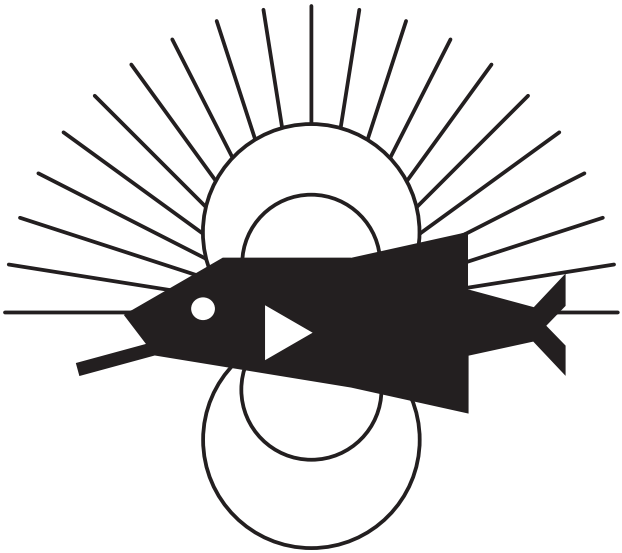


Sensorium of Animals

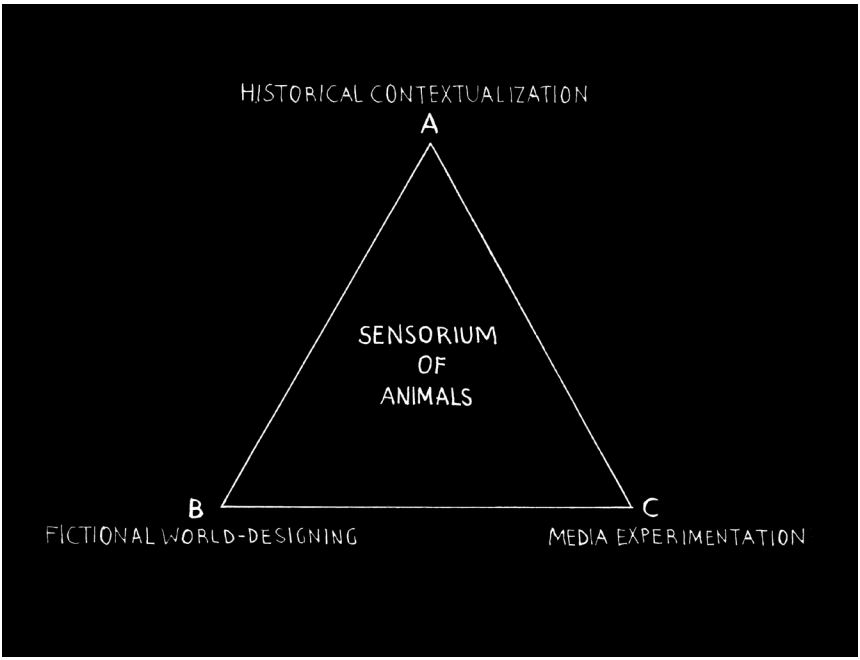
— a project by —

Susanna Hertrich & Shintaro Miyazaki

situated at the
Institute of Experimental Design and Media Cultures IXDM
Academy of Art & Design FHNW Basel, Switzerland
(2016 – 2018)

img 01 : Detail of research studio at Academy of Art & Design FHNW, 2017

Sensorium of Animals is a collaborative artistic research project by Susanna Hertrich and Dr. phil. Shintaro Miyazaki that is inspired by the sensorial ecology and biology of elephant-nosed fish. This species is capable of electrolocation and -reception, sensorial abilities which allow these fish to sense their electromagnetic environment.
The sensorial ecology of the elephant-nosed fish here operates as a vehicle, which allows intertwining the world of animals and its non-human sensorium with seemingly immaterial non-human worlds of signal-based information technologies. *Sensorium of Animals* operates as a conceptual device that embraces the complexity of our knowledge about the protected designs of our critical digital infrastructures.

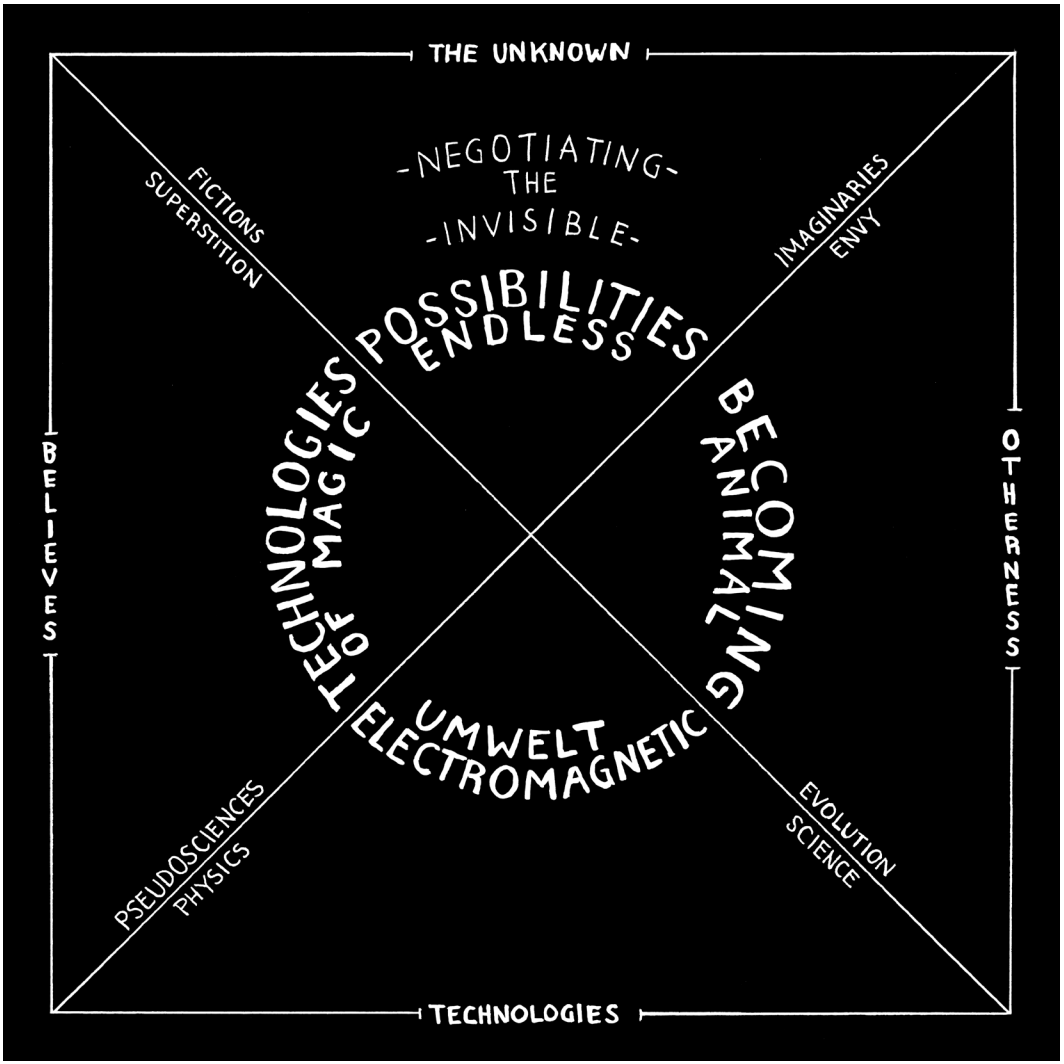


img 02 : Threefold approach, graphic, ink on paper, 2017

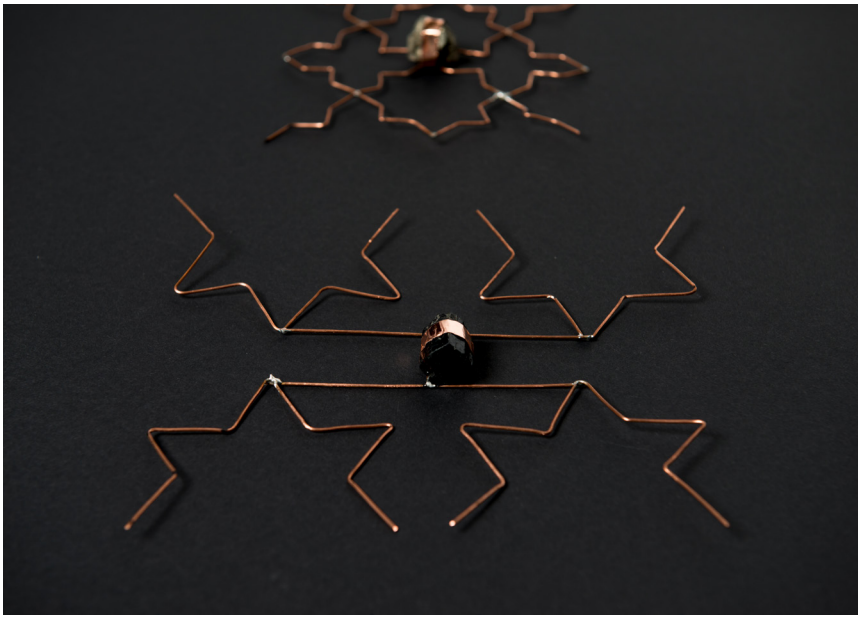
Sensorium of Animals explores ways to sense our high-tech electromagnetic environments, especially those serving as infrastructures of our 'digital' and wireless devices. We focus on artifacts and non-direct ways how human citizens in a fictional future world would handle, operate and work with electromagnetic signals.
Our research practice comprises prototyping of tactile interfaces, that could be worn on our arms, shoulders or upper body – a method we like to refer to as *media experimentation*. This process is continuously expanded and synthesized with our two other methods, *historical contextualization* and *fictional world-designing*.
This threefold approach [img 02] creates and unfolds an enriched spectrum of applied and theoretical propositions, as well as narrations and speculations. It also operates as a conceptual device to make things appear more complicated and complex than they seem to be. This way, we avoid creating a smooth, monolithic and glossy body of insights. We make this body more porous, manifold with many little docking sites and holes providing space of linkage.

The simplicity and inaccessibility of our 'digital' and wireless infrastructures is an illusion and prevents the possibility of self-exploration, production and determination. Increasing complexity by an oscillation between materialization and theorization as described before is a form of *ethico-aesthetic* (Guattari 1995, 8) and practice-based resistance towards overly profit oriented forms of research.

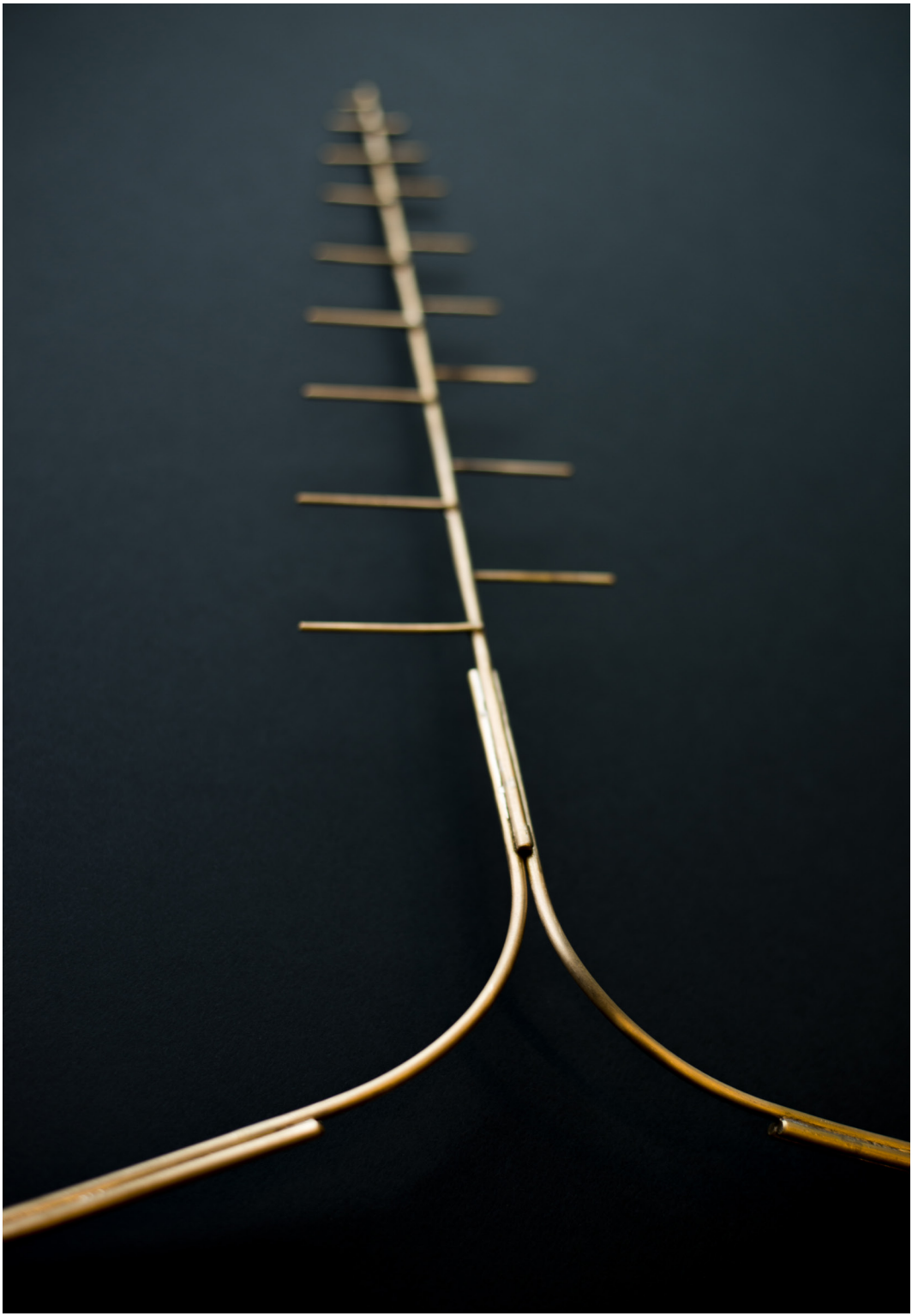
Starting with paper-based techniques such as diagrammatization or quadrant mapping **[img 03]**, we have been writing text-based narratives, film exposés or have been pondering about found objects such as a Japanese lucky charm that carries the promise of success with information technology and we created *boundary objects* (Star and Griesemer 1989; Pierre Johnson et al. 2017) – antennas or crystals – to create different artifact-based stagings and lead us to fictional scenarios **[img 04 & 05]**. Those fictions (currently in progress) are aimed to focus on socio-political issues to provide narrational vectors and sketch alternative ways of future living in an increasingly automated, highly-complicated and technology-driven world. They are intended to provoke reflections about our current infrastructures, which are intentionally designed to remain invisible.



img 03 : Diagrammatization of research areas, ink on paper, 2017



img 04 : *Antenna fetishes*. steel, copper, solder, crystals, 2017
img 05 : *Antenna dowsing rod*. brass, 2018



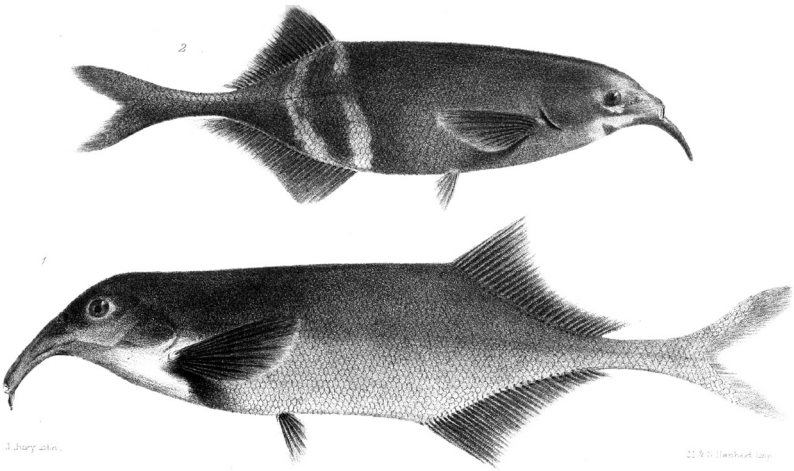


Fig 1 MORMYRUS TAMANDUA Fig 2 MORMYRUS PETERSII

img 06 : Mormyridae, J. Jury in Proceedings of the Zoological Society of London (vol. 1864, plate II)

"

Elephant-nosed fish, sometimes called freshwater elephant-fish or *Mormyridae* **[img 06]** are capable of electroreception and electro-location. This became known in the 1950s with the research by Hans Werner Lissmann, an Ukrainian-German-British zoologist, who used electrophysiological measurement techniques involving electrodes, amplifiers, headphones, oscillographs and -scopes to record emissions of these "weakly electric" fish. Similar to radar systems in military air force *Mormyridae* can actively sound out electric field differences of their surroundings by sending out electric pulses and sense their back-reflections. The most recent elaboration of these findings has been conducted by Gerhard von der Emde and his team in Bonn (Germany), who is an advisor of our research project. Von der Emde confirmed already in the late 1990s, that it is mostly the interplay between "the spatial pattern of voltage change" received by the electroreceptors on their skin and nearby objects, which enable these fish to navigate in darkness. Objects change the electric field and thus change the patterns and currents flowing through their *electroreceptors*.

Since the sense-making of such animals is highly dependent on their environment this research field is called *sensory ecology* (Dusenbery 1992). It is not merely an accident that in the 1930s Lissmann, the above-mentioned zoologist, had been a PhD-student of Jakob von Uexküll, whose concept of *Umwelt* was highly influential for example for the forming of the environmental sciences generally, and for at least two more related fields: The first is usually subsumed by the term *cybernetics*, the second evolving some decades later is called ecological psychology coined by James J. Gibson, who is known for his concept of affordance. Both are highly significant for the history of *human-machine-interfaces*.

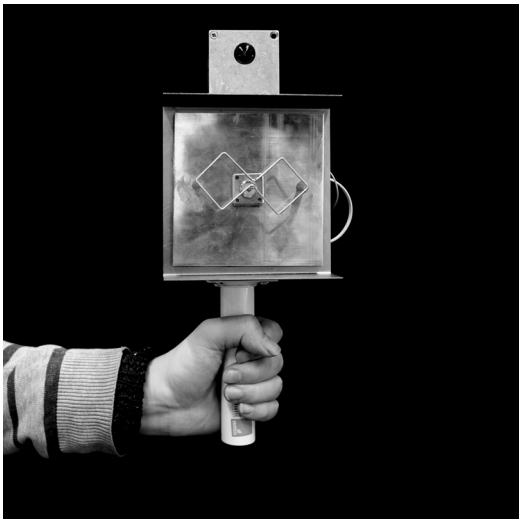
Elephant-nosed fish are not only as objects of research linked with cybernetics but as animals capable to orient themselves in their natural environments they embody its principles. Cybernetics, a neologism coined by Norbert Wiener in the 1940s, is inspired by the Ancient Greek verb *kubernáō* – meaning to steer, to navigate and to govern. The term refers to a then-new field of science that coupled technological systems such as servomechanisms originating from military fire-control with human and animal sense-making via the now ubiquitous concept of *feedback* (Wiener 1948; Galison 1994; Mindell 2002).

A *feedback circuit* is both an abstract, thus non-material, but at once also a matter-dependent concept, which simply describes the changing flow of material properties such as voltage, weight, but also monetary value leading back into its own source and thereby either causing its amplification or reduction. Feedback systems are also building blocks in ecosystem ecology, system dynamics or communication systems. From the 1960s on, they found their way into Californian counterculture, art and psychedelics. In fields such as *sensory substitution*, cybernetics met assistive technology (Mills 2011,2010), where Paul Bach-y-Rita beginning his work in the late 1960s is regarded as a pioneer.

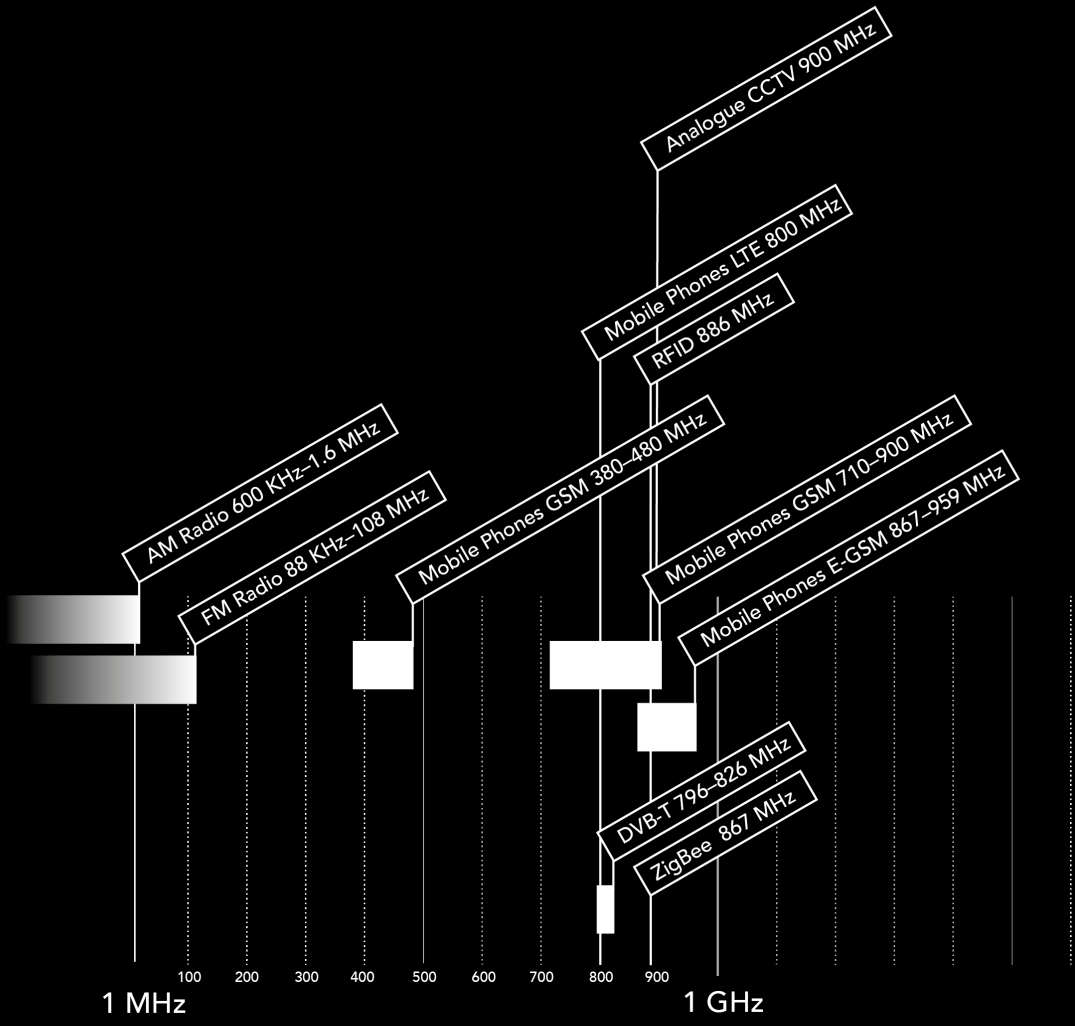
By turning everything into a system of interdependent feedback loops cybernetics accelerated the rationalization, capitalization, and exploitation of everything on our planet — and continues to do so under different disguises and keywords, such as *big data*, *machine learning* and *artificial intelligence*.

Materialization **[img 07]** is a straightforward way to tackle issues of designed environments, which becomes increasingly *ungraspable*, *invisible* and *unperceivable*. And this especially concerning our contemporary condition, where 'life' and 'living' are increasingly enabled, controlled and dependent on an invisible, electromagnetic, quasi 'magical' digital backbone. Wireless, insensible *electromagnetic infrastructures* provide the basis for our high-tech, info- and data-environments.

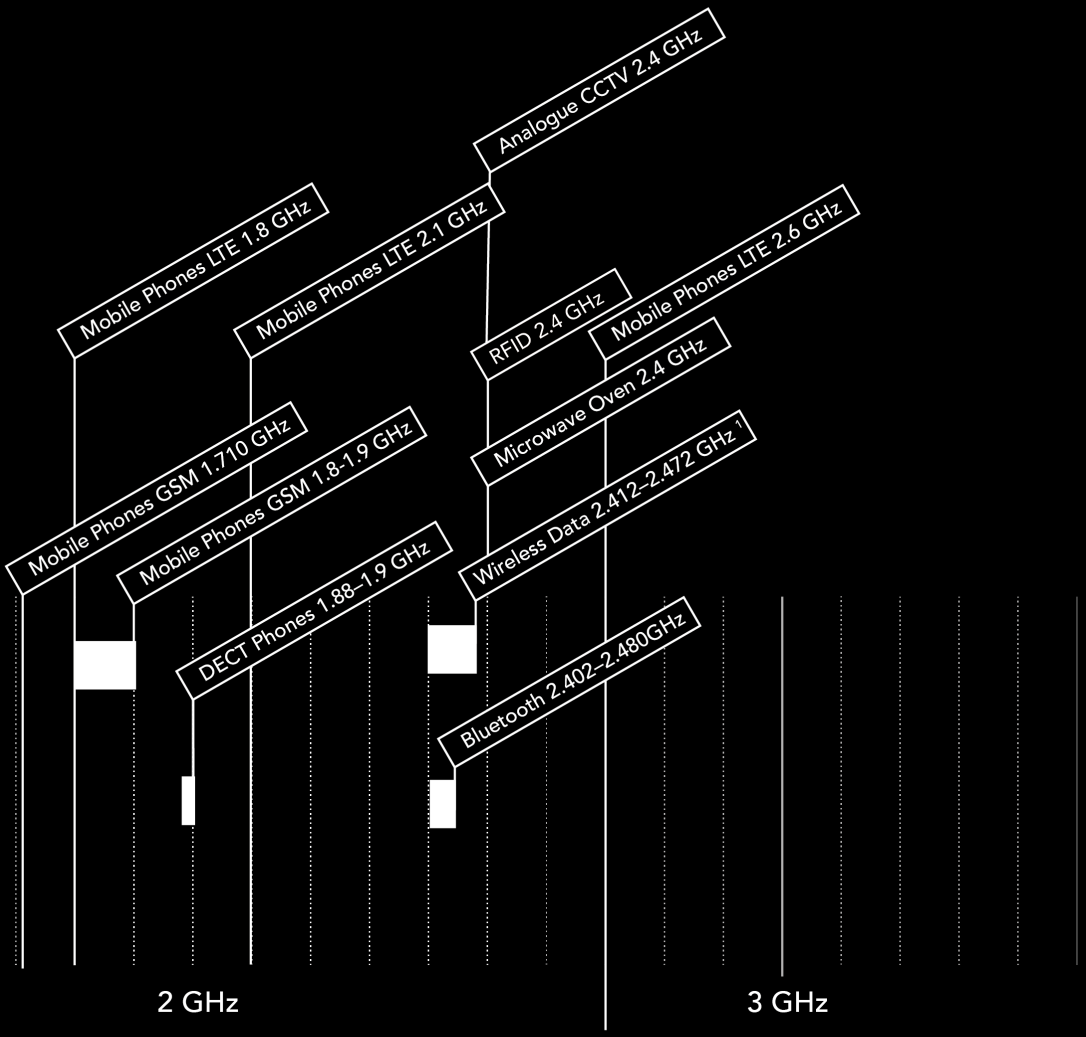
How can we show the technological operativity of electromagnetic waves, when we cannot see them?



img 07 : EMF detection device, 2017



img 08 : Infographic: EM Spectrum in Europe, 2018



[1] 802.11b
802.11ac

Sensory substitution later called *sensory augmentation* is a field of research and engineering, which is aiming at building devices and systems, that translate signals from one human sense modality – such as seeing, hearing or feeling – into another.
We re-built two historical contexts and their experiments in the field of sensory substitution between the *tactile* and other senses such as hearing and vision. The first of these contexts is the cutaneous rabbit illusion described in the early 1970s by Frank Geldard and Carl Sherrick at the time working at the Cutaneous Communication Laboratory **[img 09]** at Princeton University (Geldard and Sherrick 1972).

Engineering psychology considers the 'human' factor

At four o'clock in the morning three years ago, several water coolant pumps stopped working in the nuclear power plant on Three Mile Island. A combination of equipment failures and plant operators' mistakes turned a routine problem into the worst accident in U.S. nuclear power history.

Among the factors contributing to the TMI accident, the investigating presidential commission said, were confusing operating procedures and poor design of the plant's control room. Little consideration had been given to "human factors" in nuclear safety.

The controls and indicators were not arranged well, the commission said, with some key displays located on the back of the control panel, out of the operators' view. When things began to go wrong at TMI, controlling the plant became a nightmare.

"During the first few minutes of the accident," the commission wrote, "more than 100 alarms went off, and there was no system for suppressing the unimportant signals so that operators could concentrate on the significant alarms."

As the TMI accident reveals, "human" considerations are not always in the forefront of the plant or equipment designers' minds, points out Princeton Senior Research Psychologist Carl E. Sherrick, who is working in the relatively new field of engineering psychology. "The designer focuses his attention on materials and energy, on physical principles and their efficient use. He may assume that the user or operator will be capable of any adaptation that the control of the system may demand. He isn't." What often results is equipment that is cumbersome, confusing or even dangerous to use.

Designing equipment with the user in mind is the focus of engineering psychology. It requires knowledge of how people think and learn, as well as an understanding of their physical capabilities and limitations—subjects that have been studied by experimental psychologists for decades. Sherrick says that incorporating this knowledge into equipment design could alleviate many of these problems.

Michael J. Beahan

Research Psychologist Roger W. Cholewiak uses a matrix of 64 reed vibrators to make patterns on the skin of an observer's thigh. His experiments test the observer's ability to "read" patterns received through the skin.

Selection and training of personnel at TMI was also a factor in the accident. "The operators didn't know what was going on," says Sherrick. "These people should be able to understand enough of the physics and chemistry of nuclear generators that they can reason through what's going on at the plant when problems arise." Training in normal plant operations, maintenance and safety procedures was not a primary consideration in the overall design requirements of the plant, Sherrick says.

Michael J. Beahan

Emeritus Professor Frank A. Geldard (l) marks locations on Sherrick's index finger where he will measure the number of separate information processing channels in the skin.

Engineering psychology got its impetus in this country during the Second World War. "Psychologists and engineers were asked to make suggestions on how to select and safely train American aviators," Sherrick recalls. "One of the first things they found, for example, was that the location of aircraft controls was reversed in aircraft flown during basic and advanced training. For the inexperienced pilot, adjusting to such a change could be difficult and even disastrous. In another effort to reduce aircraft accidents, the psychologists asked hundreds of experienced pilots to describe dangerous situations they had encountered while flying. From these interviews they compiled a list of 150 "critical incidents" and then went to work informing other flyers of the hazardous situations and looking for ways to correct them (for example, redesign of indicators and controls). "The project paid off by saving a lot of lives by the end of the war," says Sherrick.

Engineering psychologists and human factors engineers have continued to make contributions to modern aviation and other transportation fields. They have also improved the design of displays used for monitoring and controlling industrial operations, of biomedical equipment used by the blind and deaf, and of computer terminals, keyboards, and even programs.

With the proliferation of computers in all aspects of American life have come new problems. Programming languages that can be easily understood and used by programmers and operators had to be developed. Sherrick says that the design of computer languages is often undertaken with little basis in research on the learning abilities, semantic habits, or reasoning strategies of the people using them.

"A computer is like a wild horse," says Sherrick. "There is a tremendous amount of power there if you can just keep it under control. Making computers easy to use ("user friendly" rather than "user surly") demands extensive knowledge of how people acquire information, how they retrieve it from memory, and how they apply it rationally in the solution of problems, he says.

"Raised" a general psychologist, Sherrick now divides his time between the Psychology Department and the Engineering School, where he is currently combining the two disciplines in a course on engineering psychology. Much of his recent research has dealt with how people process information received through their sense of touch. "Sighted people have learned to read and to find their way around in the world using visual images. We're looking at how to convert the information normally received visually into patterns of vibrations that can be 'read' by the skin." Sherrick, Research Psychologist Roger W. Cholewiak, and Stuart Professor of Psychology, Emeritus, Frank A. Geldard are examining skin sensitivity and tactile pattern recognition and discrimination. They generate a variety of vibration patterns, often with a computer. Some recreate visual images by actually reproducing letters and numbers on the skin, like a "Times Square" display. Others are encoded representations of these visual images. The direction, speed and frequency at which the patterns are introduced can be varied to determine which combinations are easiest to learn.

"We're trying to develop a set of principles or coding system for getting information through the skin," says Sherrick. Like learning to read, recognizing patterns on the skin is at first a difficult experience that becomes easier with practice.

This vibrotactile form of communication can be used to replace or supplement the defective or overburdened senses of vision or hearing. This becomes important for people whose senses of vision or hearing are either impaired or overloaded. With a cockpit full of gauges and warning lights, and a constant barrage of radio messages, pilots' hearing and visual senses become quickly overloaded. The addition of new flying safety equipment usually means another gauge, warning light or buzzer. A more effective warning device might be one that signals the pilot through the skin —with a small vibration on the tip of the finger to tell him to climb or to turn right or left, for example.

A vibrotactile device could also be used in sensory and mobility aids for the blind or deaf-blind, or in speech analyzing aids for the deaf or deaf-blind. Such a device could be incorporated into an aid designed to help the blind move from one place to another. "Basically the person wants to know his location, where he is in relation to buildings and other landmarks. And then he wants to be able to avoid obstacles. Some people think these are two separate problems and develop aids for one or the other. They might develop an aid that uses sound, but this would require covering the ears, which is not a good idea because the blind use sounds to help them know where they are. A tactile signal would allow them to use all the senses available to them and just add one more. It would expand the "field of view." "

Developing aids for the handicapped is just another example of design done without consideration for human factors. "In so much of the research we have done we keep running up against this; design that does not reflect what is known about what the person who is using the device really needs to know, when they need to know it, and how they should respond to whatever display is used," Sherrick says.

Sherrick doesn't expect the engineering students in his course to become "human factors types," but it will help them to become familiar with these considerations and to talk to psychologists. Sometimes, he says, engineers and psychologists have difficulty talking to each other. "According to the Book of Genesis," Sherrick says "the Tower of Babel was never finished for just that reason."

—Michael J. Beahan

Ourdoor Adventure Program spaces open

The Princeton Education Center at Blairstown has announced that there are a limited number of spaces available for their summer 1982 Outdoor Adventure Program.

The "Outdoor Challenge" for 13–15 year olds includes backpacking, canoeing, swimming, rock climbing, general outdoor living skills, games and natural history. Participants live outdoors for 12 days, camping along the Appalachian Trail and Delaware River in northwest New Jersey.

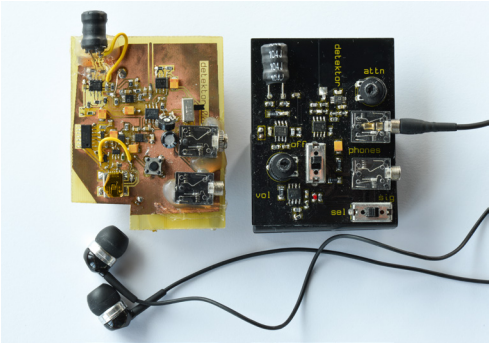
The "Outdoor Awareness" for 10–12 year olds focuses on developing appreciation of the natural environment, group problem solving through games and exercises, individual outdoor skills and personal growth. Activities are less demanding versions of the Outdoor Challenge program, with participants staying in camp for the first three-fourths of each session and then spending the final three to four days canoeing and backpacking.

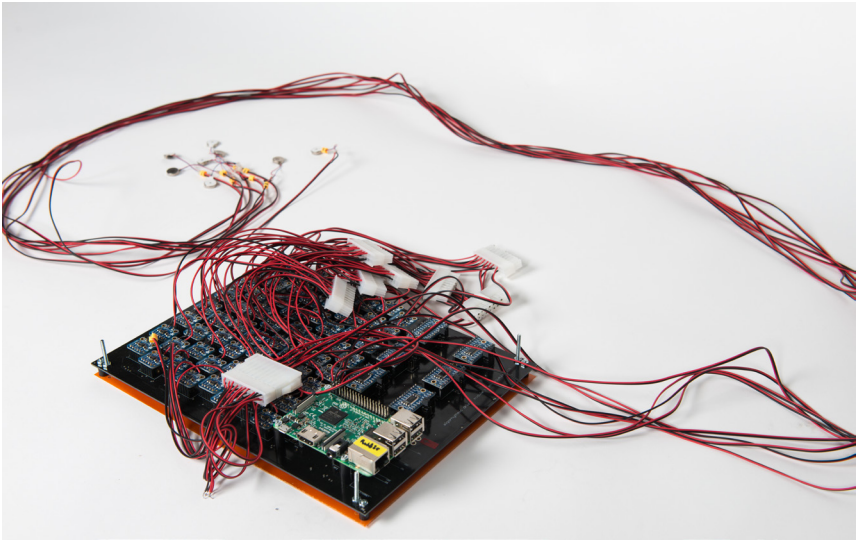
The cost of each session is $300.00 per camper. Sessions run July 6–17, July 26–August 5 and August 10–21. A special seven-day theme trip, June 27–July 2, is also planned.

A limited number of partial scholarships are available to participants whose families are eligible for the Federal School-Year Food Program and Summer Food Program.

For further information and applications, contact the Princeton Education Center at Blairstown, Maclean House, Princeton University, Princeton, N.J. 08544, or call 452-3340.

img 09 : Article on the Cutaneous Communication Laboratory, 1982





img 10 : Detektors, 2010
img 11 : Algorithmic Driver Module, 2017

Our current system is based on a previous project called *Detektors* (2010) conducted by Shintaro Miyazaki in collaboration with artist researcher Martin Howse **[img 10]**. While *Detektors* enabled us to listen to the surrounding electromagnetic signals (Miyazaki 2013b), the *Algorithmic Driver Module* (2017) **[img 11]** we build in collaboration with artist and programmer Akitoshi Honda enables to feel electromagnetic waves. It consists of a Raspberry-Pi (+ low-budget sound card), which conducts an FFT-based *spectrum analysis* and triggers the motor driver units that are connected to 64 button-shaped vibration motors. These micro-circuits operate similarly to decibel meters for sound waves, but instead measure the power of electromagnetic waves and relate that to changes in voltage. As these voltages fluctuate very quickly they become audible, when amplified and connected to a loudspeaker. The specific acoustic characteristics, dynamics and signatures of the detected electromagnetic waves are translated, coded and mapped to selected *vibratory activation patterns*. This is currently in an early phase of testing and refining.

img 12 : Left: Japanese lucky charm promising success with computers

The cultural history of the interferences of electromagnetics, esoterics, animism and other more pseudo– or non-scientific fields of knowledge form the last strand of the *historical contextualization* linked with *Sensorium of Animals*. The connex between *techno-spiritualism* and technical media networks already had its beginning with the dawn of telegraphy and the first explorations of radio even before radio existed as a distinct technology, but was a side effect of telephony (Kahn 2013, 1). With the dissemination of vacuum amplification and high-frequency radio during the 1920s and 1930s esoteric, techno-spiritual and pseudo-scientific narratives and theories exploded exponentially (Borck 2001).

Cross-comparing the aforementioned discourses with East Asian cultures, that come with a long and bulky cultural history of religious worldviews such as *animism* and *shamanism* provides alternative starting points for our fictional world-designing **[img 12]**. In Taoism or Zen Buddhism, practices of working, operating and dealing with energies are crucial. Reactualized as so-called *techno-animism* (Jensen and Blok 2013), these contexts build a broad spectrum of bizarre narratives, imaginative concepts, alternative metaphors, and terminology. They create linkages between the world of animals, electromagnetic media technology and human-based understanding.

img 13 : Research aquarium

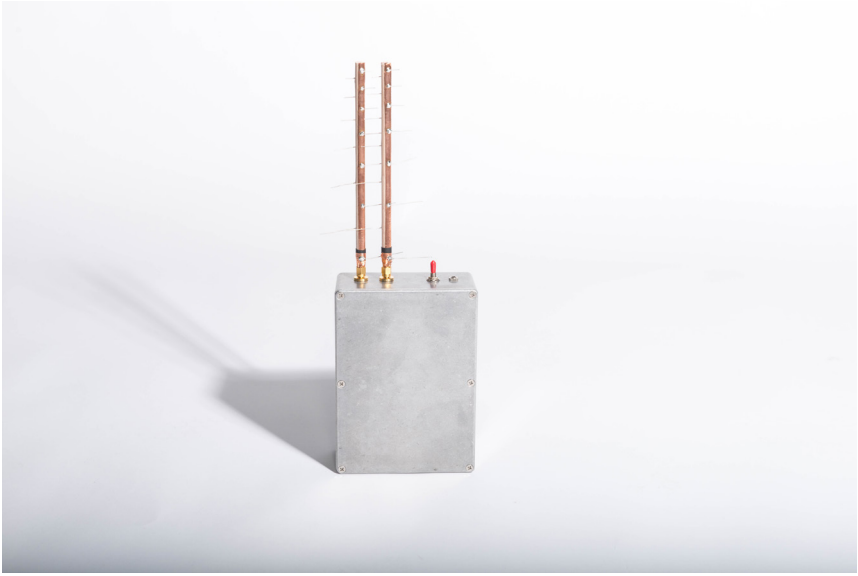
In order to work within a constrained spatial framework, we built a simple micro-studio walled by two pieces of blue colored plywood **[img 13]**. Since blue resembles the color impression of an aquarium, the studio opens ways to conjure associations with water and fish. This research 'aquarium' contains pieces for the *fictional world designing* as well as collections also visual, textual and haptic materials from our *historical contextualization* that operate here as triggers and orientation nodes to connect the pieces from our *media experimentatio*n to our narrative practice. It is thus not only a way to exhibit or display but is itself a productive environment allowing us to connect in unexpected ways with our research objects, prototypes and artifacts. It is also a simple and effective method to materialize practice-based research beyond the discursive medium of written text.

During our process, we constantly extend and refine scenario fragments considering historical contexts, socio-political aspects and technological realities. Tinkering and hands-on experimenting with currently available low-cost modules, parts and devices allows us to ground both our fictional world-designing and historical contextualizations.

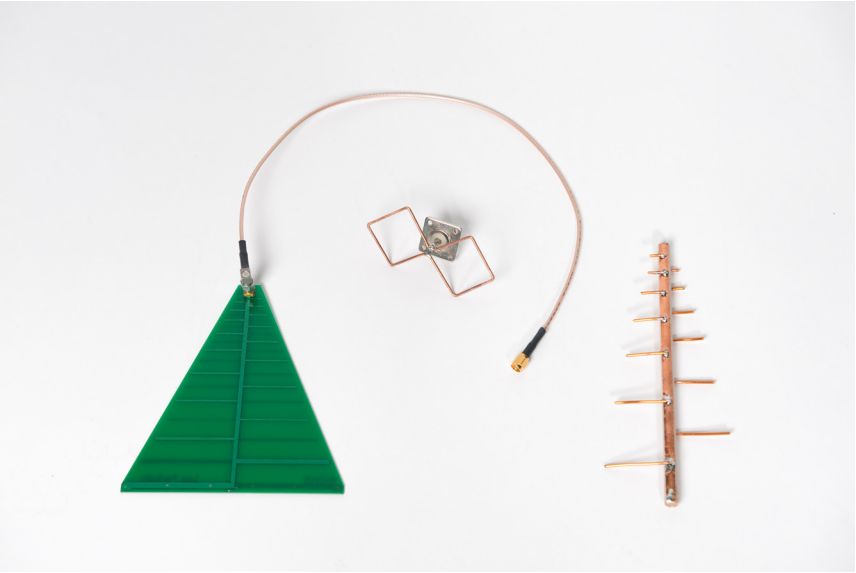
Feeling the pulsations and vast activity of data exchange, collection and surveillance provide not merely ways to become sensible and raise awareness about hidden, still crucial information on infrastructures of urban life, but moreover offer generative and playful frameworks for further experimental research. This way we link the fictional and speculative aspects of our research to concrete issues of functionality.

Sensorium of Animals although highly speculative also operates within plausible trajectories.

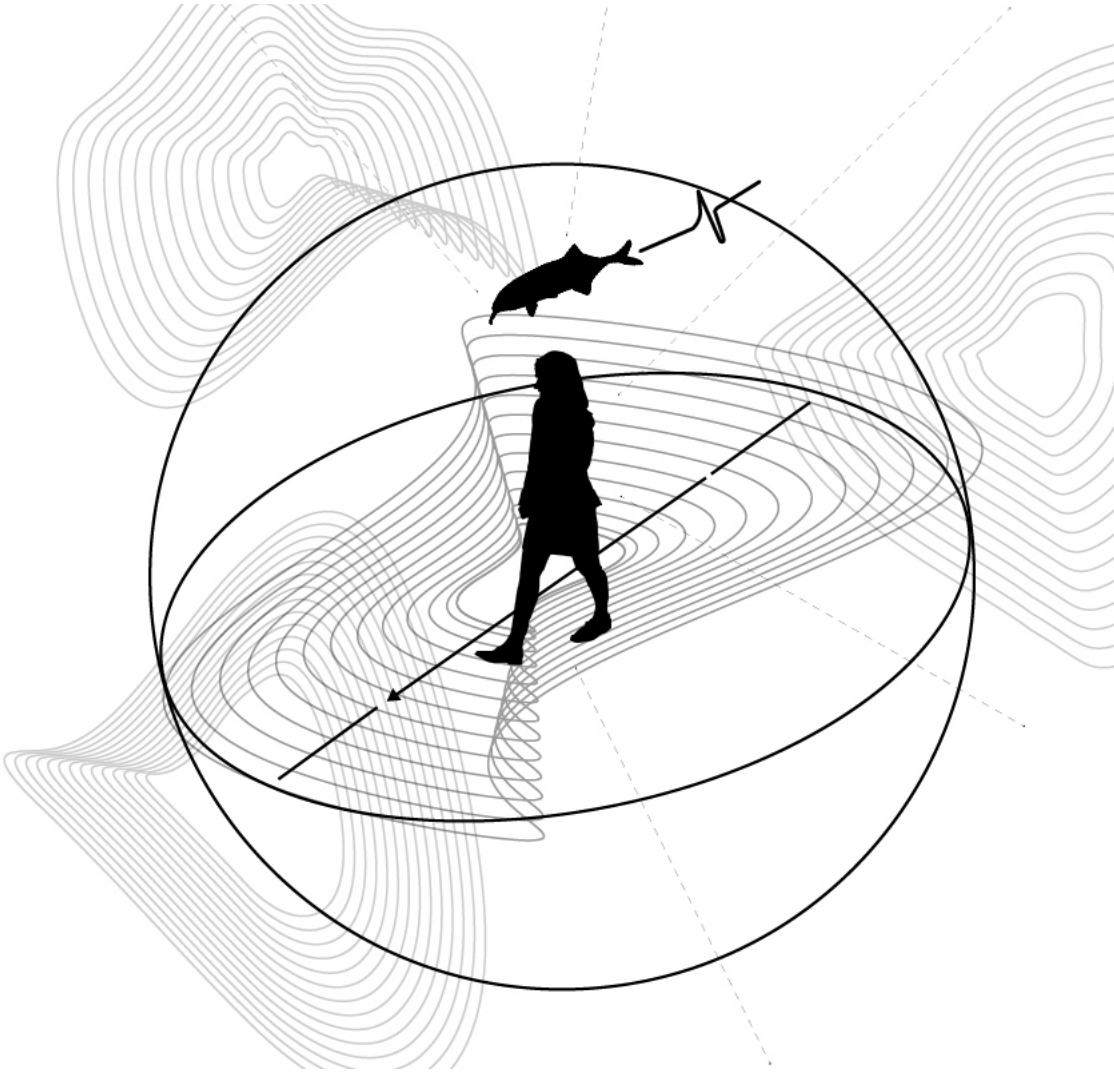
This three year research project is scheduled to be finalized by the end of 2018. This installation is a snapshot of a work in progress. We are currently preparing an expanded exhibition setup that will additionally contain a piece of written fiction describing our final scenario and two short films. We are furthermore experimenting with different antenna designs **[img 14 & 15]** and are testing different vibratory activation patterns for our prototypes.



img 14 : Two-channel high-frequency-detector, 2017–18

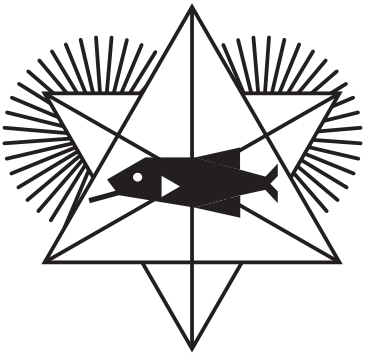


img 15 : Various antennas, self-made and manufactured



IMPRINT

All photographs by Susanna Hertrich or Shintaro Miyazaki. Except photographs **img 01** and **img 13** by Samuel Hanselmann, IXDM. Symbols, graphics and layout by Susanna Hertrich. Texts by Shintaro Miyazaki and Susanna Hertrich. This booklet has been produced with kind support of IXDM Institute of Experimental Design and Media Cultures at Academy of Art and Design FHNW, Basel, Switzerland, May 2018.



Sensorium of Animals

Electroreception in Experimental and Historical Media and Design Research

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