SHAPESHIFT

caad-eap.blogspot.com

ShapeShift

ShapeShift is an experiment in future possibilities of architectural materialization.

This project explores the potential application of electro-active polymer (EAP) at an architectural scale.
EAP offers a new relationship to built space through its unique combination of qualities. It is an ultra-lightweight, flexible material with the ability to change shape without the need for mechanical actuators.

As a collaboration between the chair for Computer Aided Architectural Design (ETHZ) and the Swiss Federal Laboratories for Materials Science and Technology (EMPA), ShapeShift bridges gaps between advanced techniques in architectural design/fabrication and material science as well as pushing academic research towards real world applications.

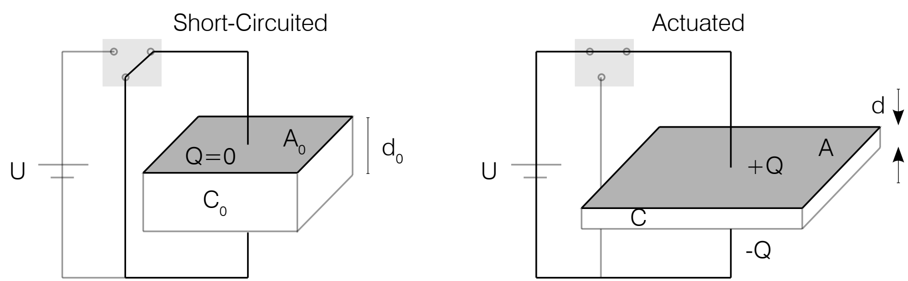
SHAPESHIFT

The initial concept was to develop an automated/responsive air control and lighting/shading system, which could be incorporated in a new kind of building skin.

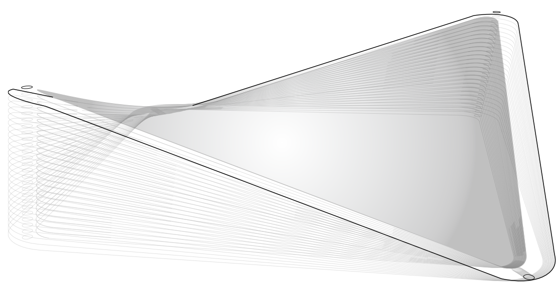
The distinctive properties of the material should not only become a mere actuator replacement but be orchestrated for their aesthetic qualities. EAP is a highly attractive component for kinetic architectural applications due to its extreme flexibility, lightness, thin dimensions and smooth actuation.

The thin film shall function as a possible replacement for conventional building skins and envisions the concept of a futuristic soft and flexible architecture. This is intended to generate a unique spatial experience and to change how the built environment is perceived in general.

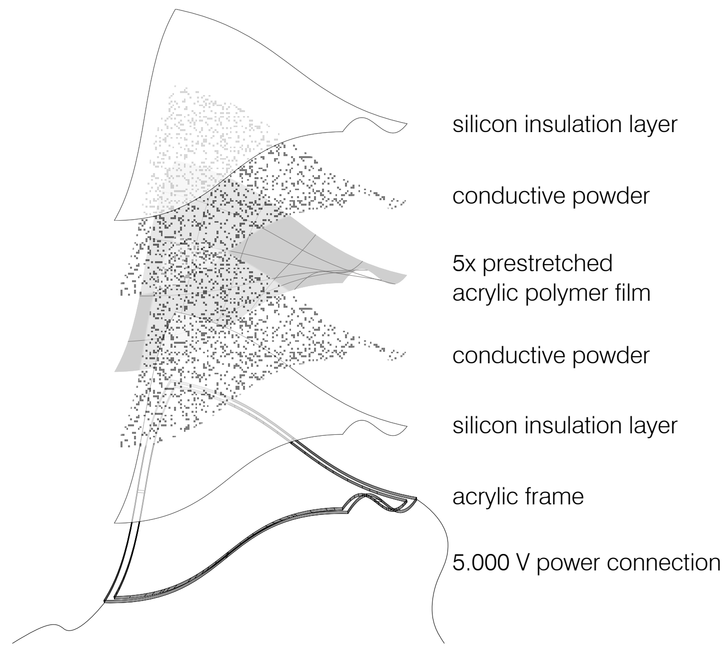
EAP is a polymer actuator that converts electrical power into mechanical force. In principle it consists of a thin layer of very elastic acrylic tape sandwiched between two electrodes. Once the voltage in the range of several kilovolts is applied between the electrodes, the polymer changes its shape in two ways.
First, due to the attraction of the opposing charges, the film is squeezed in the thickness direction (up to 380%), secondly, the repelling forces between equal charges on both electrodes result in a linear expansion of the film.
As a result, after actuation the film becomes thinner and its surface area increases.



If the supportive frame is flexible, due to the initial pre-stretching of the acrylic film, the frame bends. After application of voltage, the material expands, and the component flattens out.

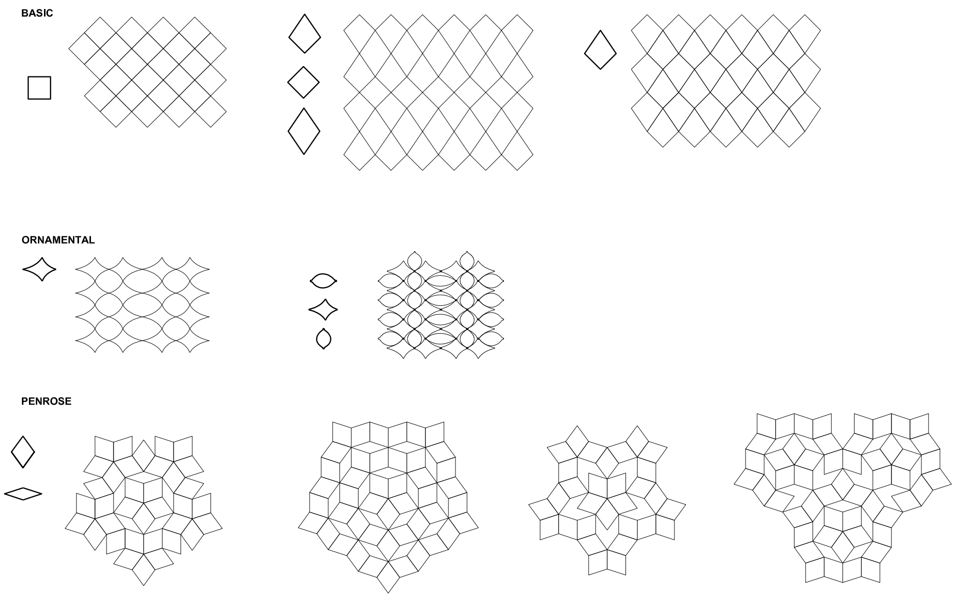


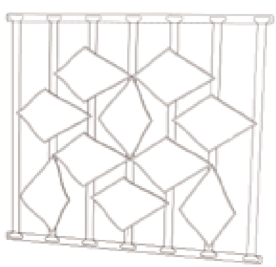
The supporting frames are lasercut from 1.5 mm acrylic. This material provides enough flexibility to form an appealing shape when the polymer is applied. In order to transport the high voltage through the EAP material carbon black powder is spread on both sides of the component. To increase the life span of the dynamic components and insulate the electronically charged material it is coated with a thin layer of silicon. The electric power comes from high voltage converters that increase the necessary 5 V to 5.000 V.

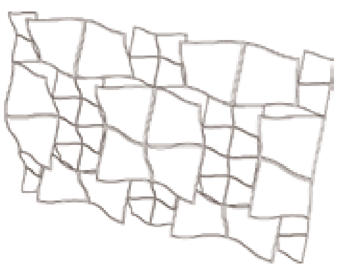


Parallel to the design of a single component experiments in structural arrangements and tessellations were performed.

TILING OPTIONS

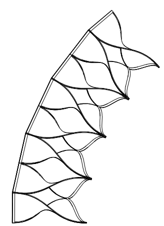




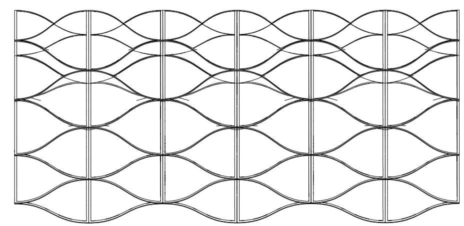


Initial investigations focused on static supporting structures for the components. After a number of experiments on static structures the interest moved towards developing dynamic structural arrangements.

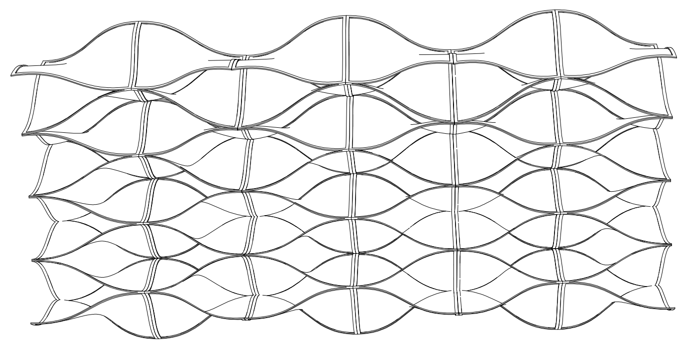
In these dynamic structures no static supporting structures are necessary, rather, individual components are connected to each other to produce self-supporting forms. As with the dynamic components, the dynamic structures achieve their form from the relationship of the pre-stretched EAP and the flexible frame. With the dynamic structures an added layer of complexity is achieved through direct component-to-component relationships. Each component has an influence on the form and movement of its neighbors, and therefore, on the structure as a whole.



SIDE VIEW



FRONT VIEW



PERSPECTIVE VIEW

In the long run thin film technologies will revolutionize the way we think about and interact with materials. They will not only find their application in everyday objects but especially in architecture and the built surroundings. There is already a tremendous interest in the development of flexible PV cells, OLEDs or thin film insulation materials. In the field of architecture, lightweight construction methods and flexible skins are of great importance as they allow for increasingly complex geometries, reduced transportation costs, and increased ease of construction.

Another important advantage of EAPs is their ability to change shape. This will allow the creation of responsive environments or spaces that can dynamically adapt to external influences and physically respond to human input.
Ever since the rise of computer technology and cybernetics, this has been a major interest in designing and envisioning kinetic and responsive architectures. Unfortunately built examples up until now are restricted to huge mechanical systems, and their functional as well as visual impact is rather small. EAPs on the other hand, have the potential to replace existing mechanical actuators such as motors or hydraulics, and at the same time can become aesthetically interesting visible and structural parts of our built environment.

Manuel Kretzer is an architect and designer from Germany and founder of Responsive Design Studio (www.responsivedesign.de). After being employed with Philip Beesley in Toronto he received a position at the Chair of CAAD at the ETH in Zürich.
His research focuses on digital design and fabrication methods with a special interest in new technologies and materials and their application in temporary, interactive art and architecture. He has realized a number of large scale sculptures and installations and been granted several scholarships and awards.

Dino Rossi is a designer/fabricator originally from California. Since 2009 he has been studying and working in the Chair of Computer Aided Architecture Design (CAAD) at the ETH Zürich. His research focuses on the confluence of computational design/fabrication and unpredictable material processes. Previous to his arrival in Zürich, he collaborated with Andrew Kudless (MATSYS) on the P_Wall project for SFMoMA (2009), and was artist in residence at David Ireland's 500 Capp St house in San Francisco, CA.

Edyta Augustynowicz is an architect from Poland. In September 2010 she graduated from the MAS course at the ETH with the major at Computer Aided Architectural Design. Her main area of focus is interactivity, programming in architecture and new technologies.

Sofia Georgakopoulou is a biophysicist and design programmer from Greece. She has studied physics in the University of Athens and earned her PhD in biophysics in the Vrije Universiteit Amsterdam. Her work focused on light-sensitive organisms and structures, as well as on creating programs that would explain the experimental results. She continued to develop her programing skills by participating in the MAS course on Computer Aided Architectural Design in the ETH in Zurich. Currently she is exploring new technologies and materials in architecture, in collaboration with the ETH Zurich.

Stefanie Sixt is an german architect and designer. She was employed at SNØHETTA architects Oslo. Her special interests range from material research, product design, interface design, exhibition design and public installations to architecture and society with a focus on social needs.

www.caad-eap.blogspot.com
www.caad.arch.ethz.ch
www.responsivedesign.de

Manuel Kretzer, 2010