



WORKSHOP

Designing with the 4th Dimension–Time

Challenges of Active / Reactive
Shape Changing Materials

WEISSENSEE ART ACADEMY BERLIN

TEXTILE & SURFACE DESIGN
EXPERIMENTAL MATERIAL RESEARCH

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This booklet summarises the processes and outcomes of the exploratory hands-on workshop with Shape Changing Materials, which took place within the framework of the semester project **As a Matter of Fact...** led by Prof. Dr. Zane Berzina in collaboration with the R&D Project **smart materials satellites** under the direction of material experts:

Paula van Brummelen
Julia Danckwerth
Felix Groll

and resulted in works by:

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Suzan Camlik
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Milan Friedrich
Lena Ganswindt
Oliver Hurdman
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Boram Park
Jack Randol
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Constance Vidalain
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and the SYN Award | sms winners: Wagehe Raufi

Charlett Wenig

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Introduction

Introduction

Workshop Topic

This workshop was a hands-on introduction to three specific Shape Changing Materials, so called smart materials: Thermal Shape Memory Alloys: SMA; Electro Active Polymers: EAP; Piezoceramics: PIEZO.

The workshop was based on two thematic bases:

One of them was **smart materials satellites***, an ongoing multidisciplinary two-year R&D project (10/2016 – 01/2019) that aims to develop communication strategies for complex scientific topics through the employment of design methods and artistic research. The Shape Changing Materials are introduced to the broader public through a series of engaging exhibitions giving everybody access to knowledge about the materials and the opportunity to experiment hands-on with them in order to take part in the broader discourse around the new material developments.

The other was the semester project led by Prof. Dr. Zane Berzina, **As a Matter of Fact... **** which aimed at taking materiality and experiment as the starting point of the design process. Within this project students were developing own processes or systems that supported them in investigating and revealing the functional, aesthetic, emotional and many often unexpected or overseen qualities of materials. The three specific Shape Changing Materials were examples taken from the variety of existing materials.

The functional materials have particular properties which let them stand out amongst the broad variety of known materials. It is claimed that they have the potential to open up a new world for design and might even help to address some of the important issues of our times.

Within the three-day workshop the idea was to take little steps towards understanding the selected materials better by hands-on experimentation in order to gain an informed view on the subject matter. The aim was to explore the multi-sensorial potential of these materials and their possible performances by manipulating these materials and integrating them into various structures and/or design scenarios.

* The project is funded by the German Ministry of Education and Research (BMBF) and part of the research consortium smart³. Collaboration partners are: Stiftung Bauhaus Dessau, Technische Sammlungen Dresden, SYN Stiftung, Fraunhofer IWU Dresden, weissensee art academy berlin. More information on the R&D-project can be found online: www.kh-berlin.de > academy > research > smart³

** More information on the semester project can be found online: www.kh-berlin.de > studies > textile and surface design > courses

Participants were asked to follow a scientific working agenda – without giving up a designers' experimental approach to material research. The workshop stages were as follows:

- › Introduction to the Shape Changing Materials
- › Hands-on experimentation
- › Exploration of possible effects
- › Understanding of materials' properties
- › Examination of materials' potentials & limits
- › Development of design concepts
- › Iterative making & testing of mock-ups
- › Documentation of the process & outcomes
- › Reflection and presentation

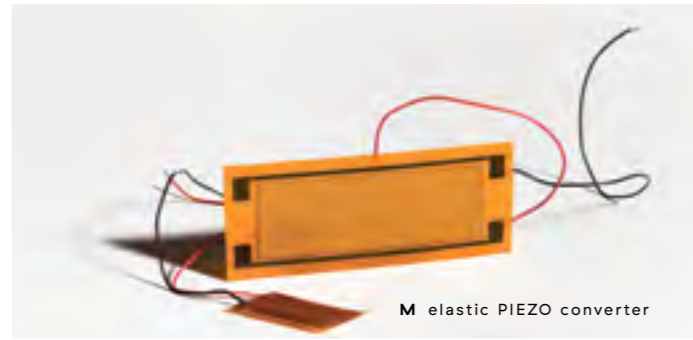
After the introduction to the materials the participants were asked to form three groups, each group focusing on one of the three Shape Changing Materials in order to facilitate a more intense working experience.



P PIEZO raw material



X SMA rods and wires



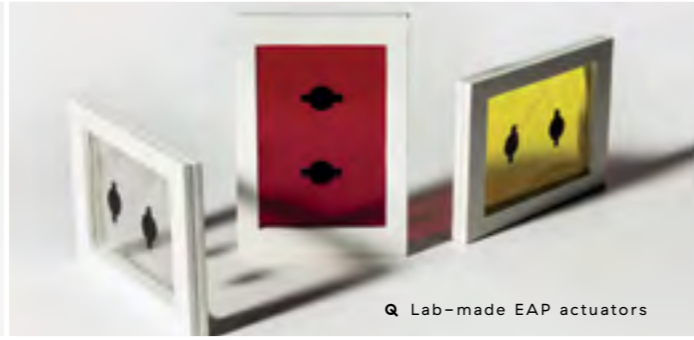
M elastic PIEZO converter



N self-made EAP actuators



O SMA sheet



Q Lab-made EAP actuators



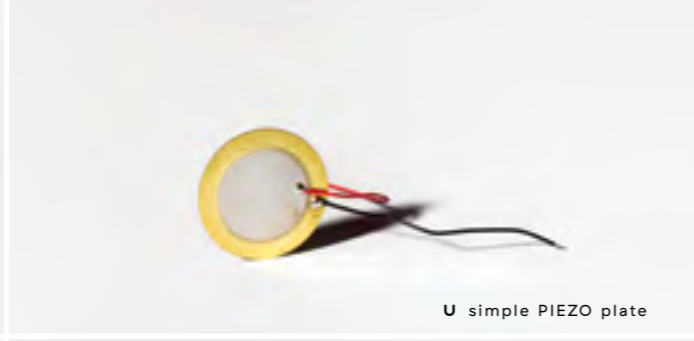
R PIEZO raw material



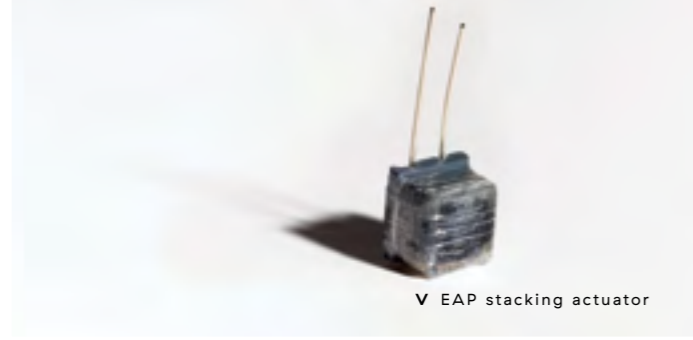
S SMA springs



T PIEZO actuator



U simple PIEZO plate



V EAP stacking actuator



W SMA wire

Shape Changing Materials

The starting point for the workshop were the three specific functional materials:

- > Thermal Shape Memory Alloys (SMA)
- > Electro Active Polymers (EAP)
- > Piezoceramics (PIEZO)

These all are currently being investigated within an interdisciplinary smart materials research cluster, named smart³ | materials – solutions – growth*, funded by the German Ministry of Education and Research (BMBF).

A lecture about the main characteristics and functional principles of the three Shape Changing Materials was held at the beginning of the workshop. The materials were demonstrated 1:1, in experimental films and by explaining their functional principle using animated illustrations*.

* More information on smart³ | materials – solutions – growth can be found online: www.smarthoch3.de

* All information material including DIY tutorials can be found online: www.st4sd.de

Selected case studies demonstrating the use of the materials were introduced to the workshop participants in order to address the wide range of possible applications: from visionary, performative concepts to specific technical applications. Even though these all are complex high-tech materials, coming directly from scientific research laboratories, they can be worked with on a Do-It-Yourself level.

EAP can easily be made by oneself, PIEZO can be used and controlled in combination with Arduino. SMA can even be manipulated on a structural level – ‘trained’ to behave in distinct manners.

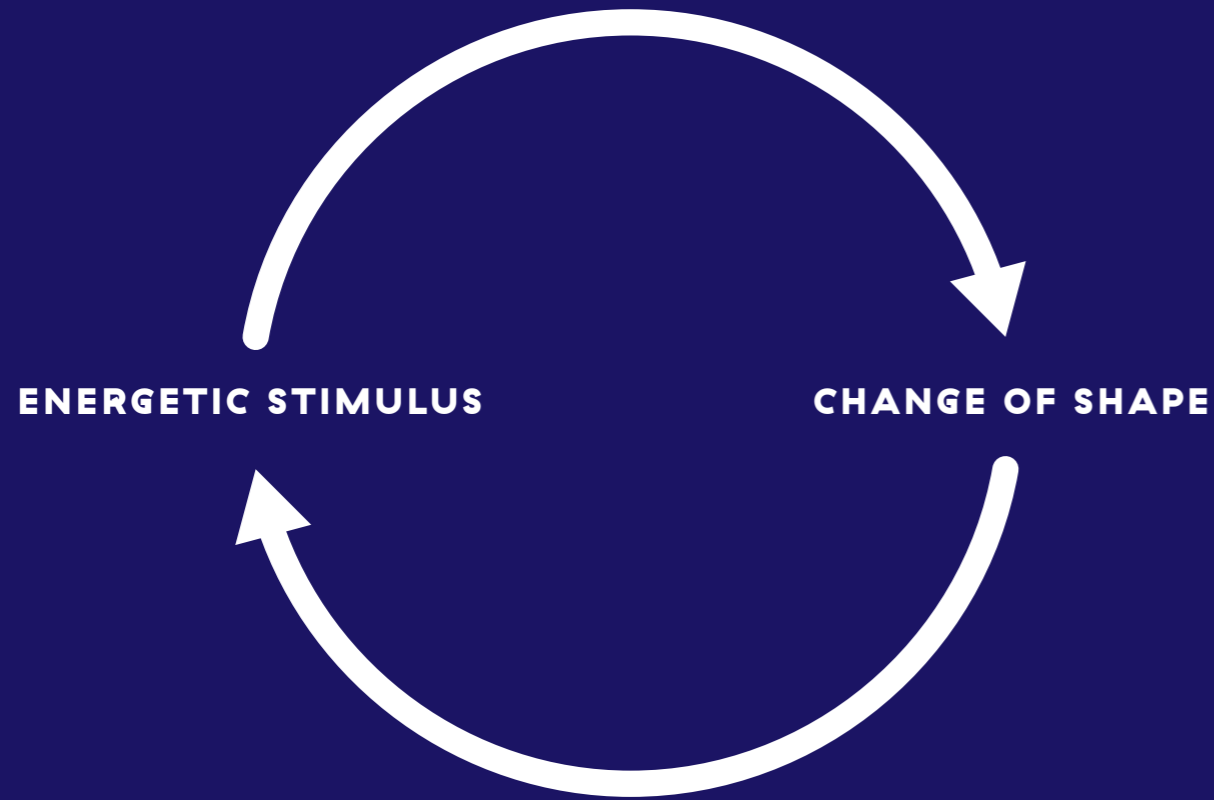
The Shape Changing Materials reversibly undergo shape change when exposed to an energetic stimulus (e.g. heat, electric current, force). Some even function vice versa.

Those can convert the energy created through their shape changing process into an energy output (e.g. light, electrical signal, vibration).

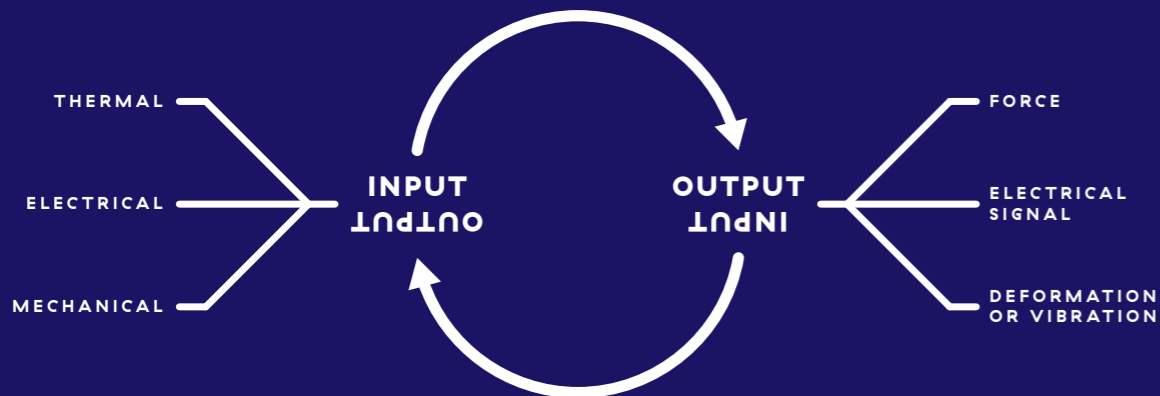
On the following pages there are schematic illustrations of the functional principles of:

- > Thermal Shape Memory Alloys: SMA
- > Electro Active Polymers: EAP
- > Piezoceramics: PIEZO

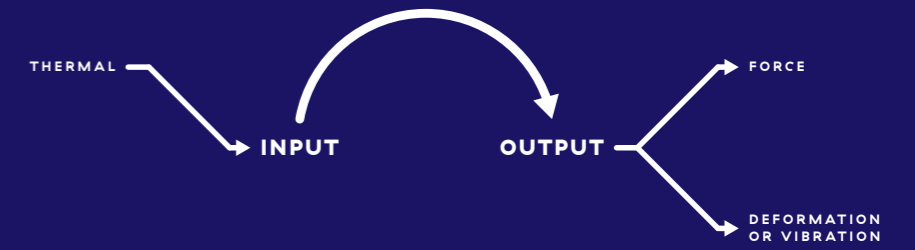
GENERAL FUNCTIONAL PRINCIPLE OF THE SHAPE CHANGING MATERIALS



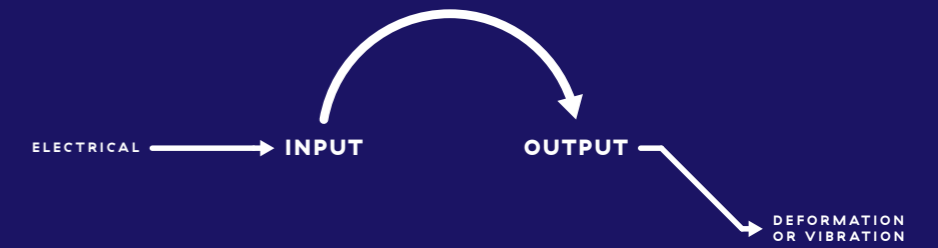
OVERVIEW: ENERGY CONVERSIONS OF THE SHAPE CHANGING MATERIALS



SMA ACTUATOR



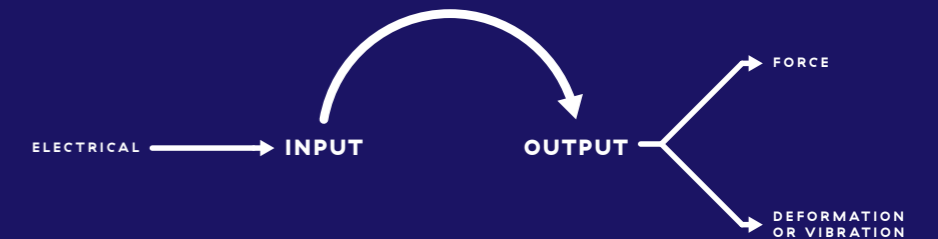
EAP ACTUATOR



EAP GENERATOR / SENSOR



PIEZO ACTUATOR



PIEZO GENERATOR / SENSOR



Questionnaire: Day I

1. Which (sensory) characteristics do the three functional materials have?
2. What is „smart“ about these materials?
3. What is critical about these functional materials?
4. In which context do you see special potential for these materials? Why?
5. Do smart materials in comparison to the, so called, conventional materials offer advantages for design? Yes, no, which and why?
6. Which of the three functional materials do you wish to explore further? Why?

Questionnaire: Day III

1. What was surprising about working with the material?
2. Which (sensory) characteristics does the functional material have?
3. What is smart about the material?
4. What is critical about the functional material?
5. In which context do you see special potential for the material? Why?
6. Does this smart material in comparison to the, so called, conventional materials offer advantages?
7. Would you be interested in further exploring one of the three functional materials? Yes or no and why is that?
8. Which aspects about this material should materials research address in the future?
9. Why do you think this material has not been used very often?

Questionnaires

In order to gain insights of the participants' ideas, questions, difficulties and opinions on the topic, they were asked to answer a few questions. Some beforehand their own hands-on exploration phase, some – afterwards.

Both questionnaires dealt with the evaluation of the materials' properties, their supposedly critical aspects, presumed potentials and advantages in comparison to the, so called, conventional materials.

The aim was to compare the young designers' expectations about the materials prior to the hands-on experimentation sessions with their opinions after actually experiencing the materials directly through making.

For the second questionnaire the perspective was broadened by adding questions concerning material research. They were asked to formulate a wish to the material scientists regarding aspects of the materials that are needing close attention in the future in order to improve these materials' properties. Or to identify the reasons why those materials, despite their special characteristics, have not yet reached the status of being fully included into the designers' basic set of materials.

Selected statements, issued by the workshop participants, can be found in the relevant materials' chapters.

Thermal Shape Memory Alloys

Thermal Shape Memory Alloys

Task

MATERIAL EXPERT

Paula van Brummelen

PARTICIPANTS

Milan Friedrich, Minyoung Han, Oliver Hurdman, Philippa Lorenzen, Boram Park, Junshen Wu, Charlett Wenig

Paula van Brummelen is Designer and Researcher at weißensee art academy berlin working on the multidisciplinary R&D project SoundAdapt. More Information can be found online: www.kh-berlin.de > academy > research > smart³

M tools, utensils and electronic equipment needed for 'training' the SMA wires



Working hands-on with SMA

During the process of developing concepts with SMA as kinetic actuators, there often occur discrepancies between the expectations a designer has towards the material and its actual capabilities and properties. In many cases, where SMA is integrated, it is only utilised due to its minimal need for space and therefore 'just' to replace bigger/more complex actuators (e.g. small electro motors). The many other positive characteristics of this functional material are overlooked and/or disregarded.

For this reason the focus of the SMA workshop was put on a hands-on, experimental and spontaneous examination of the material. The participants learnt in an instant and direct manner about the potentials and the difficulties one can have when working with SMA by integrating 'untrained' and 'trained' SMA spring actuators in flexible structures. They learned to 'train' the material and to trigger it with microcontrollers. By doing so, they got to know not only the technical parameters but also the performative qualities of SMA.

The knowledge the participants gained during the workshop is thought to be a foundation from which more complex and innovative concepts with Shape Memory Alloys can evolve in the future.

SMA experiments

I. inactivated mock-ups of various materials and geometries.

II. - III. triggering movement through heating up the SMA actuator by applying low voltage.

29. circular leather with 'untrained' stitched actuator



I.

II.

III.

30. circular leather with 'untrained' stitched actuator



I.

II.

III.

31. folded plastic rectangles, actuated diagonally



I.

II.

IV.

32. folded plastic rectangles, linear spring actuator



I.

III.

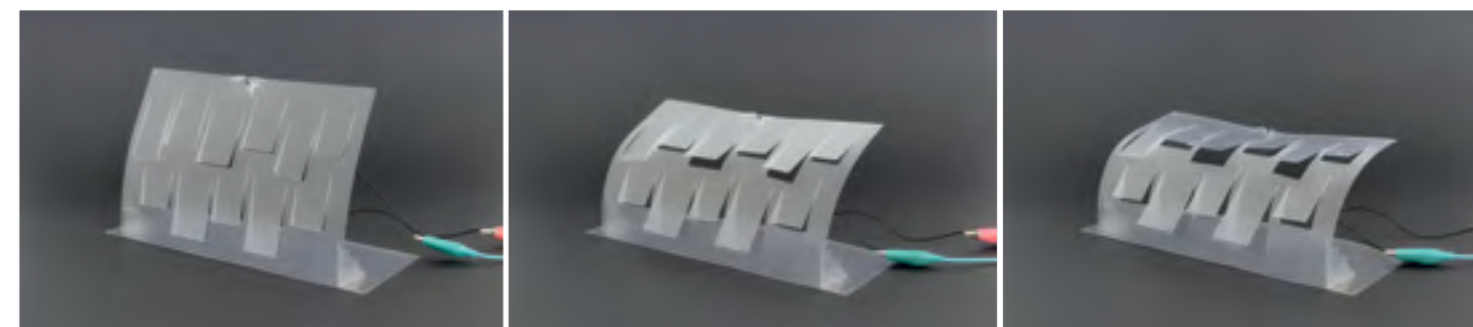
V.

Due to the structures and materials the mock-ups are built of, the actuators, after having reached their 'trained' shape, are returning back to their starting position (without any manual help) in order to repeatedly perform the shape memory effect.

I. inactivated mock-ups of various materials and geometries.

II. - III. triggering movement through heating up the SMA actuator by applying low voltage.

33. elastic sheet with centric spring actuator

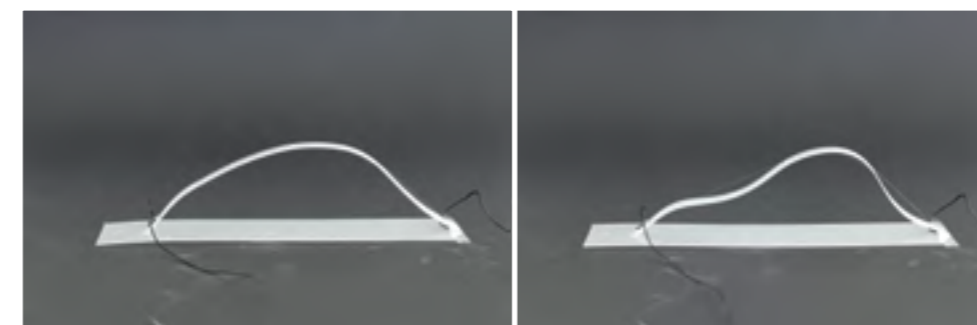


I.

II.

VI.

34. elastic sheet with 'untrained' wire that shortens



I.

III.

35. paper shape with contracting spring actuator



I.

IV.

VII.

Due to the structures and materials the mock-ups are built of, the actuators, after having reached their 'trained' shape, are returning back to their starting position (without any manual help) in order to repeatedly perform the shape memory effect.

36. three wooden veneers with two spring actuators



I.

V.

VIII.

I. inactivated mock-ups of various materials and geometries.

II. - III. triggering movement through heating up the SMA actuator by applying low voltage.

37. paper origami structure with spring actuator



I.

II.

VI.

38. paper origami structure with spring actuator



I.

III.

VII.

39. 'untrained' wire that straitens when actuated



I.

IV.

VIII.

Due to the structures and materials the mock-ups are built of, the actuators, after having reached their 'trained' shape, are returning back to their starting position (without any manual help) in order to repeatedly perform the shape memory effect.

40. flexible sheet with piercing spring actuator



I.

V.

IX.

I. inactivated mock-ups of various materials and geometries.

II. - III. triggering movement through heating up the SMA actuator by applying low voltage.

41. woolen shape with spring actuator



I.

II.

V.

42. elastic sheet folded with spring actuator



I.

III.

VI.

43. elastic sheet folded with piercing spring actuator



I.

IV.

Due to the structures and materials the mock-ups are built of, the actuators, after having reached their 'trained' shape, are returning back to their starting position (without any manual help) in order to repeatedly perform the shape memory effect.

44. elastic sheet with cut-outs and spring actuator



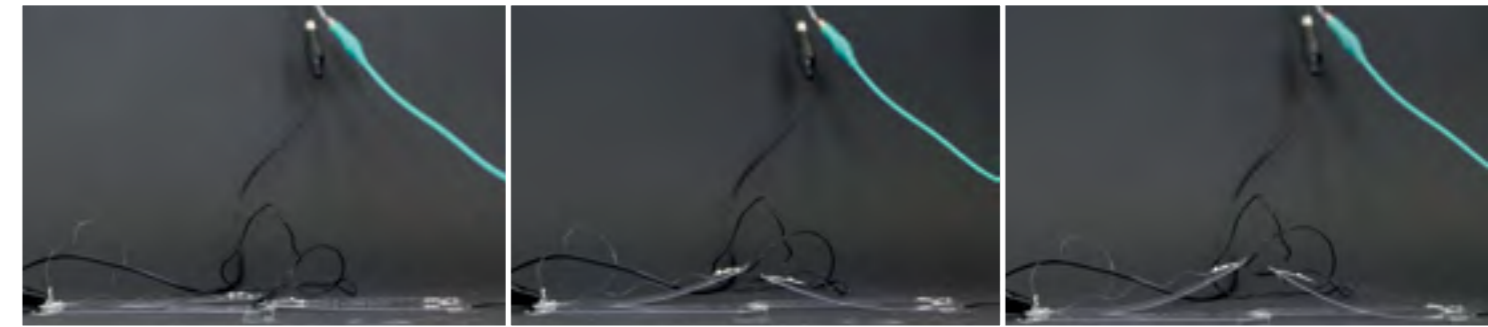
I.

II.

III.

- I. inactivated mock-ups of various materials and geometries.
- II. - III. triggering movement through heating up the SMA actuator by applying low voltage.

45. linear elastic sheets with spring actuators



I.

II.

VI.

46. round foam structure with centric spring actuator



I.

III.

VII.

47. wood veneer with stitched 'untrained' actuator



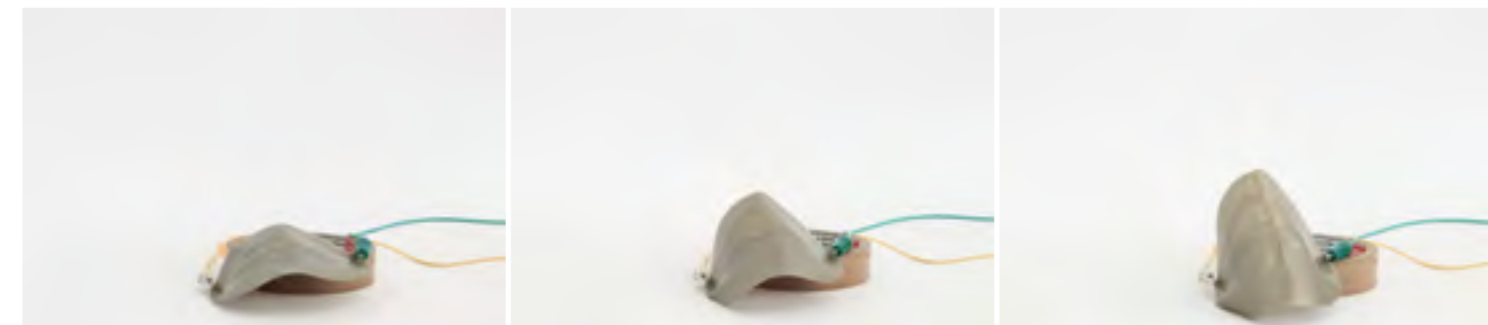
I.

IV.

VIII.

Due to the structures and materials the mock-ups are built of, the actuators, after having reached their 'trained' shape, are returning back to their starting position (without any manual help) in order to repeatedly perform the shape memory effect.

48. elastic circular shape with linear spring actuator



I.

V.

IX.

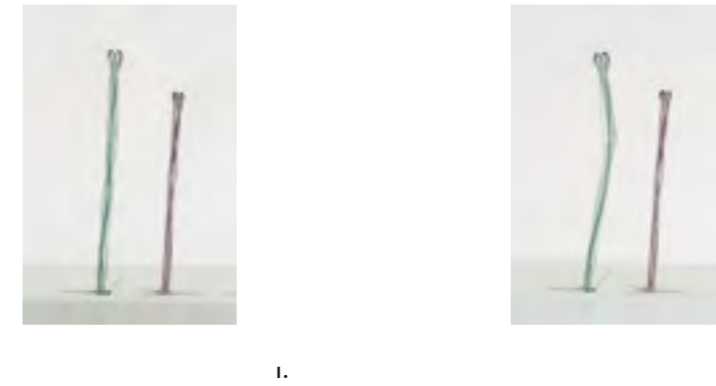
I. inactivated mock-ups of various materials and geometries.

II. - III. triggering movement through heating up the SMA actuator by applying low voltage.

49. linear actuator



50. straws with linear actuators

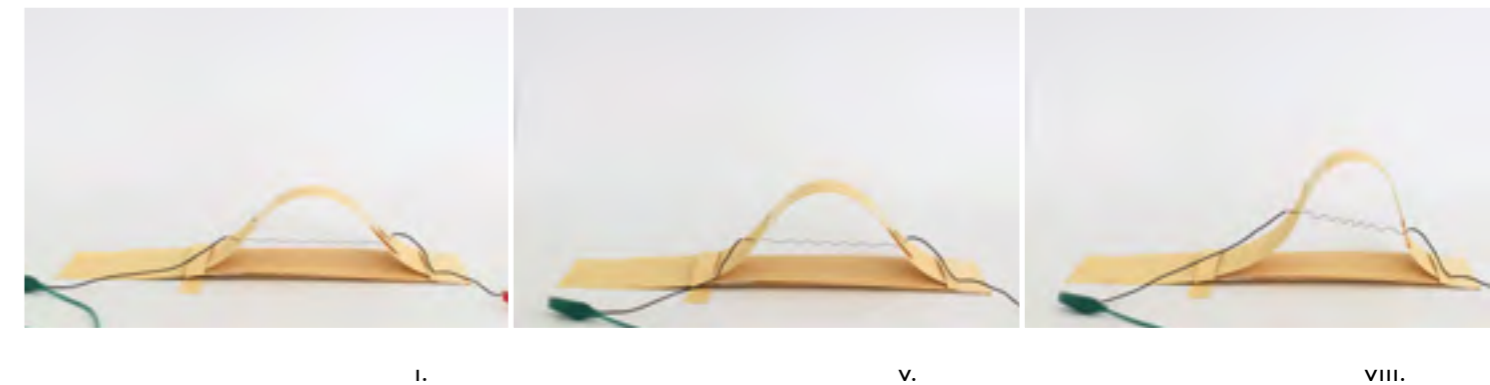


51. folded paper with spring actuator



Due to the structures and materials the mock-ups are built of, the actuators, after having reached their 'trained' shape, are returning back to their starting position (without any manual help) in order to repeatedly perform the shape memory effect.

52. linear elastic sheet with spring actuator



- I. inactivated mock-ups of various materials and geometries.
- II. - III. triggering movement through heating up the SMA actuator by applying low voltage.

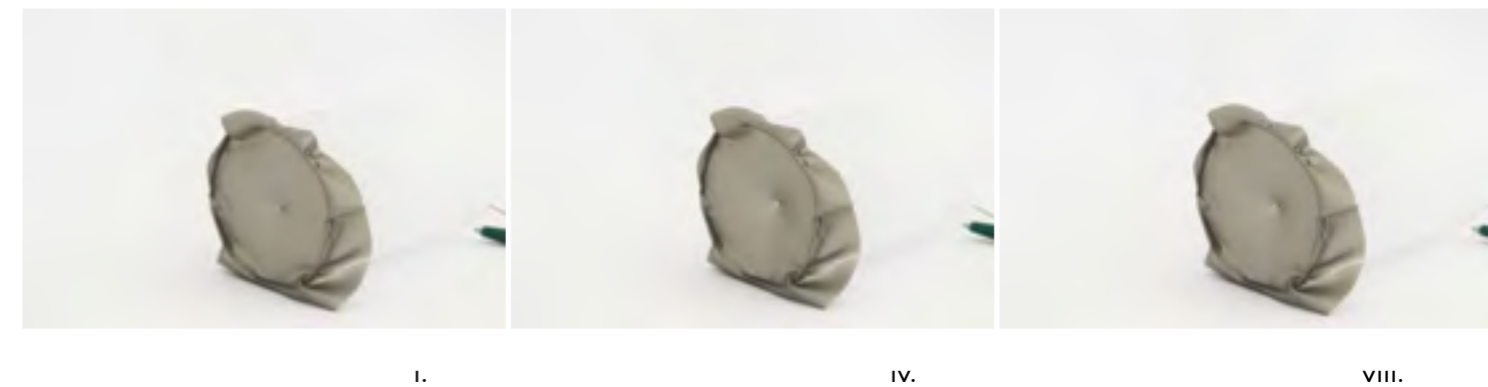
53. wood veneer with stitched 'untrained' actuator



54. textile structure with linear actuator



55. elastic film with piercing linear actuator



56. elastic film with diagonal spring actuator



Due to the structures and materials the mock-ups are built of, the actuators, after having reached their 'trained' shape, are returning back to their starting position (without any manual help) in order to repeatedly perform the shape memory effect.

The fabric of mock-up 27 does not have enough tension to stretch back the SMA wire in its starting position after contraction. Therefore the SMA needs to be manipulated manually in order to function again.

Opinions & Questions

Pros & Cons after three days of exploration

'...the strength of the spring is incredible!'

'...is it possible to increase the shrinkage of 5%?'

'...what processing technologies are available for SMA? How can they be connected to other materials or among each other?'

'...combining SMA with textile technologies to process them as 'yarns' seems very promising. Unfortunately, it is too expensive to produce whole knitted or woven fabrics at the moment.'

'...the possibility of triggering the shape memory effect by using the surrounding temperature is very interesting in terms of ecological and resource saving aspects. Is there a way of improving the functionality of those potentials?'

'...the slow and organic movement is magical!'

'...is it possible to 'program' the alloy for it to deform again by itself after having reached the memorised shape?'

'...there are too many cables and electronics necessary to activate the shape memory effect in a controlled and specific way.'

'...is it possible to 'train' a SMA with various shapes and temperatures within the same piece?'

Working hands-on with SMA

Process & Presentation



N moving SMA ensemble



O experimental demonstrators

P presentation

Electro Active Polymers

Electro Active Polymers

Task

MATERIAL EXPERT

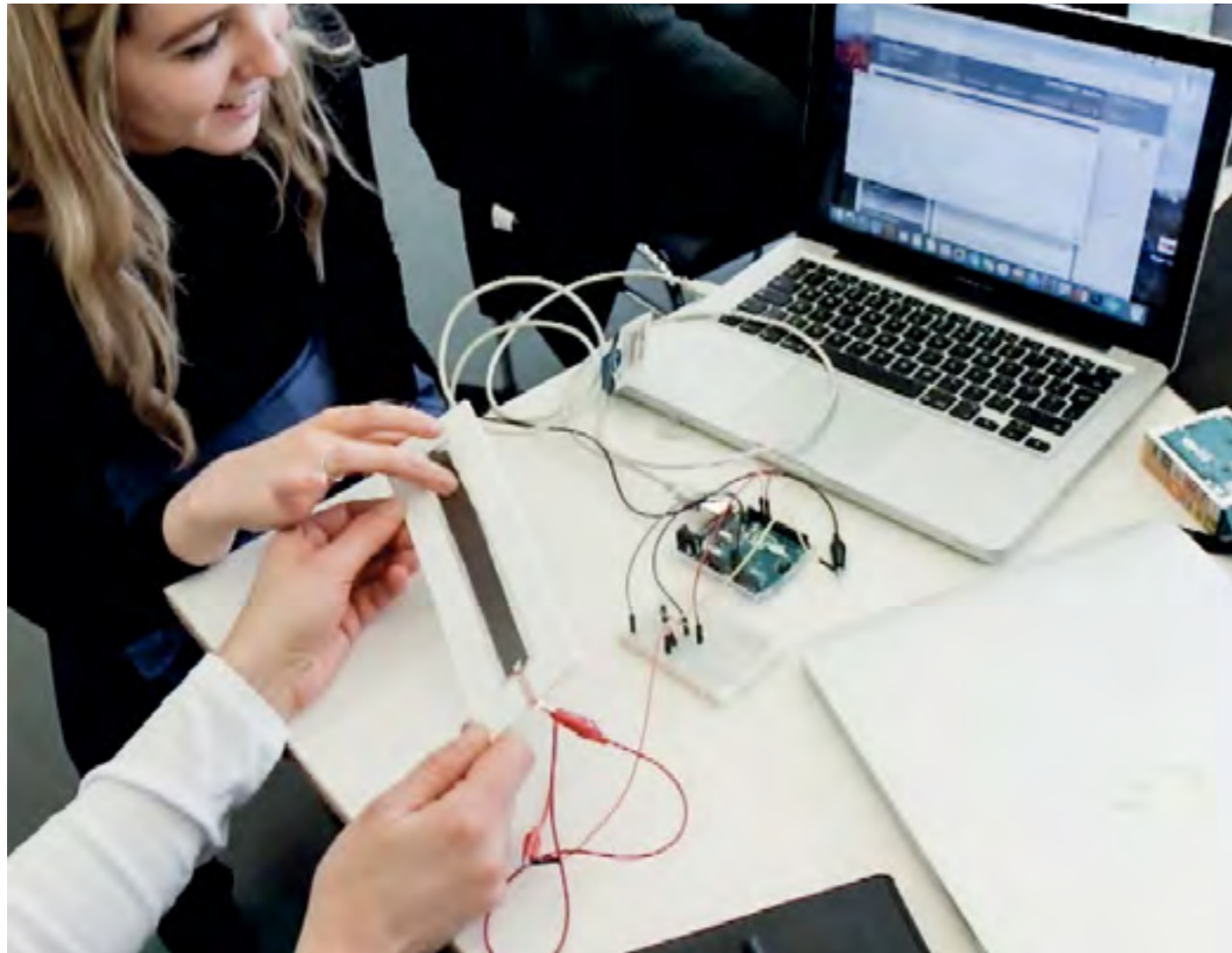
Julia Danckwerth

PARTICIPANTS

Suzan Camlik, Alice Chamberlain, Olga Kuschchyk, Liina Leo, Katja Riley, Constance Vidalain, Wagehe Raufi

Julia Danckwerth is Designer and Researcher working on conceptual textiles which recognise fashion as a new kind of interface. More Information can be found online: www.danckwerth.com

Q film still of an EAP sensor testing



Working hands-on with EAP Sensors

The starting point for the participants' own examination was a brief introduction about what EAP sensors are, what characteristics they show and how they can be integrated into design concepts.

The first task was to conceptualise and visualise application scenarios that use the sensor and actuator properties of EAP.

In a next step own EAP sensors* were fabricated and integrated into textiles to create (free) shapes in order to use their sensor-properties in different manners.

Ideas for interaction scenarios and methods of processing EAP as a material (e.g. though processes of weaving, bonding, knitting, etc.) were gathered during the brainstormings.

During the further investigation phase EAPs made professionally in a scientific lab** were introduced to see the working principle and to articulate demands to future material research from a designers' perspective. Ideas regarding aspects such as ergonomics, perforation, contact with the skin, colour, surface and shape were collected.

During the experimental prototyping stage, the electric impulses, the EAP sensors detect, were processed via an Arduino. Visualisations were made from the data and put in relation to the firstly formulated scenarios.

* DIY information material can be found online: www.st4sd.de

** provided by Fraunhofer-Institut CesMa

EAP scenarios

With a focus on the material properties, first application ideas were sketched and visualised in mock-ups. The characteristics of EAPs, which the following concepts are addressing are: softness, high flexibility, shape changing possibilities as well as the actuation and sensorial functionalities.

Participants were asked to develop use cases and applications for EAPs as sensors or actuators:

SCENARIO 1

This idea shows EAP as an actuator, which changes its shape and along that the shape of the textile.

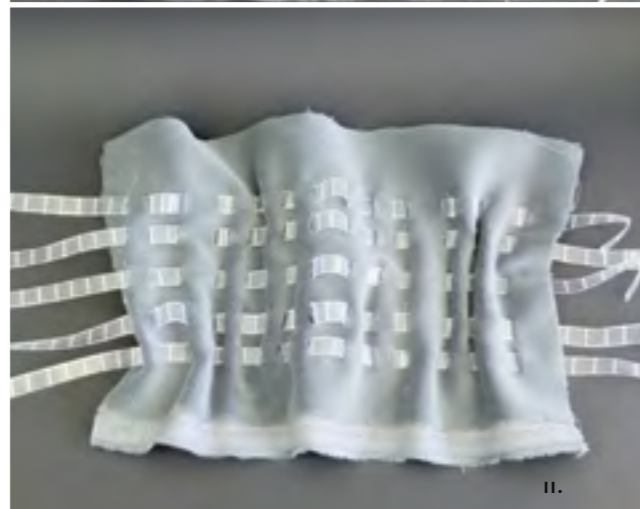
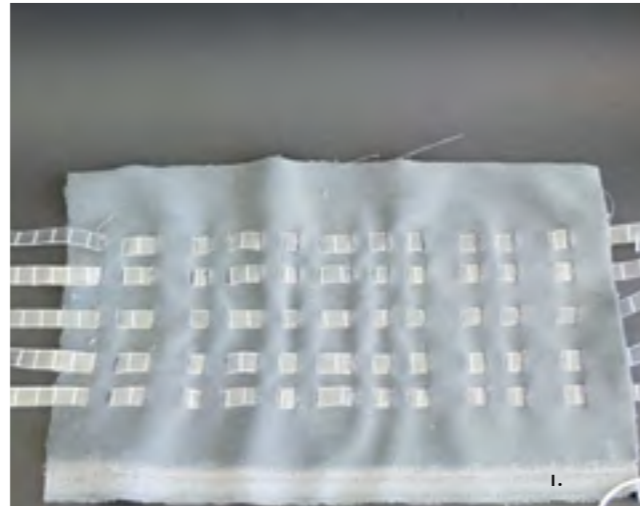
SCENARIO 2

In this concept the sensor is integrated in the process of felting. In this way the EAP is hidden in a soft material, which can measure the pressure.

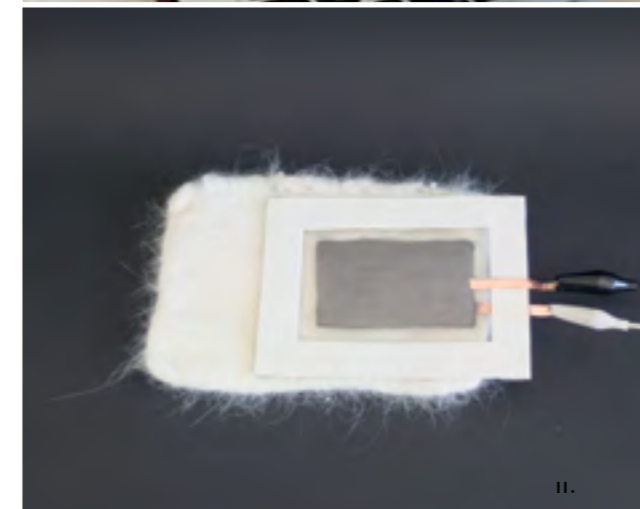
SCENARIO 3

The mock-up shows a measuring device for pressure, in an aesthetic way, which stimulate the user to interact with material. The shape is filled with liquid. The intensity of the pressure can be measured, the playful concept could be a motivation to train fine motor skills of patients in therapy. This task allowed for an open and experimental approach to the conceptualisation of applications and processing methods on the basis of EAPs. The goal was to leave aside all technical restrictions and boundaries in order for new concepts arise. In the second step, these can be combined and adjusted to the status quo of the technological situation. Such an approach enables the designers to sketch scenarios, which are currently not possible but verbalise important demands to the materials. This might influence the direction of future material development and research.

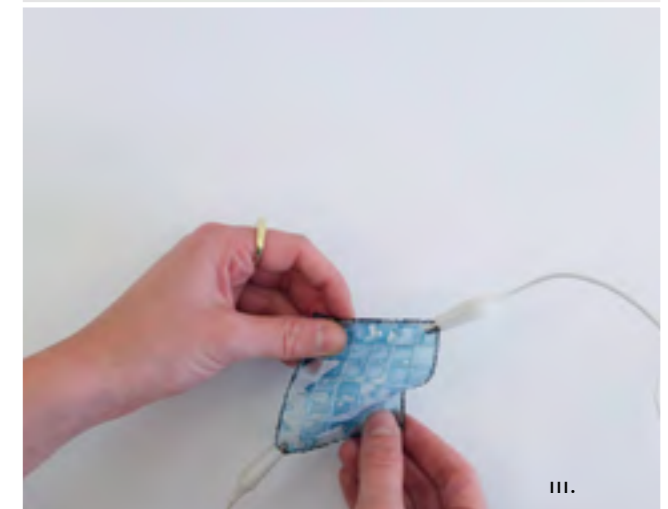
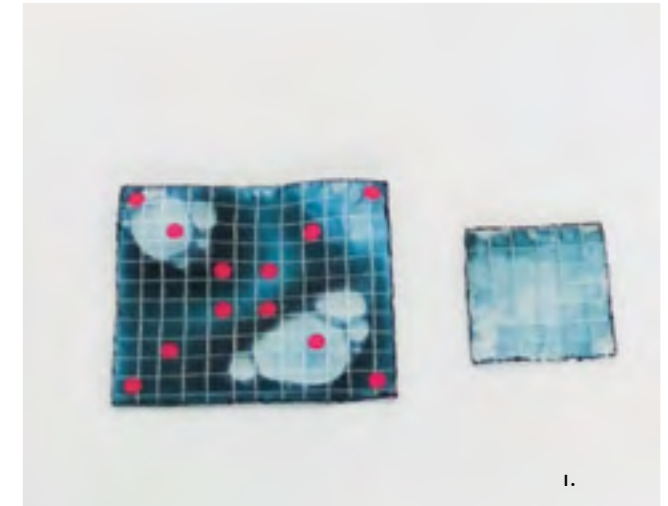
17. interwoven EAP stripes



18. EAP integrated in a felt surface



19. multi-sensorial EAP sensor



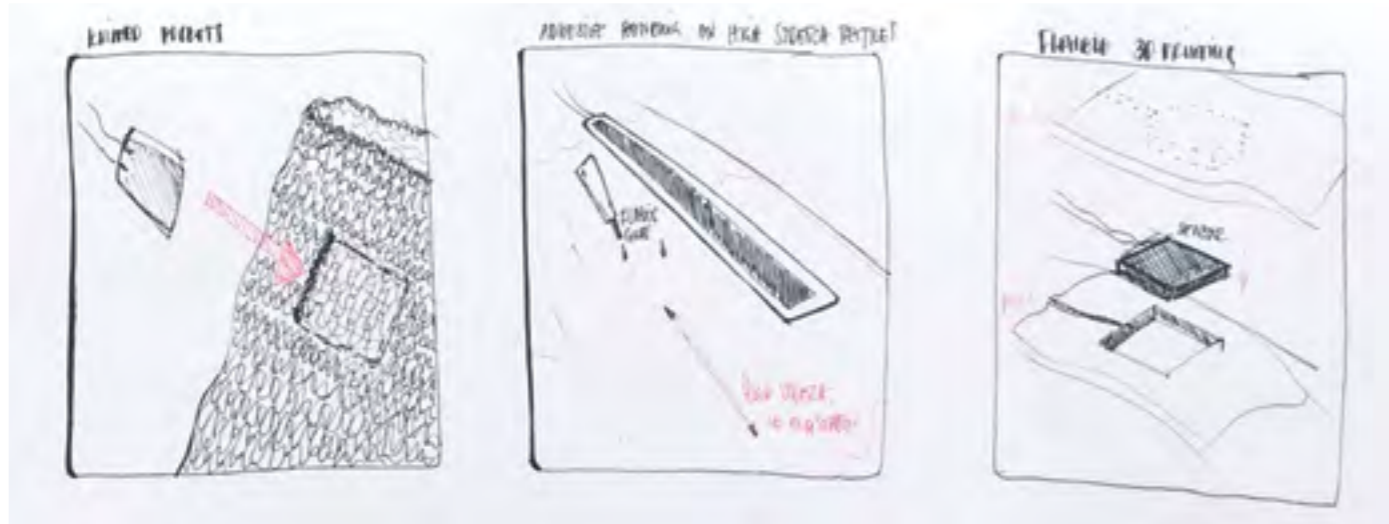
SCENARIOS 6 & 7

These concepts focus on the actuation and high shape changing properties of EAP. The flexibility of the polymer film are the basis for these illustrations.

SCENARIOS 8 - 10

For those ideas EAP is used for its sensorial qualities and relate to the human body in different contexts.

20 EAPs integrated and combined with different processing techniques such as 3D printing



21 discussing ideas for potential EAP applications



22 using the shape changing effect of EAP to open and close a surface



23 the flexibility of EAP increases shape adaptivity a surface

24 medical application for EAP sensors

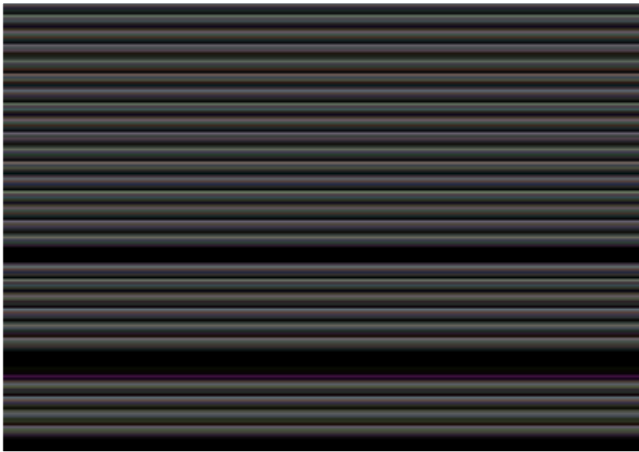


25 integration of EAP in a textile structure

26 stretch sensor qualities used for communication

SCENARIOS 11 - 14

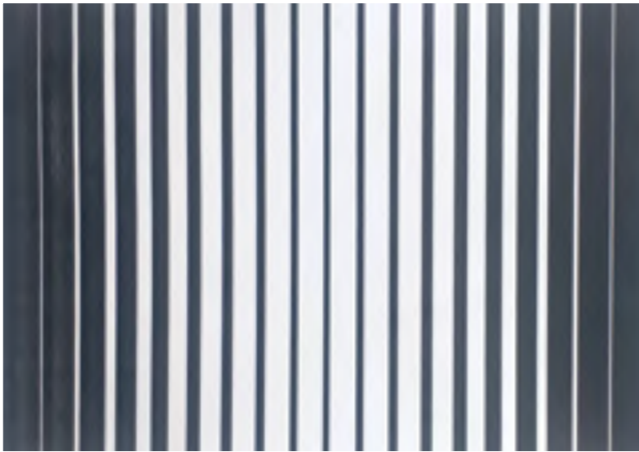
The electrode surface on both sides of EAP consist of a conductive material, usually black carbon powder and is spread evenly over the whole surface. These concepts show various patterns, with which the elastomer film could be covered and therefore the shape changing and sensorial properties would differ and be adjustable.



27 electrode pixel pattern

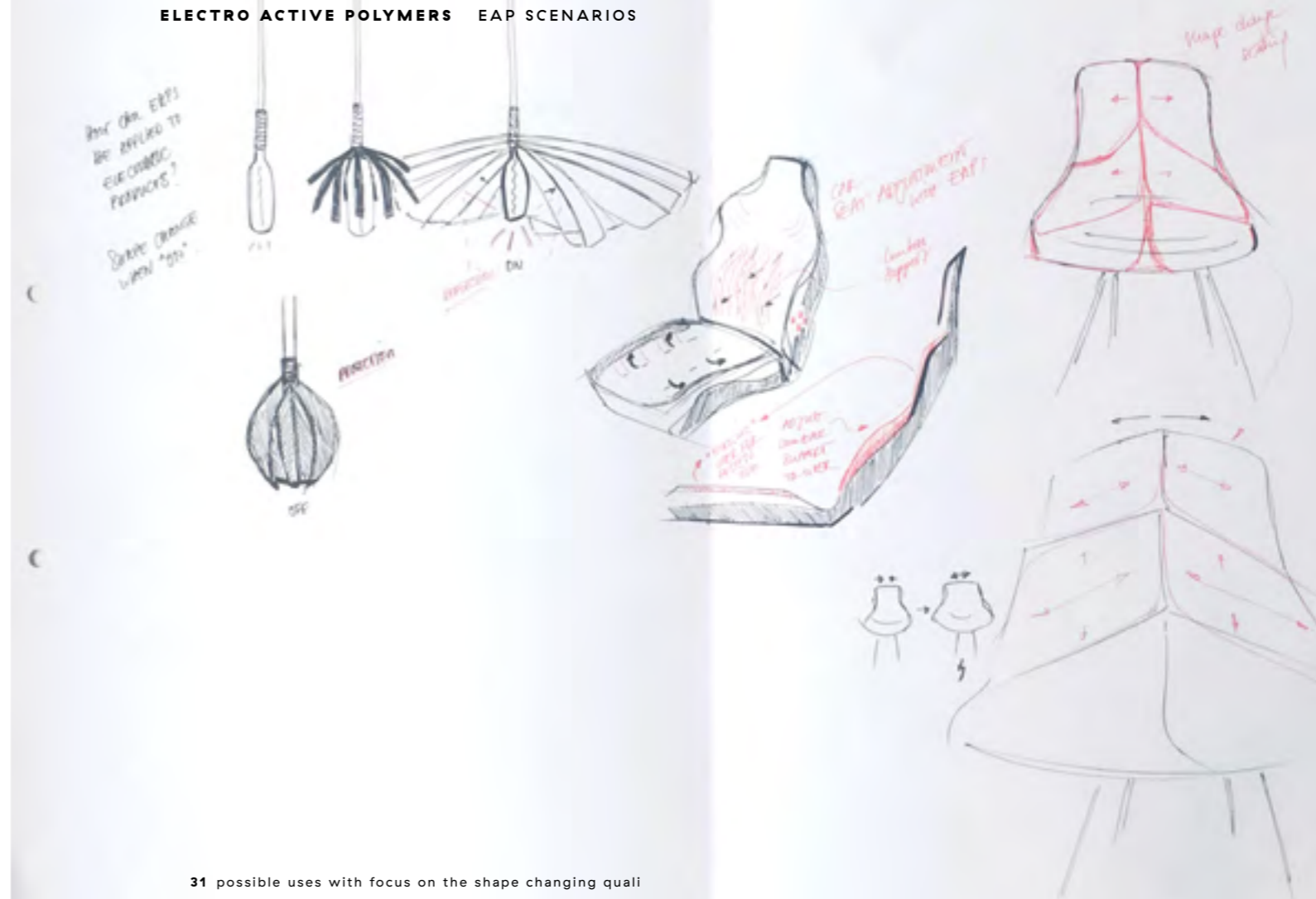
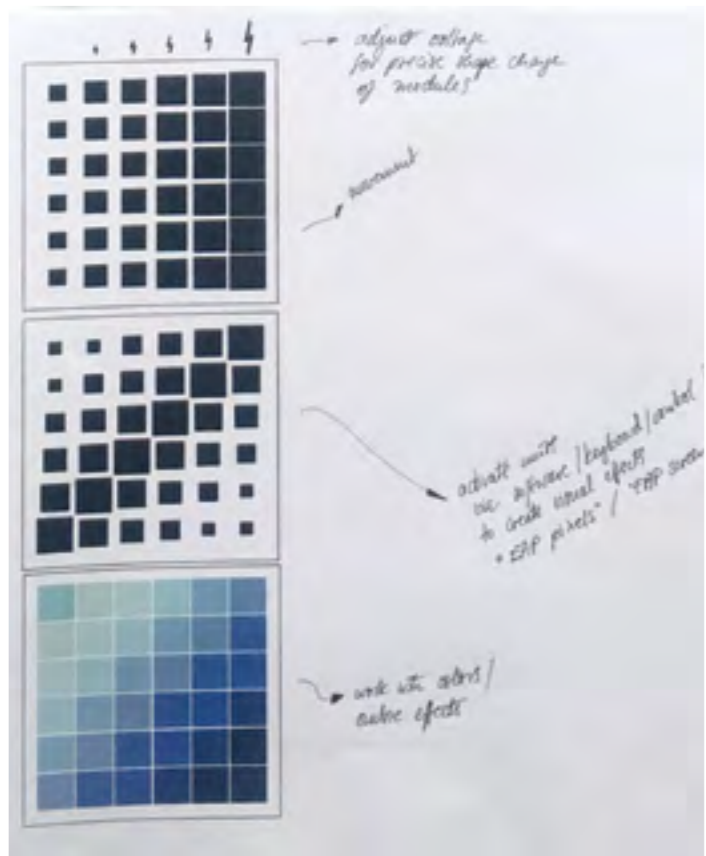
SCENARIOS 15 & 16

The sketches illustrate different ideas to utilize the shape changing and electric energy producing properties of EAP. qualities and relate to the human body in different contexts.



28 electrode stripe pattern

30 electrode pattern in inactive/active states



31 possible uses with focus on the shape changing quali



29 electrode pixel pattern activated

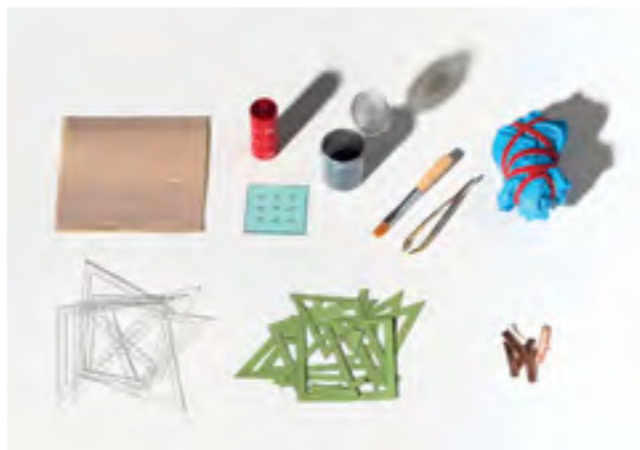
32 scenarios for the generator function of EAP



EAP experiments

DIY EAP STRETCH SENSOR

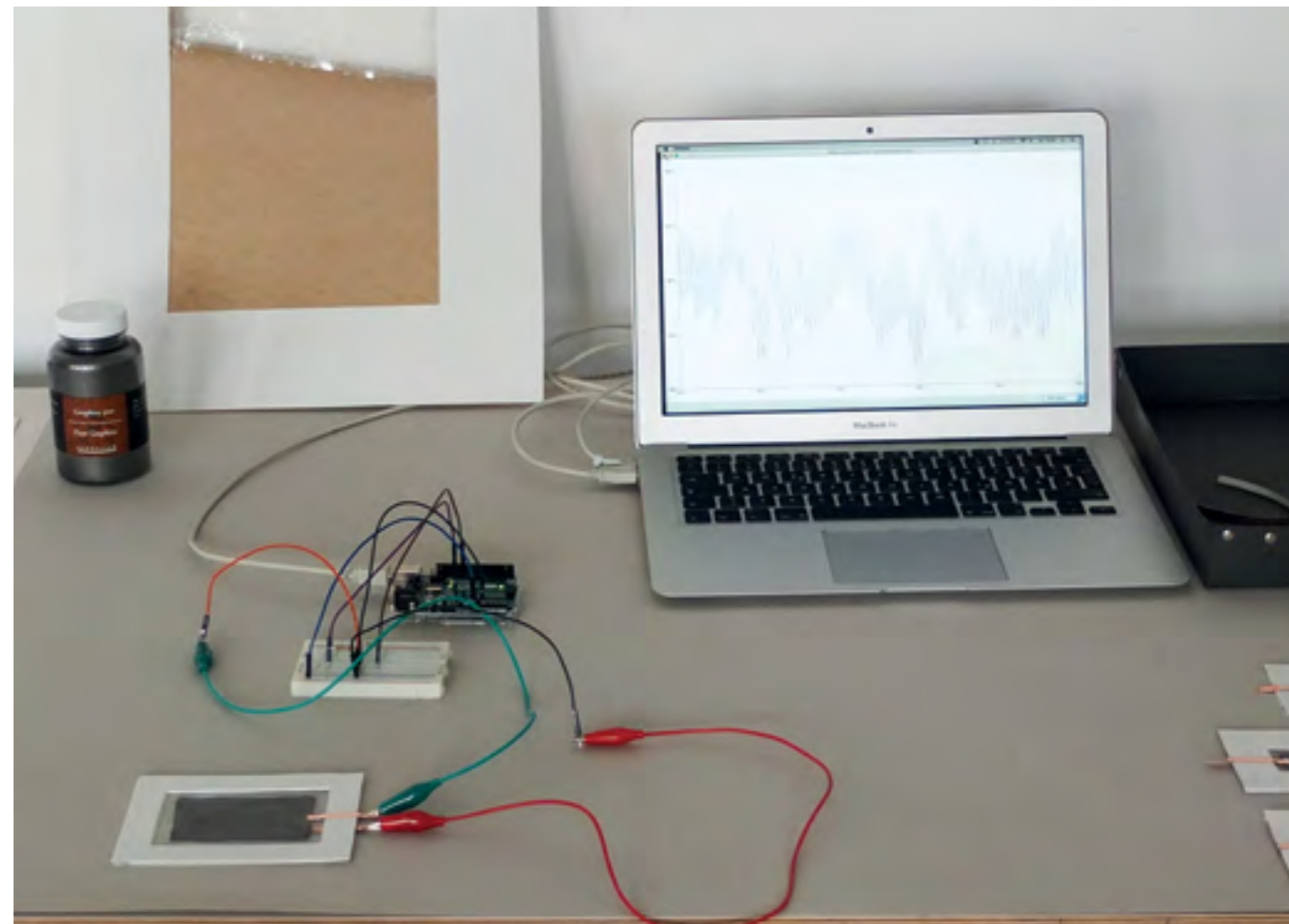
Electro Active Polymer Sensors consist of a simple combination of materials. The raw material is a highly flexible, non-conductive polymer film which is stretched and mounted on a frame to keep the tension. The film then is covered with conductive powder (carbon black) on both sides and electrical contacts are applied. This basic EAP converter can be utilized as both – as sensor and as actuator. Due to the high voltage (≈ 5 kV) necessary to trigger the shape changing effect, the EAP during the workshop is used and explored for its' sensing properties only. The sensor perceives very delicately and precisely the changes on its surface when stretched. These data can be converted into screenbased graphics or other visualizations.



11 utensils to build an EAP converter



12 self-made sensor



14 by stretching the EAP film, changes are sensed, processed via a microcontroller and visualized in a graph

13 learning by doing and following the step by step tutorial (can be found online: st4sd.de)



15 lab-made stretch sensor by Fraunhofer CesMa



16 self-made sensors

DIY EAP STRETCH SENSOR

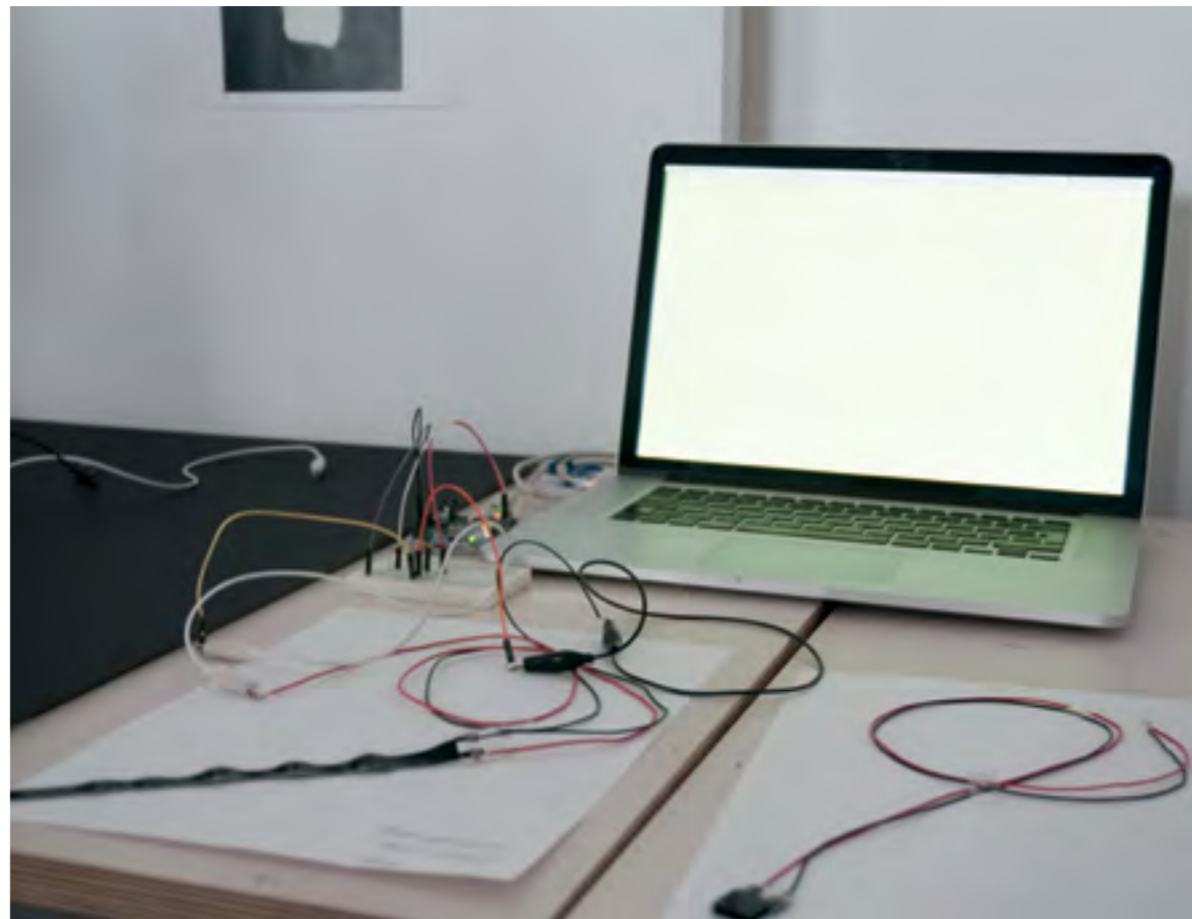
During the workshop every student built own sensor. By connecting the sensor with an Arduino microcontroller one is able to measure the pressure. In image 7 the finger deforms the sensor and the graph is changing. The sensor has a high sensitivity. In image 8 the sensor is pressed gently, the curve of the graph is softer. When the pressure is stopped the curve lapses. Usually it takes a short time for self-made sensors until the polymer film is completely relaxed again.



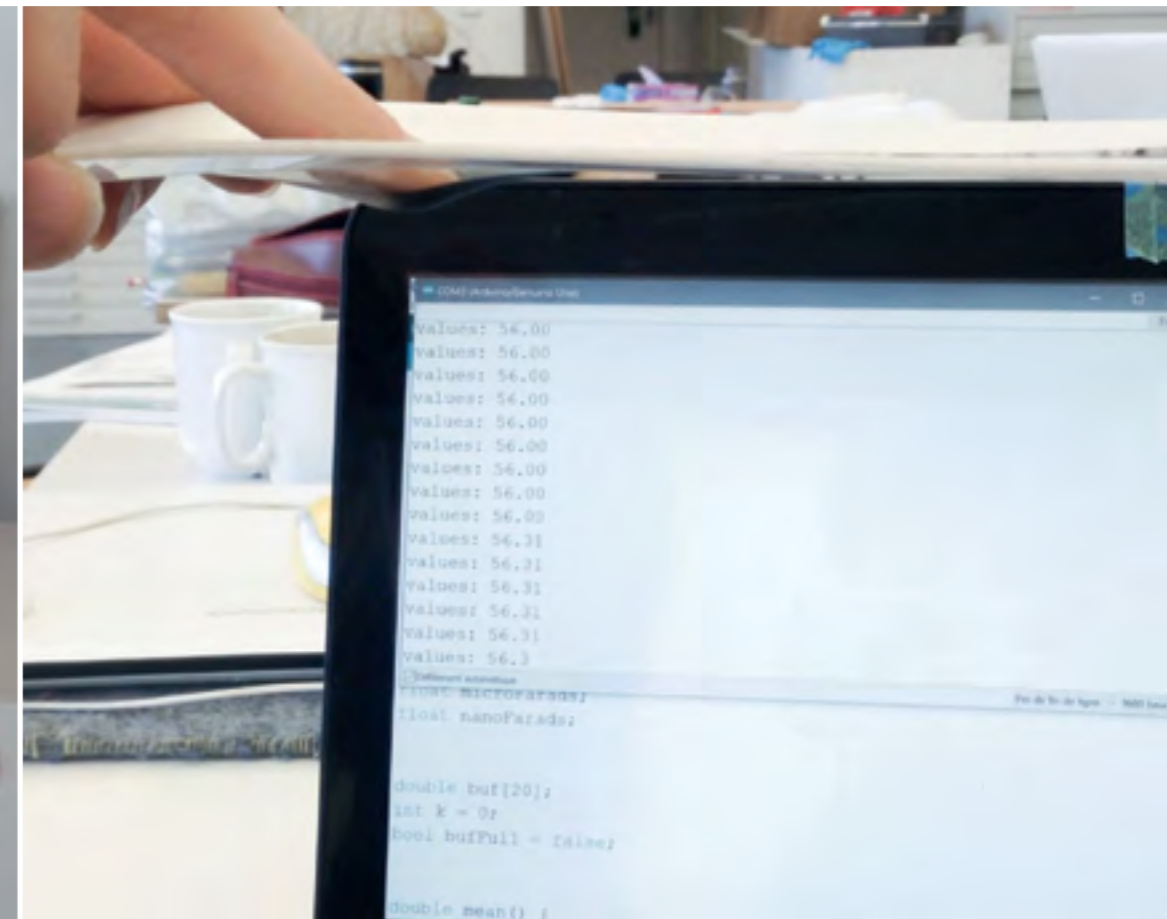
17 sensor being deformed with high pressure



19 sensor being deformed with less pressure



18 the colour gradient changes when the stretch sensor is activated



20 by pressing the flexible surface that capacity changes can be measured

Opinions & Questions

Pros & Cons after three days of exploration

'...the material is not really 'smart', because it needs conductive media and high voltage to function.'

'...it is great how stretchable EAP are! It would be great to use them as yarn and integrate them directly in textile structures.'

'...it would be interesting if the electrodes could be coloured differently or even see-through.'

'...is it really better than other materials with similar sensorial and stretching properties?'

'...what are the possibilities for combining EAP with other materials?'

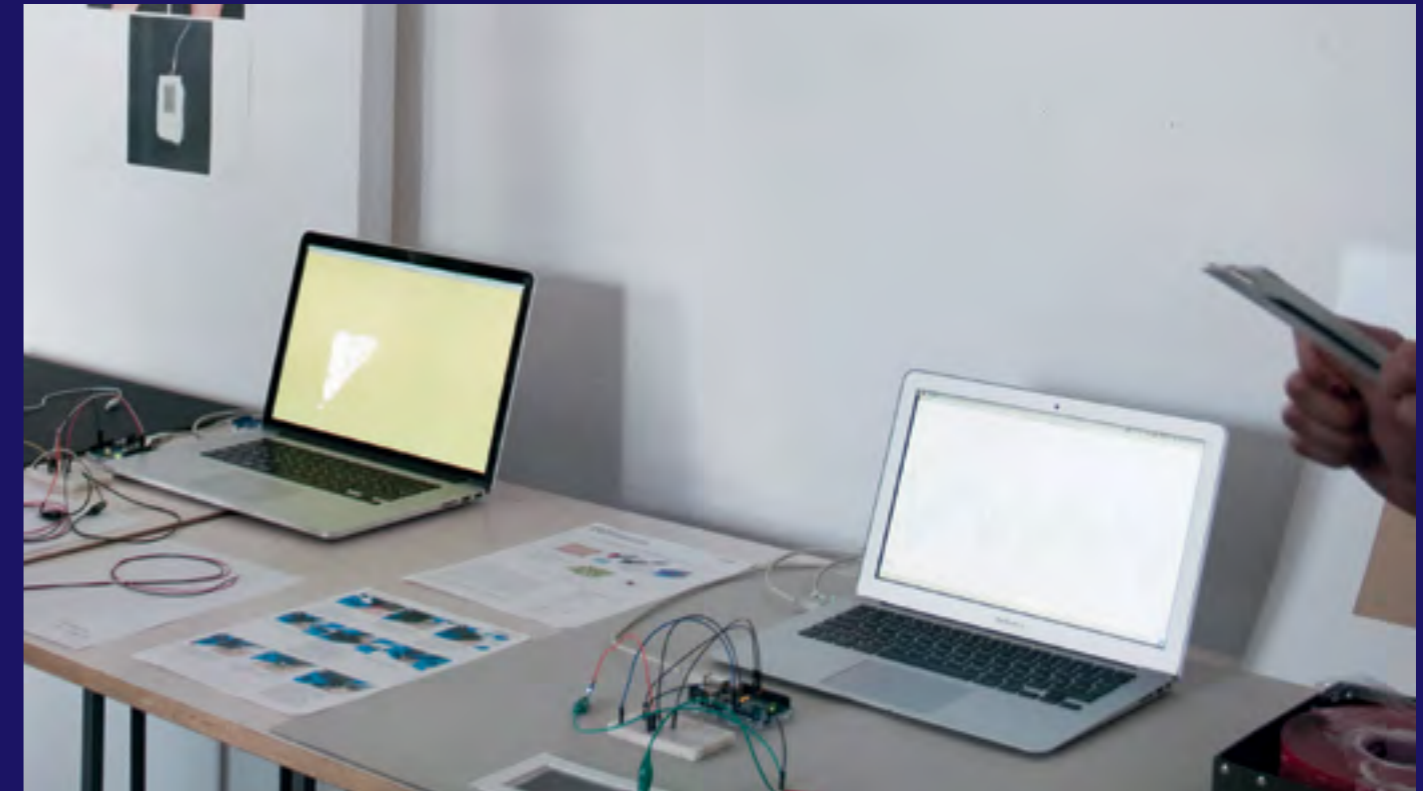
'...the prototypes were very sensitive and small. Up to what size could they be fabricated? Huge?'

'...could there be an EAP with different elasticities or densities? It could be 3D-printed in one piece.'

'...generating energy through stretching EAP could be very interesting and cost-saving in the future. When would it be efficient enough?'

Working hands-on with EAP Sensors

Process & Presentation



R presentation set-up with EAP sensors and different visualisations of the data



S presentation

T fabricating the EAP sensors

Piezoceramics

Piezoceramics

Task

MATERIAL EXPERT

Felix Groll

PARTICIPANTS

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U Arduino/PIEZO experiments and processing in eLab



Working hands-on with PIEZO

PIEZO converters are very versatile materials. They are strong, long lasting, extremely precise and sensitive. The shape changing effect can be used in two ways and works vice versa. Their properties allow them to function as generators to produce small amounts of electric energy or as sensors when they are mechanically deformed. When the shape changing effect is triggered by an electric current they start to vibrate, which results in a certain sound output in correlation to the frequency of the electric input.

During the workshop simple PIEZO converters were explored in order to do both: to record and to create sounds. The data were processed via an Arduino microcontroller.

The results are experimental studies investigating the material properties and combining them with digital technologies in a playful way.

The hands-on research sessions were complemented by brainstorming sessions in order to find potential application scenarios for PIEZO actuators, sensors and generators.

PIEZO experiments

RECORDING SOUNDS

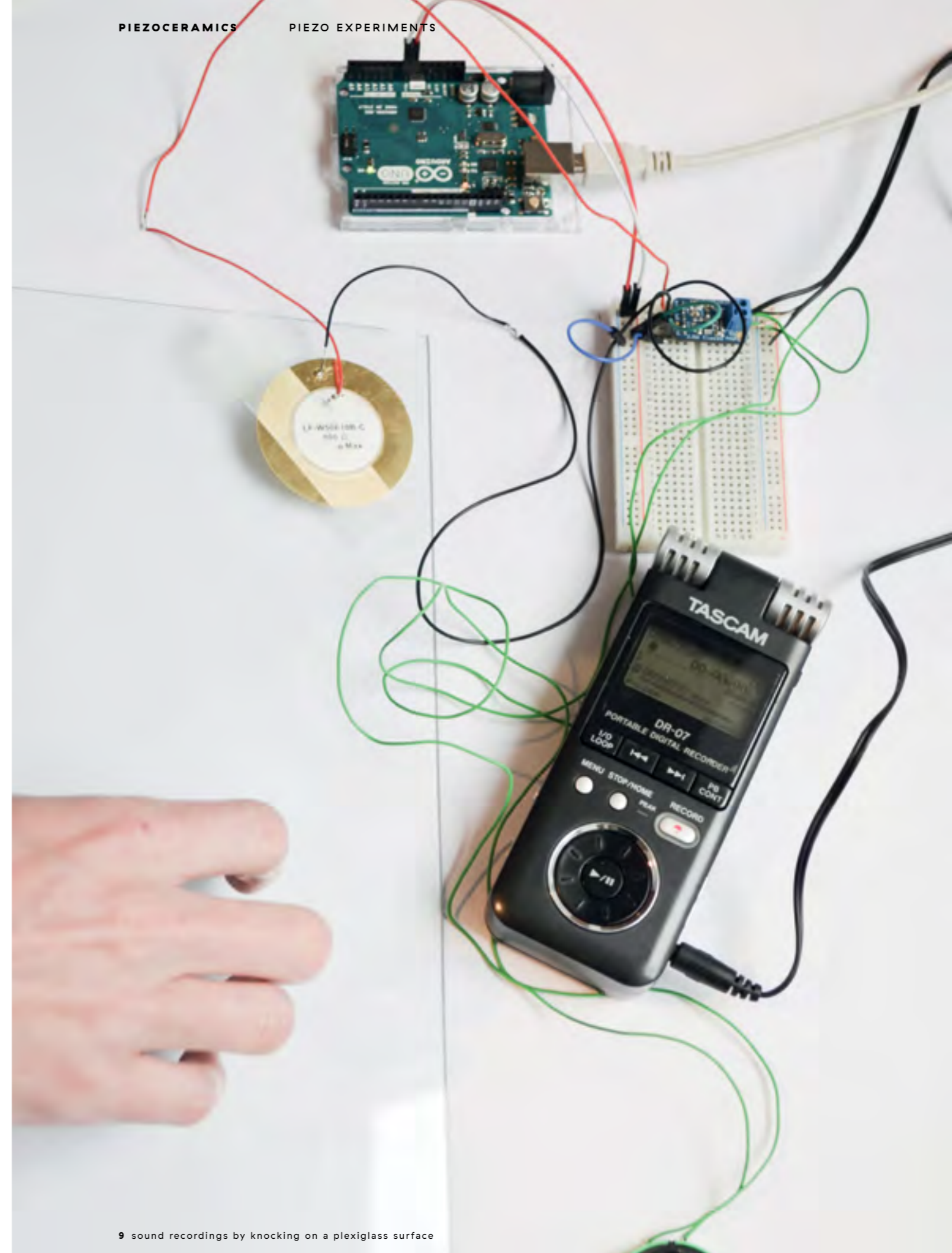
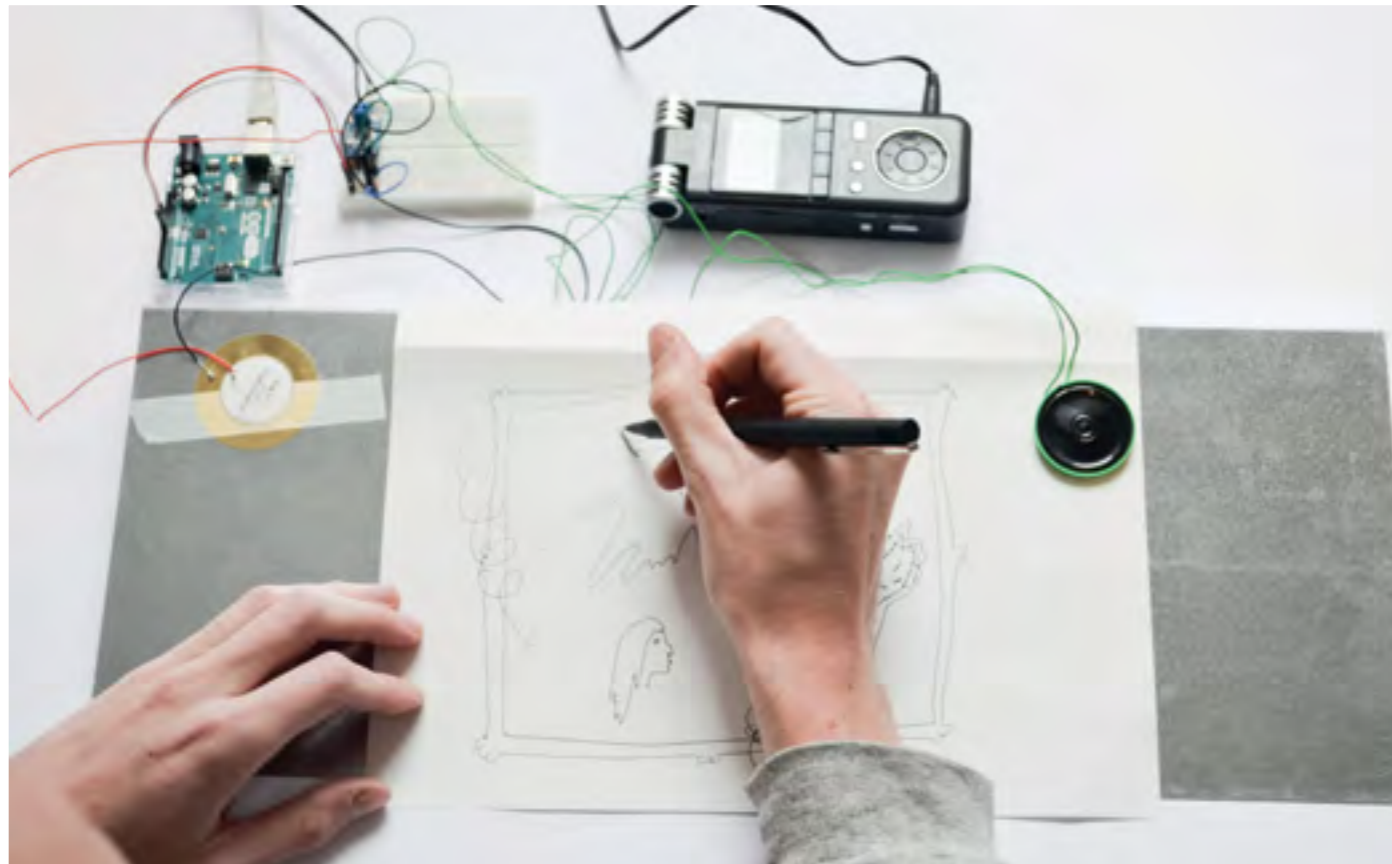
First test series: The PIEZO element was connected to an amplifier and recorded directly to a sound recording device. With that the first recordings were made by taping the piezo element to a surface (see audio files on the right).

Second test series: A drawing was made with a ball point pen on a piece of paper that was placed on top of the surface to test how the material conducts the vibrations. With that the second recordings were made using the materials and manipulating them by hand, knocking on them, tapping or bending them. The experiments from the 2nd recordings with water were made by attaching the contact mic to the bottom of a plastic bucket and recording the water that pours into it, both from the tap and then from a water pitcher.

AUDIO FILES

- bubblewrap.wav
- corrugated cardboard.wav
- fake leather chair.wav
- glass window.wav
- glass.wav
- mesh fabric.wav
- metal.wav
- metal sheet.wav
- notebook.wav
- plastic heet tarp.wav
- plexiglass 4mm.wav
- plexiglass 2mm.wav
- plexiglass 3 mm.wav
- porcelain sink.wav
- water direct from tap.wav
- water poured into box.wav
- wood.wav
- wooden table.wav

8 recording sounds through a PIEZO sensor by using the vibration of a surface while drawing on the same



9 sound recordings by knocking on a plexiglass surface

INTERESTING FINDINGS FOR RECORDING SOUND EXPERIMENTS

- › It is assumed that the recordings cut out at certain points when the vibration is too intense.
- › The recorded sounds with the drawing experiments were all very similar. The different surface materials had more effect on the volume than the actual sound quality.
- › With the water sounds it was realised that the microphone needs to be connected to a resonator in order to better pick up the sound.

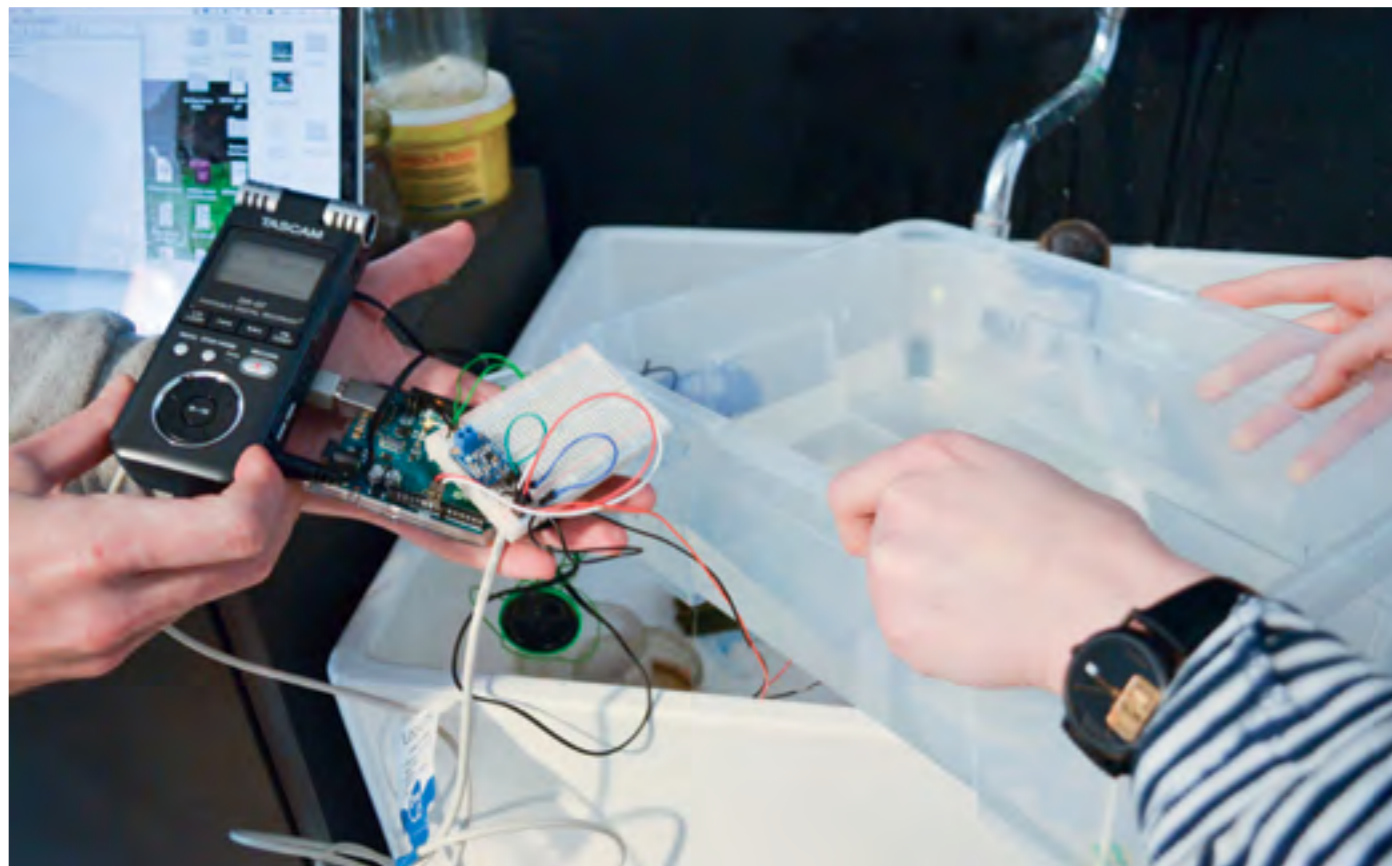


10 recording sounds with pouring water



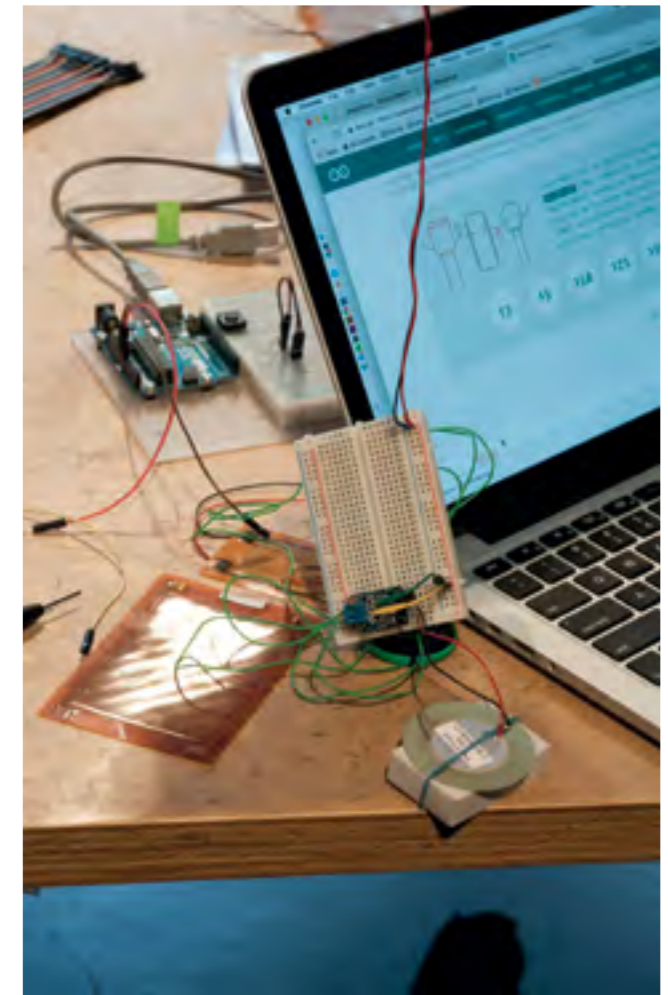
11 recording sounds by writing on different surfaces

12 recording sounds with running tap water



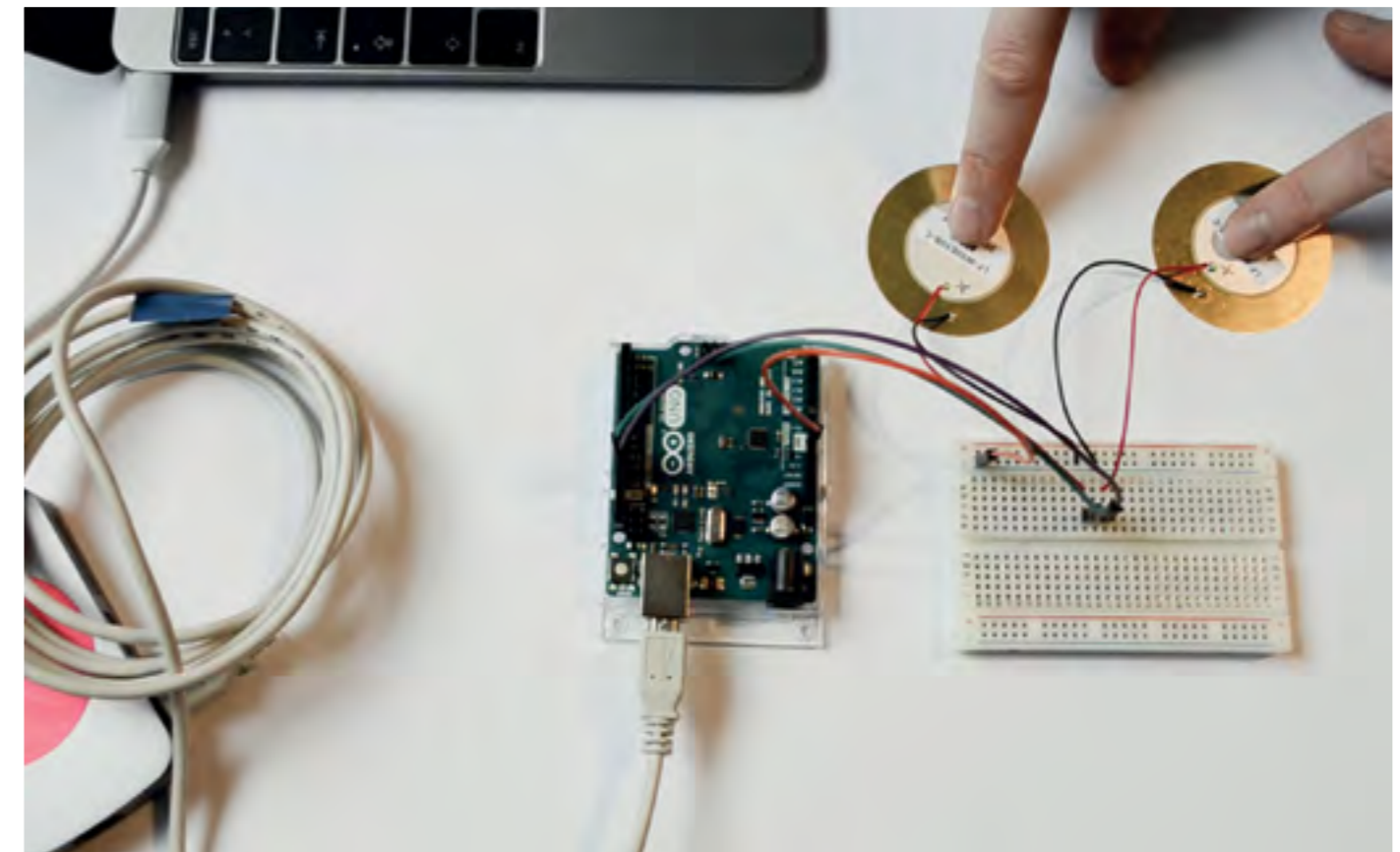
GENERATING SOUNDS

By using an Arduino microcontroller different sound experiments could be made. The programme offers a sound library based on defined frequencies with which the PIEZO elements need to be actuated. It is possible to use two elements at a time, so two different tones can be played together. Due to the Arduino UNO hardware it is not possible to use more than two PIEZOs. LF-W50E10B-C, 800 Ω, 30V-p-p max was used for the tests. The tone output is influenced by the underground, e.g. if the PIEZO is laying flat on a table and there is no air in between the metal and the table, the tone is more clear. If there is a paper or dust in between, the tone is more rustling.



13 first steps Arduino and PIEZO

14 the sounds of PIEZO actuators, which are generated by vibrations of high fruequencies can be manipulated



PIEZO scenarios

THREE FUNCTIONALITIES

PIEZO converters have many functional characteristics, which allows for a broad variety of application concepts.

SCENARIOS 2 - 6

The PIEZO is used as a sensor to trigger certain actions.

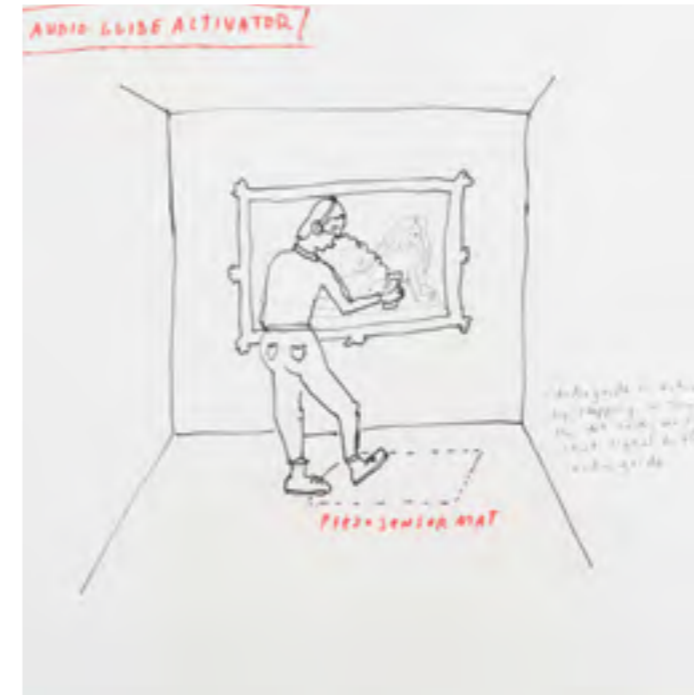
SCENARIO 7

The actuation property of PIEZO is used to generate electricity and power the light of a bicycle.

9 sensor integrated in the pavement



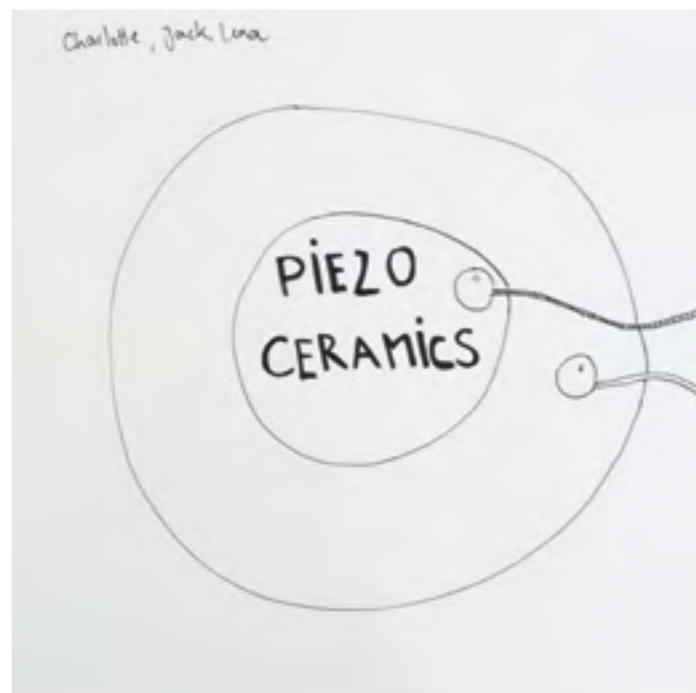
11 sensor to trigger a sound installation



12 PIEZO making sound when plant needs water



Charlotte, Jack Lora



8 simple PIEZO converter

Foto Door MAT



10 the PIEZO senses the presence of a person

PIEZO CERAMICS = sensor



13 sensor to activate information in a street scenario



14 PIEZO generator to substitute a regular dynamo

Opinions & Questions

Pros & Cons after three days of exploration

'...the fact that piezoceramics produce electric signals when they are deformed is very interesting, though they are not efficient enough at the moment.'

'...could piezo elements replace other energy-producing systems in the future?'

'...is it possible to combine piezoceramics with other innovative technologies? For example processing it with a 3D printer?'

'...piezos produce sounds, which is great! But are they good enough to built a real instrument with high quality sound out of them?'

'...do they always need to have strict geometric shapes? Could they be asymmetrical and if yes, what would change in terms of their functionality?'

'...it is fascinating that one can record sounds with the same piezo element that one can produce sounds with. It's just a matter of processing the data.'

'...it's interesting that only through the crystalline structure of the material one can produce sounds and on the other hand energy can be released from this structure.'

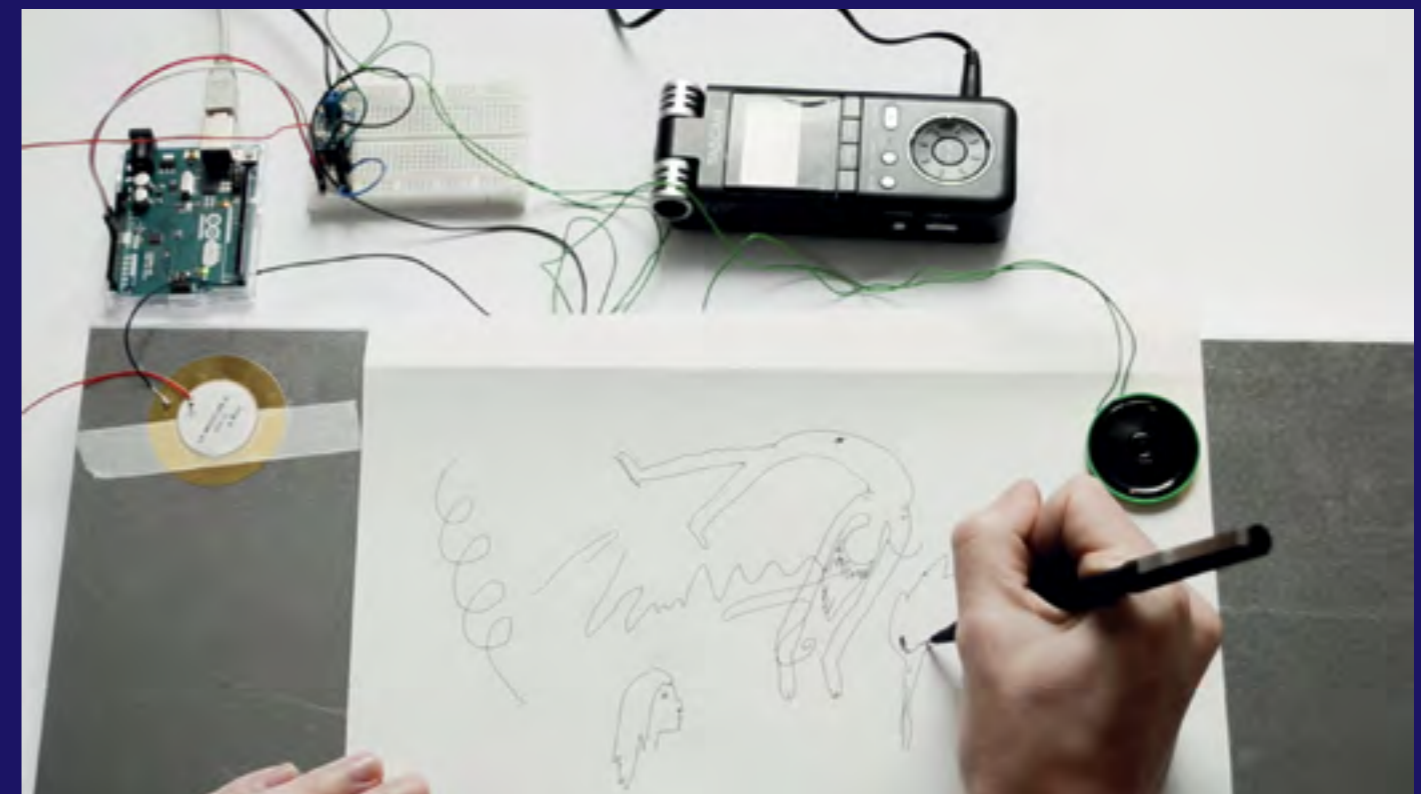
Working hands-on with PIEZO

Process



V sound recordings by scribbling on paper

W simple PIEZO converters



X sound recording by drawing on metal sheet

Epilogue

Epilogue

Conclusion

The workshop was an intense working and exploring experience for all participants.

It can be concluded that because the three functional materials have very different characteristics, potentials and limits, their suitabilities to be worked with in educational and academic settings vary widely.

Shape Memory Alloys are well accessible, their properties and functionalities are relatively easy to understand. Therefore the hands-on explorations of the material and the transfer into own design concepts is complex, yet manageable.

Electro Active Polymers are much more complicated to work with in an university environment. Even though their composition is rather simple and can be realised in a DIY setting, they are difficult to handle. EAPs can only be used as sensors in such workshops, because of the high voltage necessary for them to function as actuators.

When exploring Piezoceramics one of the first aspects that are realised is that in order to use them and explore their characteristics they need to be combined with an electronic device, such as a microcontroller and/or a contact microphone. Therefore the investigation of the material itself happens on another level in comparison to the other two functional materials.

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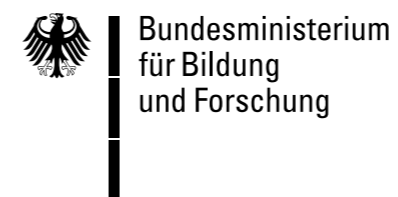
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participants, if not otherwise stated.

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Berlin, 2017

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