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SCAFFOLDING SUSTAINABILITY IN THE ACADEMIC HCID PRACTICE

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ABSTRACT

This paper is concerned with a sustainable academic human-computer interaction design (HCID) practice. We are interested in examining what such practice could involve, and how to implement changes towards increased sustainability. Reflecting over the fate of 120 prototypes, both analog and digital, developed during the last eight years as part of author's research projects or with students as part of the HCI course work, it is deduced that the process of establishing a more sustainable design practice in the academic HCI is related to increased *awareness* of sustainable alternatives in and through design, *enabling factors* such as providing for materials and giving good examples of sustainable practices and design, and *satisfaction factors*. Further, the following points clearly come forth from this reflection: 1) prototyping in HCI is about incremental improvement (incremental innovation), some novel ideas do turn up (real innovation), but most of the time, the fate of prototypes is to be abandoned 2) making HCID practice sustainable starts with building awareness around sustainability through education 3) there is a need for discussion within HCID community around best practices in this area.

KEYWORDS

Sustainability, prototyping, human-computer interaction design, HCID practice, sustainable solutions, education.

1. INTRODUCTION

Recently, there has been a considerable interest in sustainable Human-Computer Interaction Design (HCID), see for example (Pierce, Strengers, Sengers, & Bødker, 2008), and in Sustainable Interaction Design (SID), e.g., (Blevis, 2007). A good review of the sustainable HCI, as an emerging research field, is given in (DiSalvo, Sengers, & Brynjarsdóttir, 2010; Goodman, 2009). Sustainable HCI has been categorized in (Mankoff et al., 2007) as *sustainability in design* (related to material effects of software and hardware, e.g. (Kumar, Tullsen, & Jouppi, 2006)) and *sustainability through design* (related to, for example, promoting sustainable life-styles (Reitberger, Tscheligi, de Ruyter, & Markopoulos, 2008).

By its nature, HCI is an applied, multidisciplinary field, engaged in research related to interaction between people and technology, and in the practice of designing new interfaces, products and interaction modes. The HCI design practice part has been discussed widely, engaging both HCI researchers and designers from design disciplines in defining just what the HCID practice is and how it relates to interaction design (ID) as practiced by design disciplines (Culén, Joshi, & Atif, 2013; Zimmerman & Forlizzi, 2014). The research aspect of the HCID is often brought forth as a way of explaining how HCID differs from ID, e.g., (Fallman, 2003; Zimmerman, Forlizzi, & Evenson, 2007). These two disciplines can, however complement each other well, e.g. research through design (Zimmerman & Forlizzi, 2014) and preparing HCID students better for the multidisciplinary work (Finken, Culen, & Gasparini, 2014). However, addressing sustainability within HCID is complex. The reason for that, in part, is the nature of the practice itself.

The prototypes of new technological solutions resulting from the HCID practice are commonly developed with user participation, supporting users in performing various everyday tasks, such as increasing productivity, mobility, connectivity, independence and so on. Vast majority of these prototypes never become products that reach the marked, and are used for research purposes only. Furthermore, HCID often contributes with incremental improvements in products and interfaces (such as better functionality, increased ease of use), thus potentially also contributing to generating technological waste through, e.g. planned obsolescence and locking-in users to buy a newer version of digital products, with only marginal improvements. To remedy this problem, Blevis (Blevis, 2007) suggests explicit coupling of invention and disposal, as well as thinking of renewal and reuse when designing new products and technologies. Others researchers within interaction design and HCID are trying to understand why we keep some things and discard others (Odom, Pierce, Stolterman, & Blevis, 2009). Making green solutions is also in focus, as well as asking questions such as do we need all this technology (Baumer & Silberman, 2011)? There are also those researchers who propose structural changes: *"Technology creates possibilities for structural change mainly by amplifying efforts to achieve existing, institutionally recognized goals. In the context of the transition to sustainability, such goals may include the reconfiguration of institutions and infrastructures themselves. HCI can contribute significantly to the transition to sustainability by exploring how information tools can support such efforts"* (Silberman & Interpreter, 2013). Thus, participation in global changes would position also HCI as a more central factor in strategic innovation, consistent with what is suggested in (Culén & Kriger, 2014), and in line with Dourish's thinking around scalability issues in sustainable HCI (Dourish, 2010).

In this paper, we focus on the academic human-computer interaction design (HCID) practice and ways of making it more sustainable. The paper sets forth that considering the HCID as a practice, should also include sustainable practice of HCID, choosing to include the sustainability lens when thinking about research projects, in design processes, and in teaching. The later is important, as it is easy to forget that academic HCI researchers and designers are also educators of future human-computer interaction designers (Culén, Joshi, et al., 2013; Culén, Mainsah, & Finken, 2014). It is thus important to bring reflections around sustainability into the HCI education.

The paper is based on author's reflection work with design of new interfaces, running a UX lab and teaching HCI, see (Schön, 1983). Prototyping is in the core of all three of these activities. However, one could hardly add the adjective 'sustainable' to any one of them. The paper considers the fate of 120 prototypes developed over the course of the past seven years (2007-2014). The time span was determined by the point in time when HCI courses which the author teaches became project and team-work based, requiring at least two iterative cycles of prototyping, one of them with materials other than paper. As a result of re-examination of the fate of prototypes, three points become clear. The first one has to do with showing that much of the prototyping in HCI is about incremental improvement, some novel ideas do turn up, but most of the time, prototypes remain unused, or worse, become a waste. The second one is that making HCI sustainable starts with teaching about sustainable alternatives, re-use and repair, and actually trying to shift compete and consume attitude towards conserve and care one. Last, but not least, a collection of best practices, in this area would be helpful and welcome, as would a dialog around teaching sustainable HCI.

The paper is structured as follows: in the next section, a brief background on the HCI and sustainability and on the emerging concept of practice in HCI, taken as a unit of design, is provided. The section following that presents the framework used to think about sustainability in this paper. The third section shows examples and discusses issues around sustainability, and it is followed by a conclusion.

2. PRACTICE AS A UNIT OF DESIGN

Waddock (Waddock, 2013) states: *"If ever there was a wicked problem, the sustainability, or, more accurately, unsustainability, of the current world system is one".* Naturally, as mentioned in the Introduction, the HCI community joined the efforts to untangle the complexity around sustainability and technology. In a seminal paper in this area, Blevis (Blevis, 2007) proposed situating SID within HCI, focusing on invention and disposal, renewal and reuse. Blevis also pointed out that introducing sustainability may be in direct conflict with the learned practice in HCID to focus on users and their needs, instead of on the sustainability. Since, some researchers have advocated the change of culture (Goodman, 2009), while others, considering user behaviour as a difficult to change, proposed engineering approaches to sustainability (Chetty, Brush, Meyers, & Johns, 2009).

In (Kuijer, Jong, & Eijk, 2008), authors proposed a different possibility, a shift from designing products and services, to designing everyday practices, that is, taking practices as a unit of design. In (Disalvo, Redström, & Watson, 2008), the authors propose combining this idea with "*everyday design, resulting in new* *modes of design-in-use, through which practices are invented and employed in an ad-hoc manner similar to repair and DIY* (Do-It-Yourself)*".*

Pursuing this line of thinking further, we apply the idea of practice as a unit of design to everyday practice of HCID, in research, design and education. The starting point was to reflect upon the practice in the past, with a goal to identify possibilities for designing new, more sustainable ones.

There are certainly those in HCI community who already are aware of issues mentioned above, and, perhaps, are already running a much more sustainable HCID practice. It would be nice to learn from them. A collection of best, more sustainable, everyday practices of academic HCID could provide for sort of a tool box, from which 'sustainable practice blocks' could be applied in a mix and match fashion, depending on the situated context. For those who did not consider sustainability in academic HCID yet, perhaps this would be the motivation to do so.

3. THE FRAMEWORK SCAFFOLDING SUSTAINABILITY

Consistent with Goodman (Goodman, 2009), we favor the change of culture approach, starting with individual behavior, without disregarding the external environment. View presented in (Martiskaïnen, 2008) that if one is motivated to reach some goal, behavior modification is often needed, as well as a framework within which the change may start to unfold. Martiskaïnen proposes the *action framework* in which diverse factors influencing behavior modification were grouped into the three main categories: internal, external and habitual factors.

Applying this framework to the academic HCID practice, these factors could represent the following:

- Habitual: routines and habits
- External: administrative rules and regulations of the university, university culture, student body, other researchers within the research unit, research network, teaching network
- Internal: personal values of HCID practitioners, their beliefs, attitudes, teaching stile

Changing routines may be time consuming, a commodity that academics do not have in large quantities, thus, incentives to change established routines need to be strong. Breaking habits is difficult. (Holland, Aarts, & Langendam, 2006) show that implementation intentions (announcement and careful planning of implementation of something new) are helpful in breaking bad habits and forming new ones.

External factors often present very real barriers to change. Examples are abundant, however, for the sake of illustration, the following example is provided: the author had cooperation with a school of architecture and design in teaching interaction design. Starting the cooperation was a challenge, in part, because of the difference in governmental financing of the two schools, resulting in some differences in rules and regulations, but also reflecting on facilities and materials available for teaching. The cooperation ended predominantly because of differences in institutional cultures. Design students were used to long hours of work on projects, trying different solutions, discussing etc. They had very little time dedicated to lectures. The university HCID students were used to lectures, and were much less self-driven, making adjustment to the culture of the design school, where this joint work was taking place, difficult. Thus, the cooperation was not sustainable due to, predominantly, external factors.

The internal factors are very heterogeneous, but for anyone looking into practicing sustainable HCID, they would also imply willingness to reflect upon previous work practices from the point of view of sustainability.

Documentation, covering eight years of prototyping work related to research and teaching, was examined. All student project reports were posted on the web, e.g. ("Project presentations - INF2260 - Fall 2013," 2013). Research related prototyping work is documented through diverse published articles, such as (Culén, Bratteteig, Pandey, & Srivastava, 2013; Culén & Finken, 2014; Karpova & Culén, 2013), as well as reports related to UX lab activities (Roseland, Berge, & Culén, 2014). The analysis of this material has lead to proposing the following three sets of factors as instrumental in turning towards a more sustainable practice: *awareness factors*, *enabling factors*, and *satisfaction factors*, see Figure 1. We briefly consider each, as it relates to the initial process of starting the sustainable practice.

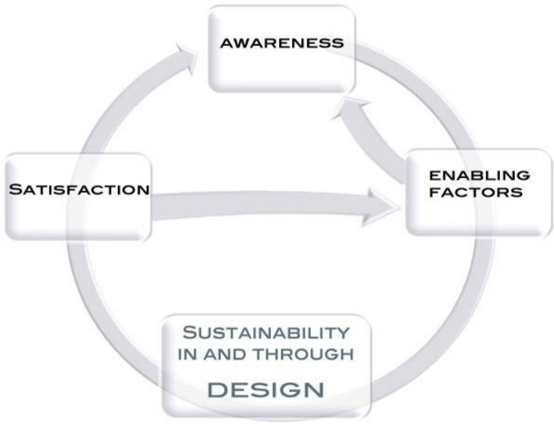

Figure 1. The academic HCID practice: a process of establishing sustainability in and through design.

It is hard to admit, but awareness was slow in coming. It was brought about by variety of inputs. Seeing sustainable HCI at forums such as CHI conference, has gotten some attention, and has had some impact on the awareness. At workplace, there are often conversations about universal design, and then the green design got woven in. But the "aha" moment happened when a physical move to a new building was made two and a half years ago. In the new building, we got a lab, serving as a user experience lab and a design studio. In no time, the room was full of various prototypes, materials, props, PCs and Macs, scanners, the mess included even a large, dead, multitouch table. There were two ways to look at this: a hopeless mass, or an incredible source for recycling and re-use. The (Blevis, 2007) paper was suddenly understood at another level. Coupling innovation and disposal, is not only about what some IT- intensive organizations out there should do, it is what was needed right here. And so, the awareness antenna got permanently switched on.

Awareness is, metaphorically speaking and using a car as the metaphor, like ignition. It sets the engine in motion, but is not enough by itself to move the car. Enabling factors, the engine, are those that actively support the change, e.g., getting engaged in projects with focus on sustainability, creating sustainable student projects by, for example, continuing the promising ones next time the class is thought, by reusing materials, getting help with organizing the lab activities, using non-toxic, but also ethically manufactured materials whenever possible, creating better practices, habits and so on. Working with some of these enabling factors may require awareness again, thus the loop at the start of the process in Figure 1.

Upon successfully completing a design project where increased sensitivity towards sustainability was required, a sense of satisfaction motivates further dedication to explore other enabling factors, to investigate and acquire further knowledge, and again, increase awareness.

Awareness and success factors are internal, when considered within activity framework for promoting behavior change. Enabling factors may be internal, but they also may be external, even habitual. For example, one may continue to use electronic components or other materials because one is used to working with them, or because those are the ones that the university provides, in spite of the fact that better (from the point of view of sustainability) options exist. Next, we provide some examples of how to prototype more thoughtfully, reducing waste.

4. PROTOTYPING AND SUSTAINABLE DESIGN

Our HCI course work is set up so that students have a semester long project, where the design brief is given by some external organization such as a library, a museum, an ICT company, etc. Students spend the first two weeks understanding the problem space, taking to users and like. The design phase takes about five weeks, followed by evaluations, experiments and other applicable research methods for another five weeks, after which a report is submitted. Student projects all required making prototypes, and for the past three years, the prototypes needed to be high fidelity, working prototypes. Students could come up with entirely new solutions to some problem, for example, use an existing technology in a new context, or they could improve existing solutions. As mentioned, only two and a half years ago sustainability came to foreground. It was explicitly mentioned in teaching for the first time in 2013. However, already in the 2012, we started with re-use, and the first example is shown in Figure 2. A group of students, designing for children's museum and addressing young children (Al-Nashy, Christensen, Jønsson, & Kvam, 2011) as their users, created an interactive octopus. The octopus had embedded RFID reader in the mouth, and arduino that powered the lights in the eyes and around the mouth. RFID tags were placed in diverse creatures from the sea, which children could feed the octopus with. When a child took, for example, the fish to the mouth of the octopus, the octopus would say: *Yaaam, I like the fish*. If the child tried to feed the octopus with something it does not eat, the recording would state so. In fact, children could record responses themselves, if they chose to do so. Children loved the octopus. Yet, as the children's museum operates as a mobile museum only, the octopus was too large, and thus, got to live in the lab (was disposed of). A new group of students, a year later, got to re-use the technological components and made a Star Ship, sending children to Mars. Before they could board the ship, the children had to decide on what to take with them (Anderson, Kleven, Cheung, & Duing, 2012). Consistent with the octopus, a child who tried to pack something reasonable would get a positive response. This prototype was easily portable, and better suitable for the museum.

Figure 2. The re-use of technology (the mobile children's museum). On the left, octopus "Brownie" with RFID reader embedded in its mouth, middle, being fed with diverse sea creatures. On the right, same technology, but the child is packing items for the Mars mission.

An objection could be made that the technology then forced the design of the second group to be very similar to the first one. However, the idea for the design came first, re-use came after. Additionally, the fact that the students did not want to repeat the project from the previous year, made them focus more on a story line and play. The user experience and social interactions around the two prototypes were rather different.

Figure 3. The box, originally made for the time-machine project, was re-used as a confession booth.

Apart from the technology, other materials may be re-used. In 2012, the students made a prototype of a time machine (Sveen, Dolva, Grimsøen, Leonardsen, & Fjelstad, 2012), see Figure 3. Once inside the time machine, a person could be transported to different periods in the past, using videos as a way of immersion. The time machine was a gigantic box, hard to move around, in fact, it could not come through the doors once it was put together. In order to move and re-use the box, the top and the bottom had to be taken off. A group of graduate students in 2013 (Gasparini, Castro, Risvik, & Heggelund, 2013), took the box and made it into a confession booth, see Figure 3, the image on the right. Subsequently, the box was used to study the act of confession in a physical space, contrasting it to revealing a secret online (Culén, Finken, & Gasparini, 2014).

In teaching, sustainability was first addressed in an advanced interaction design class in the Fall of 2013, (Culén, Mainsah, et al., 2014; Finken et al., 2014). An invited guest lecturer, the artist Amanda Steggell, was invited to show one of her projects, a mobile energy bank ("Energy Bank," 2012), enabling people on the street to charge their phones, generating the energy themselves by turning the handle, see Figure 4, image on the left. This project has inspired a group of students to focus on sustainability (Arnesen, Tahaee, & Kerstem, 2013). These students like physical activity and, in particular, biking as an alternative to driving or taking the public transportation. They view the bike as a sustainable solution to transportation within the city, resulting also in cleaner air. Due to our geographical location, it is cold many days of the year. A hand warmer, where the heating element is getting electricity by turning pedals, was prototyped as a way of extending the period of time when it is possible to cycle. The students presented their solution at a Student Faire, organized once a year at the institute, where they received a significant interest, see Figure 4.

Figure 4. Steggell's energy bank, a mobile phones manual charger, helped discuss sustainability in class. It inspired the hand warmers project - turning pedals produces the energy needed to heat hand warmers and additional visibility (lights).

Energy use and generation was also the subject of a student project (L'Orange, Ommundsen, Vegge, & Li, 2013). These students have chosen to make a mobile app, which shows how much energy is generated when using the installation in a Science Museum, see Figure 5a). The app uses examples from everyday life, enabling visitors to see the energy production in terms of, for example, smart phone battery charge.

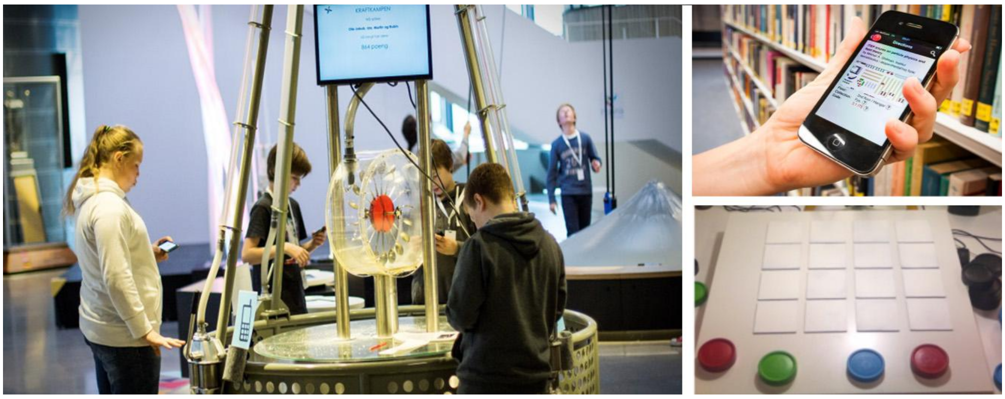

Figure 5. a) Children using an energy installation in a science museum. The students made visitors understand how much energy they generate while using the installation in terms familiar examples, e.g. battery charge for a phone. b) The App designed and developed by students for finding books in the library, presently in use. c) A tangible musical interface.

It is also worth noting that students, to a rapidly increasing rate, use places such as GitHub, see ("GitHub - Wikipedia, the free encyclopedia," n.d.), to share code and to network with fellow programmers. We show two examples of projects (Culén & Karpova, 2014; Hokholt, Thomas, Ødegaard, & Uthayakumaran, 2013) whose members shared the application codes, see Figure 6a) and b).

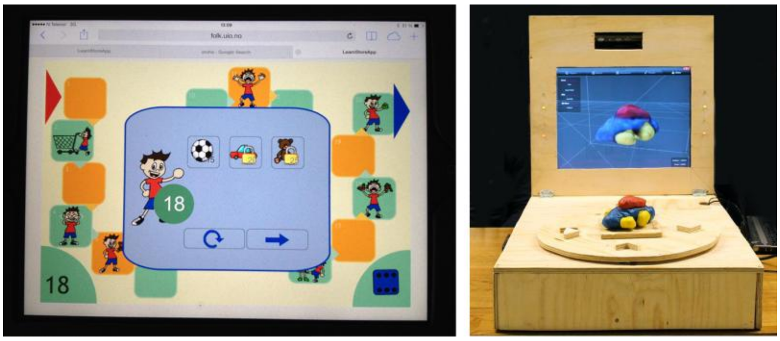

Figure 6. a) The code for the app, implementing a game for behavior modification, was shared in master thesis (Karpova, 2013). b) A student project, a 3D scanner, scans objects and stores them in 3D, was shared through GitHub.

4.1 Discussion

A total of 120 projects, involving prototypes, such as the ones shown in Figures 2-6, were viewed through the lens of sustainability. The following actions were considered to lead towards a more sustainable practice: code sharing, re-use, repair, continuing interest in a project after its official end, including sustainability in or through design as part of the design process, making a product that lasts, or even just publishing the research around the prototype, so that someone else may continue the work if the community finds it to be of interest. 110 of the projects considered were student projects related to HCI courses, and 10 were research projects. None of the prototypes developed between 2007 and 2011 as part of either research or course work, 69 of them, left trace. That is to say, the code was not shared, there was no re-use or repair, there was no carrying further of promising projects, no projects focused explicitly on sustainability, no projects led to actual products, or publishable research. Some of the projects were really fun, e.g. a project from 2010 that resulted in a tangible music interface (Lapponi & Skotterud, 2010), see Figure 5c). One could chose instruments and rhythms by placing colored cylinders on little squares. Depending on which row was chosen, a certain rhythm was played. Instruments were added by stacking cylinders on top of each other or placing them in the same row. Other rhythms could be added by placing cylinders in other rows. This tangible music prototype has been exhibited at a Student Faire, with a large success. People found it, at the time, innovative, and joyful. Since, some similar products have been made, but at the time, this was rather innovative.

In 2011, one of 11 projects was saved, the Octopus from Figure 2, and its components re-used. In 2012, the situation started to change, as sustainability was brought forward as a design issue. Eight out of 19 projects have followed at least one of the above actions leading towards increased sustainability. One of them, (Reistad, Choi, Drevsjø, Imtiaz, & Slang, 2012) continued after the semester was over, as both a product development and a research case described in (Culén & Gasparini, 2013; Culén & Kriger, 2014). The project resulted in an App (“Realfagsbiblioteket,” 2013), available from both Apple and Google stores. The App helps users to locate books in the science library, scans bar codes anywhere in the world and tells the user whether the local library has the book or not, as well as enabling the user to know if the e-book version of the book is available, see Figure 5b). Thus, up to this point in time, from 99 projects, 90 did not lead any further. The fate of student projects for 2013, 21 of them, is not quite determined yet. However, the trend is clear. Sustainability mattered more than in the previous years. Several student projects continued as research projects, e.g., (Culén & Finken, 2014), two have become products, currently in use, and three addressed sustainability in design explicitly. Many project groups have shared their code, see Figure 4, and we could see some cases of re-use, see Figure 3. Thus, in 2013 more projects than in all previous years together have considered the sustainable HCID practice.

5. CONCLUSION

Even if one thinks that a sustainable HCID practice is a good thing, the question remains how to actually implement sustainability in the academic HCID practice. When considering the action framework consisting of three classes of factors relevant to behavior change: internal, external and habitual, and applying them to

HCID practice, we found out that internal factors were crucial. In particular, increased awareness of what sustainability entails was fundamental. Enabling factors, such as knowledge, materials, institutional culture and others, all play a role in establishing a sustainable practice. The satisfaction felt after completing a more sustainable project motivates for further changes in all three classes of behavior modification framework. Changing routines and habits might require careful planning at the start, but becomes easier when projects are completed and a sense of satisfaction and increased meaning, which focus on sustainability brings about, felt. Furthermore, being a reflective practitioner also includes reflexivity around sustainability in the academic HCID practice. Thus, examining 120 working prototypes made as part of the academic HCI work, we have found out that a vast majority of them were not sustainable. However, once one starts implementing a more sustainable practice, new ways of making it into a unit of design become available. Thus, learning from others how they support sustainability in their academic work may make the semantics and pragmatics of HCID sustainability more clear, leading ultimately to a more sustainable HCID practice.

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