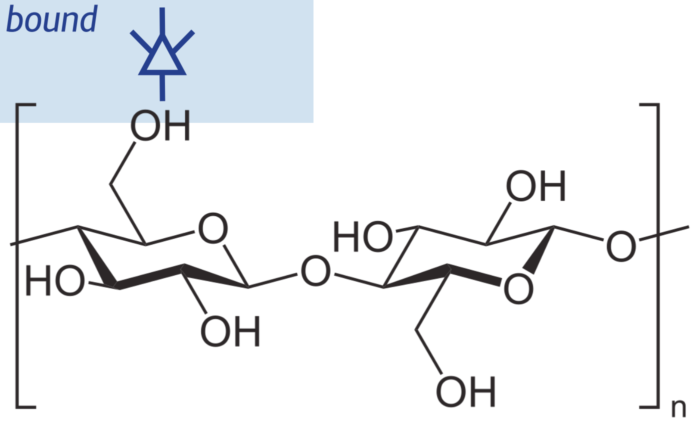
- most widely used chemicals
- supply chain processes
- costs to industry (home textiles, children nightwear, contract textiles)
- solutions implemented by industry leaders (IKEA, Camira UK, MADE.com, Matalan, Centre for Textile Excellence, MADE.com, Debenhams, Huddersfield University, De Montfort University)
- material innovation in research phase

From toxic fire retardant chemicals to safe fire resistant fibres

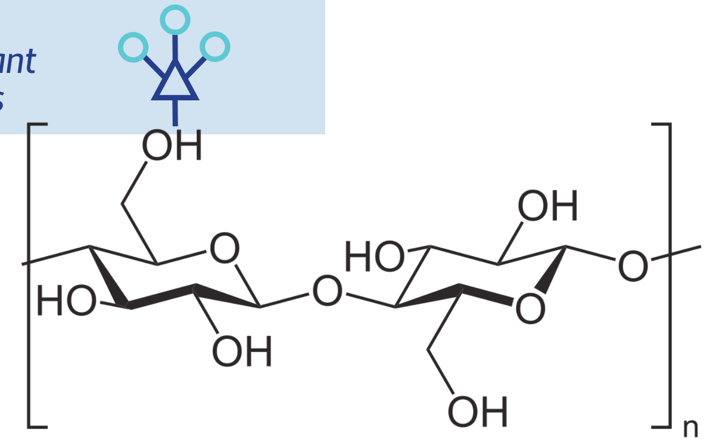
Reactive site on cellulose polymer



Covalently bound branching molecule



Safe fire resistant molecules



3 Material Innovation

We investigated how to move from toxic fire retardant chemicals to safe fire resistant fibres, focusing on the enhancement of cellulosic fibres.

Based on the Phd research of my my chemistry collaborator in the field of drug delivery, we adapted particular molecule structures used in her work to bind covalently to cellulose, creating a chemical bond with the fibre.

These molecules are able to bear (n) active compounds that in contact with fire release substances that can block the development of the flame.

Our solution:

- is based on safe molecules
- the active compounds are strongly bound to the fabric
- we can customise the molecules to hold more particles to achieve increased fire retardancy

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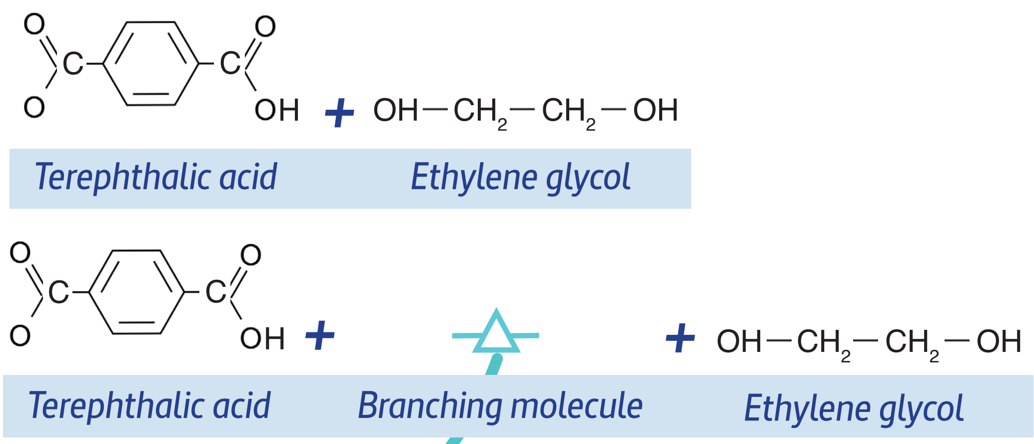
Transforming polyester in a modular polymer for infinite recyclability of dyed textile fibres



1 Problem framing

Mechanical recycling of plastic bottles in polyester textile fibres (rPET) is a commercially available option.

The main limitations of this recycling technology are:

- the colour of the raw material: only light blue and light green bottles can be recycled into fibres, since the textile industry requires to easily dye the resulting in any colour
- this process can only be performed once, since recycling of coloured fibres presents similar challenges

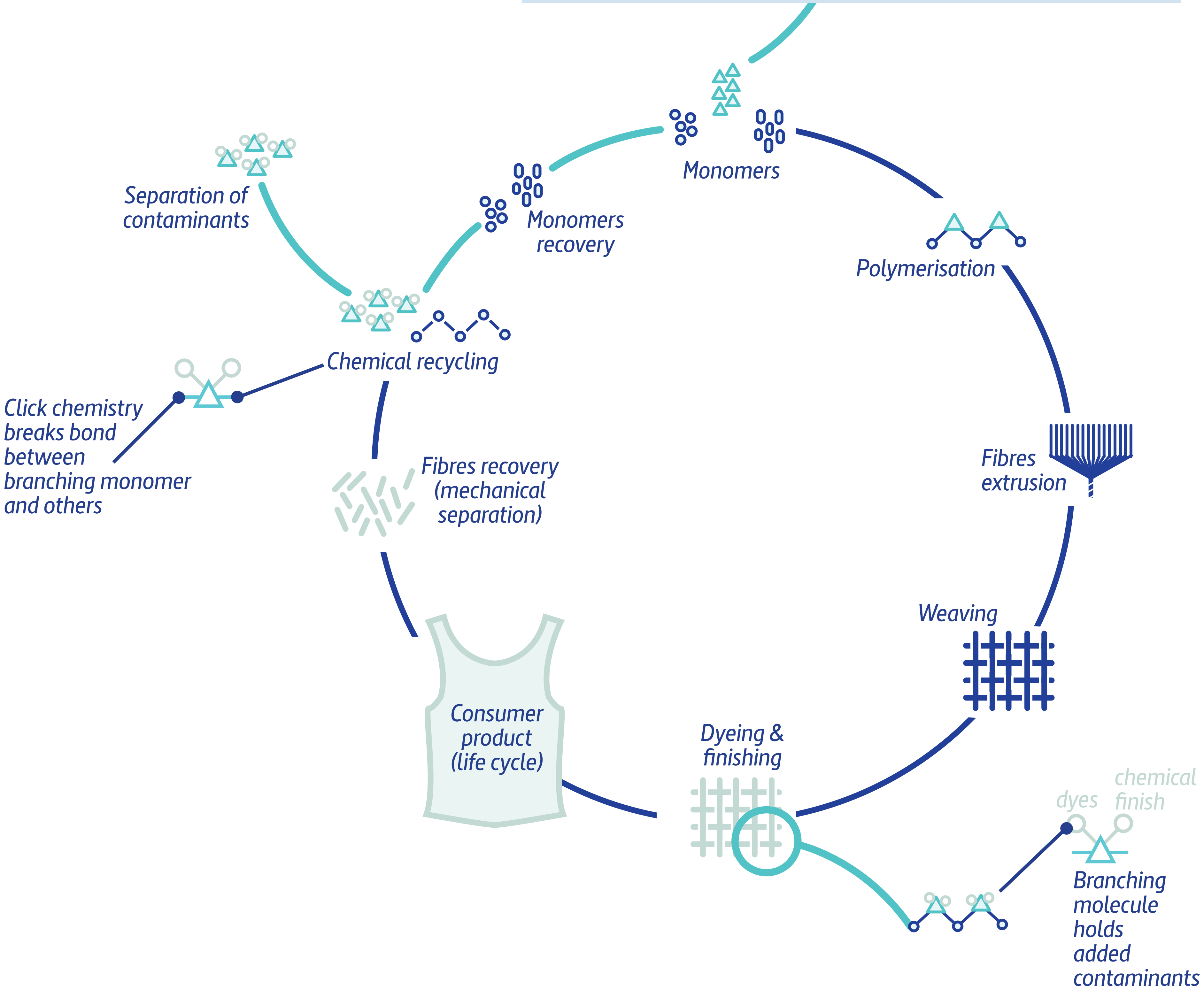
Few companies undertake polyester chemical recycling, de-polymerising the material into the original monomers.

Although this process allows to produce a higher value fibre, it is an expensive process, and few companies in the world claim they can actually separate the monomers from the contaminants (dyes) present in the polymer mix.

2 Research

We researched:

- the polyester supply chain (raw materials to post-consumer waste recycling)
- material life cycle
- costs to industry
- solutions implemented by industry leaders (I:CO, Camira UK, Huddersfield University, Centre for Textile Excellence)
- chemical recycling processes in research phase



3 Material Innovation

We designed a modular polyester polymer for easier chemical recyclability of coloured and finished polyester fibres.

We propose to add a monomer in the polyester polymerisation process that can link the 2 original monomers without compromising the material properties.

Instead of dyeing the polymer with hydrophobic dyes, hydrophylic dyes would attach to the particular structure of the added monomers, as well as the added textile finishes.

At the end of the life cycle, the modular polyester would be returned to the chemical recycling company that would be able to target the chemical bonds between the 3 monomers to separate them and obtain the original polyester monomers.

This process can be repeted multiple times, preserving the properties of the material, and allowing to remove the contaminants attached.

Deep Science Ventures

LIQUID FACTORIES

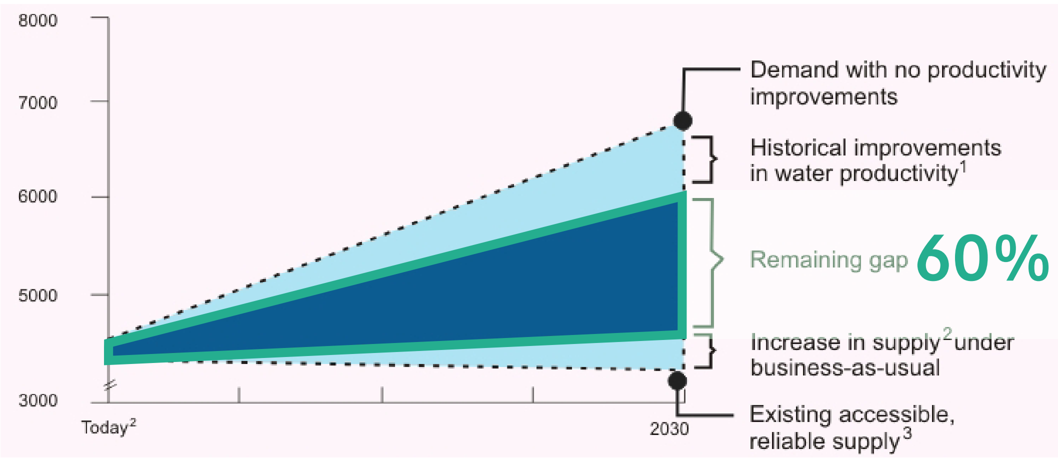
1 Problem Framing

The water footprint of cotton is huge. 1kg of cotton lint requires 9.000 liters of water.

Although only 2.4% of the world's crop land is planted with cotton, it accounts for the 24% global insecticides and 11% pesticides sales respectively.

The run-off of pesticides, fertilisers and insecticides contaminates rivers, lakes and wetlands, altering the ecosystem.

21.3 million tons of cotton were produced in 2017. 73% of post-consumer cotton waste ends in landfills.



Water demand projections for 2030

1kg cotton = 9.000 lt water

Current plantation practices

- Although GM pest-resistant cotton strains have been implemented, studies have shown that farmers have used the same amounts of pesticides as with the non-gmo plantations.
- Global brands have invested in initiatives for sustainable sourcing of raw materials. Promoting better farming practices, they have positively impacted workers' conditions and reduced the usage of pesticides and water.
- Wood pulp is an alternative souce of cellulosic fibers. Lenzing is the world's leader in this field, with sustainably processed pulps resulting in high quality lyocell and viscose. Unfortunately most of the lyocell production is still extremely polluting, and dangerous for both factory workers and the environment.

Alternative solutions to cotton plantations are needed

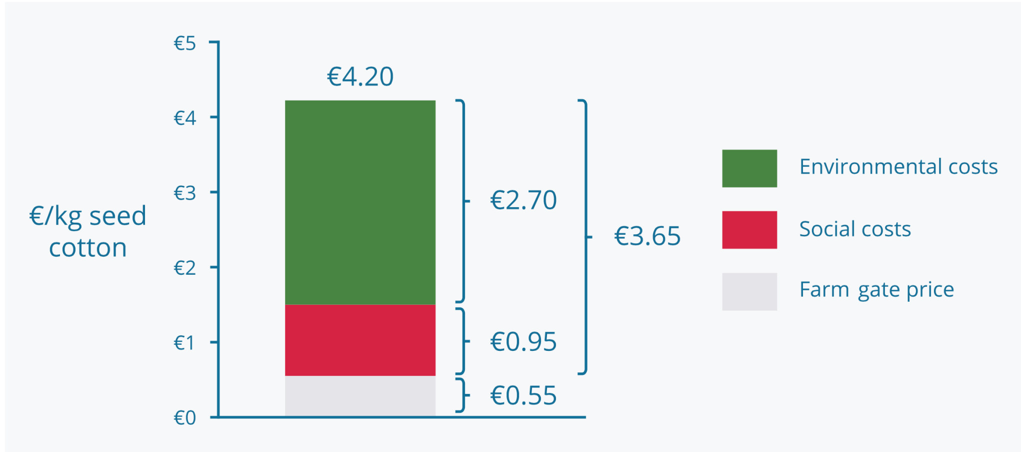
Meeting the needs of the growing human population in the next 50 years will require increasing availability of land and water for food crops.

Although sustainably sourced cotton and man made cellulosic fibers are valid approaches, alternative solutions to cotton and wood plantations are needed.

Barriers to recycling

Considering the annual cotton waste production figures and the growing interest in circular models, cotton recycling would seem an effective solution.

However, one of the major barriers to the implementation of alternative solutions is the very competitive price of virgin cotton (in particular when exploitative approaches are still in use and when the environmental and human costs are not considered).



The true price of cotton from India - IDH & True Price report 2016

In addition, fast fashion consumers are not ready to spend more for more sustainable or recycled materials, meaning that any innovation has to be as cost-effective as current fibers and easy to integrate in the current supply chain.

Innovative materials also need to prove as easily dyeable, resistant to wear and as comfortable as the current fibers, which also requires research and development efforts.

73% cotton waste ends in landfills

Can we make textile recycling economically competitive?

Post-consumer textile waste collection, sorting and mechanical recycling also prove economically challenging, although brand initiatives exist.

Mechanical fiber separation technologies also compromise fiber length and as a result, recycled fibers quality is lower.

In addition, the majority of post-consumer textile waste is mixed, with separation of different fibers also proving expensive.

How can we transform recycling processes in economically sustainable solutions?

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NEW APPROACH

From liquid collagen produced by yeast and coiled and spun into leather, to sustainable materials grown at increasing speed by waste-degrading mycelium, to chemically recycled post-consumer textiles dissolved and spun for a second life, the new frontier of textile production is a **liquid revolution**.

In which ways can we take advantage of precipitation, dispersion, binding, compression, molding and drying processes to create new and sustainable **forms of materiality**?

Bolt Threads
Modern Meadow
MYCOWORKS
piñatex
Biosteel.
nanollose

Can we produce plant-free cellulosic fibers, reducing water consumption and nutrients foot-print?

1 Bacterial cellulose

Acetobacter Xilinum is the most prolific bacterium at producing cellulose found in nature. It transforms the sugars dissolved in the liquid medium in tiny cellulose fibrils.

Could we engineer this natural mechanism to produce wearable cellulosic fibers?

2 Bottle-necks

The perceived issues with bacterial cellulose for textile applications are:

- production yield (slow process)
- identification of low-cost feed (waste sugars)
- fiber properties (the material tends to absorb the 94% of its weight in liquid)
- bioreactor optimisation for scale-up

We have found that the cristallinity of the nano-fibrils can be controlled. Average cristallinity seems to be between 2.500 and 9.000 DPE, with wood-derived cellulose being around 10.000 DPE.

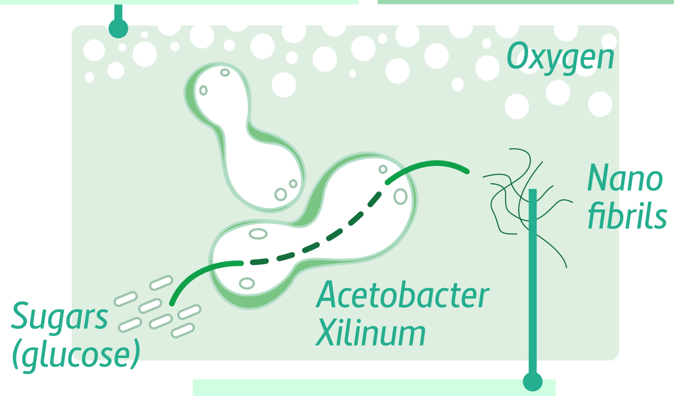
Question remaining open is the water demand for the production of the same quantities of dry cellulose.

3 Advantages

The advantages are:

- plantation-free production
- elimination of typical cleaning processes required by cotton bales

	TRADITIONAL SUPPLY CHAIN	BIOFABRICATION	
raw material production	PLANTATION	BIOREACTOR	
	PICKING		
refining processes	GINNING BALING		
	OPENING CLEANING MIXING	BACTERIAL SECRETION	
	CARDING / COMBING	MAT DRYING	FIBERS EXTRACTION
	DRAWING ROVING		
textile production	YARN SPINNING	TEXTILE DYEING	YARN SPINNING
	YARN FINISHING	TEXTILE FINISHING	YARN FINISHING
	WASHING		WASHING
	WEAVING		WEAVING
	TEXTILE DYEING		TEXTILE DYEING
	TEXTILE FINISHING		TEXTILE FINISHING



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4 **Opportunities**

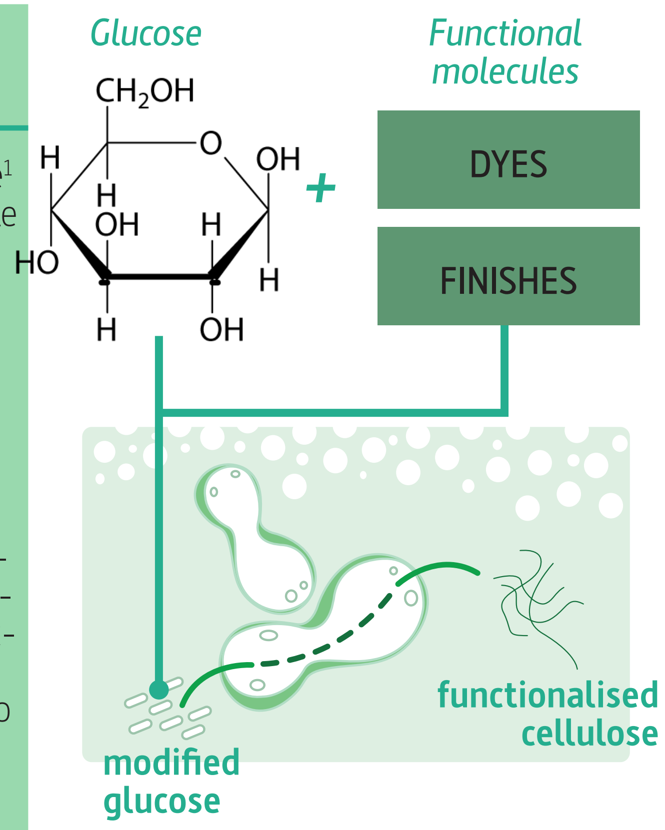
Single-step fibers production and functionalisation

Modified growth medium for synthetis of functional fibers and materials

A recent study published in Nature[1] has demonstrated that it is possible to grow cotton in petri dishes, feeding its ovule directly with modified glucose molecules. The study used glucose linked to fluorescent molecules, and showed how resulting cotton fibers grew with fluorescent properties.

Inspired by this study, we hypothesise that it could be possible to dissolve in the growing medium functional molecules, which absorbed by the bacterium, would allow it to synthesise 'functionalised' fibers, potentially eliminating steps such as traditional dyeing and finishing processes.

[1] *Biological fabrication of cellulose fibers with tailored propeties - 2017. Natalio, F. et al.*



Photosynthetic and cell-free cellulosic production

The advancement of research in the field of synthetic biology is also highlighting the possibility of:

- transferring cellulose production mechanisms to photosynthetic organisms such as cyanobacteria[2] to eliminate need of sugars
- engineering cell-free systems to improve yield
- recognising strains of carbohydrates from complex molecules, therefore potentially being able to feed cellulosic waste rather than sugars to the bacterial culture

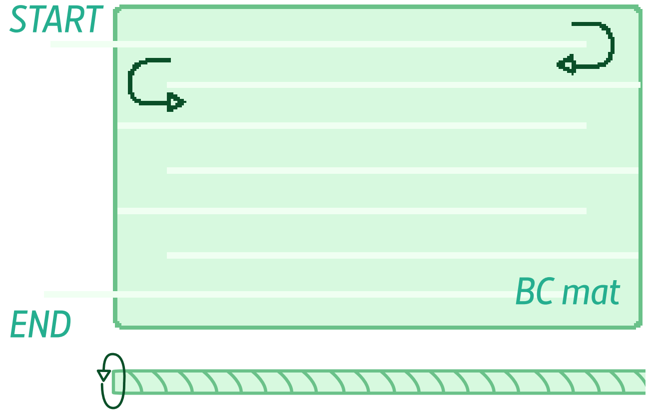
[2] *"The Brown lab has achieved a functional transfer of Acetobacter xylinum cellulose synthase genes into cyanobacteria."*

Synthetic approaches for increased efficiency

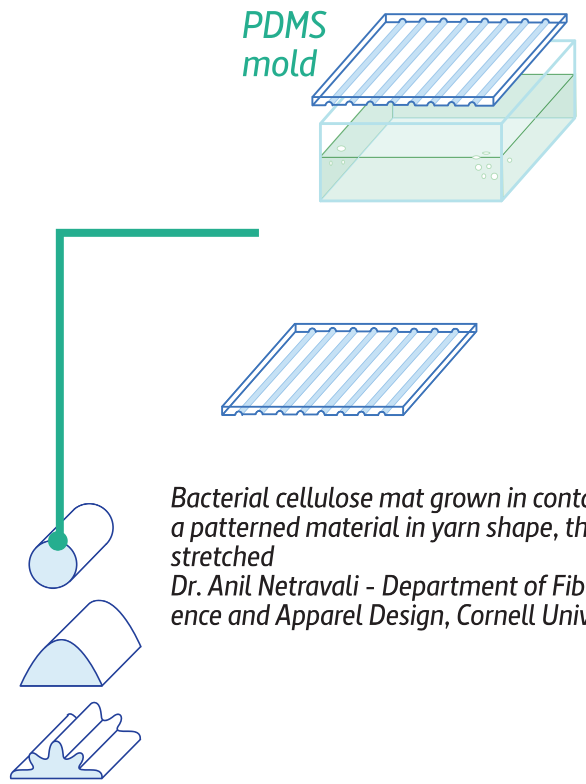
'Growing' yarns and non-wovens

Direct yarn and non-wovens production

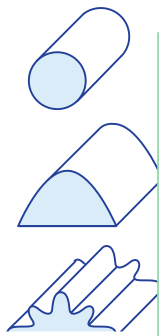
Current research in bacterial cellulose fabrication methods also shows how specific static bioreactor designs can directly form macro-fibers from bacterial cellulose mats, although both processes illustrated below are hardly scalable.



Bacterial cellulose mat, cut and twisted like a yarn
Dr. Koon-Yang Lee, Future Materials Group, Imperial College London



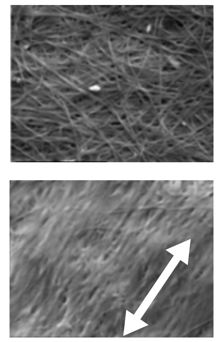
Bacterial cellulose mat grown in contact with a patterned material in yarn shape, then wet-stretched
Dr. Anil Netravali - Department of Fiber Science and Apparel Design, Cornell University



This second method allows to reach a greater alignment of the microfibrils by restraining the space for the bacteria to move freely in the tank, as well as a variety of fiber section designs.

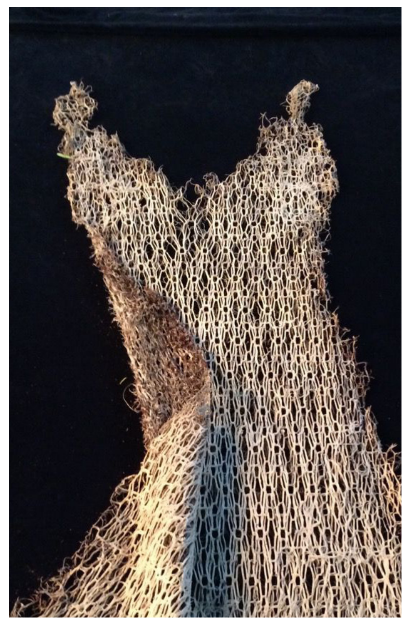
What different properties would moulded threads have?

Could we engineer different fiber directionalities?



Artist Diana Scherer has been exploring for years the possibilities afforded by growing plant root systems on templates, training them to produce lace-like fabrics.

Taking advantage of the pdms mold method, would it be possible to create similarly complex non-woven and finished designs?



Exercises in root system domestication
Diana Scherer

Deep Science Ventures

Can we up-cycle mixed post-consumer waste in an economically sustainable way through bacteria?

1 Fibers recycling state-of-the-art

A number of companies working in the field of textile recycling have recently made huge progress in both chemically recycling cotton and preserving its properties, as well as chemically separating polyester from cellulosic waste.

In the cotton chemical recycling process ionic liquids seem to be the most effective. Although environmentally sustainable, the cost of these green chemicals is still high.

In general, although these recycling initiatives receive funds to support lab scale research, few companies are actually ready to scale-up their production at competitive prices.

Although cotton and polyester dominate the textile fibers market, collecting and sorting companies such as H&M partner I:CO highlight the huge challenge in separating fiber types, since most garments are produced with mixes of 3+ fibers.

In addition, separation of contaminants such as textile finishes and dyes from the used fibers also proves challenging. Most of the recycled materials are in fact white, leaving out the majority of the available quantities.

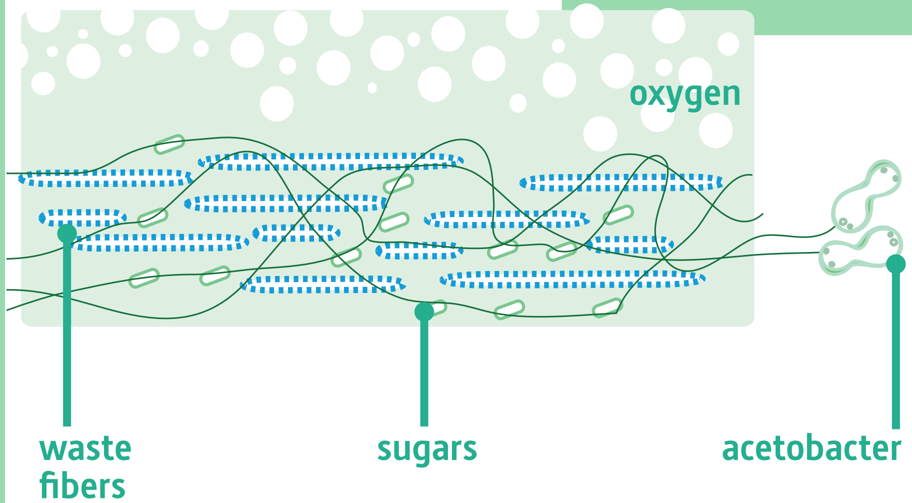
2 Opportunities

Bacterial cellulose as binder

Since bacterial cellulose production is slow, would the dissolution of post-consumer textile waste in the growth medium speed up the mat formation?

Could we take advantage of bacterial movement in the bioreactor as a 'binder' compacting and tying existing fibers together?

Could we tune the material properties with different waste sources?



Digestion and binding processes borrowed from Nature

Mixed waste digestion processes

Recent innovation in fields such as architecture have taken advantage of bacterial secretions in new, unexpected ways. For example, biomason is a brick whose sand dust has been set in the solid form by a binding agent produced at room temperature by bacterial colonies.

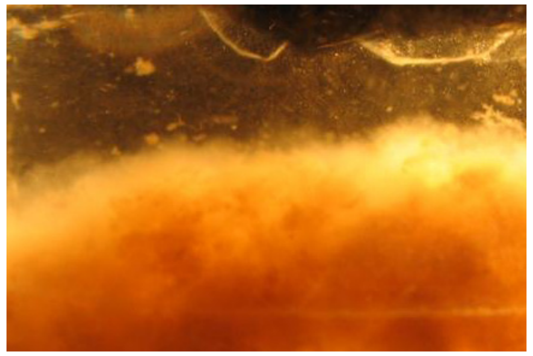
Mycelium has also been used to digest various forms of waste. If the mycelium is seeded in a mixture with textile waste sources, it will grow in the interstices, while also digesting the compounds. Once the process is over, the mycelium can be baked for a short time, and the final material consolidated.

Few conversations with industry experts emphasized how pulling post-consumer waste streams together could be key to developing effective recycling strategies.

How could we take advantage of natural binding and digestion processes to process mixed textile waste?

Coould we co-culture different bacterial colonies and organisms to obtain different material properties?

Could partnerships with companies such as Ecovative and Biomason allow to explore this space?



Liquid Mycelium

Biomason bacterial brick

Bacterial cellulose mat

Mycelium leather

RESPONSIVE HYDROGELS

Horizon 2020 materials for consumer products
Northumbria University
5 months project
2014

This design research project was developed for Philips Design & Innovation, in collaboration with their Design and Research Departments.

Our team was brought in to explore the current consumer products landscape and identify innovative material platforms that could be integrated to enhance product functionalities (Horizon 2020), as well as to identify applications that could open new business opportunities.

As research assistant, I developed the design concepts and the prototypes from conception to fabrication.

Human-centric design approach for the identification of consumer needs within stakeholders business platforms

PROMOTE HEALTHY SKIN

- DAILY ROUTINE
- SPECIFIC NEEDS

PRODUCT PLATFORMS & SERVICES

- SKIN CARE
- PERSONAL CARE
- BEAUTY
- MALE GROOMING
- ANTIAGEING
- PARENTS & KIDS
- ELDERLY
- PAIN MANAGEMENT
- CONTINUAL PERSONAL HEALTH
- HOSPITAL 2 HOME

1 Identify needs

Our team mapped consumer needs across different business areas and through different age lenses.

I focused on skin-related issues, both in terms of daily routine and specific skin conditions.

Working with our stakeholder we identified opportunites in the development of a monitoring platform for skin health.

KNOW YOUR SKIN

MEASURE + MONITOR

UV PROTECTION
PIGMENTATION
VITAMIN D LEVELS
SUN DAMAGE

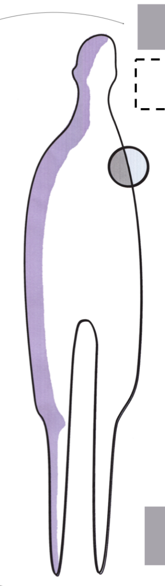
EXTERNAL FACTORS
AIR QUALITY
WATER QUALITY
TEMPERATURE
HUMIDITY
UV EXPOSURE

SKIN HEALTH
ELASTICITY
ROUGHNESS
TEXTURE
HYDRATION
TEWL
SEBUM

CLEANLINESS
SKIN FLORA
PH LEVELS
ALKALINITY OF SOAPS
MOISTURISERS EFFECTIVENESS
WATER TEMPERATURE

SWEAT
SWEAT RATE
BODY HYDRATION
SALT CONTENT

DAILY ACTIVITY
SLEEP
NUTRITION
STRESS



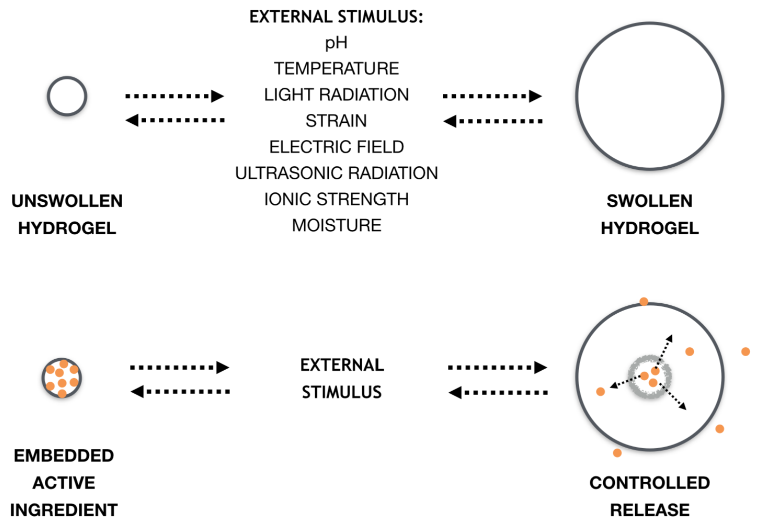
UNDERSTAND
GIVE GUIDANCE BASED ON YOUR SKIN

MOTIVATE
EMPOWERMENT THROUGH INTUITIVE INTERFACES
COACH INDIVIDUALS THROUGH INTUITIVE INTERFACES

INTERVENE
ENABLE EFFECTIVE SKIN SELF CARE AT ALL LIFE STAGES
ENABLE EFFECTIVE SELF CARE IN ALL CONDITIONS

- PROTECT OR ENHANCE NMF
- MONITOR SKIN PH
- SELECT RIGHT SOAP FOR YOUR SKIN
- RELEASE EMOLLIENTS
- BALANCE SKIN PH

Identification of material platform from literature review



INHERENT PROPERTIES

SOFT
FLEXIBLE
STRETCHABLE
WEARABLE
BIOCOMPATIBLE

ENGINEERED FUNCTIONALITIES

TUNABLE SENSING

SELECTIVE RESPONSIVENESS
SWITCHABLE RESPONSIVENESS
MULTI-FUNCTIONALITY (bi-composites)

TUNABLE ACTUATION

SMART RELEASE (by volume change)
SHAPE CHANGE

- COMFORTABLE SUBSTRATE
- SIMPLIFICATION OF DAILY RITUALS
- INTUITIVE COACHING (SIMPLE VISUAL INDICATOR)
- TAILORED MATERIAL SENSOR
- BASED ON INDIVIDUAL SKIN NEEDS
- TAILORED ACTUATING SYSTEM
- IMMEDIATE FEEDBACK

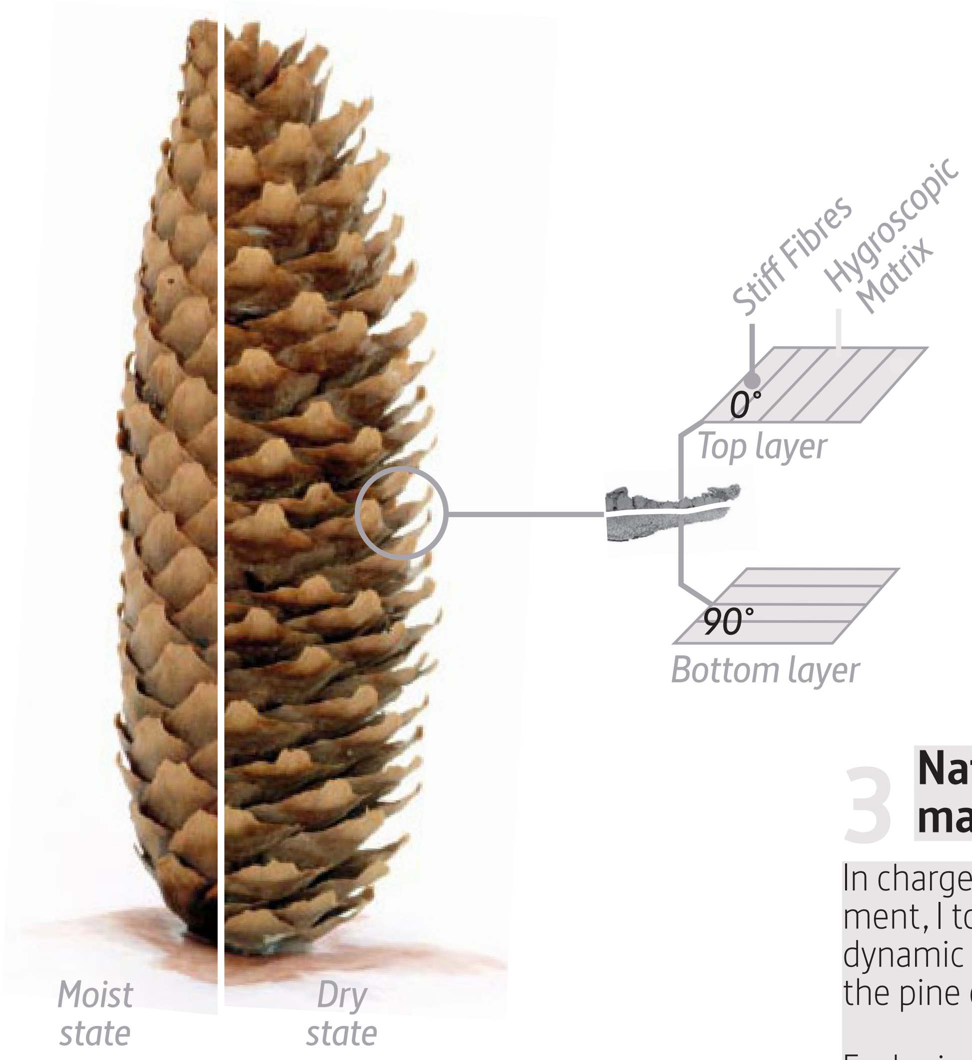
2 Materials research

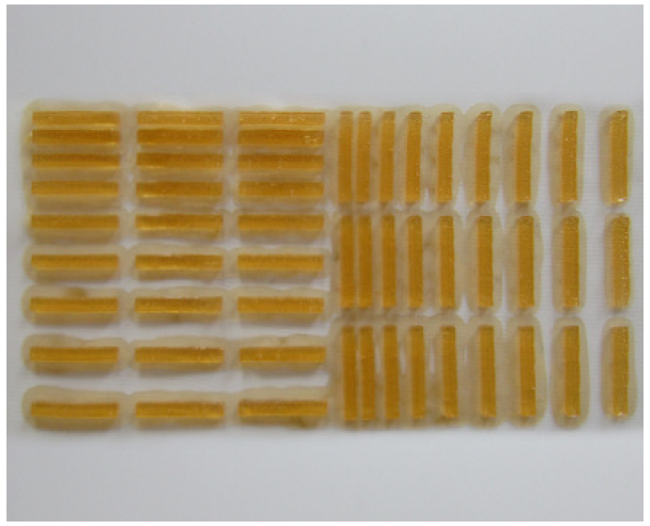
Having scoped the scientific literature for innovative materials, we identified responsive hydrogels as ideal responsive material interface for the project development.

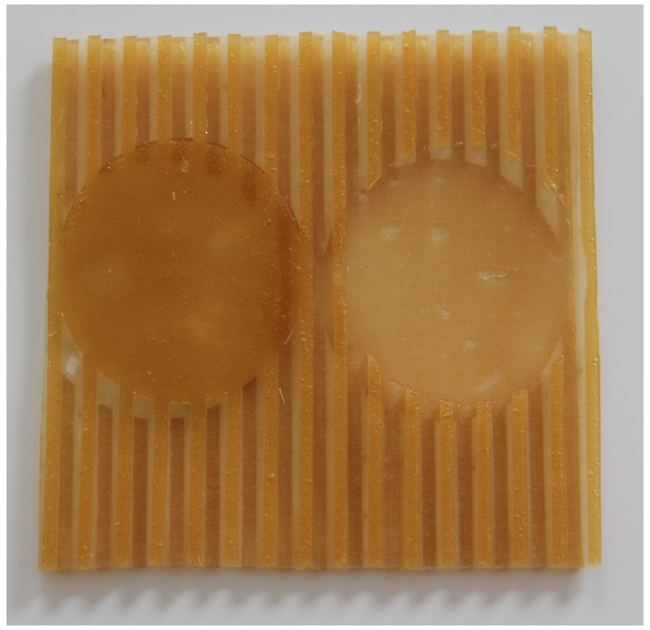
We mapped and discussed the material properties we considered relevant for skin-based products with our stakeholder.

PHILIPS

northumbria UNIVERSITY NEWCASTLE







Moisture-actuated layered structures for reversible 4D shape change

3 Nature-inspired material development

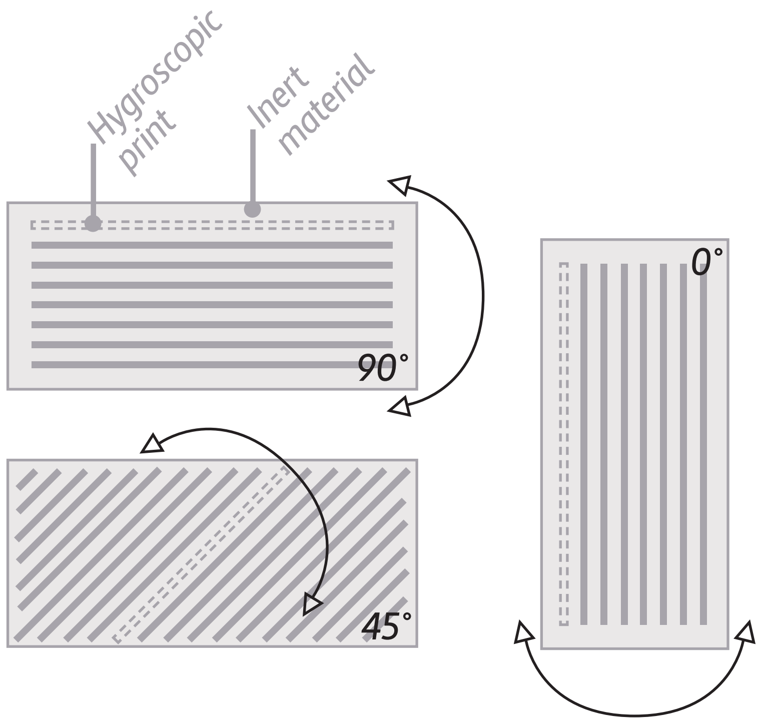
In charge of prototypes development, I took inspiration from the dynamic hygroscopic behaviour of the pine cone.

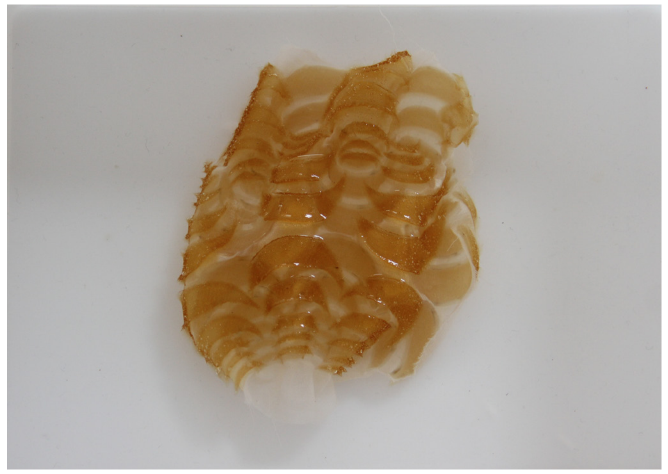
Each pine scale is composed of 2 layers, both made of a soft matrix and stiff cellulosic fibres, differently orientated.

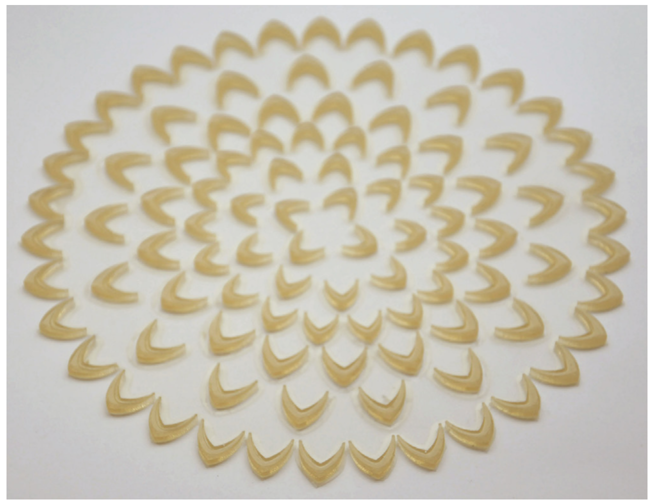
Changes in environmental moisture activate the dynamic behaviour. The bottom layer soft matrix swells and shrinks in response to these stimuli, forcing the whole scale to adapt and bend.

Drawing on these biomimicry principles I explored how moisture responsive materials similar to hydrogels could be used in conjunction with specifically designed geometric patterns to generate reversible 4D shape change behaviours on 2D printed surfaces.

In humid conditions the hygroscopic materials swell, forcing on the inert bases to bend and fold in a matter of 2 to 5 minutes.





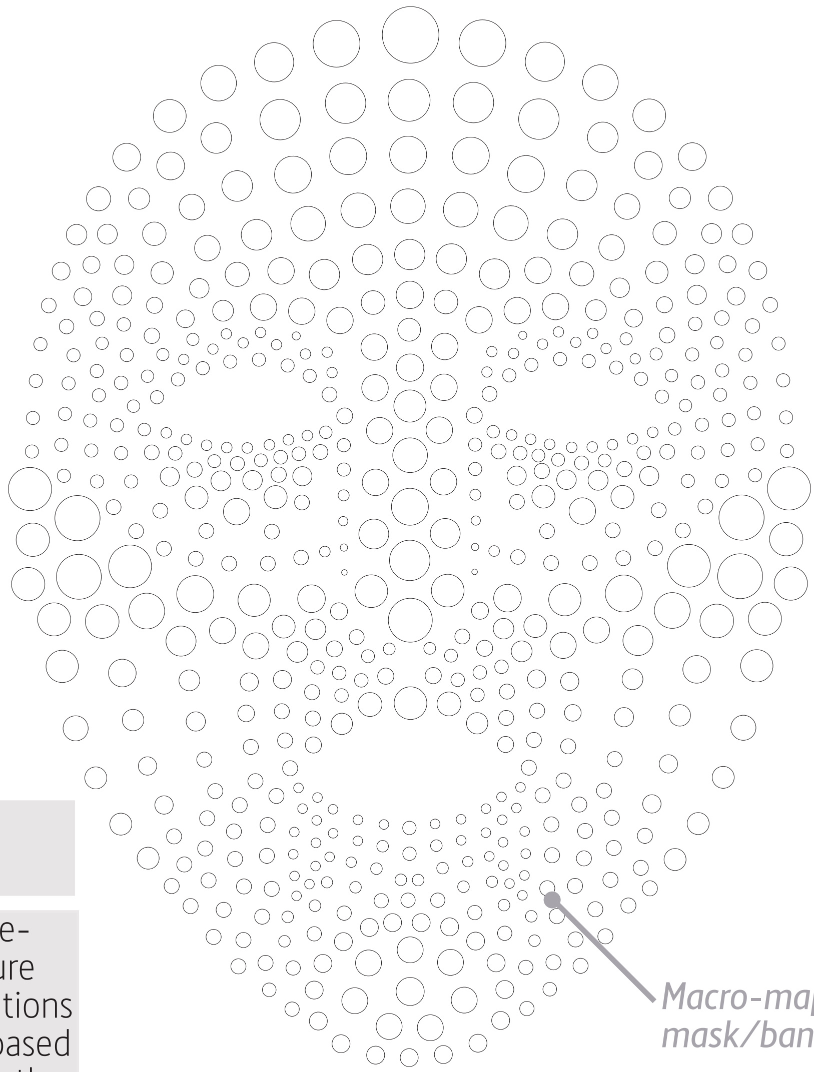


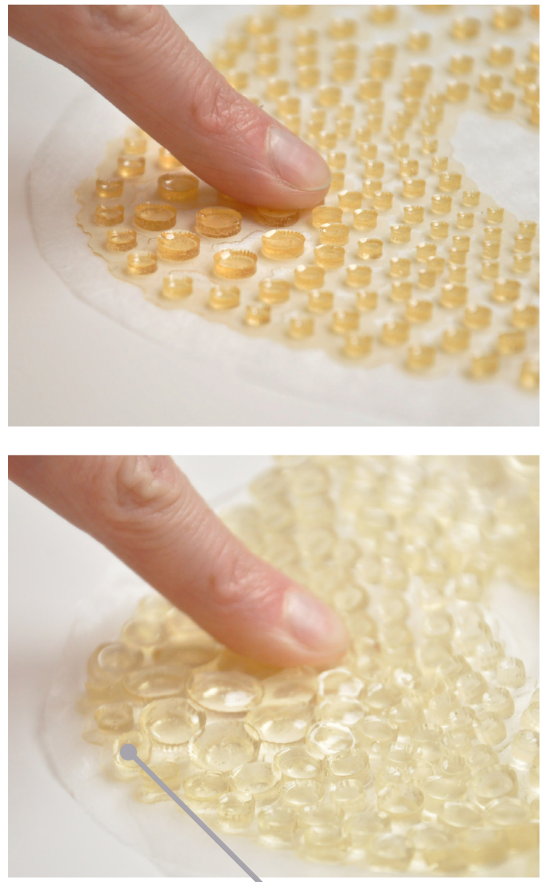
PHILIPS

northumbria UNIVERSITY NEWCASTLE

4 Product scenarios

Building on the first-hand material exploration and the literature review of cutting-edge applications of hydrogels, I designed skin-based product scenarios exemplifying the potential applications of this soft material in existing consumer products and future products.



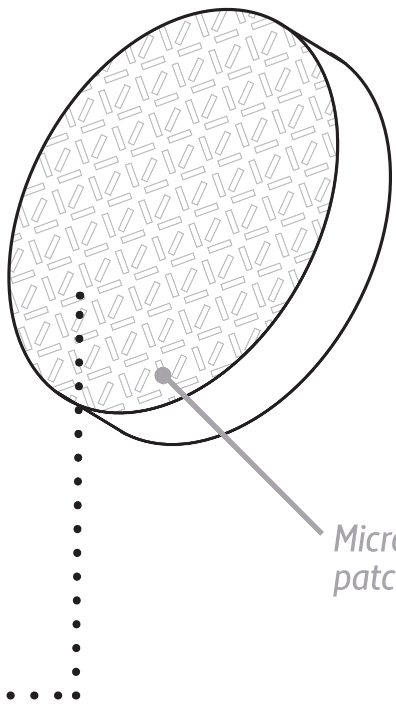


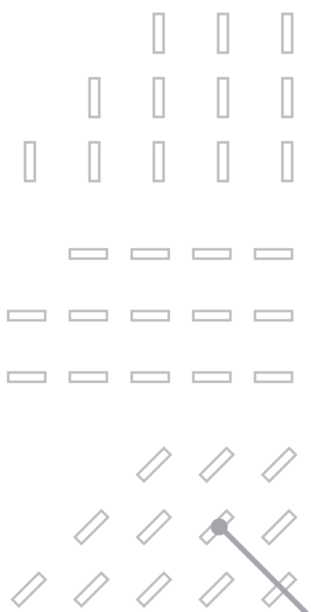
Macro-patterned hydrogel mask

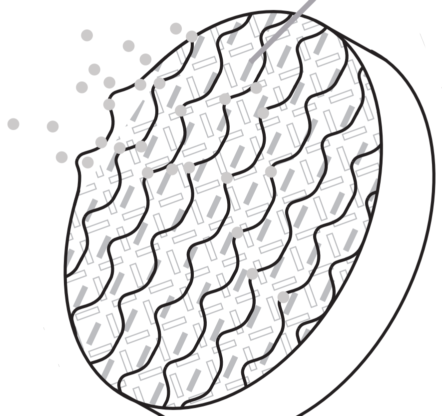
designed to sense skin dehydration levels on a wide surface area.

Hydrogel swells according to the sensitivity of different areas, releasing appropriate amount of emollients on skin.

Macro and micro patterned surfaces for skin-care products







Micro-patterned hydrogel patch

Each of the 3 patterns composing the patch respond to different skin conditions.

By swelling in response to the detected condition the patterns will modify the structure of the surface, giving a simple visual feedback on the particular condition.

PHILIPS northumbria UNIVERSITY NEWCASTLE

SHAPE MEMORY POLYMERS

Improved packaging solutions

Northumbria University
5 months project
2015

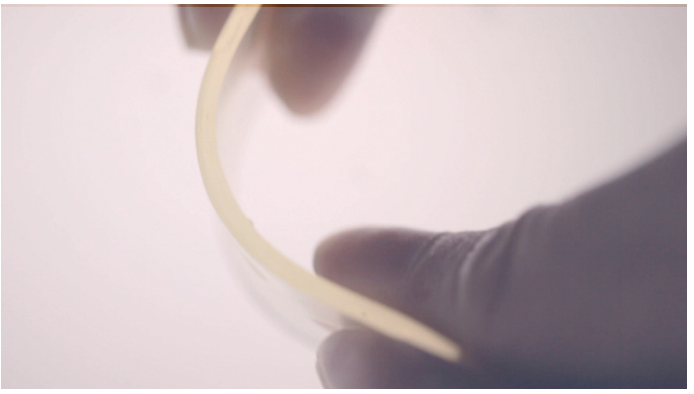
This design research project was developed for Unilever, in collaboration with the Packaging Area Managers (hard and flexible plastics).

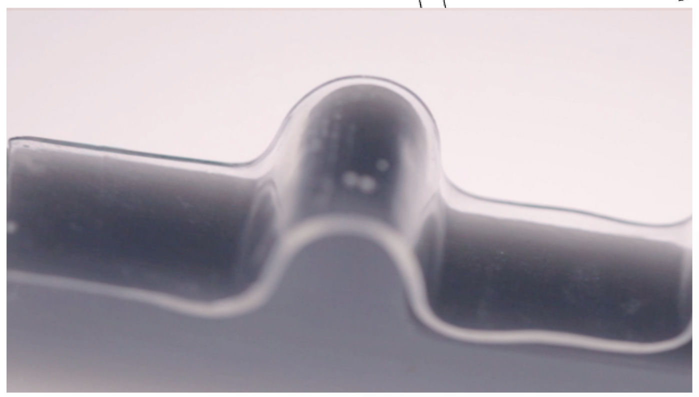
Our team was brought in to identify innovative material platforms that could be integrated in packaging solutions to enhance product functionalities (Horizon 2020).

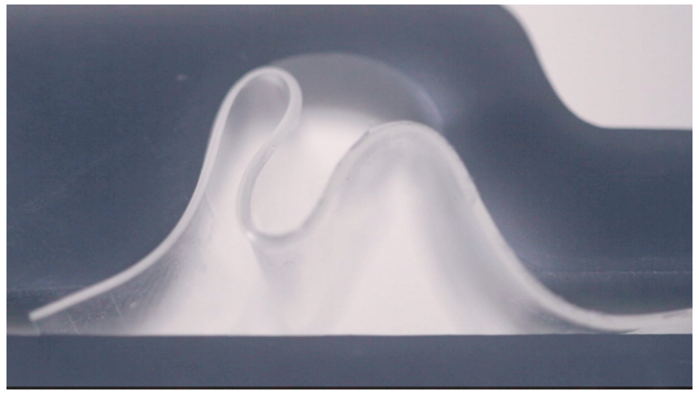
As Senior Research Assistants, my colleague Niam O'Connor and I worked on the Shape Memory Polymers (SMPs) platform with Unilever Packaging Managers.

We conducted the research and design development, also collaborating with a film-maker and animator to script and produce a video animation illustrating the design scenarios.
I was in charge of the fabrication of the prototypes.

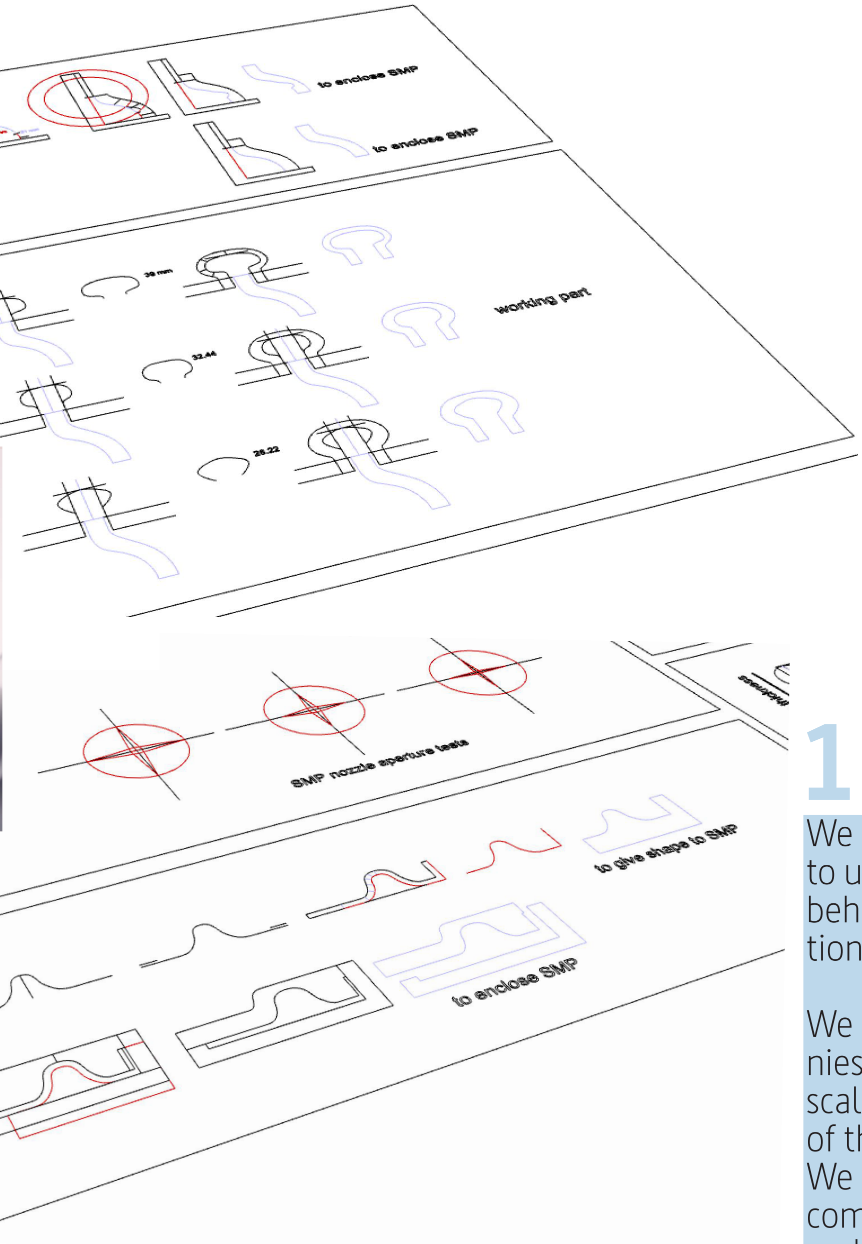
Testing material properties



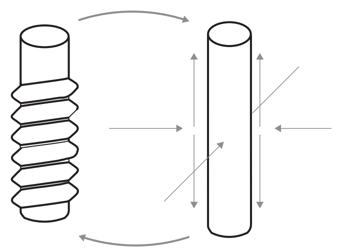


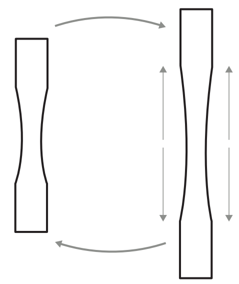


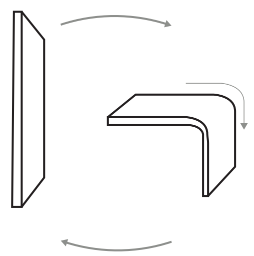
Pictures courtesy of Sapphire Goss



Shape Memory behaviours







1 Studying material behaviours

We scoped the literature on SMPs to understand their responsive behaviour under different conditions.

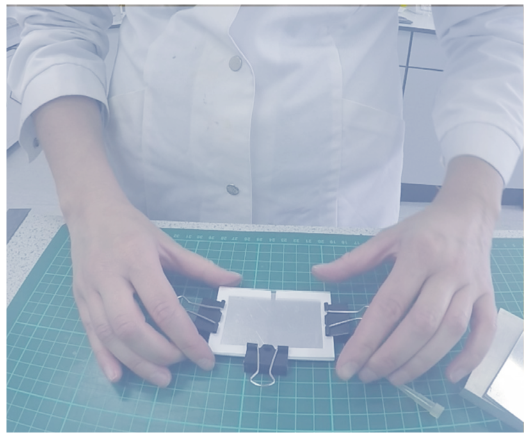
We then got in touch with companies producing SMPs at industrial scale to understand the tunability of the temperature responses.
We receive samples from these companies for properties testing and prototype development.

2 Collaborative research

Workign with the Uniliver packaging engineering managers we explored issues in current packaging production, potential consumer benefits and sustainability challenges.

We identified the potential for SMPs to:

- enhance consumer experience
- improve current manufacturing processes
- ligth-weight packaging



3 Product Scenarios and prototypes

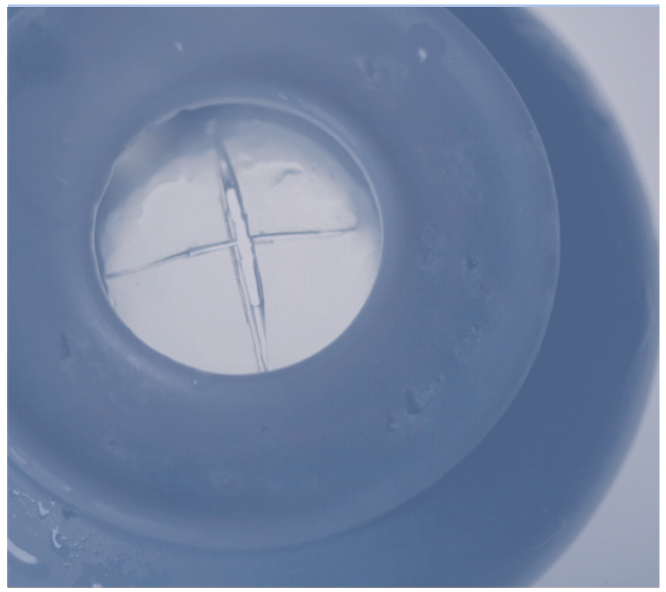
We designed scenarios and prototyped product applications to communicate to our stakeholders the identified benefits.

I was in charge of the product prototyping, which involved experimenting with selected materials in the lab, modeling and 3D printing demonstration pieces, integrating SMP samples obtained from industry to demosntrated the behaviours.

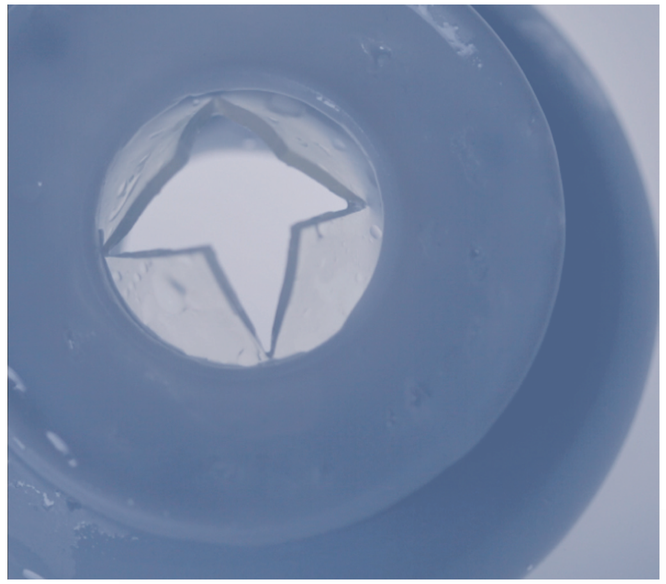
Heat-activated features for better packaging experience

Heat-activated self-opening nozzles

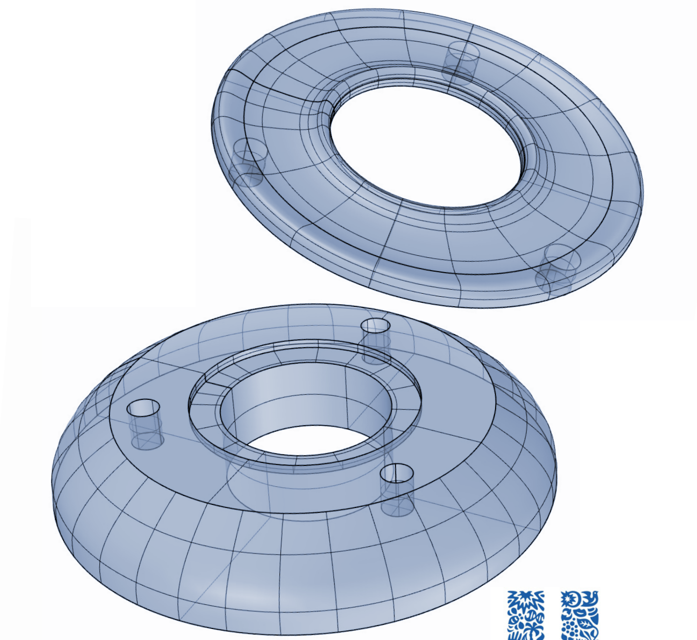
We prototyped a nozzle that would open-up like a flower in the shower when under the hot water, for a effortless shower experience.



Closed nozzle



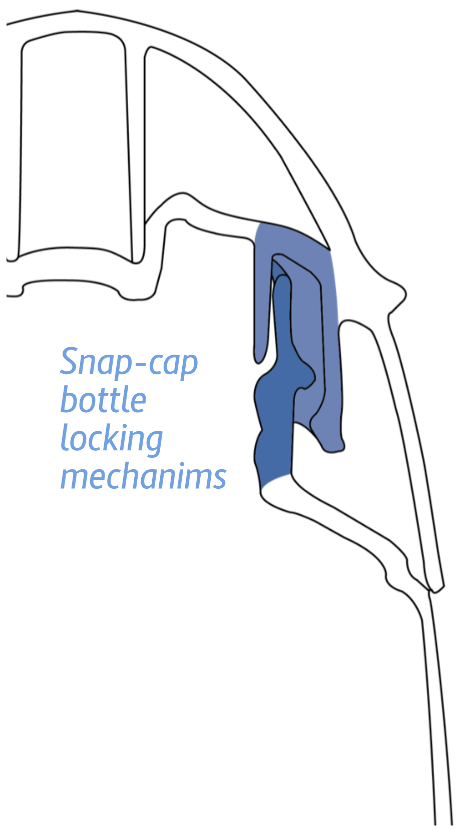
Open nozzle



Unilever

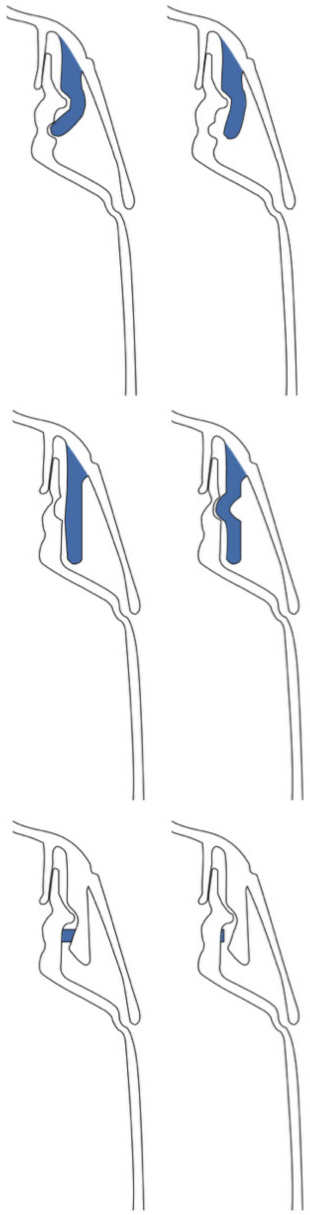
northumbria UNIVERSITY NEWCASTLE

Shape Change behaviour for faster manufacturing



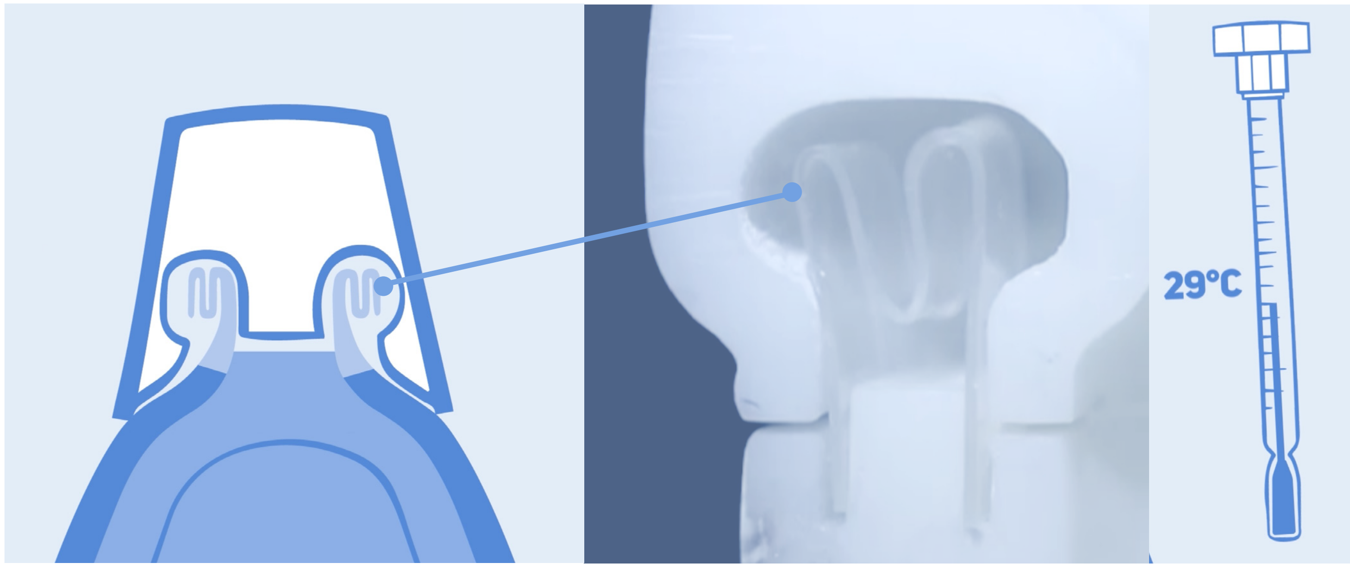
Snap-cap bottle locking mechanims

Brainstorming potential solutions



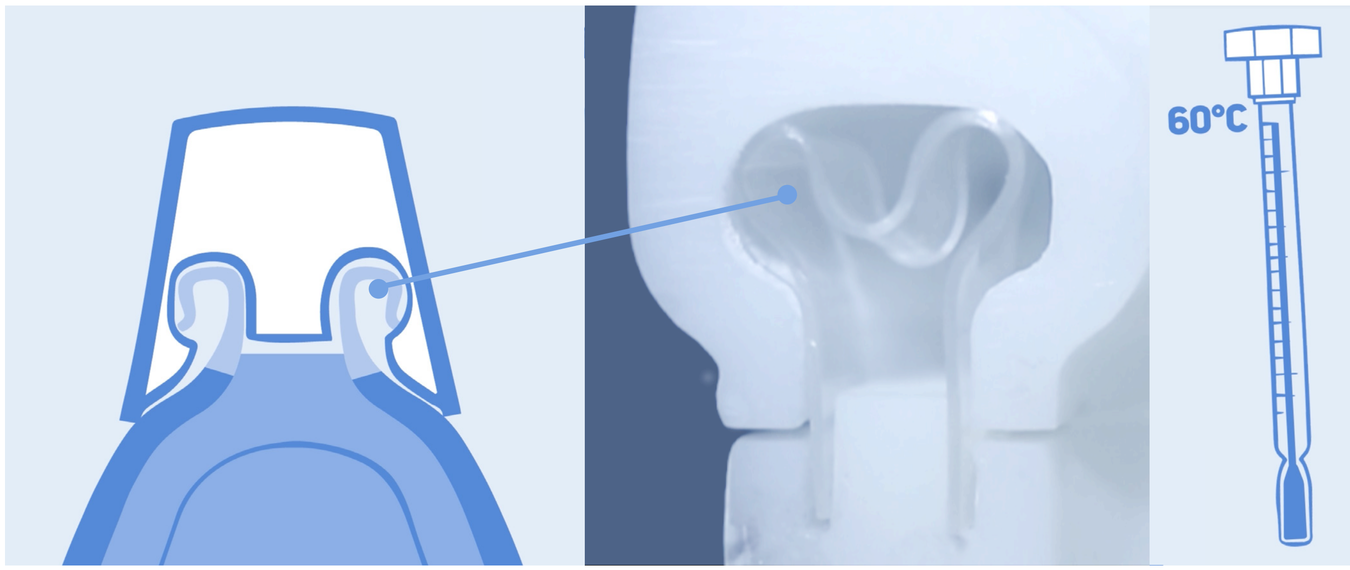
Redesigned locking

Prototype



Un-locked bottle

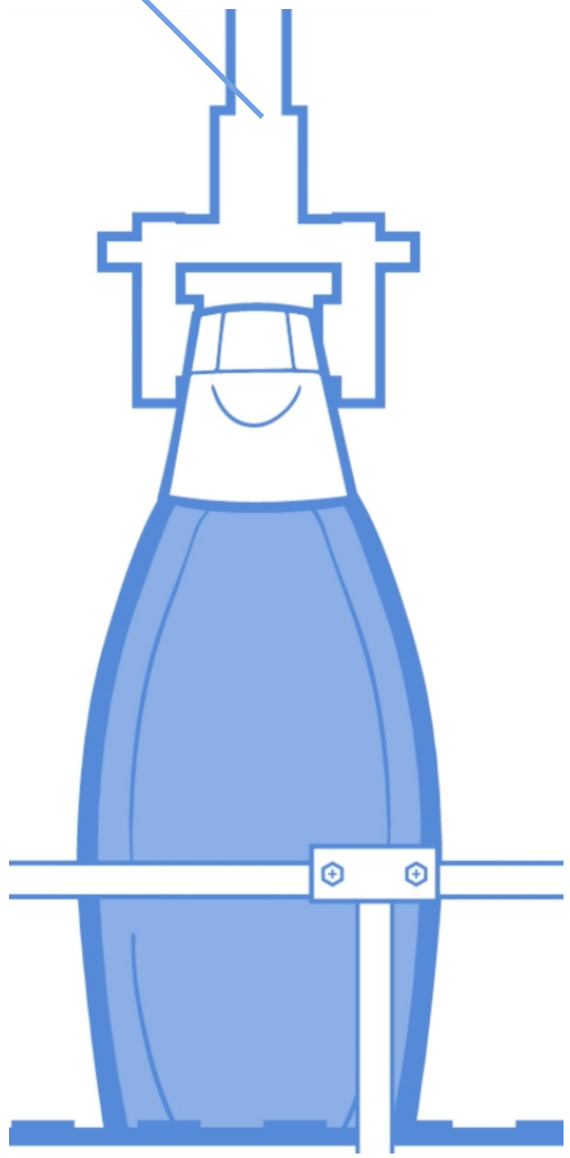
Compressed SMP layer allows easy positioning of cap



Locked bottle

Compressed SMP layer springs back locking the cap

Reduced capping force during manufacturing



Illustrations by animator Nicholas Waterton

Snap-cap bottles redesign

We prototyped a new locking mechanism for the snap-cap bottle, integrating SMPs in the bottle neck.

The use of SMPs allows to reduce the capping force applied during manufacturing, as well as improve the sealing system overall.

When the bottle is produced the SMP neck moulded in a particular shape. When heated once capped, it springs back, filling the gaps in the mechanism, locking the bottle.

Soil Sample n°3 - Villanova, Albenga

CERAMICS FABRICATION

Ceramics for the Anthropocene

European Residency commission
4 months project
2017

I was commissioned to develop a project that would ignite innovation in the long-standing (but fading) artisanal ceramics industry of Albisola (IT).

The project framework involved the community of ceramicists of Albisola, the Engineering Department of the University of Genova and the digifabTURINg robotic fabrication research lab based at FabLab Turin.

I led the project from conception to realisation, drawing on the expertise of my collaborators.

> " I observed how local ceramicists are completely oblivious in regards to the origins of the raw materials"

1 Historical and Ethnographic Research

Having engaged in in-depth discussions with ceramics historians, museum collections managers and the local community of ceramicists and clay technologists, I built a thorough understanding of the unfolding of the Albisoles ceramics production over 900 centuries.

Although the rich tradition started because of the particular qualities of the local clay, I observed how contemporary craftmen had become completely oblivious in regards to the origin of the raw materials used in their practice.

The industrial clay they use functioned as a blank canvas for complex pictorial glaze decorations. None of the craftsmen I interviewed created unglazed objects nor knew the orgiins of the clays they were working with.

2 Developing material know-how

I formed a team of collaborators that helped me to rediscovered the locally available clays. We visited and collected materials from forgotten caves, abandoned areas and geological landmarks.

We then learnt how to work with these materials and create mixes that would perform as the industrial counterparts and produce a beautiful colour palette.

digifabTURINg

Radicate
research on contemporary art and culture

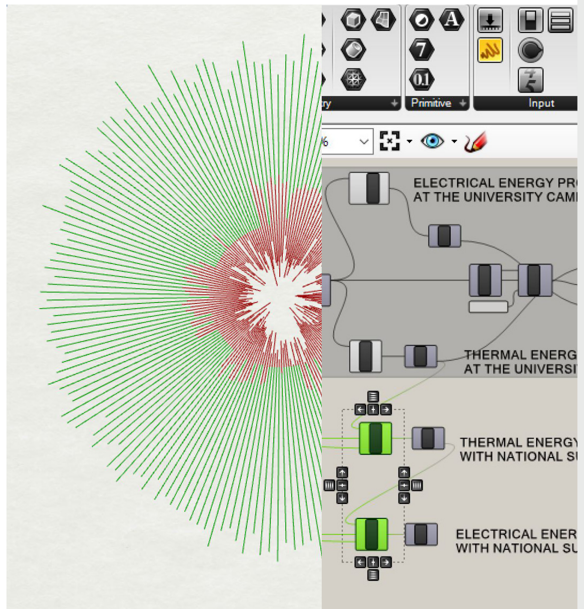
UNIVERSITÀ DEGLI STUDI DI GENOVA

3 Melding digital and traditional techniques

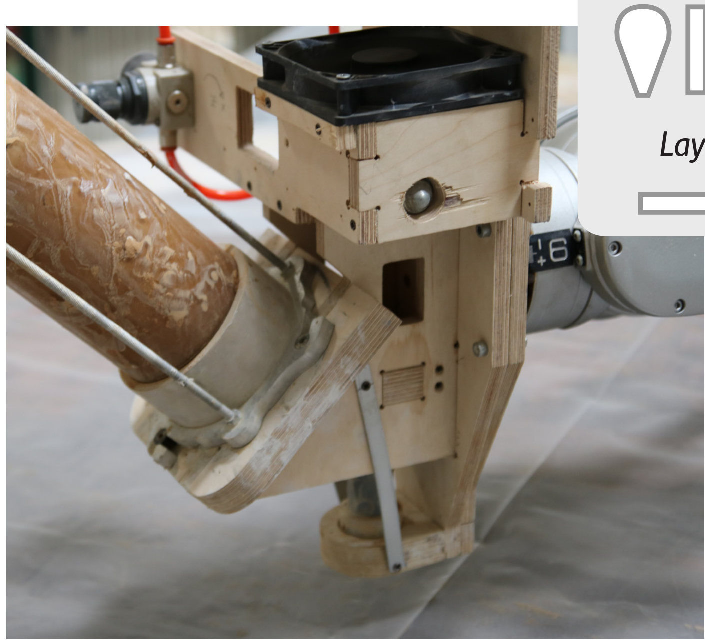
I led the fabrication experimentation through a highly collaborative approach.

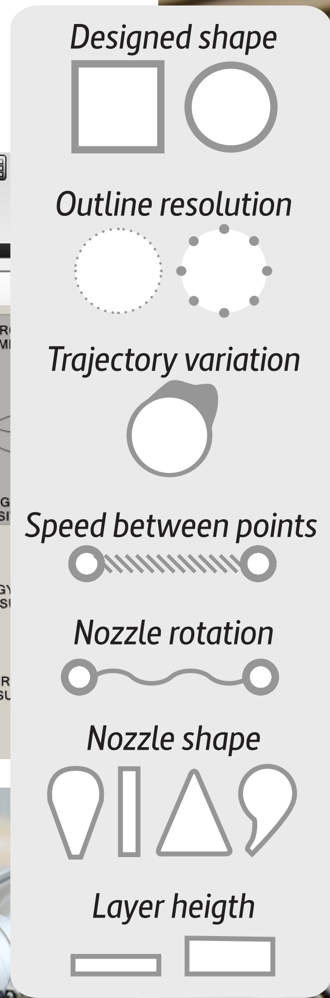
We explored the full expressive potential of the raw materials, crafted data-driven computational designs through extensive exploration of the combinations of the robotic plarform parameters.

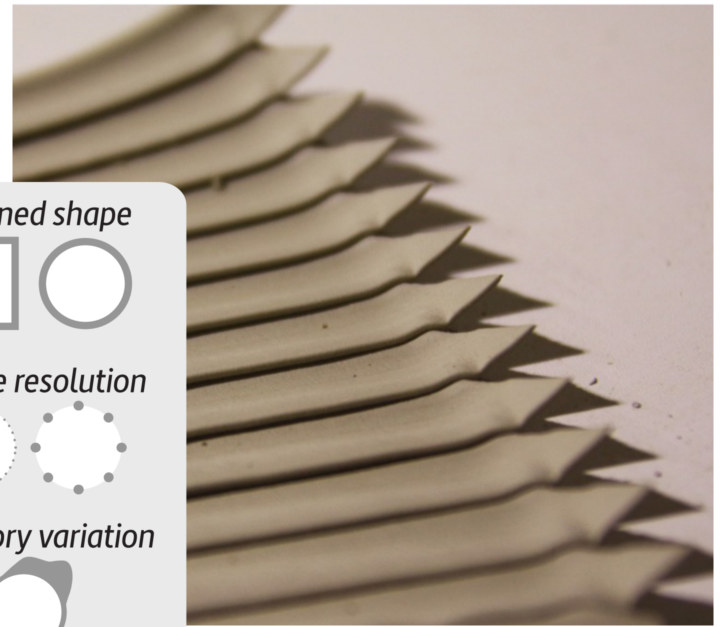
I led the experimental fabrication exploring the full potential of digital and traditional tools and techniques

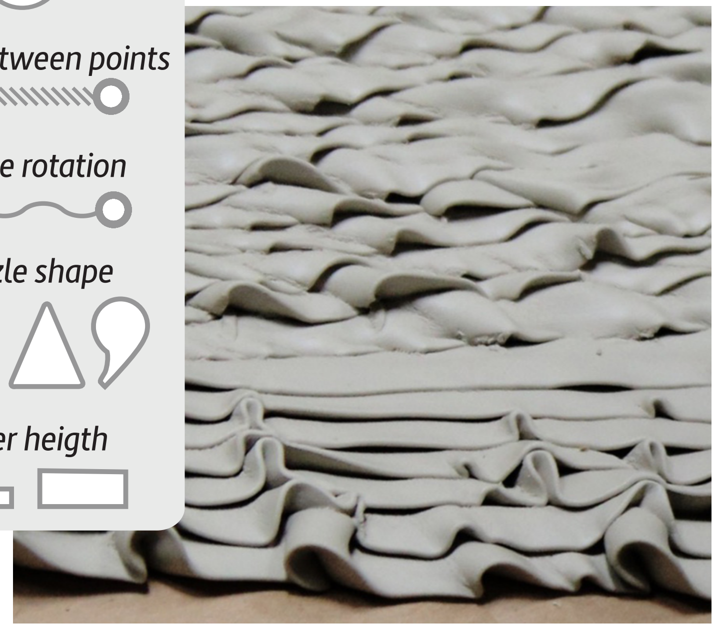


We successfully cross-pollinated digital and traditional know-how.









I pushed the team to work at a big, challenging scale.

I encouraged the exploration of new tools, bringing in a series of haute patisserie nozzles that allowed us to achieve material structures never seen before in the field of digital clay fabrication.

By leading and facilitating the collaboration, we successfully cross-pollinated the traditional know-how with cutting-edge digital fabrication techniques. Both partners have since integrated in their own practice the new approach to materials and crafting tools.

Radicate
research on contemporary art and culture
UNIVERSITÀ DEGLI STUDI DI GENOVA

The artwork is hosted at the
prestigious Museo della Ceramica
in Savona (IT)

ARTIFICIAL
MINERALISATION

Carbon Positive
Bio Art & Design Award proposal
6 months project
2016

Selected as finalist of the prestigious Bio Art and Design Award, I collaborated with the Mycrosystems group at Technical University of Eindhoven on a project proposal for a 6 months residency.

Inspired by marine biomineralisation processes and natural carbon capture strategies, I asked the team of scientists if we could take advantage of microfluidics to mimic these natural processes and sequester environmental CO_2.

Can we mimic shells biomineralisation to capture environmental CO2 and transform it in a usable material?

The experimental work presented in '*Self-assembly of amorphous calcium carbonate microlens array*', paper published by Lee et al. in 2012 was instrumental for the develoment of the project proposal,

The team was able to self-assemble $CaCO_3$ microlens spheres with uniform size, at ambient temperature, by reacting a specific liquid with CO_2 present in the local environment.

The reaction happens at the interface between liquid and air.

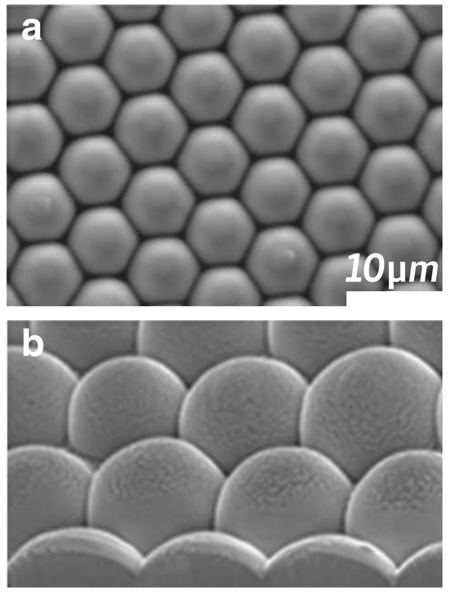


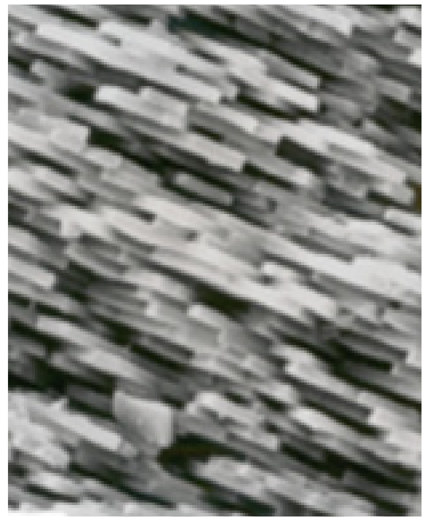
Image from paper: Self-assembly of amorphous calcium carbonate microlens array

1 Biomimicry research

I was inspired by marine organisms that use biomineralisation processes at ambient temperature to sequester CO_2 dissolved in marine water and transform it in a building block for their shells.

I asked a simple question: could these strategies be adapted to sequester CO_2 from the urban environment and build useful materials?

I investigated the literature for proof of concept experiments in this area.

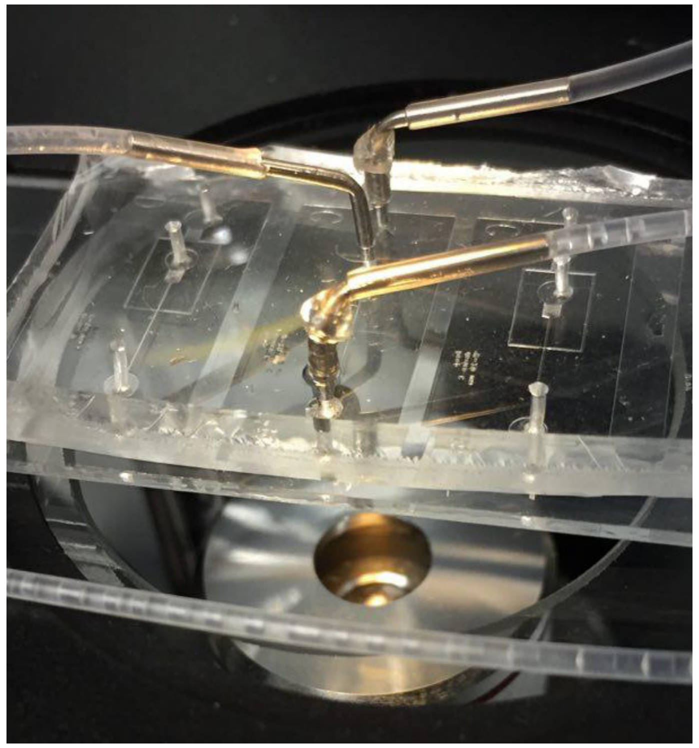


2 Collaborative experiment design

I proposed my collaborators to follow the chemistry of this experiment, and transfer it to a microfluidic system.

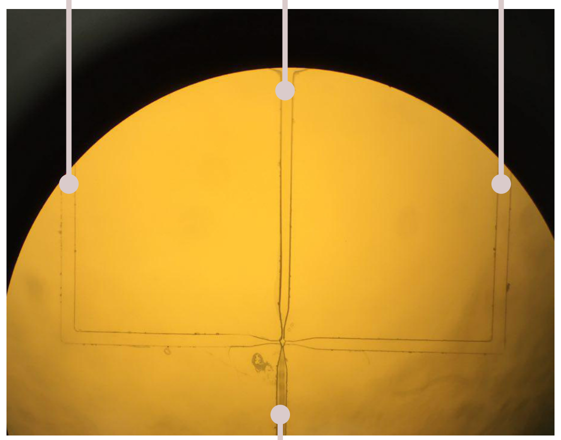
Over a period of 2 months, I held weekly meetings with Assistant Professor Regina Luttge, in which we discusses the mineralising reaction conditions and perfected the microfluidic prototype design.

Regina also tested in her lab and demonstrated the workings of the self-pumping liquid and air system proposed in the final design.



BADAWARD

TU/e Technische Universiteit Eindhoven University of Technology



The device takes advantage of micro-fluidic precision to maximise the material conversion efficiency

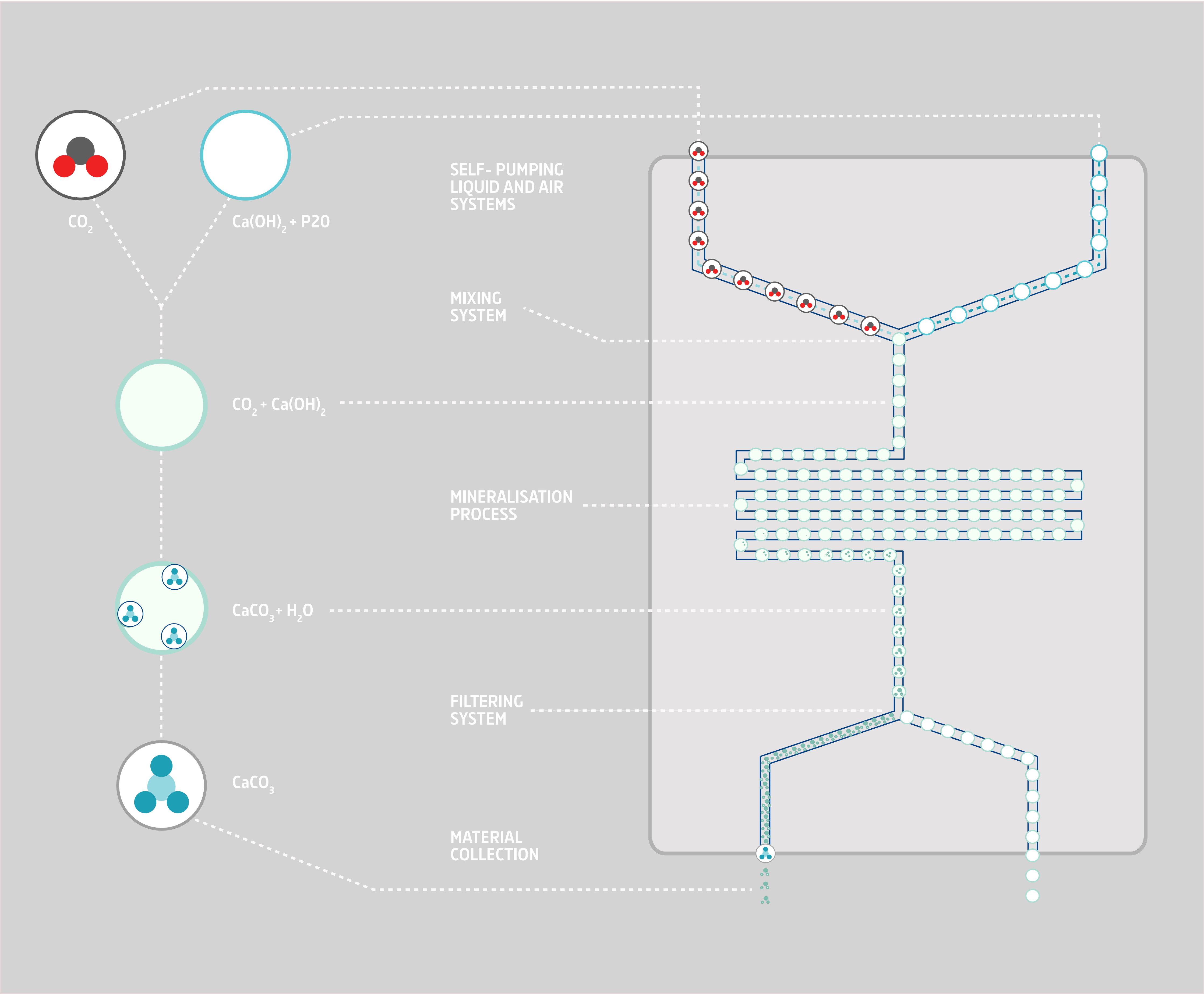
3 Proof of concept prototype

We designed an energy-efficient, self-propelled microfluidic device that harnesses natural bio-mineral-isation reactions.

The device captures CO_2 and trans-forms the particles in a safe mate-rial form through an engineered precipitation process.

The device aims to take advantage to the micro-fluidic precision to maximise the efficiency of the bio-chemical process.

The resulting material is the same material of marine shells, calcium carbonate, but obtained in perfect spherical forms that can be used for other purposes.



BADAWARD

TU/e Technische Universiteit Eindhoven University of Technology

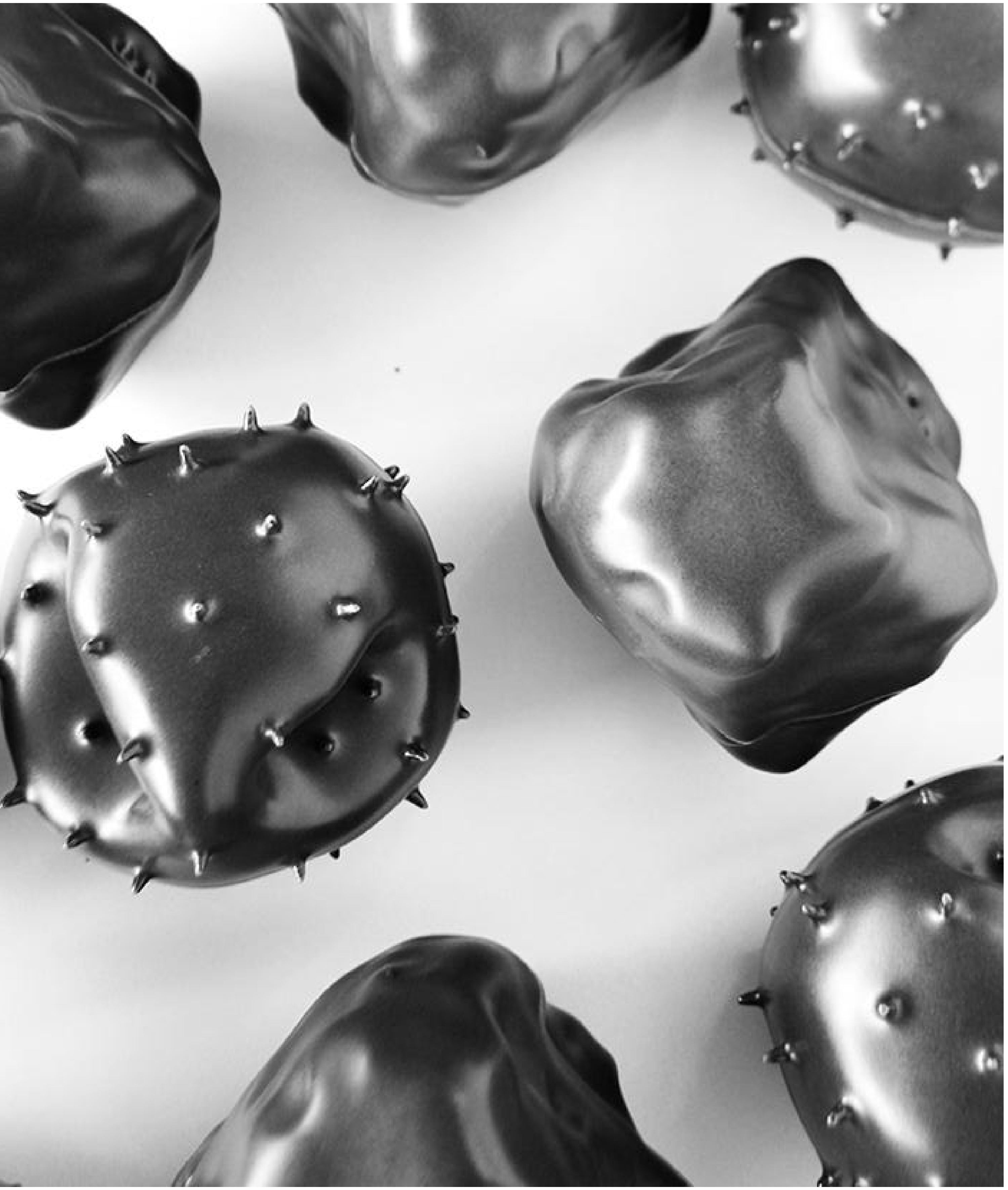
INTERACTIVE
INSTALLATIONS

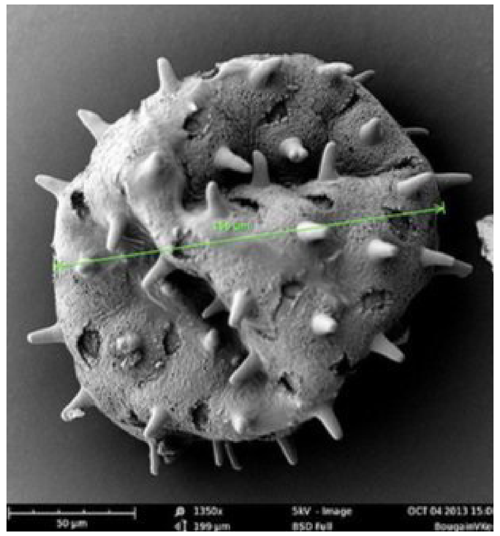
MATERIAL
EXPERIMENTATION

DIGITAL
FABRICATION

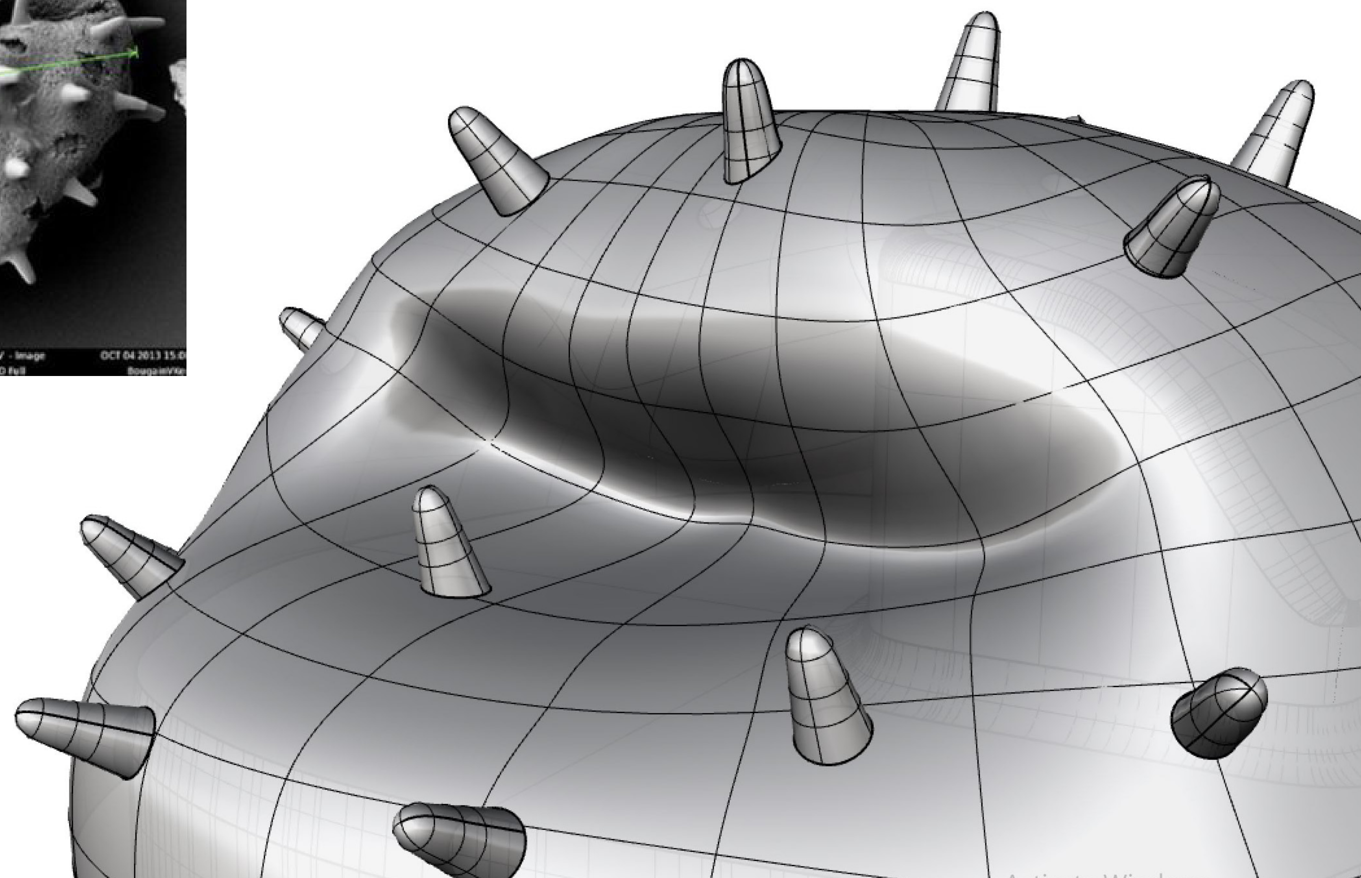
TALKS
WORKSHOPS

PRODUCT
DEVELOPMENT



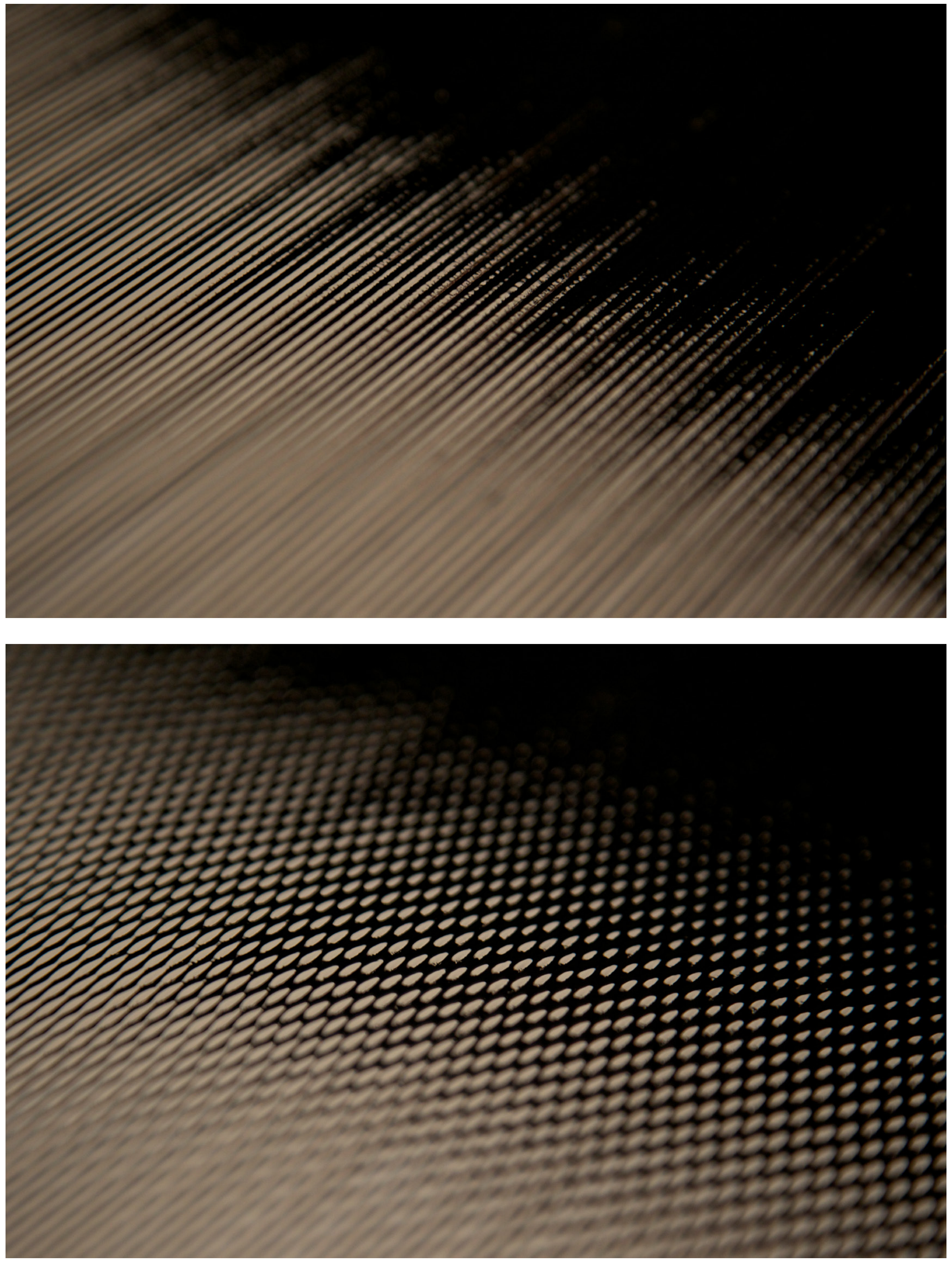


PRODUCT DEVELOPMENT



Goldsmiths
UNIVERSITY OF LONDON

Citizen Sense

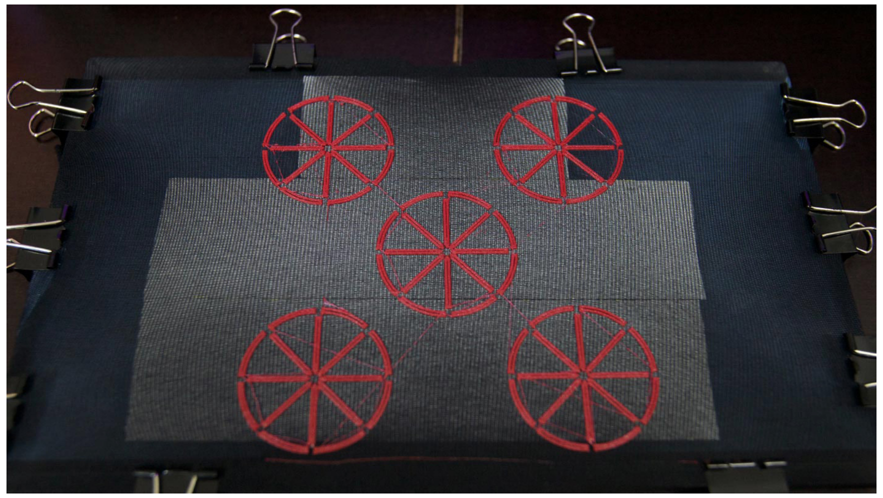


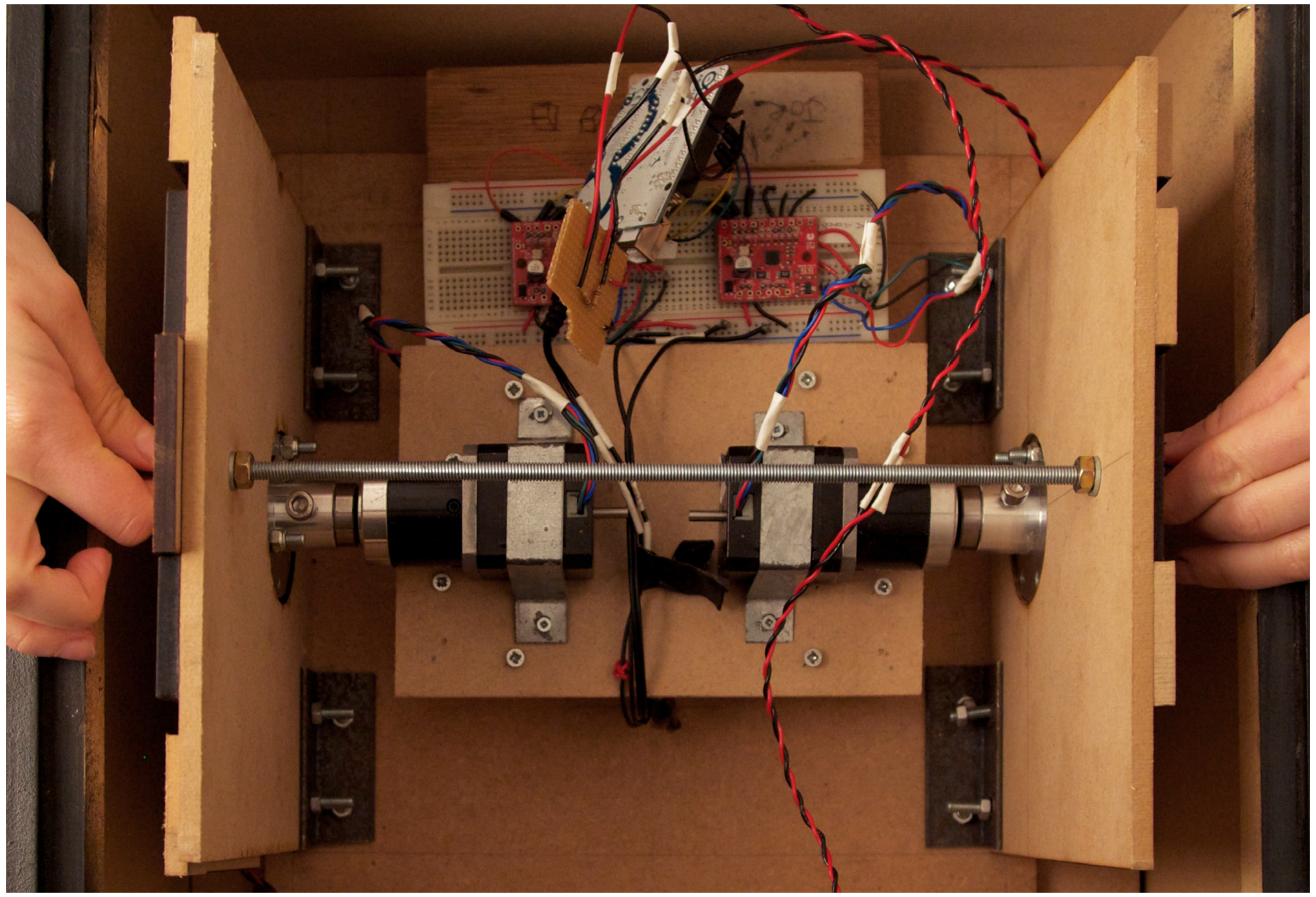
OUTLINES OF INEXISTENCE, 2015

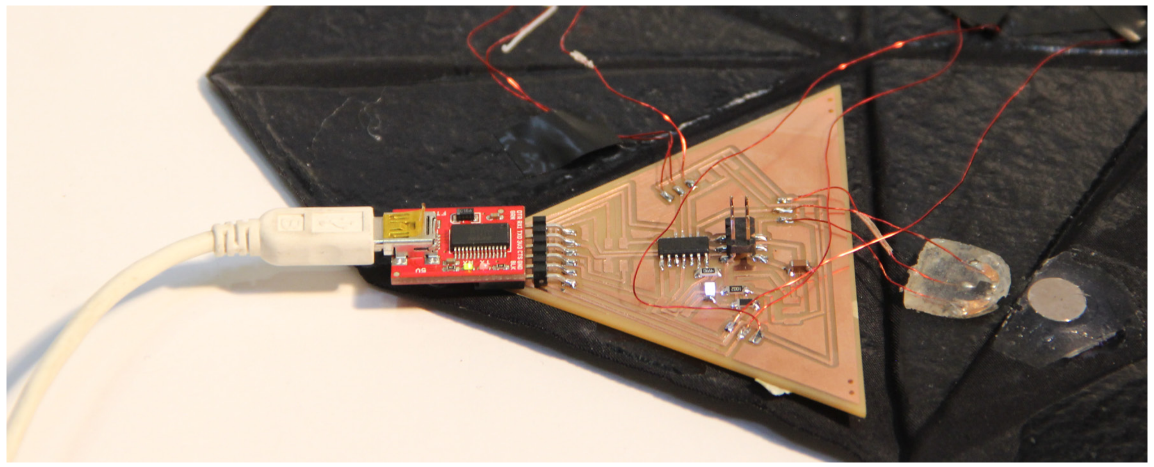
MATERIAL
EXPERIMENTATION

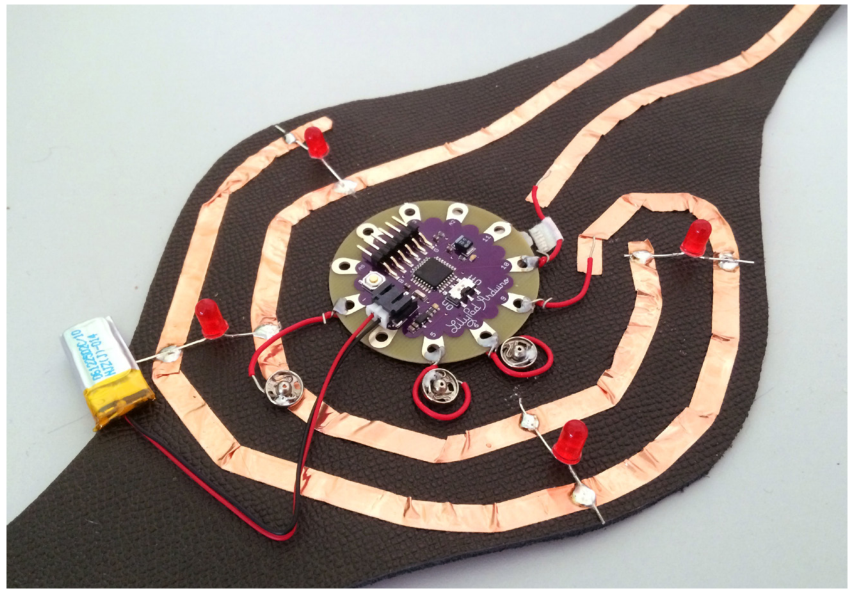
TEXTURAL GRAPHICS, 2014

3D PRINTED TEXTILES, 2015



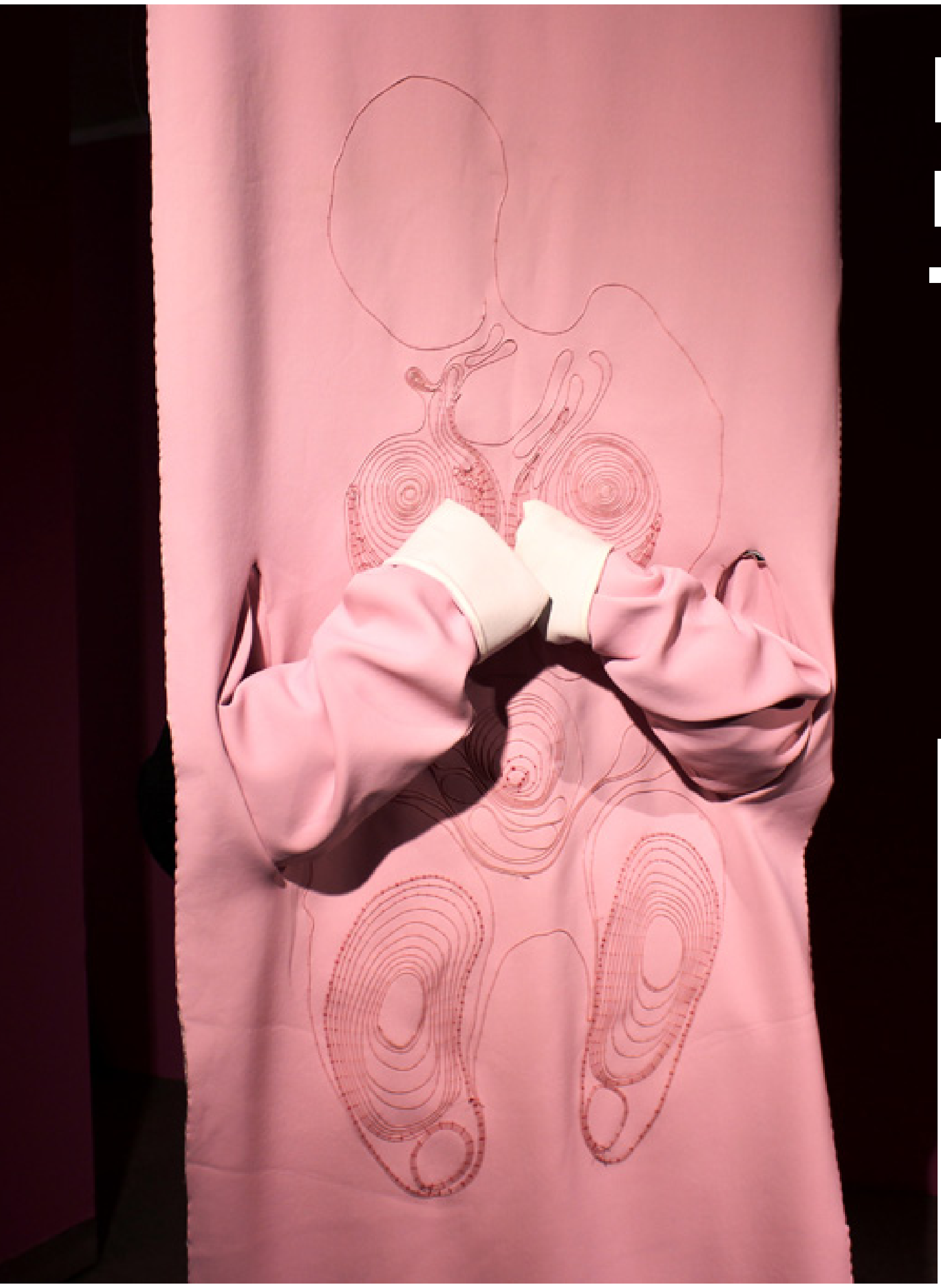




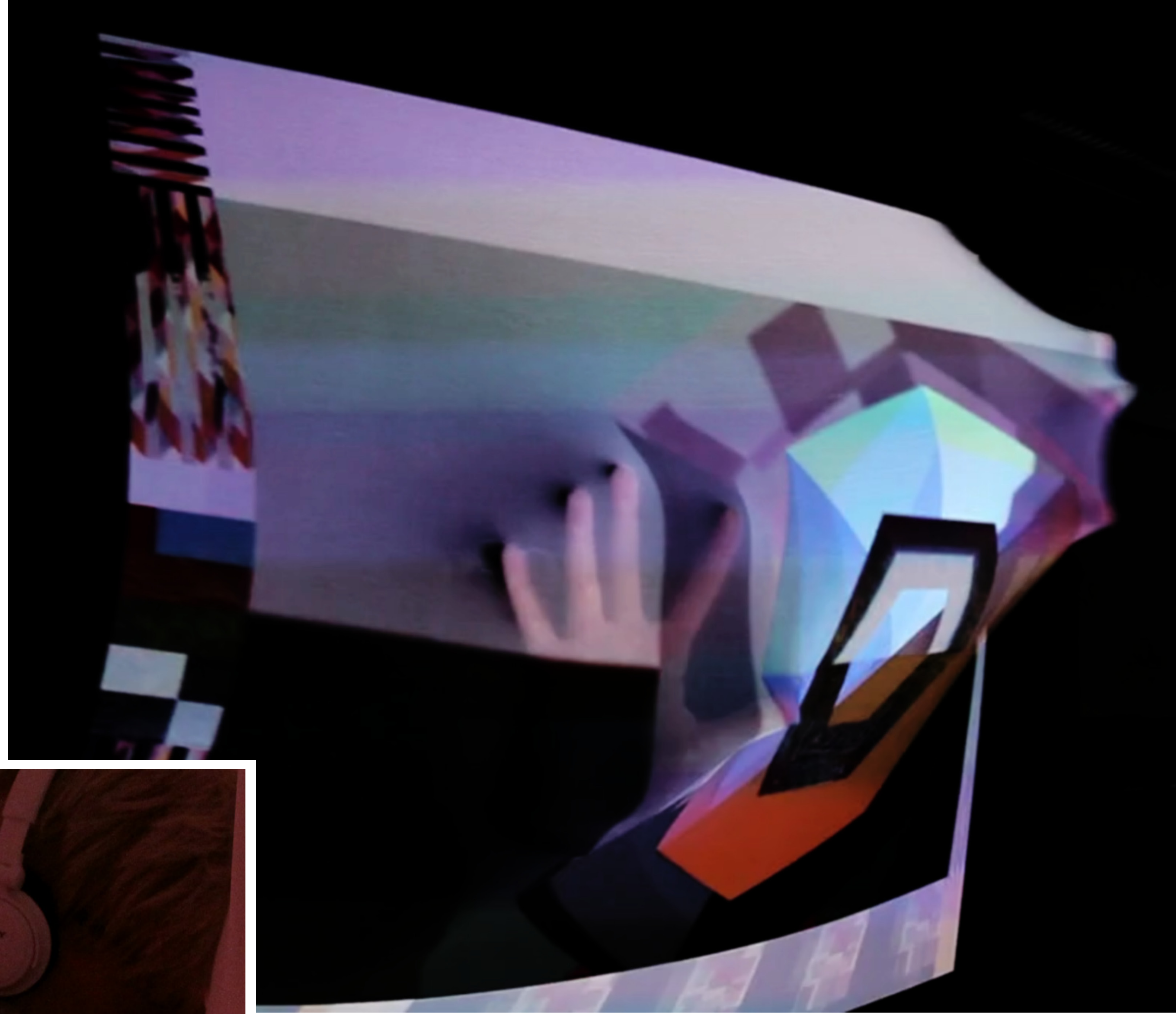


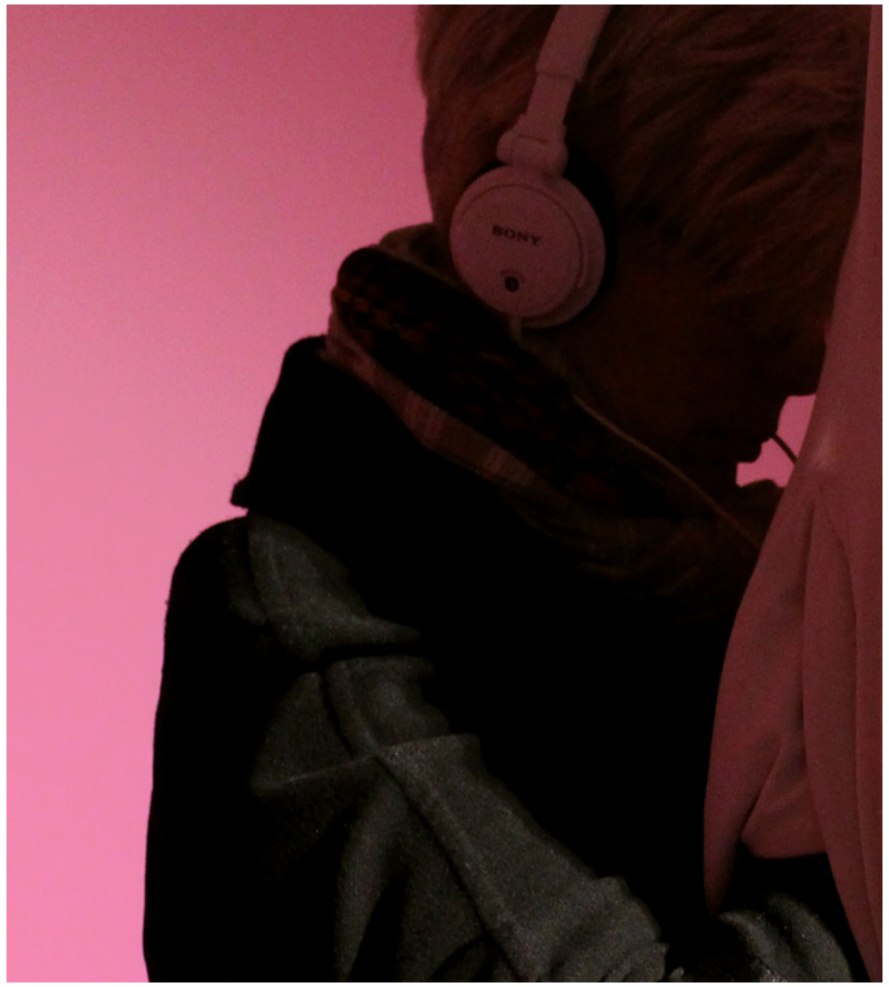

DIGITAL
FABRICATION

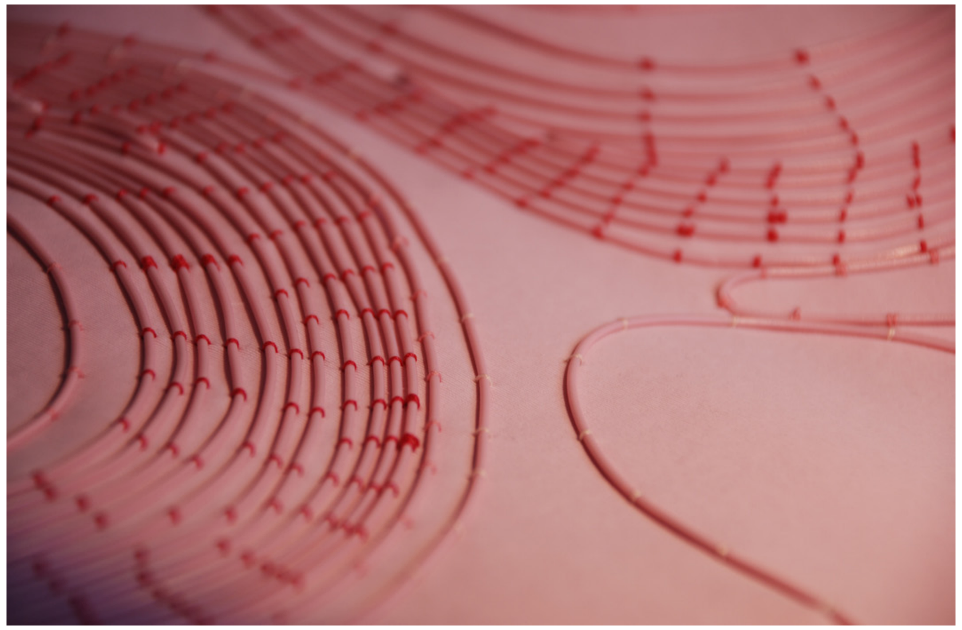
INTERACTIVE INSTALLATIONS



CRAFTING HUMAN PERCEPTION, 2012







watermans

UCA university for the creative arts

Abertay University

TALKS & WORKSHOPS

SCHOOL OF CREATIVE MEDIA

活化廳

FABLAB LONDON

ual:

KING'S College LONDON

SCIENCE GALLERY

DESIGN INNOVATION

MATERIAL DRIVEN

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