Experimental Engineering: Articulating and Valuing Design Experimentation

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Abstract
In this paper we propose Experimental Engineering as a way to articulate open-ended technological experiments as a legitimate design research practice. Experimental Engineering introduces a move away from an outcome or result driven design process towards an interest in existing technologies and how they can assist in creating completely new understandings of people, technology, and their interactions.

Author Keywords
Experimental Engineering; explorations; design research practice; bricolage; material strategy.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Introduction
Since its very beginning, a core task in Interaction Design has been to find new ways of facilitating human (inter)action through a human-centered approach to designing technology [12]. In Interaction Design, we as design researchers need to continuously expand our notion of the action spaces, experiences, materials, and technologies we work with and how we work with them. Thus, doing research within Interaction Design involves developing our notion of what is thinkable and possible.

In this paper, we present Experimental Engineering as a new frame for the outset for such explorations, focused more on the technological side of designing for human experiences, initiated with a "what if?" attitude. We argue that Experimental Engineering can be an approach to either begin a design research process or carry out an intermediary design move/action to curb a curiosity that may later become relevant. In this sense, Experimental Engineering is not unlike the experimental kitchen at the former and famous restaurant Noma. Here four chefs experimented with new ways to prepare food (e.g. variations of fermentation), with introducing new types of food (ants and fried yeast were often on the menu), or with new combinations of taste (e.g. langoustine with lavender and onion) [cf. 6; 5]. The results of such explorations are always more than the sum of their parts because the different elements interact and both limit and enhance each other's qualities. Thus, it is impossible to predict the precise outcome of this kind of experimentation and it may be the most unpredictable outcome that is the most rewarding. What we propose here will most likely resonate with the experiences of anyone working in a lab on daily basis. However, the argument presented in this paper is that we must find a way to articulate and unpack this experimental work as a legitimate intermediary research result in design for fellow design researchers to use and in their own work [cf. 3]. To exemplify what we mean by Experimental Engineering we will present three published examples which in three different ways recombine, reconfigure, or recontextualize technology (not unlike the food experimentation) to get something new out of existing technologies. First, however, we will relate this approach to other design practices like classic engineering and bricolage.

Related work

There are a lot of methods suited for a design practice in which we work solution oriented - where we more or less know the problem or the problem area for which we need to find new solutions. We move towards a defined goal where we solve a problem, refine a solution or create new possibilities for a set of users in a given context. To do so, we can for example use co-design, cultural probes, observations, or data analysis to get more knowledge about a domain, context, problems and possibilities. We may prototype a variety of solutions as a means to find the better one and we can apply use-cases and requirement specifications to drive a final product development.

However, to expand our design spaces, as is typically the goal within design and engineering research, we often have to rely on experimental methods that enable us to see new features of known technologies and their design potential. For this we also have a range of methods or approaches. Material design strategies and especially Inspirational Bits, provides a method for sharing and exploring different qualities of a technology in a playful inspirational way [7; 10]. Bricolage and mythical thinking, on the other hand, offer a mindset or an approach that strives for a locally optimal solution solely with the materials and technologies at hand [cf. 9]. Particularly, the mythical thinking aspect of bricolage - where meaning is derived from co-existence and happenstance rather than science - can lead to new and surprising uses of technology and as such it can be seen as contributing to expanding our way of working with technologies [cf. 9]. Speculative Design is a third type of method or approach which brings our technologies into a new light, typically by repurposing or redesigning to make people reflect on their use and

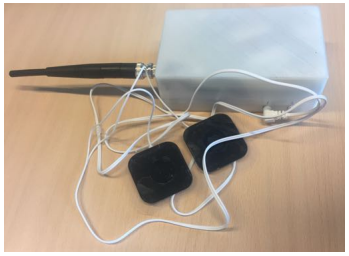

Figure 1: A person wearing FeltRadio on her arm (top), and two versions of FeltRadio, v1 (middle) and v2 (bottom) [2].

understanding of the technologies inhabiting our everyday lives [1]. Experimental Engineering can be seen as belonging to these latter types of methods, in that its aim is to open up an experimental design space rather than finding specific solutions. It is a more specific method than bricolage and mythical thinking but it has inherited some of their serendipitous aspects. It is also more explorative than Inspirational Bits but it too relies on construction as a means for the researchers/designers involved to experience and explore the qualities first hand. Finally, Experimental Engineering can be seen as a kind of Speculative Design in that it aims to see what happens when we recontextualize, recombine, or reconfigure technology. It is, however, key to materialize these speculations [cf. 11] into working prototypes that can be experimented with and experienced in use.

Experimental Engineering

Experimental Engineering is not a radically new way of working in design; rather it is about acknowledging and being able to articulate the value of open-ended technological experiments as a legitimate design research practice. Just like the food experimentation we have identified three types of experiments that we would include under this umbrella. The first is about *recombining* technologies (equivalent of garnishing langoustine with lavender) to open up radically new design spaces. The second is about *reconfiguring* well-known technology (equivalent to fermentation or frying). Finally, the third concerns *recontextualizing* a technology (equivalent to eating ants) - this could happen after discovering new side effects or new experiential qualities of a well-known technology. Below we will give a single example of projects within each category, two of which we have carried out first hand and one which we have witnessed on the sideline. The three categories are not mutually exclusive and more than one can be applied at once. However, they are meant to provide a more detailed sense of the overall action space we have identified within Experimental Engineering.

Examples of Experimental Engineering

FeltRadio is used as an example of recombining technologies as means to explore what this combination would yield [2]. Hedonic Haptics is used as an example of taking one technology and recontextualizing it [8]. Finally, TorqueScreen is an example where a technology is reconfigured in a way that utilizes an interesting experiential side effect [4].

Recombining: FeltRadio

The motivation for building FeltRadio came from an interest in exploring what kind of experience we could create by being able to bodily sense radio activity such as WiFi [2]. We thus took a 2.4Ghz radio signal strength meter and combined it with an off-the-shelf electronic muscle stimulation (EMS) device (See Figure 1). The 2.4Ghz radio signal strength meter is built from an antenna and a wideband radio receiver (AD8313). This setup creates a rather unrefined Received Signal Strength Indicator (RSSI) functionality, which we then used as input to the EMS through a microcontroller which essentially ‘press’ the EMS device’s buttons. Overall, this somewhat crude hack enabled us to get a quick sense of the experience and to finetune the relationship between input and output. Indeed, using the FeltRadio will massage your upper arm with different intensity dependent on the signal strength. It allowed us, and a series of test persons, to experience what it would be like to sense WiFi and we could quickly

Figure 2: A person wearing the Hedonic Haptic player. Where the domes distributed on the body back and front produce the vibrations [8].

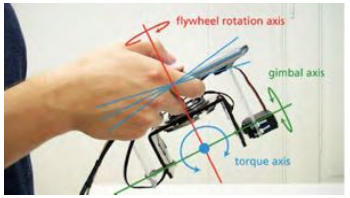

Figure 2: Image of the TorqueScreen. The Hard disk is mounted on the back of a tablet in a way that allows rotation in three directions simultaneously [4].

begin to explore what sense people would make of the experience and how changing different technological parameters affected this overall experience [2].

Reconfigure: Hedonic Haptics

The Hedonic Haptics project is about exploring new experiential dimensions of embodied vibrations [8]. Instead of starting with vibrations in the context of a haptic output for some form of communication (e.g. mobile phones, computer games, wayfinding) we did an embodied exploration of their experiential qualities. This was a process in many steps, but essentially we created a series of vibration compositions (e.g. ambient or rhythmic) and played (i.e. vibrated) them on different parts of our bodies. Specifically, we created three vibrator pods and one control unit (See Figure 2). The control unit enables the wearer to choose between a series of composition and control the intensity of the vibrations (their amplitude). Our explorations lead to many different but largely pleasurable experiences (e.g. feeling enveloped or gaining an awareness of your body) [8]. With this project, we have begun to show the potential of vibrations as more complex aesthetic experiences broadening this design space, opening new ways to use them in Interaction Design.

Recontextualizing: TorqueScreen

TorqueScreen [4] came to be as an exploration of what a running hard disk feels like when holding it in the hand - discovering how it could potentially become some sort of haptic feedback. The discovery process is not described in the paper but one of the authors was visiting the lab and part of early discussions of what kind of experience this side-effect elicited. Murer et al. [4] reconfigured the running hard disk into an ungrounded kinesthetic feedback in a handheld device. Attached to the back of the tablet in a configuration that enables it to move along a flywheel rotation axis, a gimbal axis, and a torque axis gives the hard disk rotational feedback a large degree of variation (see Figure 3). Having this haptic feedback mid-air is novel and in their design set-up the authors show how it can give visually perceived cues a physical kinesthetic property. The TorqueScreen is designed as a result of tinkering with and exploring an existing technology as a valuable activity in and by itself.

Discussion

Here we have proposed the concept of Experimental Engineering and three approaches we have identified within this practice (recombination, reconfiguration, and recontextualization). We believe all of these are recognizable for most people working in Interaction Design labs. However, we have found it necessary to articulate this act of open-ended technology experimentation as a means to aid the visibility and importance of this kind of work in Interaction Design research. As we saw in the TorqueScreen example, the paper does not mention the discovery/design process, which we partly explain by the lack of vocabulary and recognition as a valuable contribution. Experimental Engineering introduces a move away from an outcome or result driven design process towards an interest in existing technologies and how they can be redesigned to create completely new understandings of people, technology, and their interactions. The chefs at Noma may only expose their clients to the outcomes of the successful food experiments, but other chefs and food researchers can learn from all experiments. Likewise, our field of research learns not only by refined end-results, but also from experimentations and intermediate results of diverse design processes.

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