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**Critical Reflection —**

**Making Sense of Sensors**

CART 360: Tangible Media and Physical Computing

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The paper experimentation was divided into three stages. The first one was a design exploration done by one of the authors, Charlotte Nordmoen. The second one was a workshop gathering eight designers and the third one was a longer-form exploration workshop involving four designers.

A sensor is a device that detects the change in the environment and responds to some output on the other system. A sensor converts a physical phenomenon into a measurable analog voltage (or sometimes a digital signal) converted into a human-readable display or transmitted for reading or further processing.This paper explores the process by which designers come to terms with an unfamiliar and ambiguous sensor material. Drawing on craft practice and material-driven interaction design, one developed a simple yet flexible sensor technology based on the movement of conductive elements within a magnetic field.Most applications of this sensor principle typically involve a conductive element which can move in particular patterns constrained by a non-conductive substrate.

This is a paper about grain finding\*\*. Our work emerges out of HCI’s “material turn” in which the physical and digital are increasingly intertwined, and material properties are increasingly a source of inspiration, negotiation and influence. Material-driven design processes are increasingly found in HCI, where they involve the designer coming to terms with the material, possessing or developing a tacit or explicit understanding of its properties or character.; material experimentation as an “under-described factor” in recent HCI discourse, and that improvisation could help to describe “shifts the focus from outcomes to processes [...] in conversation with materials” [3].

grain : “follow[ing] its course while bending it to their evolving purpose”,“intervening in the fields of force and currents of material. directions of those forces and currents, defined subjectively according to the influence on the designer. grain can be observed only indirectly through patterns of influence on design processes and outcomes

In the first exploration, Charlotte Nordmoen desired to understand how sensors work. This first attempt investigates their abilities, richness of gestures and nuance. This exploration was divided into two main stages. The first stage served at finding the different characteristics of a signal. The experience was done by moving a magnet over a piece of conductive tape in various directions while the preamp was connected to an oscilloscope.  The results of this experiment varied depending on the position of the magnet. The purpose of this exercise was to check the possibility to produce a signal with this method and to visualize the magnetic field. The second stage of exploration was focused on finding the parameters of the sensor material. It was realized by combining conductive and non-conductive materials. Through this exercise, Nordmoen found that thin lines of conductive material are more effective than larger surfaces. The relationship between the interactive part of the object and the placement of the magnet has an impact on the signal. The results of Nordmmoen’s experiment were consistent, but not easily described. The only clear information was the result of specific signals from particular gestural movements.

For the second phase of this experimentation, two workshops were held during two half-days.

The workshops focused on teaching participants how to make their own sensors. The purpose was to observe how designers came to terms with the sensor material and these improvisatory explorations and investigating their meaning-making processes. It allows designers to familiarise themselves with this technology. Designers had to semi-functional prototype objects based on sensor material, the required behaviour was speculative and no electronics were allowed.

Before starting, the participants were asked to fill a survey about their design skills and material preferences. They got a brief introduction to sensors and offered materials and received a sensor toolkit. The first workshop has a formula of constant discussions and presentations between the eight participants while creating their objects. The second workshop was divided in two parts: the first one allows the four participants to explore the material and the second part served to iterate their sensor object. At the end of each workshops, participants needed to present the final result of their project, followed by filling another survey about their realized product, the whole process they came through, and their final thoughts.

Many outcomes emerged from this experimentation. After the workshops, organizers noticed that the created objects’ interactivity could be classified into two categories: proximity and deformation. In proximity-oriented objects, the conductive material and magnet are separated by air. The proximity of the two materials creates an interaction. Interaction gestures are varied: from holding a magnet and moving it near the conductive material to creating random signals from suspending a magnet on a string. Deformation-oriented objects were situations where the magnet and conductive material are part of a common object but separated by material. Any interaction that causes the material to deform triggered this type of interaction.

Participants had various ways to approach unfamiliar sensors material in relation to their ideas and concepts of what they wanted to make. Some had to reinterpret their work due to technical issues, others needed to simplify their concepts. Many similarities emerged between the projects, but all had different meanings. The projects’ materials were usually representing the environment where the object would be used. Three types of ambiguity emerged: how the sensor works, the meaning of the produced signal, and the function (or lack) of the objects built with. The first type of ambiguity was obvious among participants. Participants found the sensor ambiguous because it was unknown to them, most of them understood sensor material as a familiar electronic sensor component. The lack of experience with technology also led participants to erroneous conclusions. The second type of ambiguity manifested in the meaning the participants gave to the signal and how they described it. The third type of ambiguity was found through the unclear function of the object.They were three processes where the designer responds to the material that share the well-established baseline that designers “follow the materials”: Logical, Conceptual and Intuitive approach. In the Logical approach, understanding emerges through exploration and precedes application. In the Conceptual approach, an exploratory process is directed toward an established conceptual goal. In the Intuitive approach, artifacts and material understanding are co-created in an improvisatory way, with the possibility for understanding to be inferred retrospectively from specific application scenarios. The explorations, particularly those following the Intuitive approach, could be described as material improvisation: which is co-creating interactive objects and material understanding in the absence of a strong preconceived notion.

**Material / Material turn:** transformative process where material descriptors can signify relationship between surfaces, structures and forms across physical and digital;  definition of material itself “unfolds” [34] throughout a process.

**-designers challenges to design material:** Designers capability to design and restrict affordances with hybrid physical-digital objects is limited due to the “potentially endless” use cases.

**-Material-driven design processes:** This process focuses on how designers develop the knowledge that lets them follow the material and understand its properties and character. Altered material landscape has led to the prominence of material-driven design (MDD), as a method for designers to process continuous novelty and flux. MDD perspective, materials “not only enable and constrain action, they also unfold through collaborations” between people and between other materials, in effect “having a say in the process” and “shaping ways of doing and practices”.

Faraday’s Law explains how:

* “The sensor material [...], in which a loop of conductive wire moving in a magnetic field will produce an electric voltage proportional to the rate of change in the magnetic flux through the loop.”

This principle applies to almost all magnetic sensors under the sun, the text uses the example of dynamic microphones aka moving coil microphones. These microphones are arguably the easiest to understand. According to Neumann.berlin, they are constructed similar to loudspeakers.

Definition found on webpage:

* “A coil is glued to the rear of a membrane, and there is a strong magnet surrounding this coil. When sound waves hit the microphone, the membrane moves to the rhythm of the sound waves, and the coil on its back moves along with it. The relative movement of the coil within its (stationary) magnetic gap induces a small signal voltage in this coil.”

Basically to make a long story short these are standard modern (most likely) xlr microphones,

Like this one right here, Audio Technica AT 2020 (show microphone).

The text states:

“This classical principle underlies nearly all magnetic sensors, from dynamic microphones to electric guitar pickups to phonograph cartridges, not to mention countless other pieces of electrical machinery.”

But also the importance of another component, the amplifier. The text explains why with this fun little explanation:

“The electrical voltage generated by a moving wire in a magnetic field is proportional to its velocity. For direct manipulation by human hands, the velocity will be comparatively small”

Hence the importance of an amplifier. Think about it, all of this is to say, you can’t really play an electric guitar audibly without an amp.

Here is another fun quote from the text:

“The novelty in our usage lies in the wide variety of conductive and non-conductive materials from which the sensor can be crafted, and the open-ended way in which a designer can structure the materials to elicit different types of interaction.”

This here underlines the importance of which materials are picked as the combinations are practically endless.

**3) -Craft-based practice / craft based inquiry:**

The practice of hybrid crafting techniques and processes, creating objects through layers of refinement, and creating knowledge through deep engagement with such objects are all principles of craft research. Additionally, material-driven practices can be inspired by craft research and vice versa. Making sensors from “craft materials” and focusing on craftsmanship with technology can lead to more inclusive technology, owing to the “value-based” and “person centric” perspective of craft practice. What I liked about the researcher’s approach is that they acknowledged that effective digital handcrafting processes require stepping back from the technologically driven desire to produce so called “toolkits” of perfectly abstracted blocks of pre-defined functionality, since this can limit authentic craft responses. Materials were  “un-crafted” instead and presented to practitioners in more raw and open forms, to allow for more uncommon ideas to develop.

An excerpt from paragraph two of page 138 states - “The conductive element (of the sensor) *could* be an ordinary copper wire of any gauge, but for the design explorations in this paper, we typically turned to a range of conductive materials from e-textiles, including various metallic threads and adhesive metallic tape.”

**4) -Exploration in open-ended contexts:**

In order to develop creations that function effectively with the environment around them, designers explore open-ended contexts.Part of this open-endedness may involve a lack of familiarity and ambiguity, and both of these ideas have become themes in recent HCI discourse.

-Sensor material: sensor material->

**5)** This leads us to **Faraday’s Law of magnetic induction**, which states that a loop of conductive wire moving in a magnetic field will produce an electric voltage proportional to the rate of change in the magnetic flux through the loop. This classical principle underlies nearly all magnetic sensors, from dynamic microphones to electric guitar pickups to phonograph cartridges, as well as countless other pieces of electrical machinery.;