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Aesthetic, Functional and Conceptual Provocation in Research Through Design

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ABSTRACT
Recently within HCI, design approaches have appeared, which deviate from traditional ones. Among them critical design introduces deliberate provocations in order to challenge established perceptions and practices. We have engaged ourselves with this design approach out of interest in understanding how to use provocation in research through design. Towards this end, we report on a field study with four families that used an aesthetically, functionally and conceptually provocative future probe. The purpose of the probe was to challenge existing energy consuming practices through provocation and make its users reflect on them. The paper describes how all three provocative aspects were addressed, and our findings demonstrate how they were experienced in the real world, and how they impacted our research through design approach. We conclude by presenting reflections on how to design provocations, and reflections on the impact of provocations for research through design in general.

Author Keywords
Provocation; aesthetic; functional; conceptual; research through design; criticality; critical design; critical-technical practice.

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

INTRODUCTION
We are currently witnessing a growing interest in research through design where the design itself is the means to explore and understand an area of interest [13, 21, 60]. Some of the previous research through design studies has revolved around designs where usually the purpose is to improve the utility of an artifact or a practice. There are designs though that move away from this example and are characterized as speculative [20], ludic [27], reflective [52], slow [32], counter-functional [48], value-sensitive [23], adversarial [15], as well as critical [18, 19]. These approaches are often called "provocative design approaches" [44], since they share a common goal. Provocative designs aim to challenge existing norms and attitudes, provoke discussion, and provide means for a constructive critique about the design itself, its impact, as well as the broader assumptions that characterize an area of interest. Towards this end, as suggested by [44], *"provocative design refers to design approaches that operate in a design space where asking questions is as important as solving a problem"*. For these reasons we treat provocative designs as an important element of our research work since they allow us to establish a critical-technical practice [2, 16] within the field of HCI; the split identity that we must have as researchers since we are engaged both in crafting designs as well as constructively critiquing them.

Our research in this paper investigates provocation as a means to conduct research through design. Provocation has been investigated before within Interaction Design and in particular within the DIS conference community. There has been substantial research work that relates provocation to critical design and critical theory [5], as well as, proposes ways to analyze critical designs [22]. In relation to research purposes, "provotypes" where proposed as ways to design for the future [7], and provocation was utilized to promote communal sustainability [8]. Following this stream of research our aim with this work is twofold. Firstly, we want to understand how provocation is experienced in the real world at three levels, namely aesthetic, functional and conceptual provocation [5]. Secondly, we want to challenge through provocation an existing everyday practice, the activity of washing clothes and consuming energy, and understand if and how it changes. Both aims contribute to understanding provocation under the frame of research through design. To do this we designed a provocative artifact, called The Box, and we conducted a field study with four families. Our interest stems out of curiosity for understanding provocation, from our previous work with sustainability, and from the fact that many existing solutions have had limited impact [e.g. 10, 14, 56].

DIS 2017 Pre-Print

Our paper is structured as follows. First, we discuss related work on provocation within HCI. Then we present in detail how we designed provocations. We continue by introducing our field study and by discussing our findings, which revolve around how provocation was experienced in use, and how it impacted our research through design approach. We conclude with reflections on designing provocations and using provocations for research through design.

PROVOCATION IN HCI

In order to contribute to better understanding the use of provocation for research through design, we got inspired from critical design. Critical design was coined in the work of Dunne [18, 19] and gained significant momentum within the Design Community. Critical design utilizes provocation as it tries *"to challenge the status quo"*, and as Dunne suggests, it is *"a form of social research to integrate critical aesthetic experience with everyday life"* [19]. A more theoretical discussion on what is critical design within Interaction Design has been initiated with the works of [3, 4, 5]. In these works, the authors highlight the importance of provocation, attempt to relate critical design to critical theory, and provide examples of critical designs. For the authors, the link between critical design and critical theory is somehow obvious, as critical theory aims in changing society in order to achieve *"human emancipation from slavery"* and *"create a world which satisfies the needs and powers of human beings"* [34]. At the same time though, and since critical design is a rather new concept for HCI, we observed a response from the Design community arguing that critical design is independent from critical theory, while highlighting that there is a danger that the new term may subsume all the other provocative design approaches, and thus narrow our field's point of view [49].

In this paper we will not attempt to define critical design, since there is an obvious need for more discussions among the communities until we reach an established definition. Our starting point in this paper is something that both sides agree on: critical designs critique the status quo and they challenge it through provocation. We believe there are three interesting questions that need to be addressed in order to understand the relation between provocation and interaction design. The first one is why to even bother to introduce provocation in an interaction design. We believe the reason is somehow simple. When an activity becomes an established practice then the involved artifacts in use, become 'invisible' [58], or taken for granted [42]. Provocation can be used to make them 'visible', thus questioned. The second question is related to how to produce a design that is provocative. Unfortunately, there are no methods and/or guidelines on how to be provocative. For example, in [4, 22] the authors suggest preliminary guidelines and tactics on how to analyze critical designs, but they also call for more research work towards this direction. Nevertheless, there are existing axes where provocation can be anchored. According to Bardzell et al. [5], an interaction design can be aesthetically, functionally and conceptually provocative. Aesthetic provocation is related to the visual look and the materials used for crafting the design. Functional provocation is related to the way it works and conceptual provocation to the idea that it tries to challenge/critique.

Finally, the third interesting question is related to the limits of provocation. How far can provocation go? Here we will attempt to make a rough distinction between two types of provocative designs based on their *purpose*. We propose that if their purpose is to challenge societal values through "provocation in first encounters" [7], then provocation may go to extremes, as it is the case with art. For example, the French artist Gustave Courbet painted in 1866 the 'L'Origine du monde' (The Origin of the World), in order to critique the hypocritical social conventions of his time in relation to the female body. Or the Australian-based performance artist Stelarc, who was a keynote speaker at the CHI 2002 conference, provoked the idea of a permanent human body architecture, by surgically constructing a full-sized ear on his forearm that had the ability to transmit the sounds it heard, and was also a remote listening device for people in distant places [54]. In comparison to art though, not so many critical studies in HCI focused on this way of challenging societal values and considered the broader impact of technology use on humanity, even though there are papers that clearly call for more research to be steered towards this direction [17, 30, 33].

There is though, a second type of provocative designs, whose purpose is to challenge everyday practices and these are the ones typically used for research through design ("provocation in use", [7]). We believe in these cases provocation cannot go to extremes, because the designs are domesticated and therefore need to be inconspicuous, otherwise they will be rejected [7]. For these cases *"a slight strangeness is the key - too weird and they are instantly dismissed, not strange enough and they're absorbed into everyday reality…"* [18]. These provocative designs can be used: a) for research through design with the aim to understand a specific, current practice, or b) for research through design aiming to explore future design possibilities. In the first case, the provocative design acts as a technology probe [35] that has some provocative characteristics. In the second, it acts as a provotype [7, 42, 43]. The difference between a provocative technology probe and a provotype is that the first focuses at the present, while the second focuses on design possibilities for the future [7]. In both cases the designs allow us to conduct research through design, as they force us to think of new ways of looking at the world, and stimulate discourse around a challenging topic [13, 21, 53, 60].

Within Interaction Design a few studies have acted as provocative technology probes and/or provotypes for research through design. For example, in Dawn Chorus [26] the authors designed a smart bird feeder that trained birds to sing users' favorite songs and provoked the idea of human

dominance over animals. The Drift Table [27] is an interactive table without a specific set of tasks that challenges using task completion times and rates as a core metric to evaluate a product. In [5] they challenged the role of the male handyman through the design of the Significant Screwdriver, and the fact that spaces are often gendered through the design of the Whispering Wall. Furthermore, the Digital Music Box approached file sharing not from a legal point of view, but as an experience centered design challenge [6]. The Switch! project focused on the production of provotypes for exposing hidden norms and values in relation to sustainability [41], while in [8] the authors utilize provocation in order to bring forth the fact that energy consumption should be addressed at the communal level and not at the individual one. A similar area is also explored by [29] and their deployed Energy Babble. Finally, provocation has also been used in research approaches for studying participants' behaviors. For example, in [51] pedestrians encountered what appeared to be an autonomous car, while in reality a driver was hidden inside a seat costume, in an effort to explore how pedestrians would react to driverless cars in the future.

THE BOX

As we mentioned before our aim in this paper is twofold. To understand how provocation is experienced in the real world (*provocation in use* [7]), and how it may challenge existing practices. For this reason, we designed and implemented a provocative design called The Box, which aims to provoke domestic laundry practices.

We chose laundry in private households as the domain for our study inspired by existing critique within sustainability research. Here users are often seen as the problem, and HCI research in sustainability often does not aim to change users' lifestyles, but tries to improve their sustainable behavior on a small scale. In order to go beyond that, there is a call to study the everyday practices of our users [46, 47], to go beyond persuasion, and to shift from prescription to reflection and from behaviors to practice [10, 38, 56]. Furthermore, current sustainable HCI research often holds the assumption that users act rationally and make intentional decisions. This view about the user is beautifully described by the Resource Man, an archetype who *"in his ultimate imagined state, is interested in his own energy data, understands it, and wants to use it to change the way he uses energy"* [57]. This perception of energy consumers has also been criticized (see [10, 38, 56]) as it has led to limited results [10, 14].

The Box was designed with the purpose to challenge every day washing practices, to make its users reflect upon them, and even change them. It also attempts to go beyond the simple presentation of information and the idea that users are always rational, by combining information with provocative elements. The Box was deployed with a research purpose that lies in between a provocative technology probe and a provotype. The Box was used to understand an existing practice (as a technology probe), but this practice was also challenged by presenting to the users a provocative, future scenario. Therefore, we characterize The Box as a *provocative future probe*. In the following we present how The Box was designed to provoke conceptually, functionally and aesthetically [5].

Facilitating Conceptual Provocation

Conceptual provocation is about an idea/belief/concept that we want to challenge or critique through a design [5].

In relation to conceptual provocation we deliberately chose to focus on two issues: a) the quite dominant and western world belief that electricity is always available and cheap, and b) the idea that there is no need to reveal the energy's production origin to the consumers [8]. The Box categorizes electricity as green and red, and the way information is presented to the users is inspired by previous sustainability research, and in particular eco-feedback systems [25]. The Box forecasts the electricity type for the next 12 hours through a simple scenario. It relates the energy type to the local wind conditions. If there is a lot of wind, then the electricity is mostly produced from windmills and is characterized as green, otherwise as red. The type of electricity is materialized through a color-coded clock. When the electricity is red then The Box cuts off the electricity from the washing machine, and users are expected to "shift" their consumption [similarly to 9, 12, 36, 40, 46]. If, for example, the wind is not blowing, users may experience a clock like the one in Figure 1 (left side), where all the available slots are red. Thus, there is only red electricity for the next 12 hours and therefore they cannot use their washing machine (unless they override - details in the following section). With a bit of wind though, they may experience a clock that looks like Figure 1 (right side), where many slots are green.

Furthermore, conceptual provocation is also facilitated through the implemented price schema. The Box creates a savings account for its users. When they consume green electricity, then it is free and the money they save is added to their savings account. On the other hand, if they consume red electricity, then electricity is very expensive and the money they spent is deducted from their savings account. In Figure 2b we can see a numerical LED screen which materializes users' savings account: 239 Danish Kroner (equivalent to 36USD).

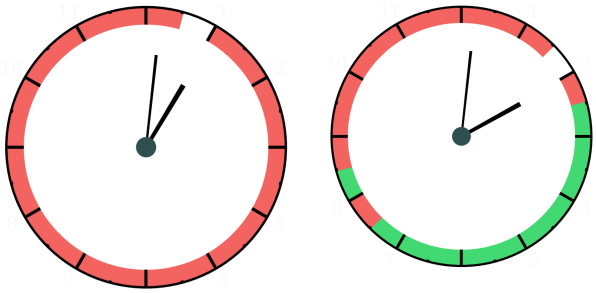


Figure 1. Examples of electricity status for the next 12 hours.

Facilitating Functional Provocation

Functional provocation deals with how far from the norm is the way a design works or operates [5].

Functional provocation was facilitated by imposing a dilemma to the users. According to [44], provocative dilemmas are triggered: a) by embodying symbols, b) by forcing users to make a choice, or c) through behavioral barriers. The Box imposes a forced choice to its users by cutting off the electricity when it is red, and providing only one physical interaction point in order to override this. For this, we adopted the emergency button metaphor that is often used in industrial equipment and the override button was placed on the bottom left corner of the box (Figure 2d). The button was purposefully selected to be red and fairly big in order to provoke a sense of reluctance, as it signals that it is something that should not be pressed accidently or without consideration. Inspired by [44], we believed that hesitation to press the button would make the users to slow down and reflect on their choices. In order to make the functionality even more provocative a second numerical LED screen was used to project how many times the override button was pressed, and thus the rules were violated (Figure 2c, 16 times in the current example).

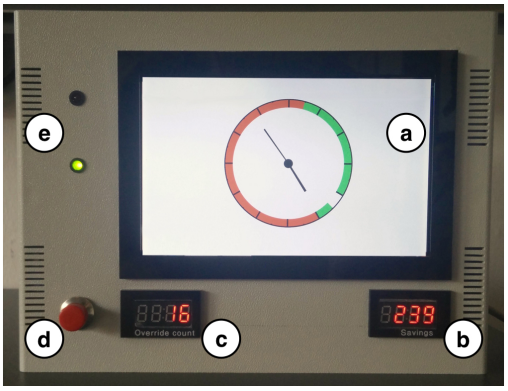


Figure 2. The Box: a) electricity status - 12 hour forecast, b) savings account, c) override button presses, d) override button, and e) electricity status at the moment.

Facilitating Aesthetic Provocation

Aesthetic provocation deals with how far from the mainstream is a design's visual look and the materials used for crafting it [5].

By browsing the sustainable HCI literature, we noticed that the majority of produced solutions are software applications either running on participants' existing mobile devices, e.g. [1, 24, 36, 40], or the mobile devices are provided as part of the study, e.g. [9, 11, 12, 40, 59]. In such studies, it is often stressed that the designs are beautiful, artistic, and conforming to the latest trends of simplicity and elegance. In a few cases, where the researchers did craft the physical form of their product themselves, e.g. [31, 37, 38, 45, 46], the majority or physical designs are also characterized as elegant as well as ambient, since their purpose was to reflect the calmness of the natural environment. Additionally, we investigated how off-the-shelf products look in terms of their physical design. Even though there are commercial products that have an industrial look, the majority of them can also be characterized as elegant and minimalistic (for example The Nest thermostat).

The Box attempts to provoke aesthetically by deviating from the norm in two ways. First, we decided to move away from the mobile application paradigm and design an actual physical probe. Second, we did not want to follow the style trends that we observed in most of related work and commercial products, namely simple, beautiful and minimalistic designs. Instead, we turned for inspiration to the past where such equipment was bulky. Several ideas were considered on how to design The Box. We experimented with different types of physical boxes, from old PC cases to even a military ammunition box. We also experimented with different layouts by attaching paper representations of the core functionality onto the boxes. In the end, we opted for an old, industrial case for electric equipment (Figure 2). Furthermore, in order to highlight the retro style of The Box instead of using nice, modern buttons and high-resolution screens, we visited various hardware stores in order to find components that had a retro look (override button and LED screens).

Creating The Box

The Box was crafted using the selected case (25 x 18 x 8cm) and by making the necessary modifications. A 7in screen was mounted and holes were drilled for the LEDs, the LED screens, and the override button. The black frames surrounding the screens were laser cut.

For the hardware, we used a Raspberry Pi with a GrovePi shield (Figure 3d) to control the override button, the LEDs (Figure 3c) and the numerical LED screens (Figure 3b). Furthermore, an off-the-shelf smart electrical plug (Energenie) was used to wirelessly control the power of the washing machine. In relation to software, we programmed in Python and used a variety of open source libraries to get real-time information about the wind conditions and for creating the interface.

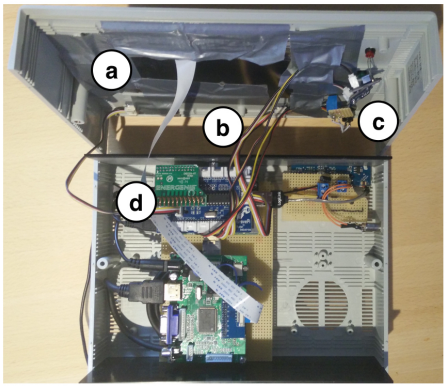


Figure 3. Internal components of The Box: a) 7in screen, b) numerical LED screens, c) LEDs and override button, d) Raspberry Pi and GrovePi shield.

FIELD STUDY

In the following subsections we present details on the results of our pilot study, the participants, the process we followed, and the data we collected in our field study.

Pilot Study

Before deploying The Box in the field, we conducted a pilot study with a five-person family for two weeks. They used their washing machine on average once per day. The primary purpose of the pilot study was to test The Box from an engineering perspective. Several software bugs were identified during those two weeks, which were addressed on the spot. Even though the pilot family used The Box for two weeks, we did not engage in deep discussions with them as the deployment period was often interrupted by software and hardware bugs and our interest was mainly in resolving them. Nevertheless, we gathered a few insights in relation to our design's provocativeness during these repairing sessions from the father. He informed us about its conceptual and functional provocativeness that *"he did not like it in the beginning but it made* him *think"*, and in relation to aesthetics that we *"could have done a better job because our design is very ugly and he wouldn't buy it if it was a real product"*. These findings provided indications to us that our design had indeed some provocativeness.

Participants

Four families participated in our field study. They all lived in Aalborg, Denmark and were recruited by snowballing within our social networks. In Denmark electricity blackouts are extremely rare and electricity prices are inflexible and cheap. Thus, in the context of the study, the perception that electricity is always available and cheap was common to the four families.

The first family was comprised by two adults (49 and 61 years old) and 3 children that were 16, 18 and 20 years old. The father was an electrical engineer, while the mother was a process coordinator at an energy company. They lived in their own relatively large house that extended into two floors. The washing facilities were located in the basement, in a utility room. The father was in charge of washing, drying, ironing and folding the clothes. They had *high* laundry needs since they were five and because they all physically trained almost everyday day. The father did at least one washing load per day, and often several during weekends (on average 10 laundries per week). We can characterize the level of environmental awareness of the first family as *medium*. They were recycling, bought a car with the main criterion of having a low fuel consumption, replaced most of the light bulbs at home with low consumption LEDs, all their new appliances were rated A+++ from a consumption point of view, and they were closely monitoring their water consumption too.

The second family consisted of a carpenter aged 51, a dental surgery assistant aged 46, and one 17-year-old boy. Two other teenagers, aged 14 and 19, were occasionally around. They also had a large dog that produced one load of washing per week. Together they had fairly *high* laundry needs (on average 7 loads per week). The family lived on a privately own rural property, where the washing machine was located in a hallway next to the entrance. The wife usually took care of laundry and she preferred washing in bulks during the weekend. The level of environmental awareness for this family can be characterized as *low*. They were mostly motivated by saving money, and thus they were buying A+++ appliances when replacing old ones, and recently changed all their light bulbs to LEDs.

The third family also consisted of two parents and three children. The father was 59 and the mother 49 years old, while the three kids were 6, 11 and 17 years old. The father worked as a surgeon at the local hospital and the mother was finishing her Master's degree in psychology while working at the same hospital too. They lived in a sizeable rural properly with the washing facilities located at one of the entrances. The father would usually wash his own work shirts and running clothes, while the mother would take care of the rest. Together they accumulated on average 7 loads a week, and they washed almost daily. We characterize the level of environmental awareness of this family as *high*. They mostly cooked with ecological food, recycled, bought energy efficient appliances and they had recently invested in a solar heat panel in an effort to *"support the environmental cause"*.

The fourth family was a young family consisting of only two adults aged 25 and 28. The boyfriend was a software engineer, while the girlfriend worked as a nurse. They had just bought a new semi-detached house, which they had recently moved into. Their washing machine was located in the bathroom. The girlfriend usually did the washing, but the boyfriend would occasionally do a wash if needed. Their laundry needs were *low* as they only washed on average 3 times a week. The level of environmental awareness for this family can be characterized as *low*. Like the second family, the main motivation for buying eco-efficient appliances and getting into the habit of turning the lights off was the prospect of saving money.

A summary of the most relevant demographic characteristics of the four families is presented in the following Table.

Family	Persons	Laundry needs	Environmental awareness	Additional details
1	5	High (~10 per week)	medium	washing machine in the basement
2	3+2	High (~7 per week)	low	washing machine next to the entrance
3	5	High (~7 per week)	high	washing machine next to the entrance
4	2	Low (~3 per week)	low	washing machine in the bathroom

Table 1. Relevant demographic characteristics.

Process

Each of the 4 families used The Box for 4 weeks. In each household The Box was placed on top of their washing machine in order to be closely related to the laundry activity. Eight, in-home, semi-structured interviews were conducted, two with each family, one before and one after the deployment of the probe. In the first interview we mainly focused on their existing laundry practices and their environmental awareness, and we introduced them to the purpose of the study.

Participants were presented with a future scenario that electricity companies are looking for ways to shift people's consumption away from carbon based sources and steer them to consume energy from windmills as much as possible. For this reason, electricity companies consider implementing different price policies (green = free and added to savings, red = double the price per KWh than the normal, and deducted from savings). Families were also instructed to use The Box in any way they thought suitable to their needs, and that their savings account would start at 100 Danish Kroner (equivalent to 15USD). Furthermore, we informed them that electricity is characterized as green or red based on the local wind conditions, but we did not exactly tell them how much wind should be blowing in order electricity to be green. We purposefully left this ambiguity in the scenario inspired by [7, 44], who suggest that some "mystery" should be maintained to allow for multiple interpretations to emerge. The second interview revolved around issues related to the usage of The Box, if and how it affected their washing practices, and their perception about its provocativeness in all three categories.

All data from the 8 interviews (each was on average 1 hour long) were transcribed (using interviewScribe) and the 4 concluding interviews were also coded (using NVivo). In all interviews both adults were present. In the families with children, we chose not to involve them in the interviews as we found out that they were not related to the laundry activity at all. We used the three provocation categories (aesthetic, functional and conceptual) as themes in order to guide the data analysis, which was conducted using a procedure known as 'explication de texte', or close reading, an analytical method that originated in the humanities [50]. Furthermore, all families' interactions with The Box were stored in a log file.

FINDINGS: EXPERIENCING PROVOCATION

Conceptual Provocation

With The Box we tried to challenge the idea of always available and cheap electricity, and that energy is often presented decoupled from its production source. We provoked the first by cutting electricity during the red, non-environmental friendly periods and by implementing a different price scheme, and the second by associating energy with local wind conditions.

In relation to the effect of the attempted conceptual provocation, we had mixed results. Families 1 and 3 informed us that had experienced in the past periods where electricity and water were scarce resources. Thus, they did not feel provoked. For example, the father in the first family informed us that he had *"experienced hot summers where you were not allowed to water your garden because there was a shortage in water"*, or that he remembered they *"were paying cheaper prices per KWh when consuming electricity in off peak hours"*. The other two families informed us that even though they did not enjoy that they couldn't use their washing machine during red periods, they chose to *"try it out"*.

In relation to the effect of conceptual provocation to their laundry practices, all the families eventually accepted the fact that electricity is not always available anymore, and they all perceived doing what they used to do before as "cheating". Three families used the word cheating to describe instances where they had a similar behavior as before the introduction of The Box. What was interesting though were the two reasons that drove them to change their practices. Families one and three, which pressed the button the least amount of times, told us that they hesitated to press the button as they wanted to *"take care of the environment"*, and *"have the feeling that you are actually doing something good"*. For them taking care of the environment was the motivating force. The second reason we identified, was the prospect of saving money. All families mentioned that saving money was an important factor, but for families two and four it was the strongest motivating force. Thus, even though they knew they saved the equal amount of *"two coffees"*, or *"a burger at McDonalds"* it was still enough for them, because *"if we do the same with other appliances we can save a lot"*, and *"it is the same as buying fuel for the car, it doesn't matter how much it is cheaper, just the fact it is cheaper is enough"*.

In relation to our decision to relate local wind conditions to the characterization of electricity and the ambiguity we introduced by not clearly defining the borders between green and red, we had two interesting findings. Since, wind is something that people can experience in the real world, for families one and three the wind conditions became a point of discussion. The father in the first family told us that he found very challenging the fact that he could not do a wash while the flag in their garden was moving: *"you know, we got a flag there and you can see its windy, and you think it should be green and it's not"*. The third family was also challenged by the fact they could see windmill farms from their living room: *"I have the feeling that your weather forecast is wrong or from another city, because a couple of times we could not wash, but we could see the turbines spinning"*. For those two families, provocation seemed to have an effect, as questions were raised in relation to how much wind is necessary in order to achieve 100% green consumption.

The second finding in relation to wind is more technical but it had important consequences for the families. In our implementation we decided to check the wind conditions and update the clock every 30 minutes. This decision resulted to situations where the families observed a green slot, for example 2 hours in advance, and when they went to wash, they found out that The Box had updated, and the slot was now red. We received a lot of critique about this and it was discussed for a long time by two families, even though the maximum reported number of times that this happened from all families was three (family one). Nevertheless, this perceived inability to properly plan became a discussion point for all families. For the example, the father in the first family informed us that he would *"immediately inform"* his wife *"whenever the bloody thing was red"*. They were annoyed by the update mechanism as *"it was impossible to plan"*, and because *"you get offended when it changes"*. Despite that, planning was also characterized by them as a *"mystery"*, *"a quite fun game"* and *"a funny race between* him *and the computer"* as he was *"sort of chasing the green slots"* as they were *"ahead of him"* and he *"constantly tried to pin them down"*. The same issue with planning was also pointed out by the second family, but more mildly as they told us that *"it should stay green"*. The third family somehow bypassed this issue, by characterizing it as a *"mischief",* while the fourth family completely circumvented it, as they had observed patterns of long green periods between 2 and 6 o'clock in the morning and they tried to do their washing then. To this end, the boyfriend informed us that his girlfriend started getting *"up early very often to put a load on"*.

Functional Provocation

When we asked the families about the functionality of The Box, most reported that they felt a bit provoked but not challenged. The first family informed us that they felt provoked because that it *"governed"* whether they *"could or could not do a wash"*, but in the end they even got *"surprised that it has not been any inconvenience"*. In the end, they characterized The Box as *"practical"*, *"functional"*, and an *"instrument to be informed on what is going on.* The second family characterized The Box as *"smart"* and *"unsmart"* at the same time. Smart because it gave them information that made them *"more conscious"* about their consumption, and unsmart as it did not provide any kind of automation in order to schedule their laundry. The third family characterized The Box as *"rational"*, *"structured"*, and *"simple"*. They decided that they were going to *"be ruled by the box"* and that they would *"only wash in green slots"*. Overall it provided *"food for thought"* and it was characterized as *"a tool to take care the environment"*. Along the same lines, the fourth family characterized The Box as *"informative"* because it provided a *"really quick overview of when to wash"*.

Besides these positives comments, families also felt really provoked by the functionality of the override button and the counting screen, as they proved to be focal reflection points. Families one and three commented that the override button looked like industrial emergency equipment. The father from the first family, who was responsible for the laundry, told us that he didn't want to *"cheat and press the button, unless it was absolutely necessary"*. The Box was perceived as *"a game"*, and pressing the button felt like *"breaking the rules"*. Both parents expressed their strong disappointment that they had to press the button the last day of the deployment period, because they knew that we would pick The Box up at a specific time and thus *"they felt cheated cause he had to override, otherwise he would have worked around that ... he would have waited"*. They both insisted that the last press *"shouldn't count on their score"* (even though there wasn't one). In the second family, the mother told us that when she pressed the button she would *"swear at it, because it was not fun to press it"*, that *"it is bloody annoying when you have to do it",* and that *"the screen should have stayed at zero"*. The third family informed us that they decided the first day that they would never press the button, and thus canceled from the beginning our imposed dilemma in an extreme way. They did that since the thought of pressing the button *"made* them *stubborn, so* they *just had to make it work"*. They approached the new laundry situation as a *"competition"* where *"the box and not the laundry basket is now in charge"* and they *"wanted to see if it is really feasible to be ruled by the box"*. Finally, in the fourth family they both perceived The Box as a game to beat, and breaking the rules was ok *"because it only happened when it was really necessary"*. Furthermore, the boyfriend informed us that he perceived The Box as rather *"boring"*, because its physical interaction was limited to *"one button to play with"*.

Aesthetic Provocation

We specifically discussed with the families about the physical design of The Box. First, we asked them to use three words to describe it and most characterized it as *"bulky"*, *"retro"*, *"industrial"*, and "*ugly"*. After being engaged in in-depth discussions about it, we have been told that they felt challenged since it is *"obviously not the finest design"*, and since it looks *"like something* we *have created from stuff we had available", "like an old retro arcade game"*, and *"like an amperometer from a physics school class"*. Some also *"hoped the designer did not spend a lot of effort to come up with that"*. When we told the families that it was purposefully designed to look like this, most got surprised. The first family told us that they would prefer *"something smaller, something that looks like an Apple device"*, while the third informed us that *"it is ok as long as it stays in the utility room"*. This distinction between the utility room and other rooms within a home, was often highlighted as they told us that they wouldn't like to place something that *"looks like that next to designer furniture"*, or that *"people in general do not like cables and stuff in their living room and they even hide their internet boxes"*.

In relation to specific design elements, most of the discussions where positive. The two numerical LED screens

that materialized *"how many times they cheated"* and their savings, were positively received. The mother in the first family specifically pointed out that The Box was very good at guiding them in saving money and reflecting on how to be more environmentally friendly because *"the screens put the information straight in your face"*. The boyfriend in the fourth family told us that it was good that the LED screen was there *"because if nobody is counting and I pressed the button 5 times, and then "forget" 4 of them –then it would be as bad"*. Interestingly, when we asked the families whether they would have had the same engagement if its design was more modern and all the information was presented on a single screen, or in a mobile application, we got different answers. Three families stated that they would have had the same level of engagement, while the first one told us that it wouldn't have been the same because right now they enjoyed that information was tangible.

In relation to the design of the color-coded clock, which we associated it with red and green energy, we had slight different perceptions about it. The first family told us that the clock was perceived as a traffic light that guided their washing activities, where *"green means Go, red means Forbidden"*. The second family associated the colors to sustainable behaviors and for them *"green means economical and sustainable, and red is wrong"*. The third family distinguished between *"rational"* and *"not rational behavior"*, and green color meant *"throw something in the washing machine now"*, and red *"no go"*. The same "go", "no go" approach was reported by the fourth family too.

FINDINGS: THE EFFECT OF PROVOCATION ON OUR RESEARCH THROUGH DESIGN APPROACH

Through The Box we did research through design. Thus, The Box should not be viewed as a product, but as a research tool that allowed us to have a better understanding of an area of interest, in this case electricity consumption. Since in studies like ours, the most valuable source of information are the participants, we want them to be highly engaged and as reflective as possible. The following subsections present findings in relation to those two issues.

Provocation increased participants' engagement

We view participants' engagement at three levels. The first is related to how much they got engaged with The Box, the second how much they got engaged with us during the interviews, and the third how much they related to our research purpose.

From the log files as well as the discussions with our participants, we understood that they got really engaged with The Box. All the laundry activities that took place in all households were conducted through The Box. Even though the participants knew that they could simply unplug it and go back to what they used to do before, none chose to do so. The Box was up and running throughout the duration of the study, except for a few instances were there have been some internet connectivity issues and it had to be reset. In detail, the first family pressed the override button 3 times, the second 19 times, the third 0 times and the fourth 3 times. They all saved money, according to our scenario, with the first family saving 6.5USD, and the rest 2.7, 3.4, and 3USD respectively. These results show that our probe was an overall success from a sustainable point of view as shifting did occur, even at extreme rates.

Furthermore, very often and with all four families, we experienced instances where we did not fully control the interviews, and the participants were so engaged that they started interviewing each other. Such instances were really useful for us, as they did not only give insights that were limited to the outcomes (e.g., how many times they pressed the button), but revealed to us their thinking behind their choices (e.g., what motivated them not to do a wash).

In relation to the third level of engagement, which is how interested they were to our research work, our findings also show a deep engagement. We experienced a similar situation as reported by Bardzell et al. [5], where our participants started behaving as researchers. Many asked questions about our research purposes and our study setup. When we informed them that we were interested in understanding provocation, we had interesting discussions in relation to its limits, and whether we did some things on purpose in order to provoke more. For example, the father of the first family told us that he *"knew there would be a green section in an hour's time, so I did go down at that time, and it was red again, so I couldn't do anything. So I began to wonder whether you did this on purpose"*. Then he asked us if we purposefully introduced these sudden changes from green to red in order to study extreme usage scenarios of The Box, since *"he would have done that"*. For him, provoking participants by making them experience extreme situations, was an interesting way to identify the limits of both provocation and interaction. Similar discussions occurred for all three provocation aspects. Finally, some of the participants shared their views on issues that went beyond our research interests in this study, such as privacy and security concerns, and existing research in electricity distribution.

Provocation strongly motivated reflection

All four families got deeply engaged with The Box and tried to reflect on their washing practices. These reflections went beyond what we anticipated in the beginning of the study, and occurred by both adults on every family, even though only one of them was responsible for the laundry. They even got diffused to other areas of their life, as most reported that they demonstrated The Box to visitors, and discussed about it with colleagues from work.

Firstly, we observed that the practice of doing the laundry became visible to our participants, it was deconstructed by them, and reflections and changes occurred to their practices on almost every aspect. Our participants reflected on the amount of clothes they washed every time, the temperatures they used to wash their clothes, even on the type of detergents they used, even though The Box was

mainly designed for shifting. For example, the fourth family tried to fill up their washing machine with as many clothes as possible *"because when there is a green period we do not always have the time to wash two loads"*, while the father of the first family informed us about the washing temperatures that *"I mean, I suppose, I have been hypocritical about it in the past, because you can wash in 30 now with the detergents we have"*. In relation to shifting, we did also have unexpected results as most did shift their laundry times. In an extreme example, the third family that did not press the override button at all, sent their kids to school with day-old clothes a couple of times, and their teenage son *"was annoyed that we did not wash exactly the clothes he wanted. There have been complaints about it, but he has come to terms with it"*.

Furthermore, another very interesting finding was that our provocative future probe facilitated reflections that went beyond our scenario. For example, the mother in the second family told us that she *"often just caught myself thinking, well it is now green, so now it is a good time to run the dishwasher"*. Thus, our scenario got extended to other appliances, even though they were not part of the study. The families also reported that they started discussing energy consumption and sustainability issues in general. For example, the third family used The Box as an *"example of sustainable behavior"*, and as an *"educational tool"* to inform their children on why it is important to turn the lights off when no one is in a room. Finally, all families discussed and reflected about The Box itself as an artifact. We got suggestions on how to make it less energy consuming, how to combine it with a mobile app that would send *"service messages"*, discussed ways to make the laundry activity *"automated"* and *"remotely controlled"*, and talked about how to embed our functionality into an actual washing machine.

We treat all the above-mentioned instances as strong indications that provocation can facilitate strong reflections about existing practices, which may even lead to long lasting behavioral changes. Of course, at this point we can only speculate about such outcomes from studies like ours, but we would like to highlight that such instances could also be expected from other similar studies in the future.

DISCUSSION

Our discussion section revolves around two types of reflections. Reflections on designing provocations, and on using provocations in research through design.

Reflections on designing provocations

We identified two important issues on designing provocations.

Designing provocations is challenging but achievable

We started our design process by having in mind that our probe should by "slightly strange" [18] and a bit "mysterious" [7] in terms of aesthetic, functional and conceptual provocation. Since there are no specific methods for designing provocations, we understand that other researchers may experience the same difficulties we had during our design process. We will highlight three approaches that we found useful in dealing with this issue. Firstly, we strongly recommend to embrace *design authorship* [49] in order to design provocations. Design authorship highlights that not all designs need to be directly linked to specific requirements and users' needs, but can emerge out of the curiosity and the intuition of a designer. Design authorship should be combined with an iterative design process where the limits of provocation will be understood within the area of interest, and they will be instantiated through conceptual, functional and aesthetical elements. Secondly, we believe that often it is useful to involve users in the design process in order to define the provocation limits. In our study, we did not do that and we believe we might have missed some valuable input on provocation alternatives. Thirdly, we recommend to look for inspiration into existing provocative designs and identify aesthetic, functional and conceptual provocative elements that are successful. In order to do that we believe there is a clear need for "annotated portfolios" [28] within the Interaction Design community that will act as exemplars for future researchers and practitioners. According to Gaver [28], annotated portfolios are collections of designs that can act as an alternative to formalized theory, by explaining in detail the concepts behind a design, and the issues, values and themes which characterize them.

Provocations in use need to be experienced in the real world

As discussed before, we see a difference between "provocation in use" and "provocation in first encounters" [7]. In our study, we wanted to understand how provocation in use impacted everyday laundry practices. For studies with a similar purpose as ours, we believe it is important to have a deployment in the field, where the actual practices are realized. Otherwise, the participants will not easily make their practices visible, and reflect upon them. Also, since ambiguity and provocation go hand in hand [7, 44], we do not believe that we would have had these findings if our study was a laboratory experiment, which may be more suitable for studying provocation in first encounters.

Furthermore, it is also interesting for us that by introducing a probe into the real world, we may actually provoke more ideas/concepts than anticipated. For example, The Box did unintentionally provoke the idea that technology makes our lives more convenient in one of the families, as they had their washing machine located at their basement. The father told us that going up and down just to take a glimpse at the clock was *"annoying"*, but at the same time *"intriguing"*, and *"a good physical exercise"*. This openness in relation to what is provoked goes hand in hand with research through design approaches, as "designers can be *prepared-for-action*, but not *guided-in-action* by detailed prescriptive procedures" [55]. Therefore, we recommend to researchers that study provocations in use, not to be strict in their research plans, but to make them as flexible as possible [5].

Reflections on provocations & research through design

We will relate our reflections on using provocations for research through design, to the proposed model of interaction design research proposed by Zimmerman et al. [60], where researchers may assume three different roles within an interaction design process. The first is that of an engineer where they need to consider which technologies to use to make the design ("the *how* knowledge", [60]). The second role is the anthropologist, where researchers are interested in exploring the field by collecting data ("the *real* knowledge", [60]). Finally, the third role is being a behavioral scientist and integrate theory and models ("the *true* knowledge", [60]).

Designing provocations impacts all three roles. First, it impacts the role of being an engineer, as the decision of which technology to utilize in a design has to be filtered through conceptual, functional and aesthetic provocation. This is the reason, for example, that we did not materialize the savings account of The Box using software on the 7in screen, but we opted for an old-school, numerical LED screen. Second, it impacts the role of the anthropologist. Since provocations make the "invisible", "visible" [58] for a particular practice, as well as, increase the engagement and reflection level of the participants, they allow us to understand more of the "real" knowledge. We believe that this is really important for any research through design study that focuses on everyday practices. Finally, provocations also impact the role of the behavioral scientist, by facilitating unanticipated effects which may feed back to theories and models. For example, if we continue studying the energy consuming practices in private households, we might better model how to achieve behavioral change.

Another issue we will address is the notion of validity for using provocations in research through design. We will address the issue in two ways. The first is its relation to the notion of experimental setup. If someone considers our study as an experiment on provocation, then he might believe that we failed in our experimental setup since not all subjects received the same treatment – they did not perceive the imposed provocations the same way. We believe though that this way of viewing research through design studies is inherently wrong, as their purpose is to understand "what is real" and not on "what is true" like behavioral scientists [60]. Research through design studies and design theory in general, are unfalsifiable as their purpose is not to falsify a theory but to provide alternatives that confirm the theory [28]. Consequently, since The Box is a research tool and not a product, our study was successful since our purpose was not to solve a specific problem, but to understand different "realities" of practice. And these practices were uncovered in rich detail not because we had a rigid experimental setup, but because we did not have one.

The second way of approaching the notion of validity is related to provocation itself. Did we really design a provocative probe? Is there any criterion for evaluating its provocativeness? Again, we treat this discussion as irrelevant for research through design studies for the same reasons mentioned above. At the same time though we recognize that through more studies on provocation, through the creation of annotated portfolios [28], and through better understanding on what constitutes a good provocative design, we will be able to design better provocations. Towards this end, we do not believe we need strict definition on what provocation is, but a better understanding on what it is not.

Finally, we want to briefly touch upon the role that provocations can play for interaction design practitioners. We believe the decision to use provocations for the design of real products should be taken after careful consideration. The reason for believing this is that provocations may not fit well with all-in-one solutions that address the general public, since they may be experienced in vastly different ways. Therefore, they may facilitate negative experiences, when for example users believe that provocations went too far. With this we do not want to argue against embedding provocations into real products, but to simply highlight the challenges that such a decision might facilitate.

CONCLUSIONS

In this paper, we report on our efforts to understand provocation in research through design, through the design and deployment of a provocative future probe.

In short, our findings showed how provocation was experienced by our participants, how it affected their practices, and how it impacted our research through design approach. Overall, even though provocations may be experienced differently by participants, they can help them to better engage with a future scenario, as well as, to reflect and question their existing practices. This high level of engagement that provocations facilitate can be very useful for interaction design researchers in general, as they will allow them to better understand the "realities" they impose to users through their designs. Furthermore, provocations may impact all three roles interaction designers take within a research through design approach (engineer, anthropologist and behavioral scientist) and may guide them to discover more of the "real" knowledge.

In the future, we want to continue researching provocation. We want to study its long-term impact on domestic practices and do more research on how to define its limits. In relation to sustainability, we plan to extend this study and go beyond the individual, by studying provocation at the community level, and by researching its effect on resource consuming practices in general.

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