Background Research

Bachelor

Overview

Introducing Responsive (Smart) Materials

an overview

(Research) Projects

Manta Rhei
Flexible and Transparent AMOLED
PixelSkin02
Reef
HygroScope – Climate-responsive artwork in wood
Shapeshift
3D Suface texture / Polybraille
„spring roll“ actuators
haptic tatoo ink

Books

Interactive Textures for Architecture and Landscaping
Digital Elements and Technologies
Interactive Architecture

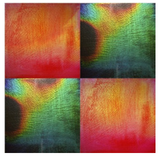
- I would like firstly to show common and the not very common smart materials which are in use today and may be in use tormorrow (experimental/research phase).
- Mainly non-electronic / non-electromechanical projects which covers an aspect of interactive materials in an environment have been selected as examples.

Introducing responsive (smart) materials

Background Research

Introducing responsive (smart) materials

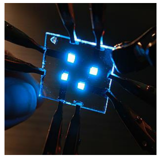
an overview



color changing / temperature changing materials

Color changing materials such as photochromatic materials change colour with changes in light intensity. Changes from one color to an other one is possible by mixing. Thermochromatic materials change color with changes of temperature.

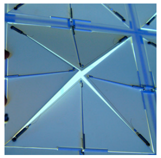
- could be interesting in combination with a video projector
- well established technology
- typical appliance: color changing coffee mug, instrument back lighting.



light emitting materials

There are different kinds of light emitting materials such as electroluminescent materials. These can emit different kinds of colors when applied to electricity. Phosphorescent materials (also known as afterglow materials) produce visible or invisible light when the source of the original excitement has been removed.

- can be combined with conductive polymers.



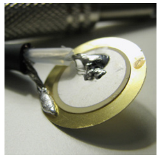
shape memory alloys (SMA)

Also known as „smart metal, shape memory alloys „remembers" its original form, returning to its pre-deformed state when heated. It is a solid-state alternative to conventional actuators.

- can eventually crack (structural fatigue).

Introducing responsive (smart) materials

an overview



moving materials

conducting polymers or „electro active polymers“ has been used for the development of micro muscles as in the resaearch of artificial robotic muscles. One side of the plastic expands while the other side contracts resulting in mechanical energy such as a contracting or bending movement. Dielectric polymers or „electrostrictive polymers“ are similar as piezoelectric materials but have a much higher capability of striction and a high actuation pressure.

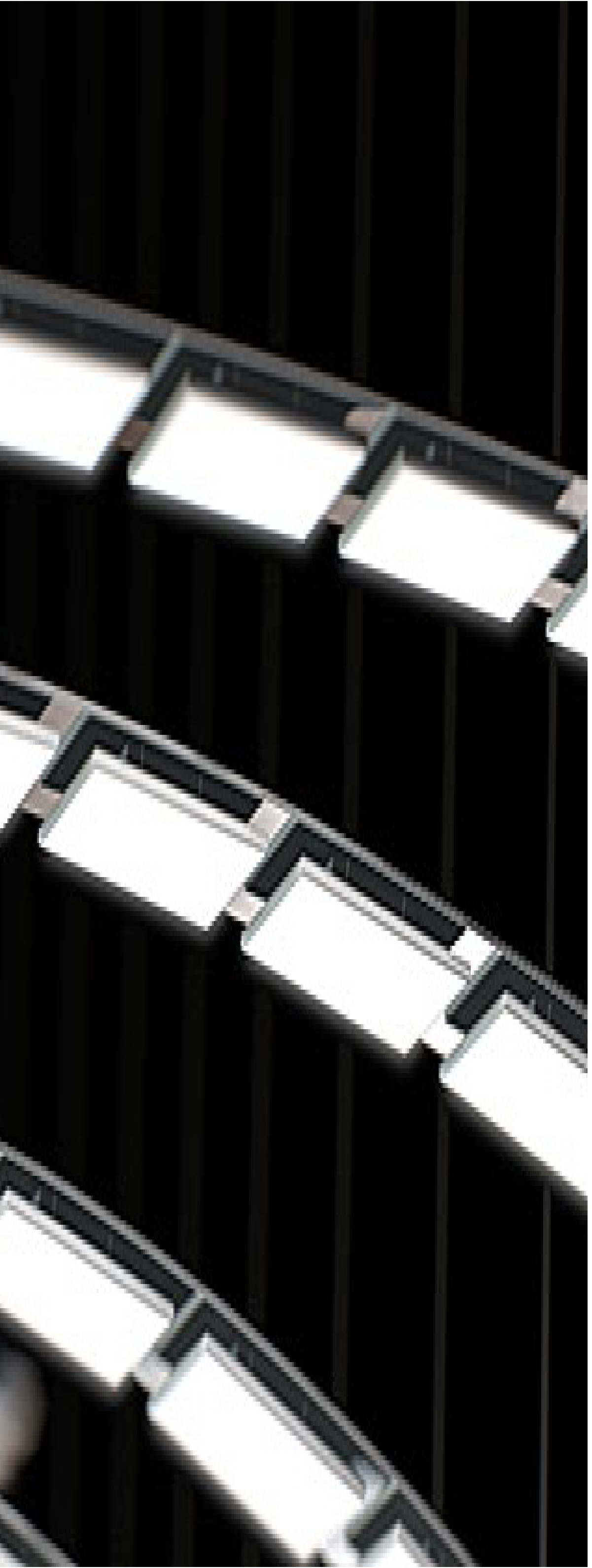
- most versatile material
- low cost, DIY
- can be combined with other technologies
- disadvantage: not very robust

thickness changing materials

„Smart fluids“ such as magnetorheological fluids increases viscosity when a magnetic field is applied to the point of being solid. Other such fluids change their surface tension in the presence of an electric field (electrorheological fluids). This has been used to create very small controllable lenses.

- less interesting, has more an industrial use.

(Research) Projects
Background Research



Responsive Materials - light emitting materials

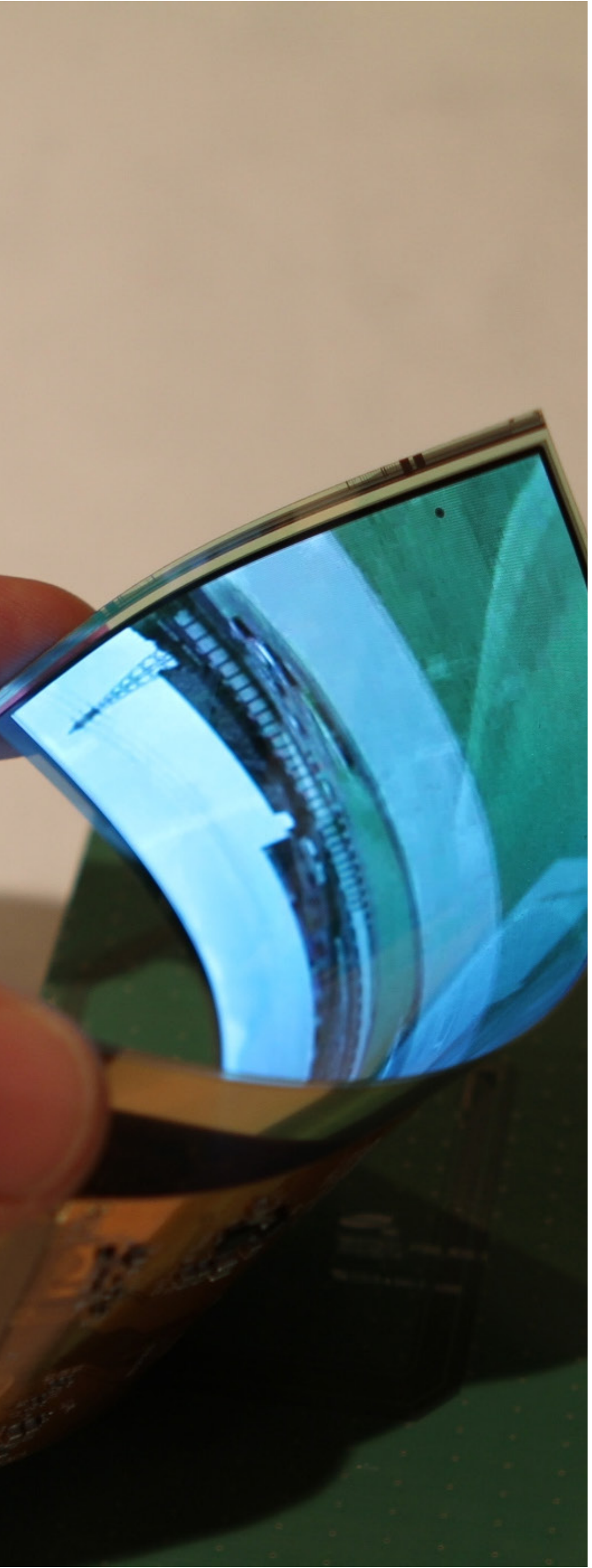
Manta Rhei

Manta Rhei merges physical movement and light choreography for a new kind of luminaire, the first to be based on OLED technology. The light sculpture is the result of a collaboration between light fixture manufacturer Selux and ART+COM and emerged from their joint exploration into 'kinetic luminaires'.

Manta Rhei consists of fourteen 1.2 metre flexible metal lamellae, each of which carries ten paper-thin OLEDs. The lamellae are attached by thin steel wires to motors hidden in the ceiling. The individually controllable motors raise and lower the lamellae allowing the luminaire to perform various movement patterns.

Different choreographies of moving lamellae and animated light give the luminaire a poetic and performative spatial presence. At the same time, due to its minimalist design and constant lighting values, Manta Rhei is a functional and versatile light fixture. Constructed of modular elements, it can be easily scaled to different sizes.

Manta Rhei utilizes on one side electromechanical motion (motors) to create the fluid motion and on the other side OLED technology by subdivided panels. The „digital", pixel-like appearance makes it an overall expensive but esthetically clean installation.



Responsive Materials - light emitting materials

Flexible and Transparent AMOLED

By replacing some pixels of the display with blank, transparent elements, Samsung has managed to produce displays that offer the power consumption, brightness, color saturation and contrast benefits of AMOLED while allowing you to literally look through the display. Transparent displays compromise resolution, but the effect is aparantly amazing.

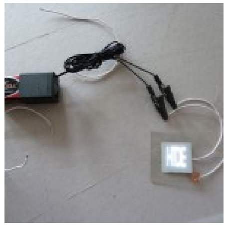
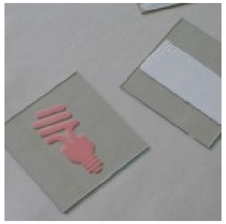
Flexible OLEDs are still in the R&D phase - and there aren't any products on the market yet. Samsung and LG Display seems to be the closest to commercialization. Samsung seems to be leading flexible OLED commercialization - they launched their YOUM flexible OLED panels in January 2013.

Transparent AMOLED (active matrix OLED) could be integrated in or between windows, glassed walls or doors to show information or just to dim/change light in a sertain way and enabling interaction using for example integrated, mobile-like buttons. It is also not constrained to just flat surfaces which make curved or round displays possible. DIY possibilities is, alas, far off. Furthermore, the particulary new technology is very expensive and untested.

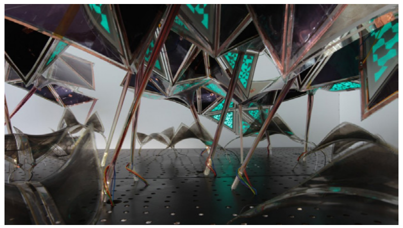
Responsive Materials - light emitting materials

Electroluminescence

Commercialisation of electroluminescent screens go back to to 1960s. There are different kinds of materials and it is possible to build it „DIY" to a certain degree.

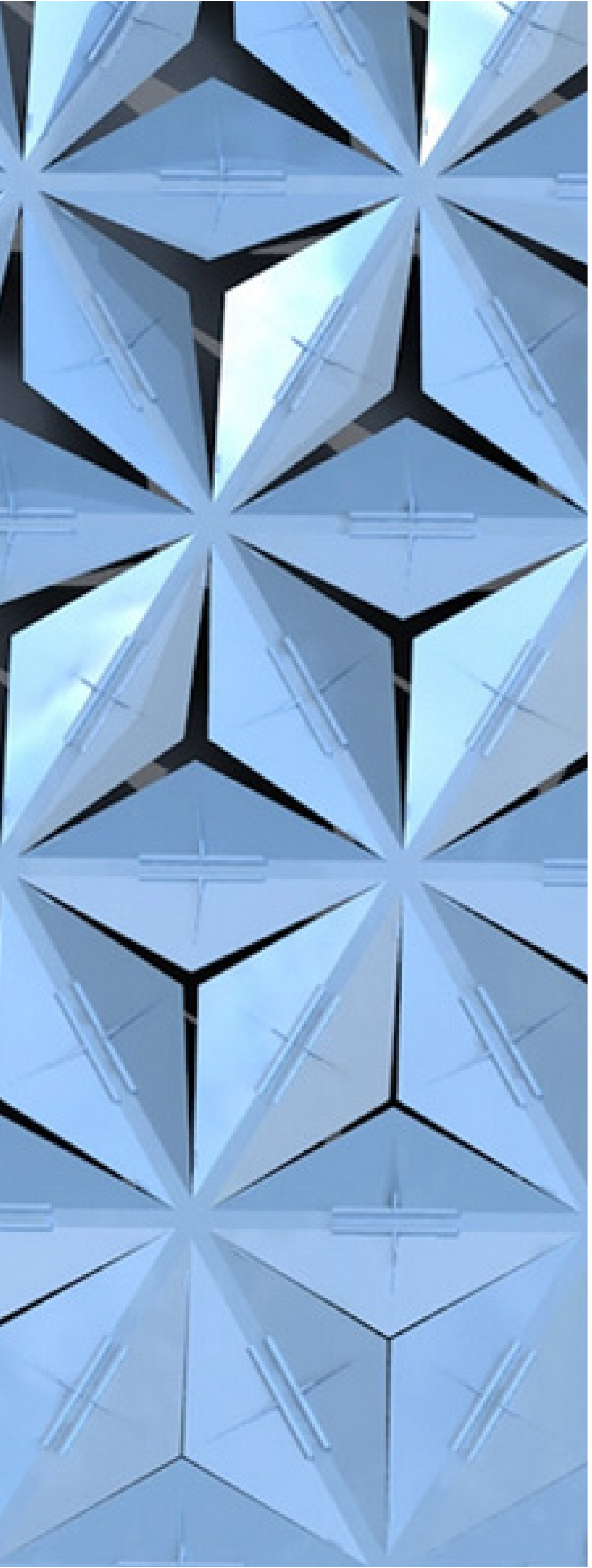




Phototropia merges self-made electro-active polymers, screen-printed electroluminescent displays, eco-friendly bioplastics and thin-film solar cells into an autonomous installation that produces all its required energy from sunlight and responds to user presence through moving and illuminating elements. The generated energy is stored in batteries below the platform and then distributed via microcontrollers to the respective elements.

Electroluminescence is well established and has its usage in art, design and architecture. The interesting aspect is combining electrolminescence with other (smart) materials, which has been done with *Phototropia*. The available colors are limited and dimming is not really possible. Yet it is pretty cheap compared to other technologies.

I am also thinking of using or combining afterglow pigments (photoluminescent) with EAP and/or electroluminescence.

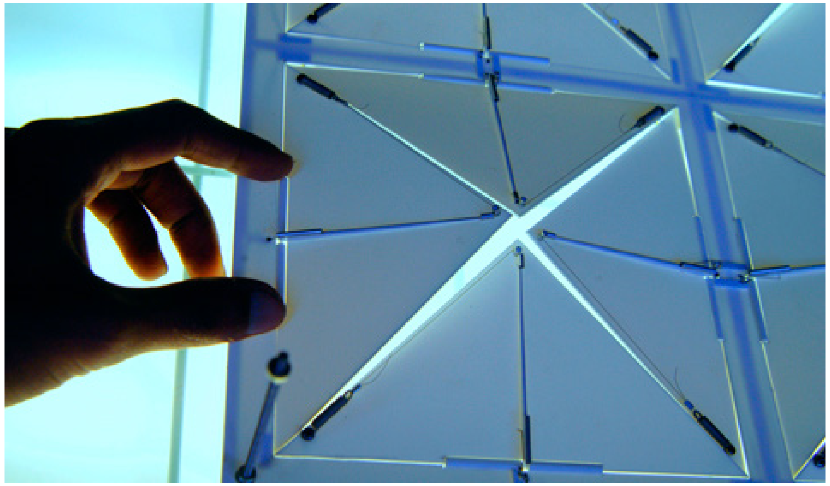


Responsive Materials - shape memory alloys

PixelSkin02

PixelSkin02 explores new possibilities in media augmented surfaces by employing the mechanical properties inherent in shape memory alloys (SMA). In an attempt to bridge the gap between "lifeless" facade automation systems and highly expressive yet functionally thin media facades, Orangevoid's Sachin Anshuman developed a matrix of interconnected pixel-tiles that are controlled interactively via embedded electronics.

Described as "electrographic architecture," PixelSkin02 creates a transparent visual field that also generates low-resolution images and low-refresh-rate videos via electromechanical means. Each pixel-tile consists of four triangular panels actuated by 200mA SMA wires. Surface-embedded microcontroller consoles regulate the degree of opening of each panel by adjusting the power supply twenty times per second. Each panel has 255 potential states of adjustment between fully opened or closed, and a technique called "multiplexing" allows for the control of the collection of pixel-tiles in order to create moving patterns and imagery.



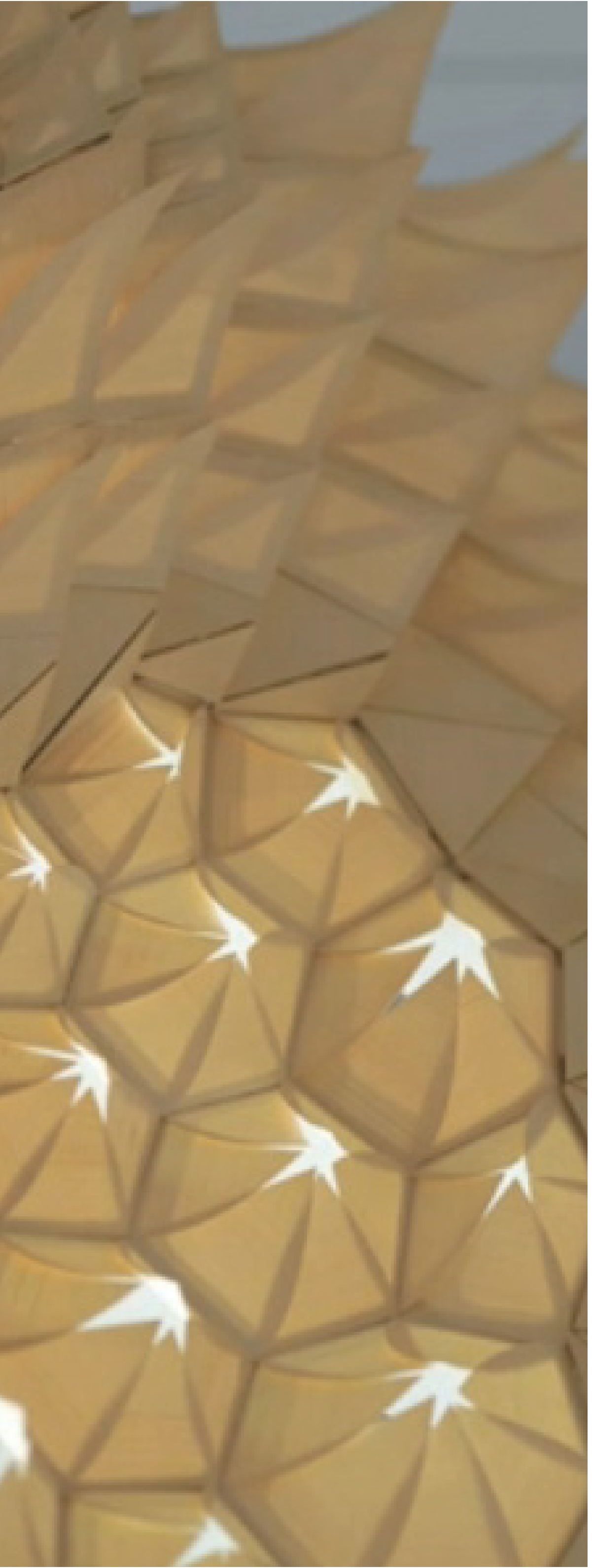
In using the properties of shape memory alloys as motors, *PixelSkin02* can create pixel-like images. This technique is silent as well as robust and does not need lots of electical parts. What I find interesting also is that it is the „gap" which creates the pixel, by which light can pass through -or not. Furthermore, the pixels are not classical square or rounded. I think it is possible to also use it in the other way around as a sensor by applying pressure to the blades.

Responsive Materials - shape memory alloys

Reef

Reef investigates the role emerging material technology can play in the sensitive reprogramming of architectural and public space. Using this technology, Reef creates an interior condition which reacts according to an exterior streetscape, and reasserts an active, willful role in shaping that public space.

Similar to *PixelSkin02,* it has a more scale-like, organic apperance. It uses in addition an interface fed by an RGB camera and special software to create an installation that responds to its audience. It is a kind of technological hybrid combining smart materials for movement and and software/hardware for interaction. The installation becomes „aware" of the audience.

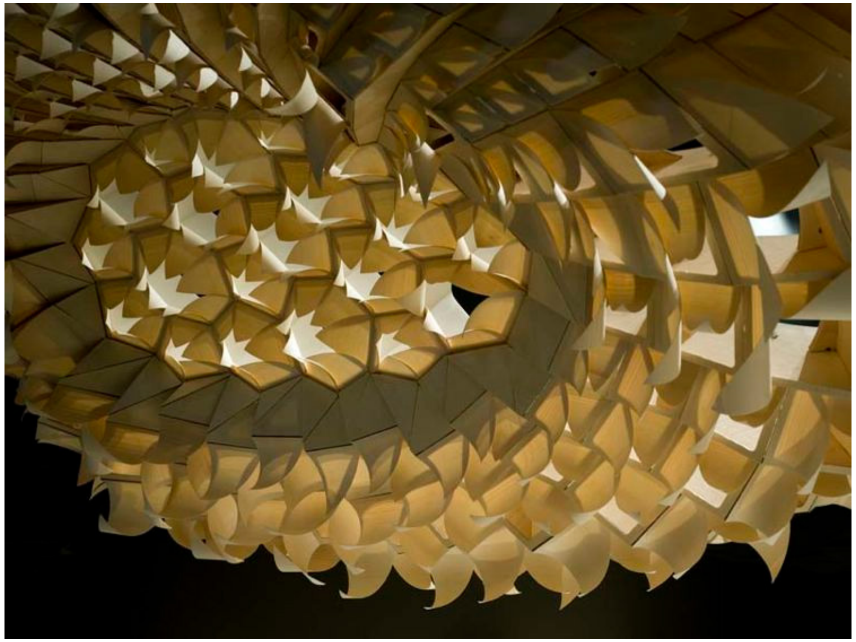


Responsive Materials - „others“

HygroScope – Climate-responsive artwork in wood

This art piece illustrates nicely one of wood’s most interesting properties – its hygroscopicity. Wood attracts water from the surrounding atmosphere and binds it in its cell walls. What the artists did here was laminate an uneven number of veneers (usually a no-no in plywood production), which results in a plywood that curls up when air relative humidity (and therefore wood’s moisture content) changes.

With an intricate arrangement as shown in the image above and the video below, a structure can be created that opens and closes based on its surrounding climate.

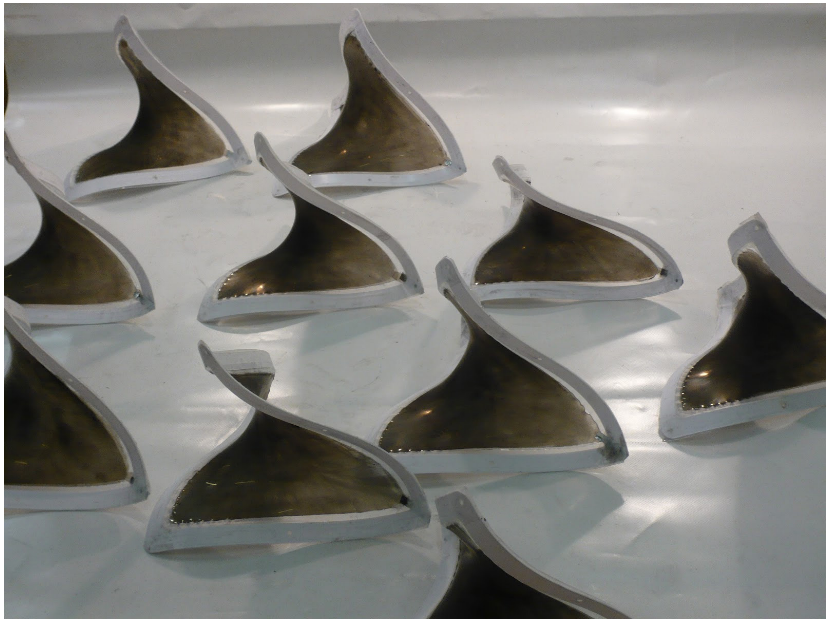


What I find special about this installation is that it is for once not audience-responsive but climate-responsive. It does not use any of the smart materials listed before but is still reactive -to a macro-environment which is dependent of many factors. A similar project is introduced later on named *Living Glass* (see: Interactive Architecture).

Responsive Materials - moving materials

Shapeshift

Shapeshift is a master project fromt the Swiss Federal Institute of Technology Zürich and explores the potential application of electro-active polymer (EAP) at an architectural scale. shape-shift bridges gaps between advanced techniques in architectural design / fabrication and material science as well as pushing academic research towards real world applications.



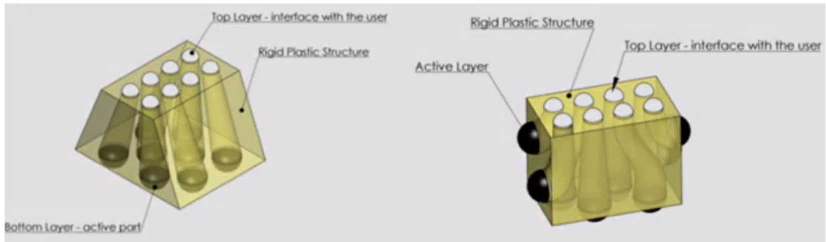
Mixing scale-like moving parts and origami-like structures makes sense as Origamis are basically a complex contruction of edges and sides which can move if desired.
I would like to look into using EAP not only as moving elements but also as a skin which repsonds to touch. Haptic feedback may create an electric signal which then can be used to trigger something else. Furthermore, could it be possible to use EAP as low-res microphones -like hearing the environment through skin.

Responsive Materials - moving materials

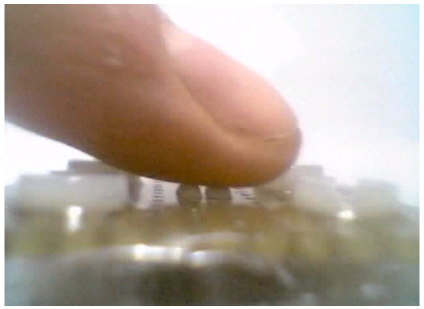
3D Suface texture / Polybraille

Surface topology actuation using SRI International's Dielectric Elastomer.

Dynamic textures such as SRI's is still very experimental but shows the possiblilities of creating interactive surfaces, patterns, textures etc. Alas, there is not a lot of information available.



Dynamic Braille dot (1.5 mm diameter) based on dielectric elastomer actuator



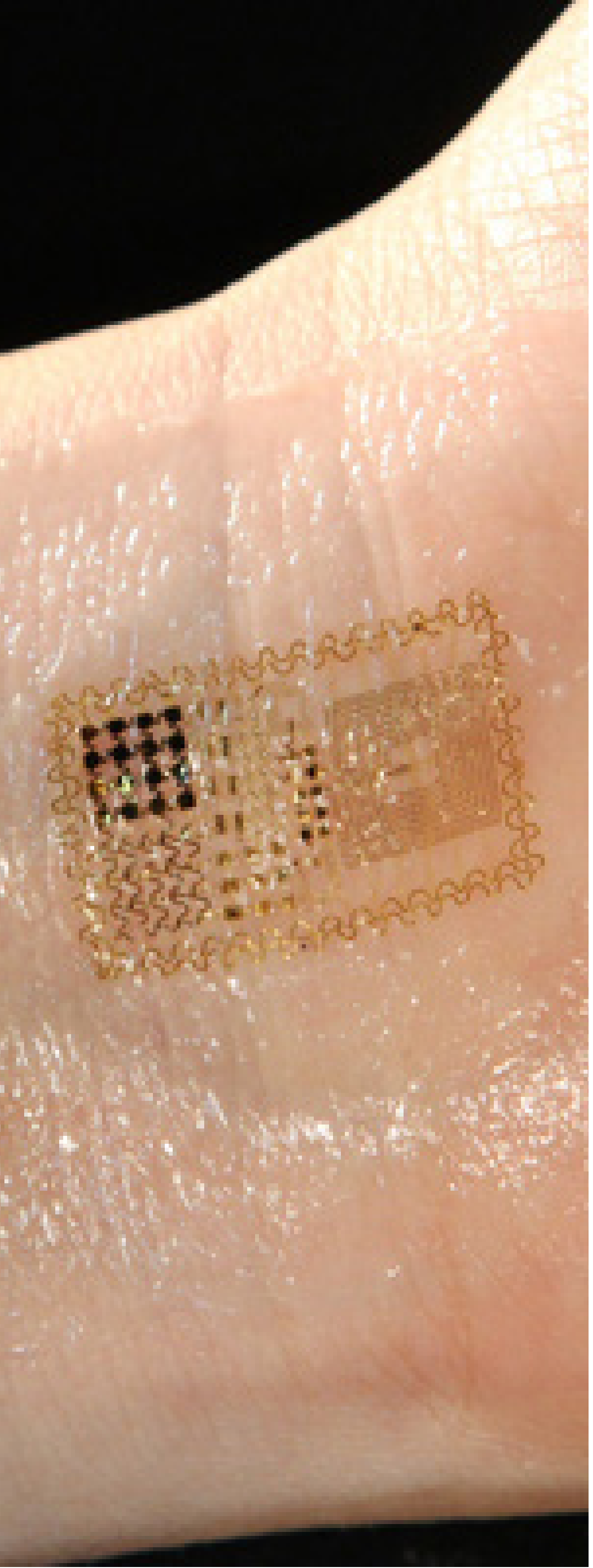
Dynamic haptic surfaces in a pixel arrangement gives wide possibilites. An experimental braille system which is cheaper due to no electromechanical motors or expensive materials opens up new kinds of haptic displays or surfaces.

Responsive Materials - moving materials

„spring roll“ actuators

Six of these spring roll EPAMs were used to build a hexapod called MERbot. The cool thing about MERbot is that the EPAMs provide both structure and actuation. From a bio-mimicry standpoint, this is particularly compelling; if the EPAMs could store energy as well, it would be very nearly an „ideal“ component. Check out the MERbot video below

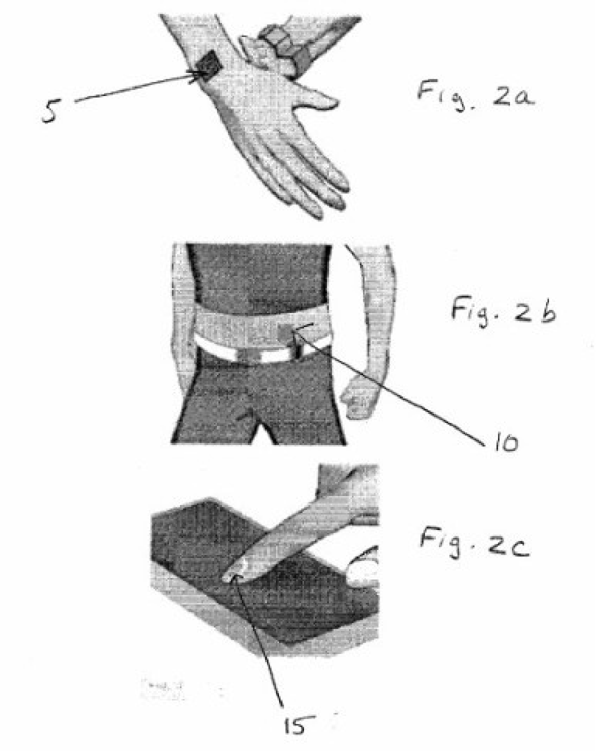
The robotic aspect is for me less interesting, but in terms of movement / actuators, they are very useful.



Responsive Materials - thickness changing materials

haptic tattoo ink

Nokia has filed for a patent that offers a new and interesting take on mobile notifications. The patent, dated March 15, 2012, is for a ferromagnetic ink tattoo that is able to vibrate based on signals sent from a phone.
Nokia first describes a material that can attach to the surface of the skin, not to dissimilar to a sticker or a "patch". The material would be able to be paired to a phone and emit various vibration patterns. In essence, a user could give a contact a specific pattern, which would enable them to be able to know who is calling without looking at the device, much like a custom ringtone.
Nokia also describes the same technology being deployed in an actual tattoo.

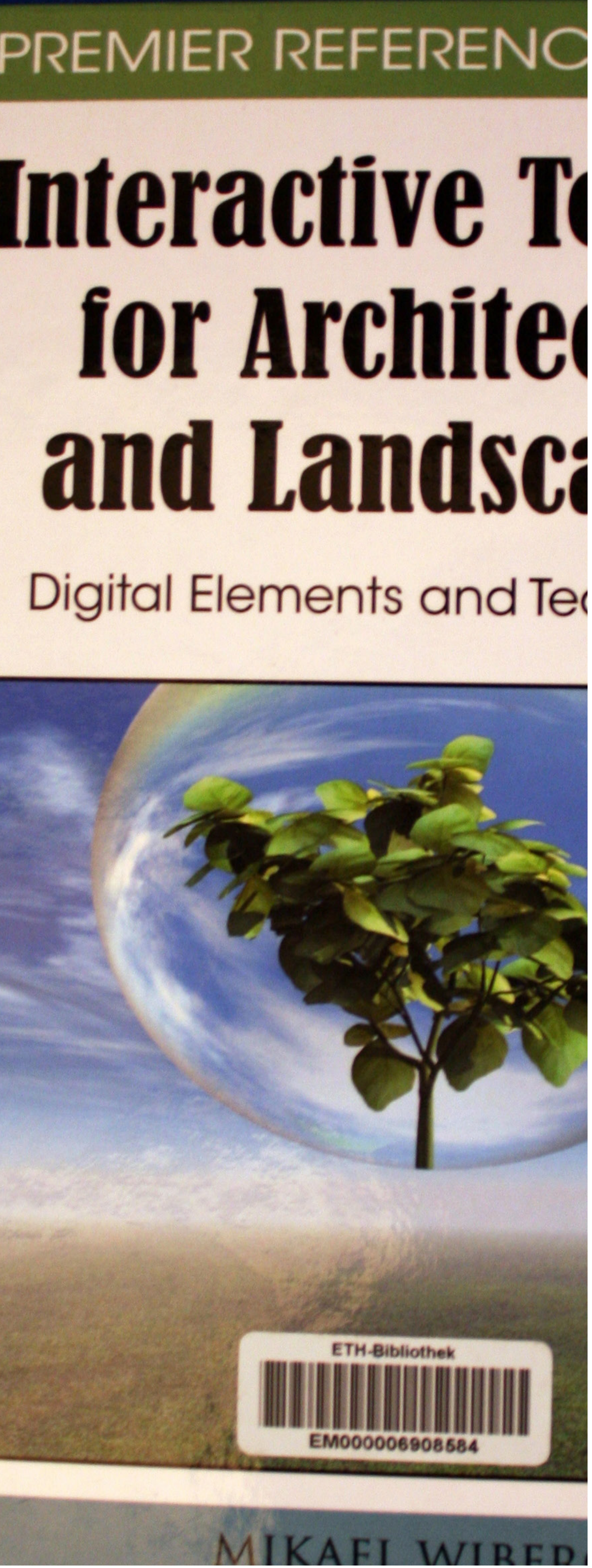


There is barely any available information concerning thickness changing materials in design or architecture. It is more commonly used in the automobile industry to regulate a car's suspension. There is research in changing the shape of lenses. I see here a practical use in haptic pixels by changing the „hardness" of the respective pixel for example.

- „Liquid haptuators", which changes viscosity, shape, etc.!

Interactive Textures for Architecture and Landscaping

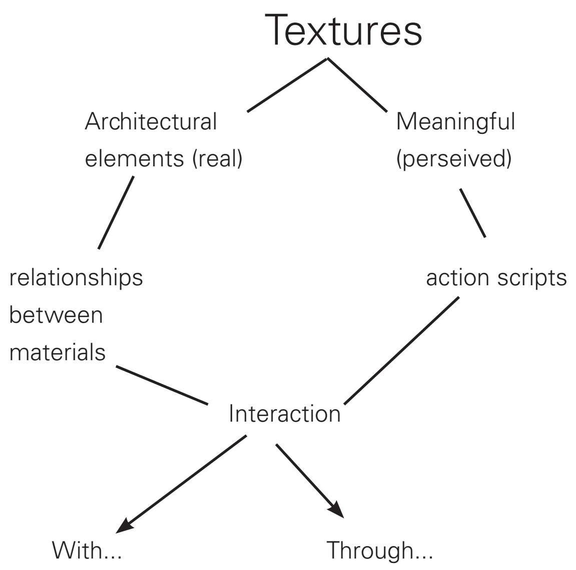
Background Research



Interactive Textures for Architecture and Landscaping

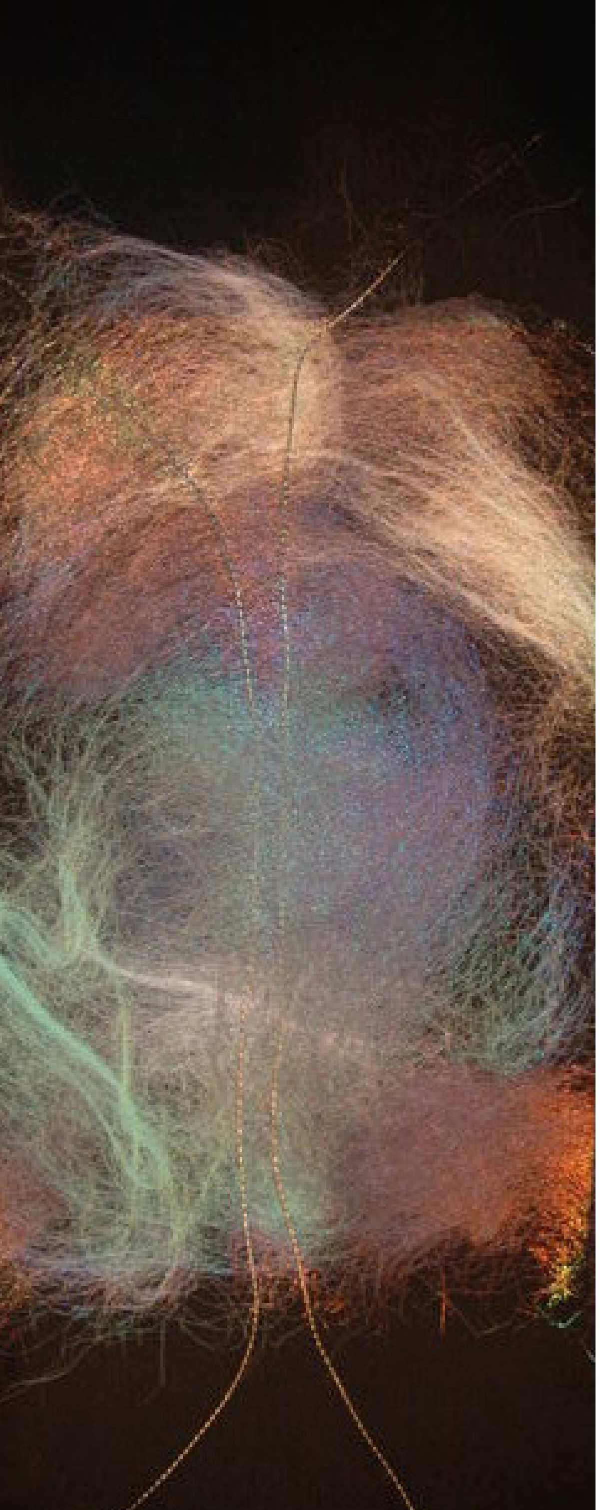
The book explores a relatively new phenomena clalled „interactive architecture“ -the blending of building materials with interactive components. Furthermore, the book looks at the integration of architecture and digital technologies as „Media spaces“ to address how digital technologies enable us to spatially stretch places, connect places, and connect to other human beings across ditances.

We live our lives with textures. We see them, feel them, interact with them, and we are constantly aware of them. Textures are in many ways the „skins“ of our everyday world (Lupton 2002)



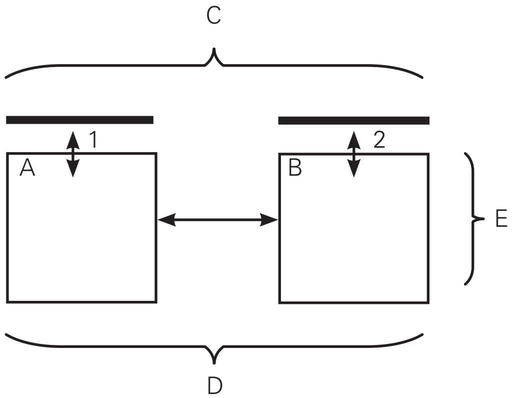
Schematic model illustrating the „textures of textures“

- I have picked out some references to relationships between texture-architecture-materials.
- Relationships between different materials that compose a built environment.
- The architectural perspective together with our interpretation of the world around us enable us to start working with materials to interact with and through the materials.
- Textures might work as media or channel.



example of textile with integrated conductive threads:
fusible fibers and conducting thread

Interactive Textures for Architecture and Landscaping



Modeling of material integration as texture:

Each material (A+B) has its own texture (thick lines) and each texture has a certain relation to the material from which it is crafted (arrow 1 and 2). In any design the integration (3) of different materials and textures is crucial for the overall appearance of the design (E) as a wholeness (C). The choice of different materials can further on build on a commom value base or foundation (D).

Thoughts

The book focuses mainly on textures / skins on architecture in a traditional manner. Embedded electronics, circuts, lights / LED, media etc. No mentioning of smart materials. In which way can smart materials also act as texture? Can texture be added to them?

References

Interactive Textures for Architecture and Landscaping, Mikael Wiberg, 2011

Interactive Architecture
Background Research

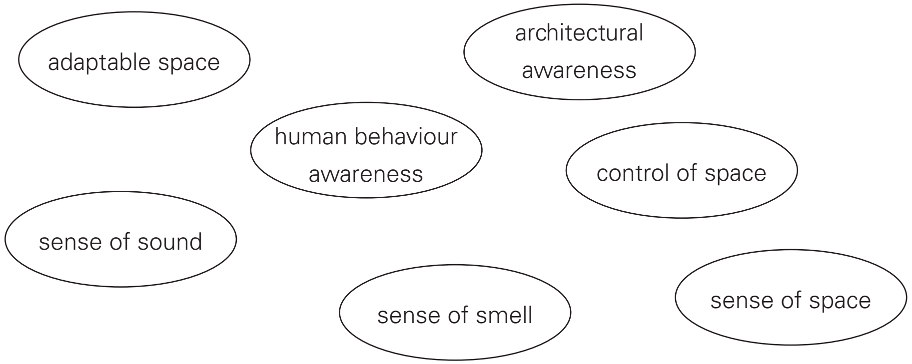
Interactive Architecture

Intelligent environments are defined as spaces in which computation is seamlessly used to enhance ordinary activity. p. 16

Form may change very slowly through evolution, moderately through process of grough and decay, and very quickly by internal muscular, hydraulic, or pneumatic action. p. 50

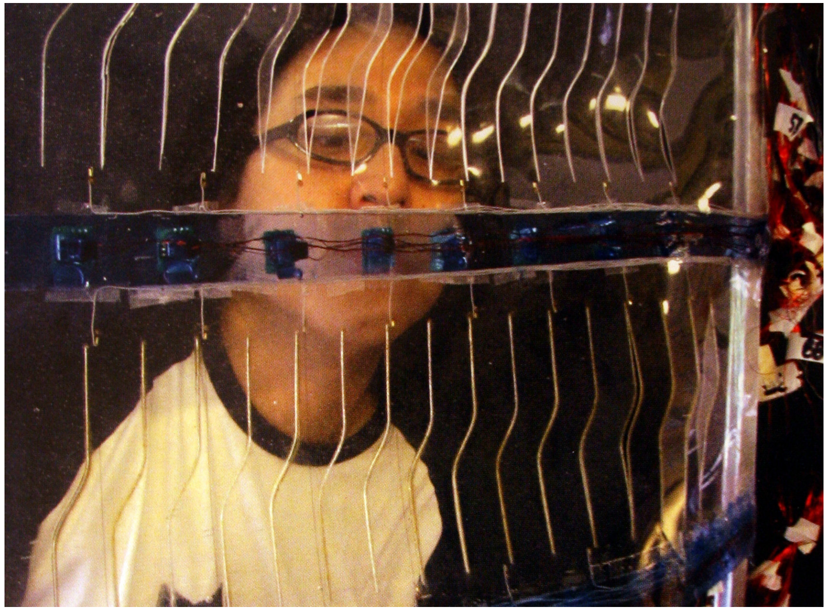
In the simplest system, movement, is actuated directly by any one of a number of energy sources, including electrical motors, human energy, or biomechanical change in response to an exchange of information between user and computer. p. 83

While the architecture can adapt and learn from our actions and adjust itself accordingly, it also has the capacity to teach us how to live and how to work. p. 142



Interactive Architecture

Perhaps the moste important goal of an interactive system today should be to act as a moderator responding to change between human needs and external environmental conditions. p. 113



In *Living Glass* they created a polymer glass substitute that opens and closes in response to human presence to control air quality in a room by linking an array of gills to an array of sensors.

References

Links

electroactive

http://tube.7s-b.com/Electroactive/

grinding

http://grinding.be/category/haptics/

Design News - Haptic Actuators Energize Video Games

http://www.designnews.com/

Emotive environments

http://blogs.iad.zhdk.ch/emotiveenvironments

CAAD

http://www.caad.arch.ethz.ch/blog/

Report On ELECTRO ACTIVE POLYMERS

http://www.seminarpaper.com/2012/01/report-on-electro-active-polymers.html

Transmaterial

http://transmaterial.net/

Iannis Xennakis

http://en.wikipedia.org/wiki/Iannis_Xenakis

Books

Interactive Architecture, Michael Fox and Miles Kemp, Princeton Architectural Press, New York, 2009

Interactive Textures for Architecture and Landscaping, Digital Elements and Technologies, Mikael Wiberg, Information Science Reference, Hershey, 2011

Smart Materials: In Architecture, Erior Architecture and Design, Alex Ritter, Springer, 2007