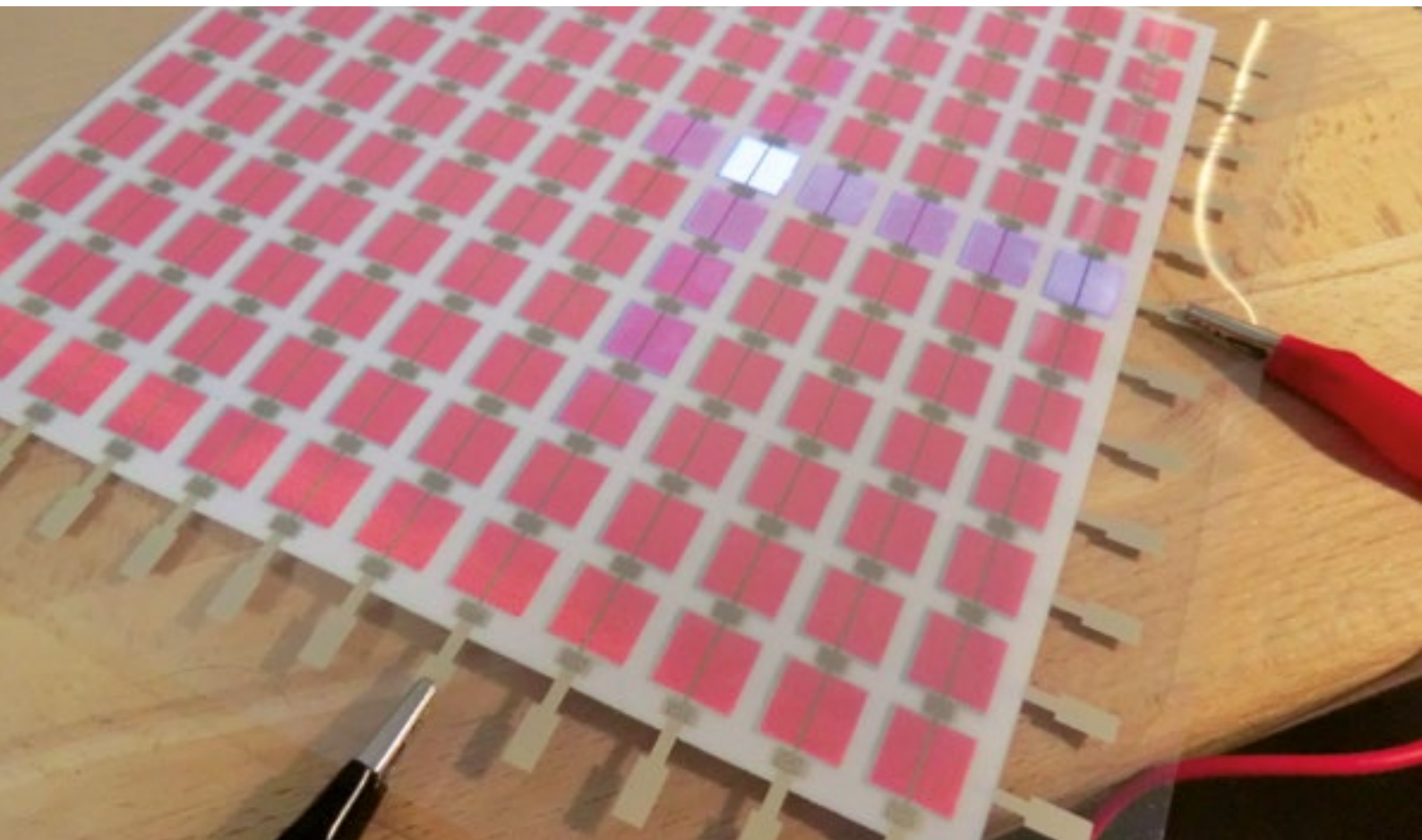# PRINTED ELECTRONICS
AT BAUHAUS-UNIVERSITÄT WEIMAR

A selection of projects related to Printed and Organic Electronics developed during courses offered by the Interface Design Group as part of the Media Art and Design Master's programme.

**Printed Electronics
at Bauhaus-Universität Weimar**

Since a few years, the Interface Design Group of the Bauhaus-Universität Weimar conducted by Prof.Dr. Jens Geelhaar has been doing research on the topic of printed and organic electronics in connection with interfaces that give access to the digital world in interactive and networked environments. *Fingies,* a rapid prototyping platform for Internet of Things applications, was the first research project in this area.
The following documentation displays a selection of projects related to Printed Electronics which were developed during courses starting in 2016 offered by the Interface Design Group.

For more information please contact:

Prof. Dr. Jens Geelhaar
Interface Design Group
Bauhaus-University Weimar
Marienstrasse 5, Room 105
D-99421 Weimar
phone: +49 (0) 3643 - 58 37 63
email: jens.geelhaar@uni-weimar.de

The courses

The selected projects were developed during one of the following courses (Fachmodul/Werkmodul), supervised by Florian Wittig. The courses were offered in 2016 and 2017 by the Interface Design Group as part of the Media Art and Design Master's and Bachelor's programme.

• Experimenting with Silk Screen and Silver Ink: An Introduction to Printed Electronics.

• Printed Electronics Inkjet: Electro-Papercraft

• Printed Electronics Silkscreen: Squeegee, brush, and multimeter

• Printed Electronics Inkjet: Button Up!

• Printed Electronics Silkscreen: Electronic Upcycling

During the duration of one semester, students should be able to get a basic understanding of the technology of printed electronics. In class-room sessions the basic qualities and possibilities of printed electronics were explored, as well as the characteristics of the tools used later on. During so-called prototyping sessions the students then had the opportunity to experiment and combine printed circuits with electronic components. For this purpose, materials such as different types of paper, electronic components such as LEDs and measuring tools like multimeters were provided. In the final phase of the course, each of the students developed their own personal project, depending on the predefined subject of the course.

The posters that resulted from the class »Printed Electronics Silkscreen: Squeegee, brush, and multimeter« were presented as part of the University's yearly exhibition summaery2017.

Materials used

For printing circuits with a digital inkjet printer, Silver Nanoparticle Ink by Mitsubishi (NBSIJ-FD02) was used. This type of ink will only show ideal conductivity on specially coated paper. In our case depending on the project we either used Mitsubishi Silver Nanoparticle Resin Coated Paper (NB-RC-3GR120) or Silver Nanoparticle Transparency Film (NB-TP-3GU100).

Different models of consumer household inkjet printers are able to print nano particle ink, in our case the Canon Pixma iP100 inkjet printer was used. The ink was manually filled into cartridges with the help of a syringe.

Conductive ink for screen printing was printed on a simple analog silk screen printing table. All the prints were made by hand under supervision by the students themselves.

Conductive ink which contains silver particles is always solvent based ink, so all the screen printing materials used in the printing process need to be solvent resistant.

Different types of conductive ink for screen printing were tried for different projects, we were able to use conductive silver inks manufactured by Henkel and DuPont. Carbon based ink by Bare Conductive was tried as well as mixing our own carbon based conductive ink.

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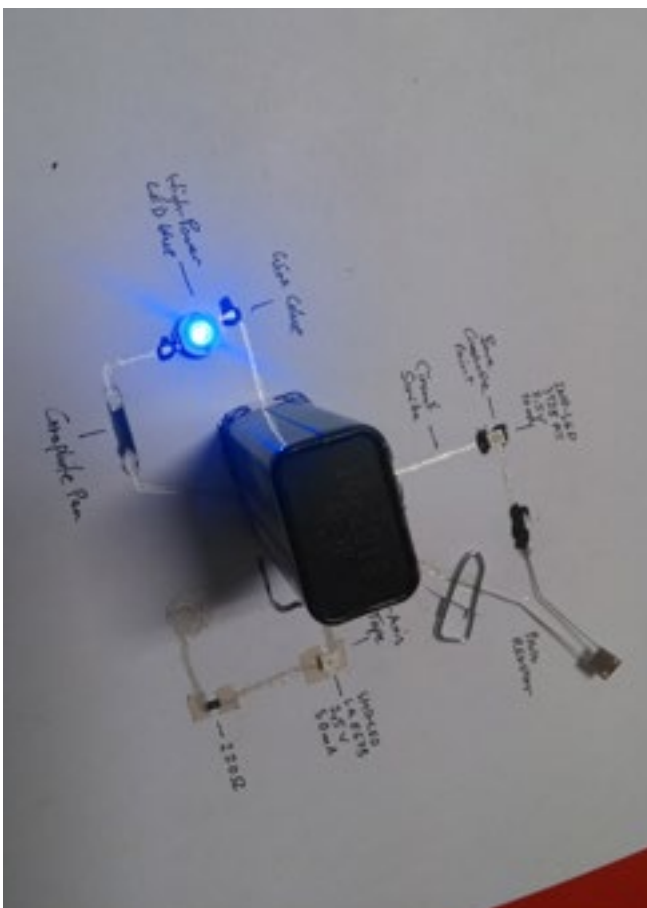
For research projects such as the Electroluminescent Roll-Up Banner the equipment of the *Bauhaus Form and Function Lab* was used. The BFFL is a research lab which is committed to explore and develop innovative interfaces and functional prototypes for interlaced digital applications and services. For the project mentioned a semi-automatic screen printing table was used. The inks needed to fabricate electroluminescence were kindly provided by the InnovationLab GmbH.

The pictures and description texts of the projects displayed in this document were mostly submitted by the students themselves.
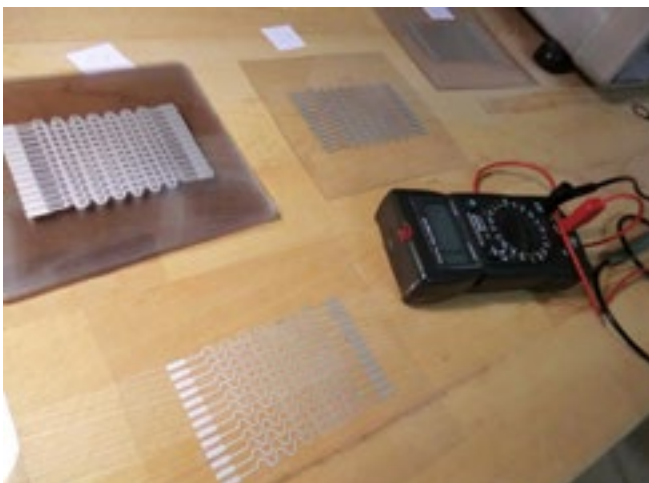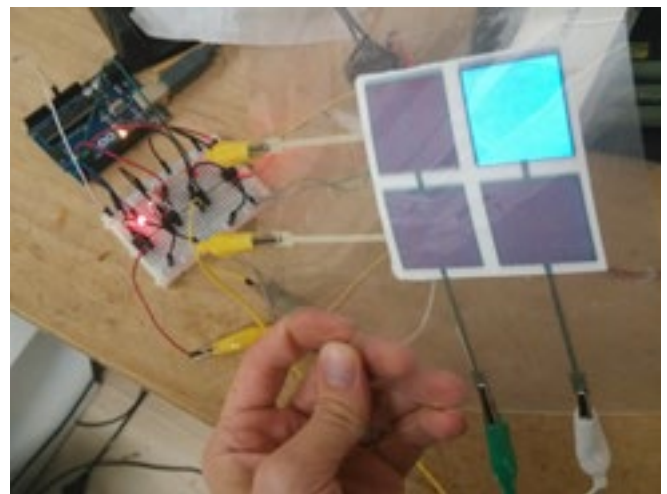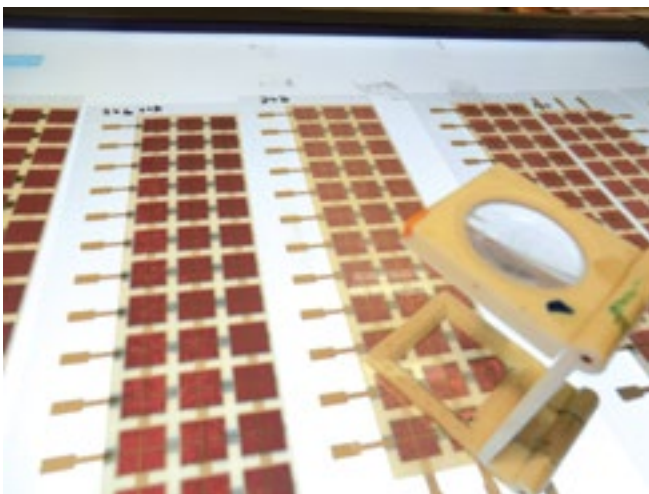
Paper Prototyping + Printed Electronics

Project by *Laura Agudelo*

Paper prototypes are quick and easy to build, but need to be rebuilt digitally later on. This project combines the preparation of paper UI mockups for user testing with a direct digital visualization in a web application.

Interface components made out of paper are placed on a grid which is printed using conductive ink. The placement of the components is synchronized with a web app which will visualize the layout of the different components such as elements of a menu bar.

Different Patterns printed on the back of each paper component make sure that the position of the different elements is recognized correctly.
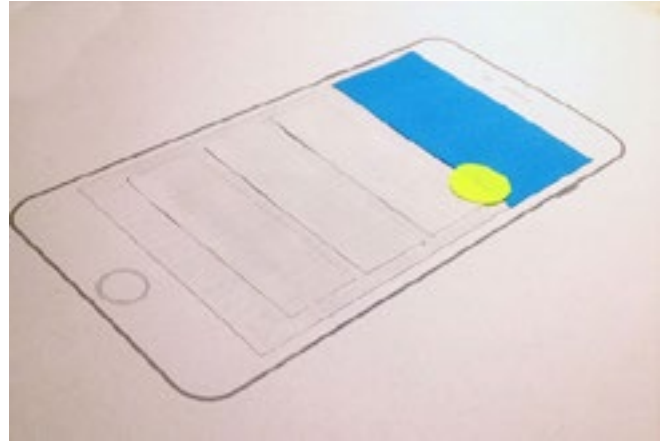
Printed speaker postcards

Project by *Elham Masoumi*

The idea is creating postcards with illustrations of different Persian female singers with a printed conductive spiral which serves as a speaker.

When a magnet is placed in the middle of the spiral and the two ends are connected to an amplifier, the postcard can produce a faint sound through the vibration of the paper. The spiral was printed in two layers with a digital printer using conductive ink on a paper with special coating.

Singing and publishing the women's voice in public space in Iran was forbidden after the Islamic revolution in 1979. Therefore the idea focuses on the contradiction of having an image that can produce sound. The image shows an illustration of Ghamar ol – Moluk Vaziri, who is known as the Queen of Persian music.
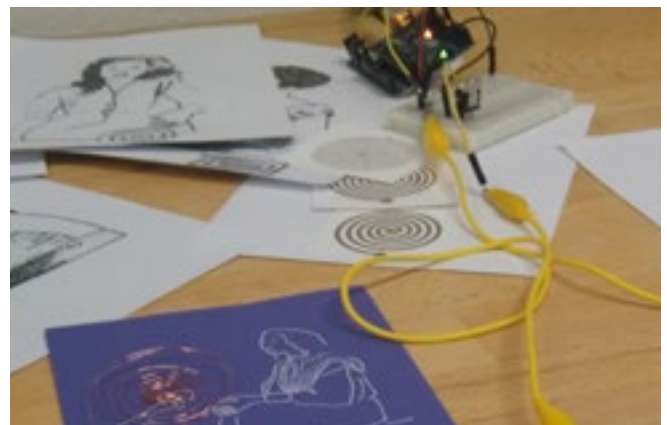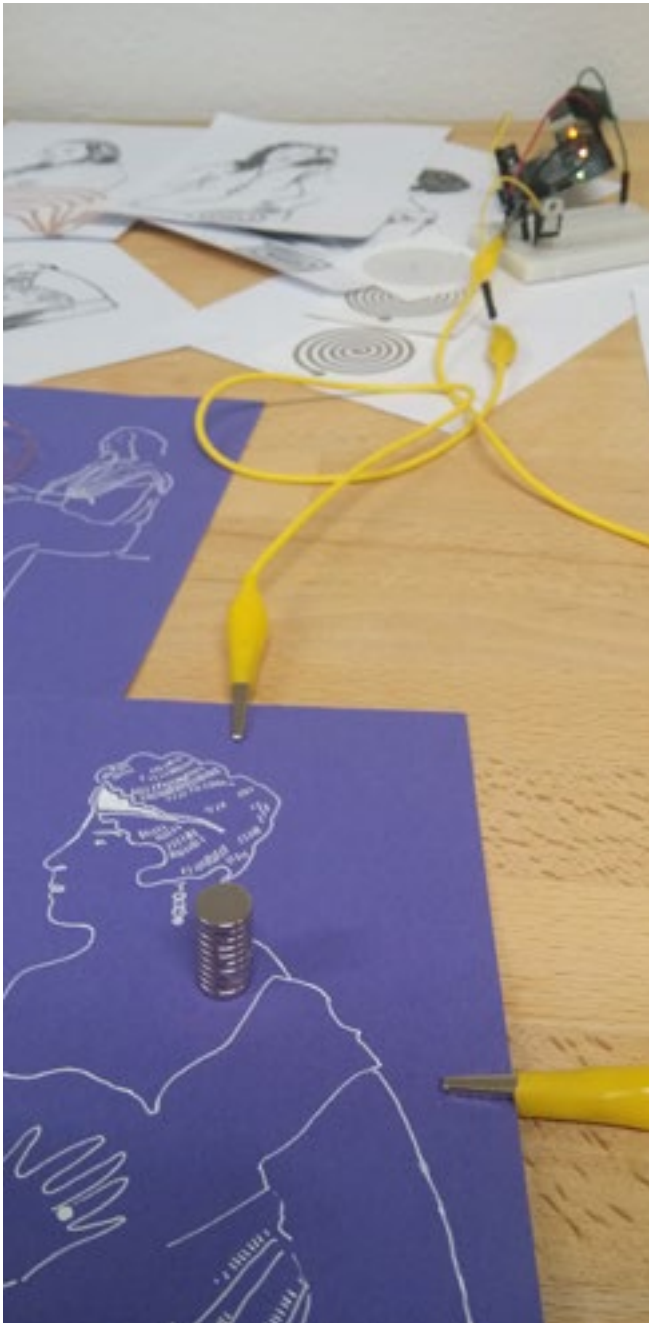
Planted Personas

Project by *Linda Deringer & Bita Rezazadegan*

Planted Personas aims at building a deeper, fun, and educational connection between plants and their owners. We came up with the idea of a sticker. It could be sold along with the plants, individually online or as predefined sets, such as ‚herbals'. The stickers would be equipped with sensors, a microchip and lights, which would

• fit any pot
• fit any plant
• be recognisable.

Every pot sticker comes equipped fully functional with the relevant sensing capacities and display units. They function autarcically and will send light signals to you in order to indicate your greenery's wellbeing without additional devices. On top of that, stickers can send their information via the greenlink to your mobile. The greenlink is set to communicate with subordinate stickers via buletooth and it comes with a *gsm* module in order to make a connection to our phone.
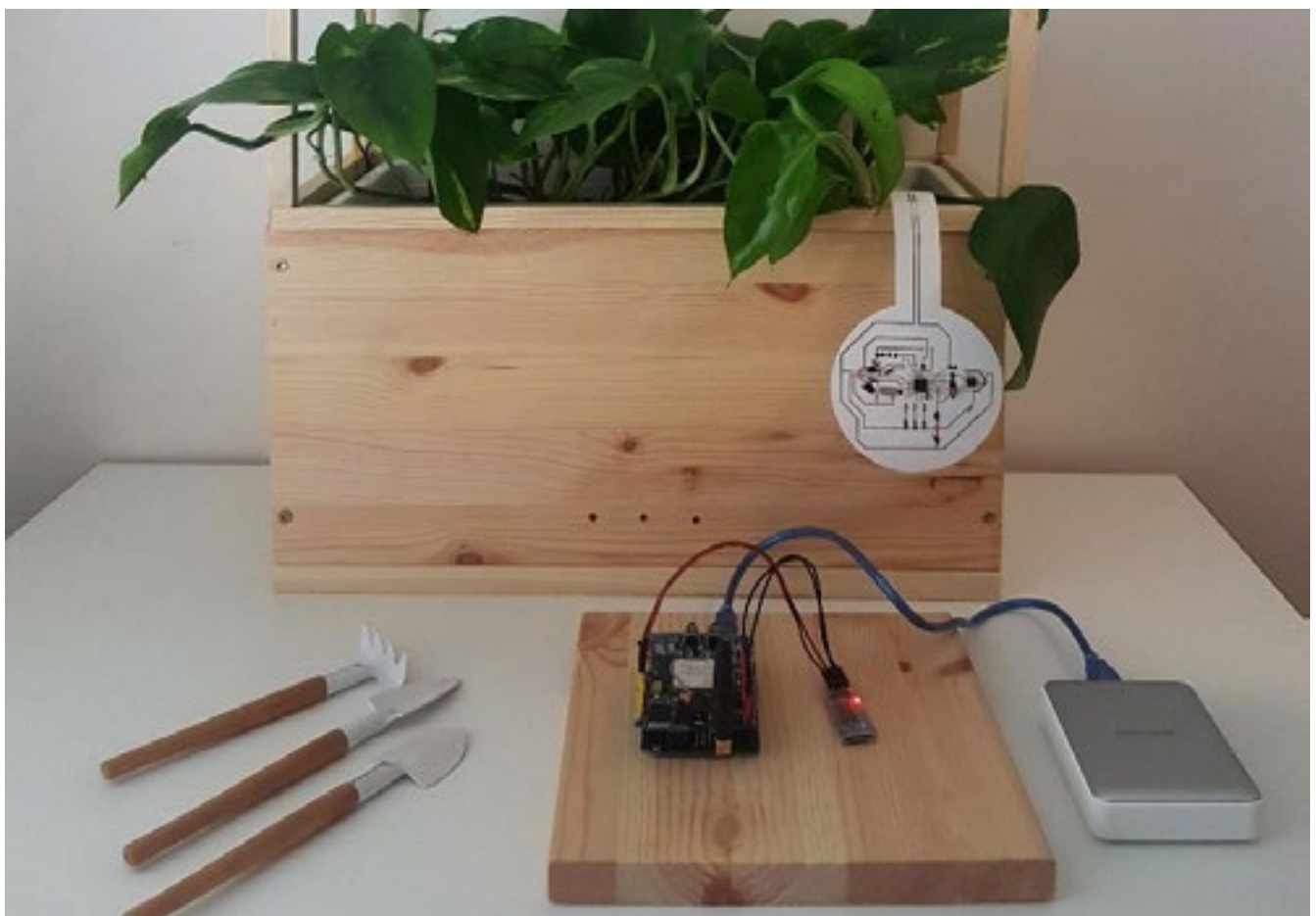
Electroluminescent roll-up banner

Project by *Florian Wittig*

A multi-layer electroluminescent display in form of a low-resolution dot matrix is screen printed onto the foil of a common roll-up banner which usually only displays static information. With the help of electroluminescence the dots or pixels of the matrix are able to actively emit light and thus display modifiable information. The matrix is connected to a small power source as well as a microcontroller which are located in a box attached to the roll-up banner aluminum case. The microcontroller is accessible through a wireless connection, enabling users of mobile devices to remotely control the EL display. As the EL display is printed on flexible PET foil, it can be rolled and stored in the aluminum case in which the banner is transported.

This project was realized in cooperation with Innovation Lab GmbH Heidelberg.
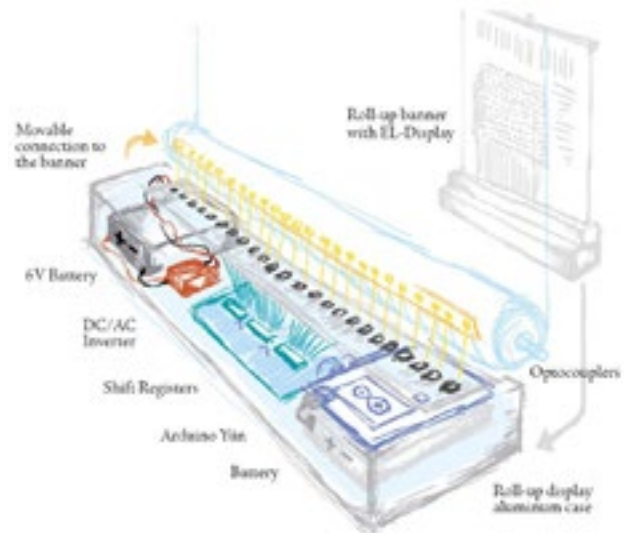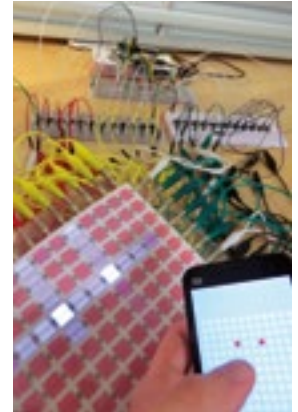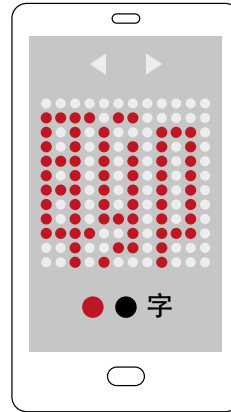
Tattooed Electronics

Project by *Jörg Schneider & Jessica Rentzsch*

We used carbon-based conductive ink to tattoo conducting paths into pieces of old leather. Although the resistance of the conducting paths is high, we managed to fabricate capacitive sensors which were sensitive enough to trigger electronic components such as LEDs.

We designed four patterns which we tattooed into a used leather bag and connected them to an Arduino microcontroller. This way we created flexible touch sensors. With a speaker attached, the bag can be used as a musical instrument.
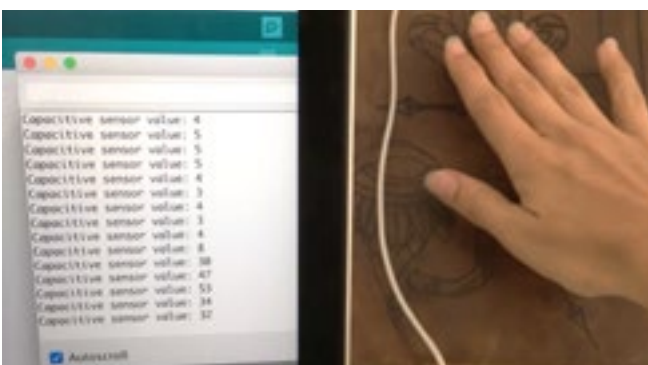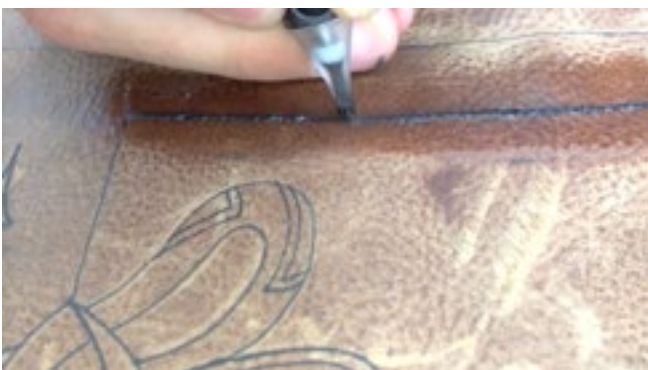
Notes On Your Fingers

Project by *Yang Di*

Notes On Your Fingers is a conceptual instrument for music lovers who would like to play music wherever and whenever on their fingertips. It will turn the user into a part of the instrument system. The main approach is using conductive ink to connect the human body to the circuit board and the note will be triggered by a corresponding finger. You can imagine your fingers as keys from a piano, but you can play with the keys in different postures.

The shape of this instruments is inspired by a Chinese childhood origami. It's easy to fold the shape and it can fit most people's fingers. I have tried several forms like: gloves, rings, finger-stalls, etc. But none of those is as simple and easy to make than a paper origami. With the conductive ink printer, I can print the contact points on an A4-sized paper or film to make out two parts for the instrument in minutes.


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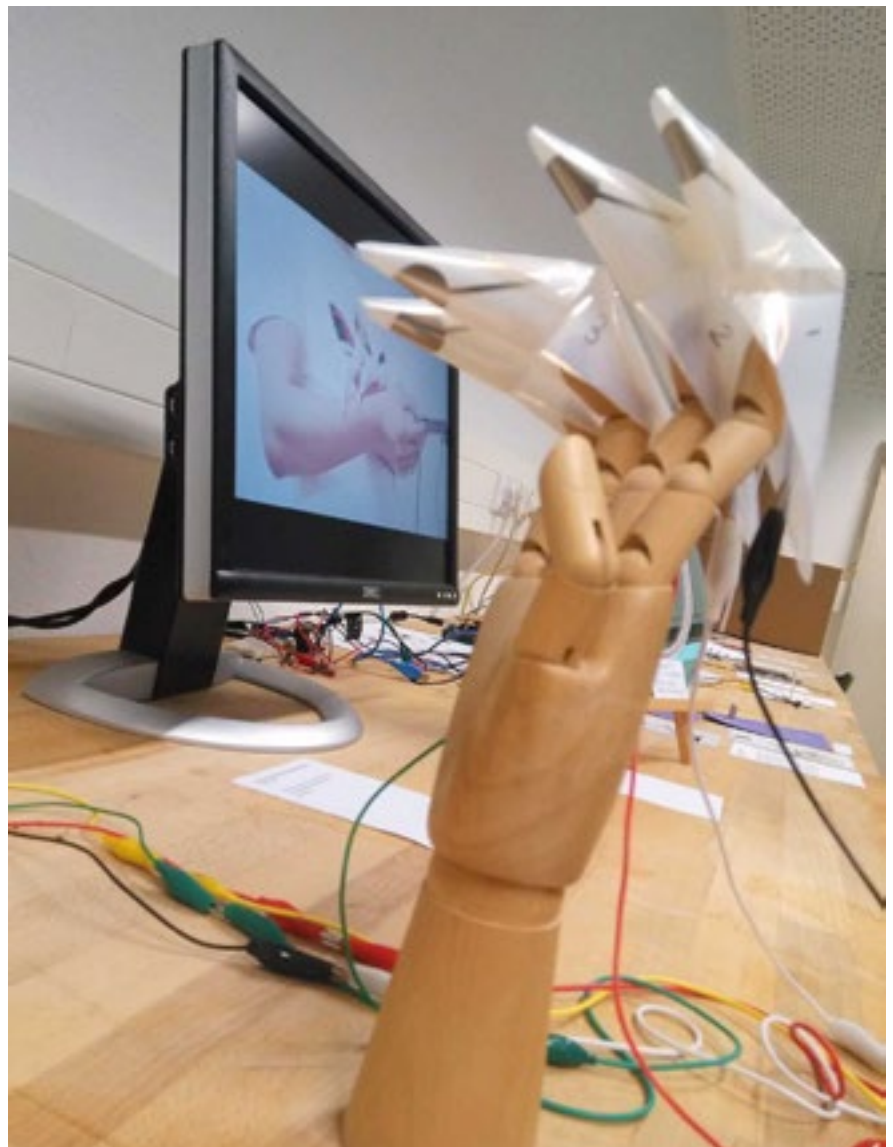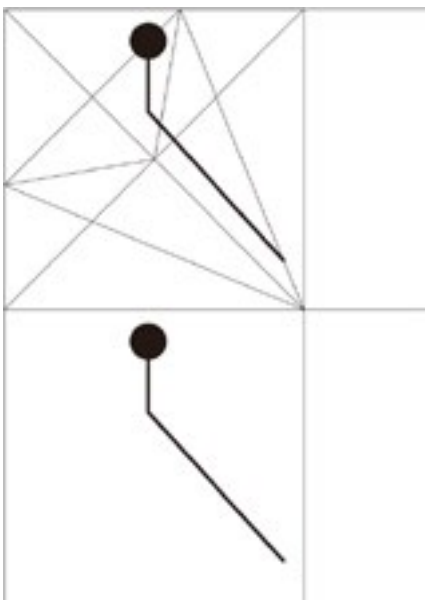
Thematic memory card game

Project by *Natalia Martínez Bermúdez*

This memory card game uses printed electronics and sound to teach words in the Wayuunaiki language, a native colombian language spoken by the Wayuu people in the northern part of Colombia and Venezuela.

Both the deck of cards and the circut connected to the speaker are fabricated using printed electronics. An Adafruit Audio FX Sound Board is used to trigger the sound effects of the device. The board is connected to the printed circuit, an amplifier, and the speaker. The functionality is a simple trigger mecanism; each of the cards can be used to close the circuit and trigger a sound. The identification of each card is made by the position of where the circuit is closed.
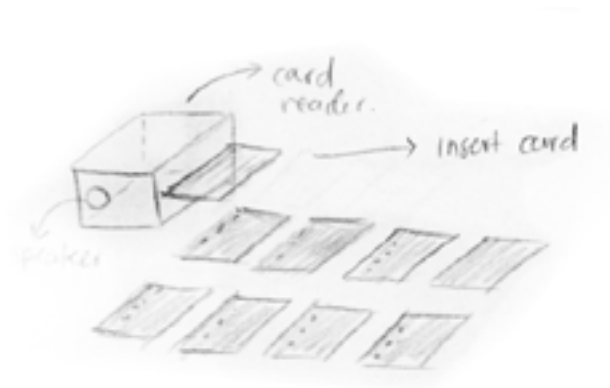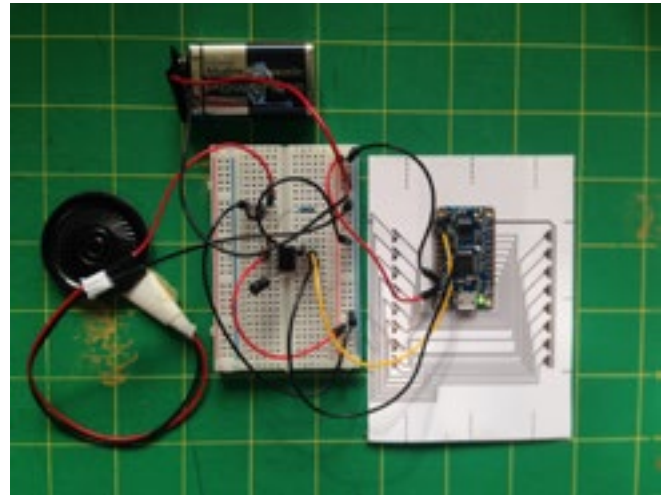

Interactive learning material for teaching color theory

Project by *Mariana Sanchez Artola*

The project was conceived to be implemented in learning environments in order to allow students to interact with an analogical representation of a color model cube. This device will enable to see the mathematical relation between each of the three basic lights. It consists of a printed circuit with three SMD-RGB LEDs that are connected with an arduino microcontroller. These LEDs are placed in different corners of the cube, determining the three axis. The idea is that the student can see the different gradients, measure and also check and predict which color they obtain by varying the RGB values. The circuit is printed with silver conductive ink with an inkjet printer on coated semi-transparent paper.

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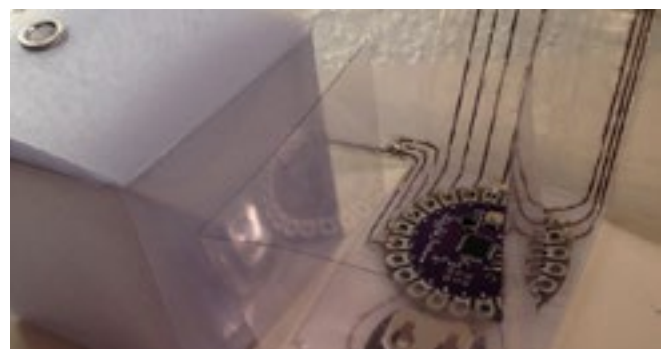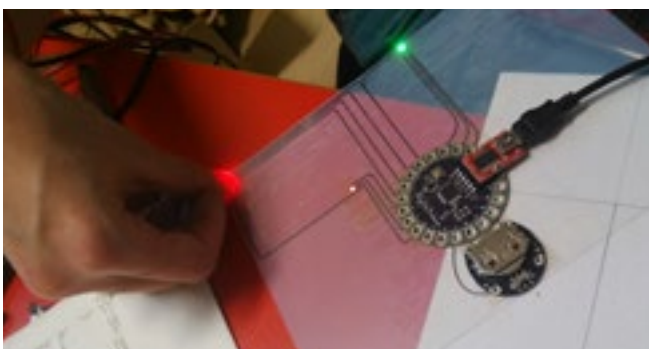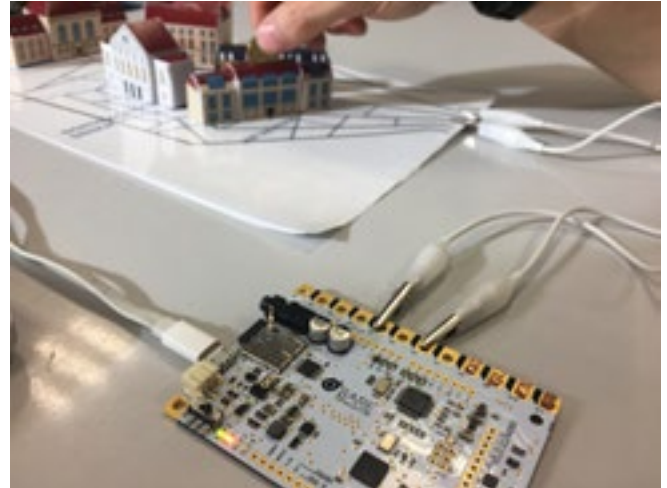
Electronic tourist map

Project by *Li Jingyi & Bai Haicheng*

The idea is to use printed electronics and a micro controller to fabricate an electronic map that serves as a city guide with pre-recorded sound. Users can trigger sound introductions to buildings they are interested in by inserting a coin into a 3D paper model of the corresponding place. This will close a circuit and trigger the sound. The bottom layer is a simplified background map, on top lies a printed circuit showing the way to places of interests. The 3D paper models give the appearance of a big board game for people to play with, in order to get a first impression of the city they visit.
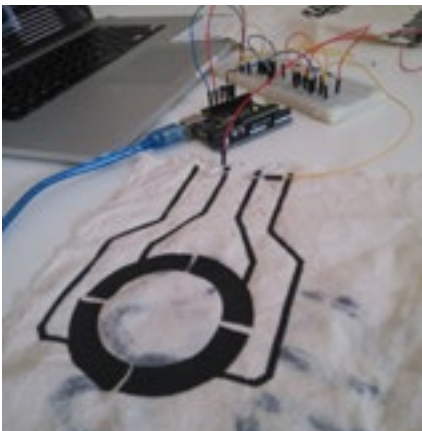

# Fabric sound board

Project by *Esra Demirel*

This project aims to create an interaction with crafts and electronics at the same time. By using ancient printing methods it is possible to transpose our design to fabric.

The patterns printed on used fabric are connencted to an Arduino and serve as input by using capacitive sensing. An attached speaker will create sounds depending on the intensity of the touch and the resistance of the user's body.
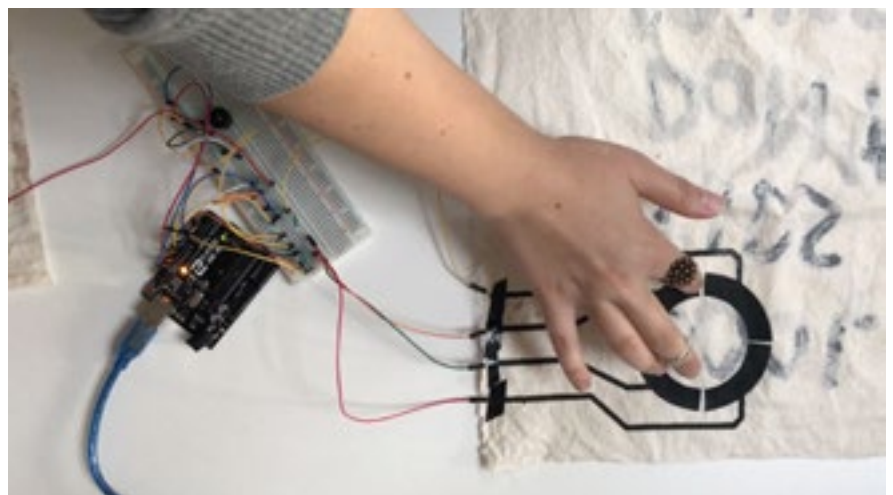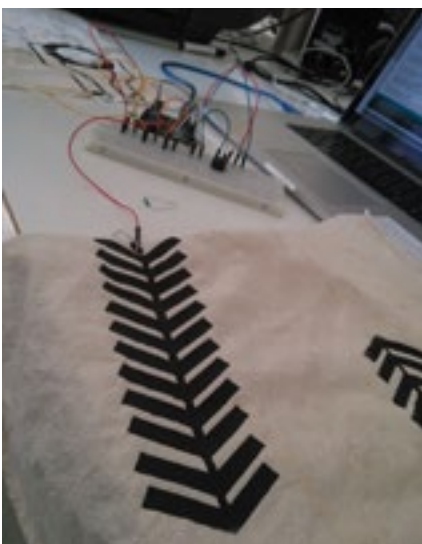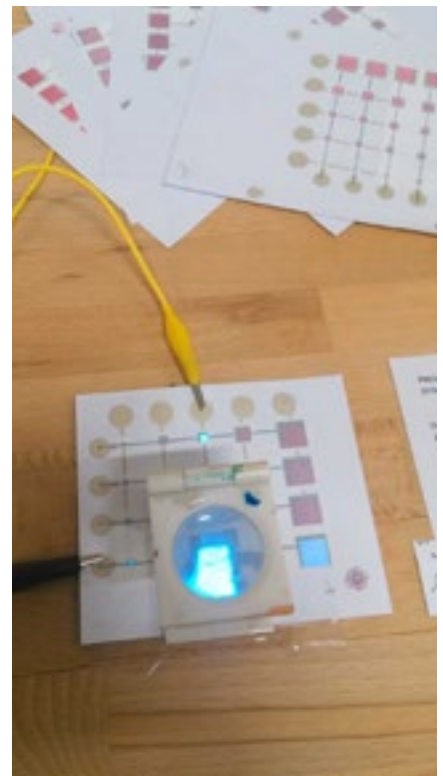
Impressions of more different projects at Bauhaus-Universität Weimar using printed electronics
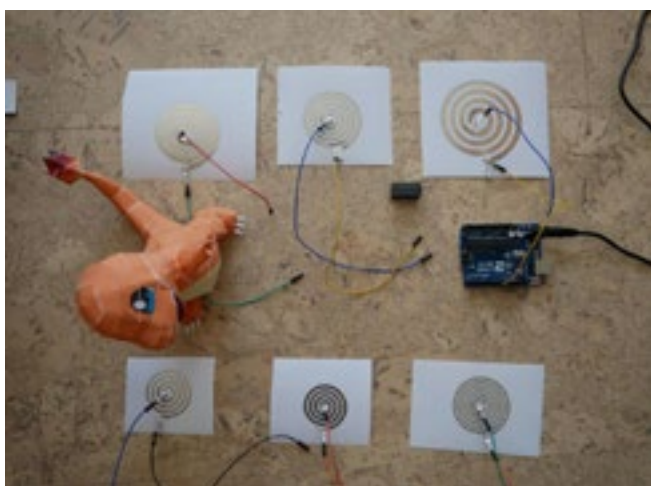
Selfie mirror *by Yang Zongbin*
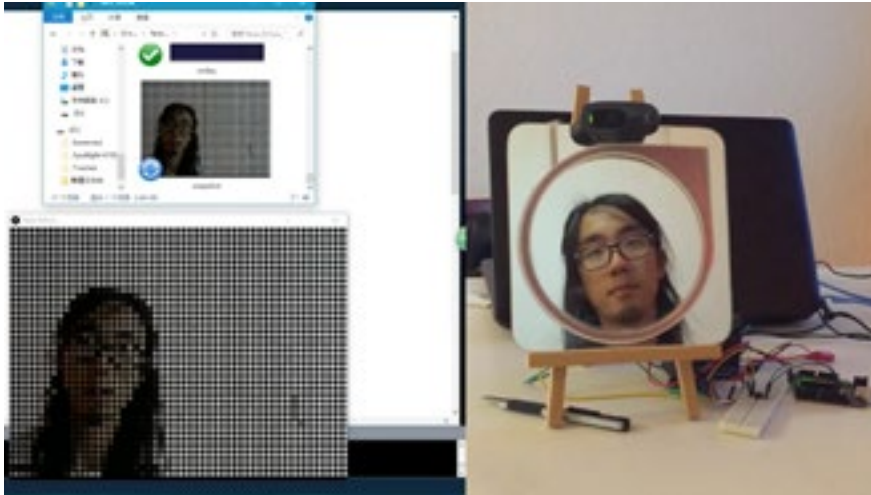
EL experiments on paper
by Benedikt Vogler

Moving lotus lamp *by Kei Kitamura*

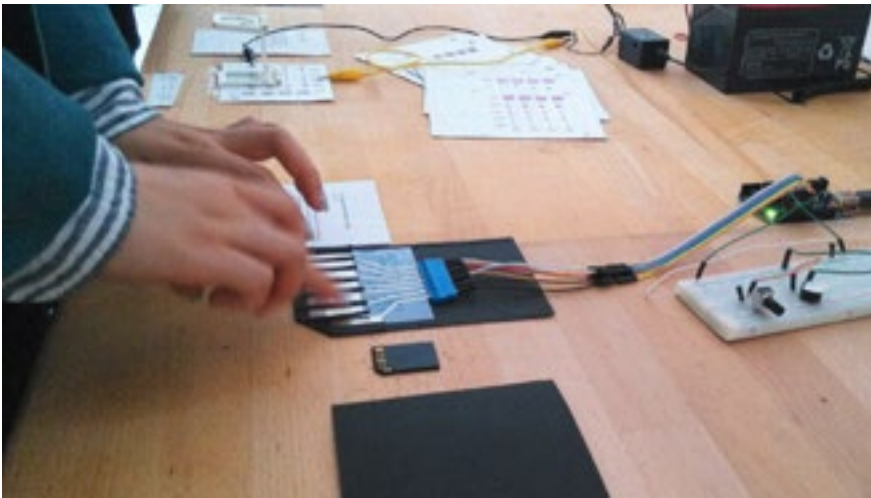Papercraft speakers *by Dominik Markert*

Self-made conductive ink *by Pavel Karpashevich*

T-shirt interface *by Aline Martinez*

Inflatable architecture model *by Justina Dziama*
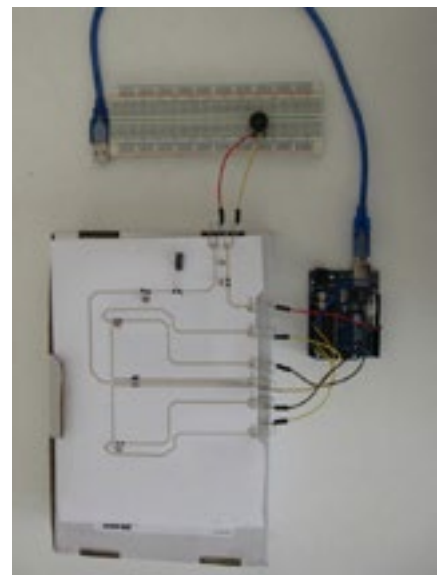

Printed USB piano *by Luo Ji*

Clock with printed wires
on glass *by David Howlett*

Interactive audio map
by Nadin Keabi

Interactive book
 by Mana Mazidy

Shadow light sound generator
by Clint Paul Büchner