HCI AND DESIGN THINKING: EFFECTS ON INNOVATION IN THE ACADEMIC LIBRARY

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ABSTRACT

This paper is concerned with how two design processes that are seemingly very similar, human-computer interaction design and design thinking, affect innovation in the context of an academic library. Twenty different multidisciplinary projects involving advanced students of interaction design, researchers and library employees, using either of these two approaches or their combination, were conducted during the past four years. We chose two projects that we consider as illustrative of overall findings, in particular, regarding outcomes for diverse stakeholders. Both projects were focusing on the same problem, which many academic (and public) libraries face, of accessing library's e-book collections and making doing so more enjoyable.

KEYWORDS

Design thinking, human-computer interaction, innovation, user experience, leap-motion, apps, e-books.

1. INTRODUCTION

For the past two decades, the Internet has been a game-changer for academic libraries. Appearance of disruptive technologies, such as e-books first, and tablets later, posed further challenges. Also, fundamental changes in users' behavior became apparent. Users were increasingly demanding regarding the quality of services that they use, as well as capable and creative in their use of technology. Following users and their technology use patterns became a problem for many traditional institutions, among them also academic libraries. Many libraries worldwide are turning to service and user experience (UX) design, and design labs to address the problem (Mathews, 2012; Rundblad, 2011; Schmidt and Etches, 2012). Academic libraries are particularly hard pressed to re-think their role in academic life, technology use and willingness to innovate.

Four years ago, open user-driven innovation (Von Hippel, 2009; Chesbrough, 2007) was chosen as an approach to create innovative solutions that improve existing, or introduce new services and user experiences in the context of the academic library. The innovators were users, who also were students of human-computer interaction (HCI), and the innovation processes were carried out as semester-long projects within an HCI course. Even though that year no real innovation took place (in the sense of producing new products or services that were made available for use in the library), the student projects were evaluated positively by the library. The approach seemed promising since it brought forth users' perspective on library services. Consequently, a long-term cooperation was established between the library and interaction design students and researchers. Over the next two years, additional projects (and resources from the library) were dedicated to developing innovative interfaces and services through this cooperation that was then re-framed as a living lab. The living lab framework implied a strong focus on users, innovation, and co-creation (Bergvall-Kåreborn and Ståhlbröst, 2009).

This paper describes what we learned regarding differences between design approaches – the HCI design and the design thinking – in supporting user-centered innovation and co-creation processes. In particular, we were interested in finding out how the choice of the approach affected stakeholders. As researchers

associated with the living lab, we have done participatory observations, and interviews with students and library employees after each project. Our main finding is that both approaches support innovation, but in different ways, and with different effects on stakeholders, as this paper aims to show.

Two projects, one using HCI design and the other both HCI and design thinking combined, are chosen to illustrate our overall findings. Both projects explored the problem of finding e-books, and making people aware of their existence. Many academic libraries are trying to solve this problem (Buczynski, 2010; Shelburne, 2009), and find it to be complex. The complexity stems from the combination of human causes (e.g., users actually not knowing what an e-book is, or not recognizing it even when looking at it) and technical issues (e.g., systems and platforms for finding e-books that are unintentionally hidden from users).

The paper is structured as follows: in the next section, we present the background for this paper, followed by a section presenting the two interface design cases, solving the e-book finding and awareness problem using either HCI or design thinking, in combination with HCI, approaches. The discussion section then focuses on the effect of HCI and design thinking approaches on partners/stakeholders and further activities in the living lab. Conclusion closes the paper.

2. BACKGROUND

We start by establishing a common understanding of what an HCI design process is, at least in the academic context (HCI practitioners in the industry may have a different understanding). Even within academia, there are quite a few opinions on the theme. However, we believe that we take the mainstream approach when describing HCI design processes as activities starting from understanding the design context and identifying the needs and requirements for design, creating a conceptual design, implementing the solution (prototyping), evaluating it and then iterating (including new requirements, if found, or redesigning based on results of evaluations, and repeating these steps) (Sharp et al., 2007, p. 448).

Research through design, advocating design practices as a way of supporting the research in HCI, gained ground in HCI through works such as (Fallman, 2003; Forlizzi et al., 2008; Zimmerman and Forlizzi, 2014). The difference between the traditional HCI approach and research through design is that the latter brings design (and design methods from disciplines engaged with formal design training, such as product design, art or architecture) and designerly practices into HCI.

For the passed two decades, design and designers have, according to (Krippendorff, 2005), taken a semantic turn, seeking to embed meaning in what they do in the world and take a lead in solving complex problems. Design thinking (Brown, 2009) aided this movement, and established itself as one of the drivers of innovation and competitive advantage in business (Culén and Kriger, 2014; Lockwood, 2009; Martin, 2009). According to (Martin, 2009), everyone can work on becoming a design thinker. In order to do so, one needs a stance, tools, and experience that facilitate design thinking. The stance is related to one's worldview and the role one has in it, tools are the mental models used to understand the world and organize thinking, while experience is needed for building of skills and sensitivities. This implies that one becomes a keen observer and finder of opportunities for design (Wagner and Compton, 2012). The three main pillars of design thinking are its user-centered approach, rapid prototyping, and abductive thinking, or the inference to the best explanation. The latter is often quoted as a necessary tool design thinkers should have (Kolko, 2012). In spite of the fact that theoretically, everyone can become a design thinker, what we see in the literature are predominantly success stories of how design thinking processes give good results when guided by professional designers, e.g., (Brown, 2009, 2008). Papers that present how to establish well-working, novice multidisciplinary teams using design thinking (Seidel and Fixson, 2013), are more seldom. The design thinking processes typically include understanding of the problem space and empathy with users, framing the problem, divergent thinking, creative thinking, generating many ideas and possible solutions, using abduction to find best options (convergent thinking, sensibilities), prototyping, testing, and iterating, similar to HCI.

While the two approaches, HCI design and design thinking, may be seemingly similar, their effects often differ. HCI design processes usually involve incremental innovation and small changes (e.g., new versions of existing software), that are readily supported by the iterative nature of the process (Culén and Følstad, 2014). Design thinking, on the other hand, offers a possibility for radical innovation through divergent and convergent thinking (Runco and Acar, 2012) and focus on proper framing of the problem (e.g., rather than solving a problem, solve the right problem). Also, while HCI design processes rarely bring about

organizational changes, design thinking approach to innovation often affects the whole organization (Brown, 2009, 2008; Leavy, 2010; Martin, 2009).

The idea that design thinking could be integrated in HCI education led to re-examining the teaching of HCI (Culén, 2015; Culén et al., 2014). It was found that one of the main obstacles to successfully integrating two practices is students' perception that design and design practices require talent, or the above discussed abilities such as abductive thinking and designers' sensibilities. HCI students (prior to the exposure to creative practices) often stated that they are not creative or, that they feel more comfortable following prescribed procedures rather than more open processes. However, after being exposed to creative thinking techniques, they felt, and reported so through the end of the year questionnaire, that they became more confident, learned and grew professionally in the process (Culén, 2015). We now present the two illustrative design projects, both engaging computer science students in solving the same problem of finding e-books.

3. CASE: FIND E-BOOKS!

These days, our academic library, in likeness with many others, uses the majority of its funds on digital content. Yet, this content is either not readily available to users or is so seamless that users do not realize that they are actually using the library resources when, for example, downloading articles that are free of charge to them because the library already obtained rights to the content. The now large quantity of library's e-books remains underused by the academic community. This is in part due, the library believes, to the fact that they have no good solutions for making people aware that most books that they view as paper books in the library, also exist in the digital edition. What is easy on Amazon, often gets forgotten in the academic library.

As mentioned in the introduction, the library's living lab innovation efforts are implemented through co-creation between students from a project-based interaction design course at the computer science department, researchers and library employees. As described in (Culén, 2015), the course is a combined bachelor-master level, teaching research methods in HCI (Lazar et al., 2010). Two prior HCI courses are prerequisites. About half of the fifteen weeks (duration of the course) is used for concept development and prototyping, and the other half for evaluation and experiment design, including both qualitative and quantitative analysis methods.

We now describe the first project, Bookworms (Reistad et al., 2012) from 2012, which followed a traditional HCI design approach and was part of the user-driven innovation approach. The project team consisted of three library employees, two researchers, and five HCI design students (as innovators). The idea that a mobile phone app could help find a book in the library building motivated the students highly. Apps were cool, and the team settled on this idea from the very beginning. They then worked hard to implement the app through iterative improvements, until the product was finished and launched through both Google Play and Apple Store ("Realfagsbiblioteket-Google," 2013; "Realfagsbiblioteket-Apple," 2013). The app is in use today, in its third version, surprisingly, also by the librarians.
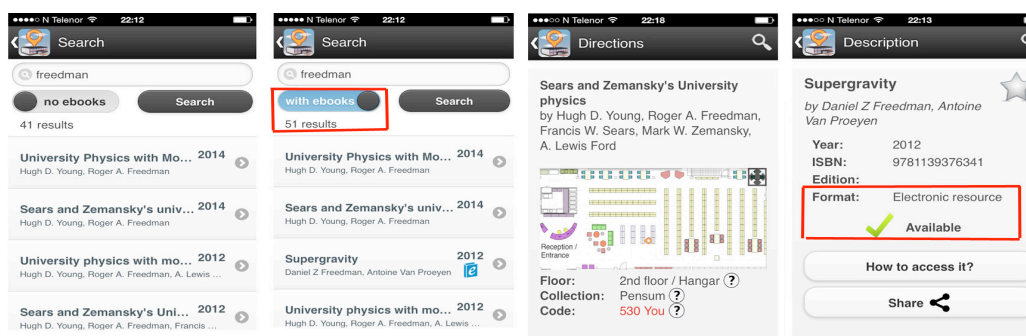

Figure 1. Screenshots of the app, with search without e-books for Freedman's books, and with e-books, followed by a screen showing how to find a book in the library, and a screen showing whether an e-book is available, and if so, how to get it.

As part of their overall solution for finding books in the library, an easy way to check whether a book is available in digital edition or not, was provided. As shown in Figure 1, the application's main search had an e-book option, and provided a way of accessing e-books once they were found. The app was well designed,

with a clean user interface. The library helped with relevant information on their current search systems and databases. The prototype made for the course was fully functional but used a small portion of the book collection. The students were consequently hired to finish the work for the entire science library. The students also wrote a research report, describing their methods for gathering data, ways of involving users in the design, and research results related to the usability testing (Reistad et al., 2012).

In preparation for the fall 2013 projects, where the library wished to continue looking with solutions to e-book collections presentations (online and in the library), a workshop was conducted, introducing design thinking and relevant service design concepts to library employees. The workshop had 25 participants. Seventeen participants were library employees, including some leaders, librarians, digital services management and support, e-resources and open access consultants, and others. Four participants were graduate students in interaction design and four were researchers. The participants were divided into four multi-disciplinary groups. The outcome of the workshop was, for the library employees, the understanding that service design uses a *design thinking approach* and tools such as *customer journeys* and *touch points.* A customer journey is the complete sum of experiences that users have when interacting with the library. Touch points are contact points between users and the library (where understanding user position is important). They can be digital (e.g., a website), or physical (e.g., a front desk). Customer journeys (prototypes of future services) were easy to visualize using service design cards (touch points cards). Design of good future services depends on considering diverse journeys and infering the best solutions.

The workshop was hands-on. Each team got their deck of service design cards, dots and arrows, a large sheet of paper, and colored pens. The participants took some time to become familiar with cards. After that, the cards became an excellent tool, facilitating the building of common understanding of the problem space. Soon, all groups started also using arrows and dots to reason by assigning importance to specific cards or processes and mapping out present and future customer journeys while searching for e-books, see Figure 2. Design thinking was an approach, at least in the simplified format in which it was presented, that all could easily understand and use. A less visible, but perhaps more important, outcome of the workshop had to do with awareness building around the role that design thinking may play in library innovation processes, in line with what is claimed in (Brown, 2009). The workshop was evaluated as informative and engaging.

Figure 2. The workshop with library employees, students and researchers: creating customer journeys related to e-book searches, both present and future. Finding and considering importance of touch points.

The second design case, the project BookMotion (Okun et al., 2013), was carried out during the fall of 2013. Similarly to the first project described, it resulted in a high-fidelity prototype that is used also today.

As described, we have engaged the library employees in the workshop prior to the start of the course. In order to give students the same basic knowledge regarding design thinking, customer journeys and touch points, the workshop was repeated with students who chose this project. Now, all team participants (students, researchers and three to eight library employees that attended design sessions) had the same basic knowledge to work with. Rather than simply providing information, as was the case in the first process, the library employees were now much more active, clearly showing interest to participate as co-creators in the process. This interest, in combination with design thinking approach and new tools (service design cards, customer journeys and so on) motivated the students highly. A new technology, Leap Motion, appeared on the market just before the start of the course and offered new design opportunities. A virtual browse of a physical library was already tested and described in (Lynema et al., 2012). The team added the Leap Motion as a new touch point. Considering different possibilities for placing this touch point on customer journeys (rapid prototyping), they found out that, initially, the best solution for awareness building around e-books is for it to

start within the library building. Bringing the virtual (e-books) into the library room was seen as interesting, and worthy of further exploration. The task now included more than prototyping with the Leap-motion, it also included the design of an interactive space in the library, see Figure 3, building awareness around what e-books are and how to get them. This was a bit more open and 'designerly' task than what was common for HCI students. (BookMotion by Y-TEK, 2013) shows a short video demonstration of the project.
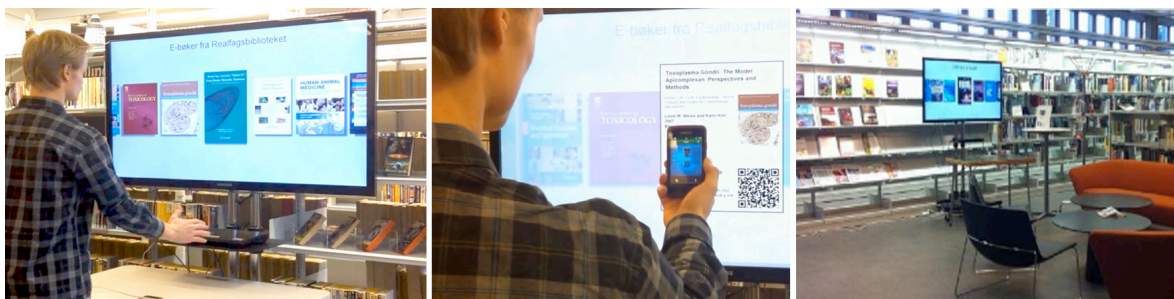

Figure 3. Browsing gesture while searching for e-books. When an e-book is selected, the QR code is scanned and the link to the e-book sent to the user's email address. Placement of the system within the library (Okun et al., 2013).

However, in the prototyping phase, it became clear that the technology, the Leap Motion, had its limitations. The 'natural' gestures were not the same for all users, and finding the 'right' natural gestures to browse, select, and check out e-books turned out to be a problem that is not simple to solve. The Leap Motion had issues with interpreting the same gesture performed by different users accurately. The students used the HCI approach this time. Different gestures were carefully tested in order to find the most appropriate ones for the final prototype. Ways of displaying books, amounts of space between the books enabling the most comfortable and satisfactory interactions (the latter depending strongly on precision needed for correct selection), were tested as well. However, many users continued to experience frustration despite the best efforts from the team, and the problem remained unsolved.

As this project was carried out within the living lab framework, the research was done in–the–wild, at the library. In addition, as a biology conference took place during the project, it was used for testing purposes. Natural gestures-based search was implemented for a small collection of biology books that were new and being introduced to conference attendees. Many attendees tried the system, and despite above-mentioned problems, liked the interface, in particular, the newness of the interaction. The same conference recently made a request to the library to have the BookMotion installation available again. The library thus can re-use the code and with moderate investment of time, make the installation work for special occasions, such as this conference, where the number of books to search through is relatively limited.

4. DISCUSSION: EFFECTS ON INNOVATION PROCESSES

A panel of four professional interaction designers and HCI practitioners selected the Bookworm project as the best HCI student project for the year 2012. The resulting app was *playful* and had a *great functionality*. The research related to *usability and user satisfaction* was rigorous and the results sound. The most fun part of the app, finding a physical book on the library shelf easily, was location bound. With relatively small efforts and further investment, the app could be made to work in other libraries. The search for e-books, though, was not location bound. With this in mind, the next generation of interaction design students was offered a possibility to consider making an app that facilitates browsing of e-book collections, as its primary functionality. Students, however, felt that they did not have much to add, and no team chose this possibility. One way they described the sentiment was that the app was "too finished".

In contrast, the BookMotion project, which ended with a number of obvious problems, was picked up first by the library that developed interactions with the system further, adding a student card reader, enabling knowing the identity of a person downloading the e-book. A special collection, ("Collection 42 - University of Oslo Library," 2015) was designated for use with the BookMotion. Furthermore, the medical library wished to use system's gesture-based interactions to browse collections of human anatomy images.

A new student team starting a year later, joined in, utilizing both design thinking and agile programming to implement changes in the interface addressing gesture precision difficulties. The design thinking approach was visible in creative generation of rapid prototypes, hands-on (sensorial) exploration of intermediary surfaces such as a soft touch screens made of plastic foil, bubbles that need to be popped in order to make a book selection, diverse magic or conductor sticks, were tried. Some prototypes tried are shown in Figure 4.
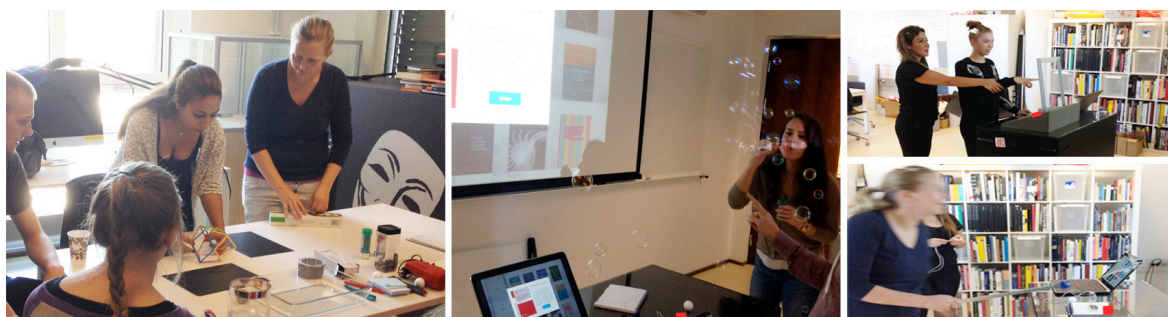

Figure 4. Co-creating an intermediate interface workshop (with Paria Tahaee, a master student in interaction design).

So why was there so much interest in BookMotion? *"It felt like a building block, like a Lego block, you just have to play"*, said one member of the student team, referring to the Leap itself. This remark illustrates the general trend showing how *cool new technology* becomes an important actor in innovation processes, in line with what design thinking literature shows, e.g., (Brown, 2009). The *openness* of the original application, both with regard to the technical platform (open source on Github) and the possibility to build easily upon the basic applications were important to many students. Another student liked the *value* aspect of this project: *"As a developer, I get a good feeling when I develop not only for myself, but also for others. I thought that this LeapMotion is good for bringing awareness around e-books. After one understands what it is about, one can browse on all platforms. So, I think it is useful."* And finally, the power of design thinking was seen, in particular, through the power of divergent and convergent thinking.

The convergent thinking implies the understanding of the known in a new light, the ability to see new possibilities. It also implies taking risks (Cropley, 2006). The LeapMotion was a new technology at the time, and students clearly took a risk when choosing it as a platform for a public service. The openness of their solution triggered other students to try to find solutions to gesture recognition and precision problems, attempting prototypes such as the ones shown in Figure 4 and forcing the new group to take several types of risks. The uncertainty of the final result for the library was a certainty, as were possible negative implications on the students' course grade. In contrast to convergent thinking, divergent thinking invites to failure, and opportunity to learn from mistakes. This was also the case in this project, as many of the prototypes were not functioning or were difficult to implement.

This risk taking aspects and invitation to fail are not common for HCI design projects, where it is nearly always possible to improve existing solutions, or design new ones following steps that (nearly) insure success. In design thinking and innovation, risk taking is the integral part of the process. In addition, producing and using new knowledge is required (else, there is no innovation) (Cropley, 2006). When using designerly practices, the knowledge production mostly happens through making, through rapid prototyping. Within the co-creating teams, where participants brought with them different type of knowledge based on their experiences, we could see how new knowledge and perspectives were added through the process of making. The latter may be seen as construction design research, which refers to design research where the construction of a product, system, space, or media is central, and becomes the key means in producing new knowledge (Koskinen et al., 2011). On the other hand, the knowledge produced by HCI was often generated as in natural sciences, through hypothesis postulation and experimentation. The risk taking, failure, learning and knowledge production, or absence of those, were all clearly observable through innovation projects, whatever design approach was chosen.

Since making of high fidelity (working) prototypes was a course requirement, nearly all teams could try and test their solutions in realistic (living lab) settings. The prototypes have, as a rule, generated a lot of research questions. The nature of questions and answers differed between two approaches (HCI design and design thinking), one being more focused on answering 'why is this so?' and the other 'how can I make this

work?' This is illustrated by the first attempt to solve the gesture recognition problem for BookMotion through HCI research, and the second, trying to make it work by circumventing the problem (Figure 4).

From students' questionnaires, filled at the end of the year, all student teams that used design thinking (alone, or in combination with HCI design processes) reported that they now consider creativity to be important, and think that what they do is creative. In addition, they find the group work, particularly in truly multidisciplinary teams, to be of great importance. Contributions from diverse members created a knowledge base that, in addition to creativity, significantly increased chances of creating good innovative solutions. We believe that for students, this may be the most important demonstration of what good learning practices are.

5. CONCLUSION

It follows from the discussion above, as well as from our observations of other projects, that cool new technology, openness, values and design thinking (in particular divergent and convergent thinking) make a powerful mix for innovation purposes in the context of the living lab and co-creation with interaction design students, researchers and library employees. This finding is in line with literature on open innovation and design thinking.

Also the students who tried innovation in the traditional HCI way, have achieved remarkable results. They tended to produce functional products, giving good user experience, and their evaluation and analysis were good, as the Bookworm project shows.

The interesting new insight is that we believe that HCI education should increase focus on creative thinking and integrate it more profoundly in starting phases of HCI design processes, when novelty and innovation are desired. Based on students feedback, as well as participatory observations, we further conclude that constructive design research and designerly practices, when focusing on innovation, provide for good learning practices for HCI education. Since computer science students are not trained designers, designerly practices and design thinking may be opening the door to creativity in appropriate ways and in line with todays increasingly accepted constuctivist learning practices.

In relation to the library, some innovative products were made during the past four years. These, when taken in use, as Bookworms and BookMotion, could be called innovations. However, the most important changes for the library and the library employees have been the organizational changes influenced by design thinking. Gaining the confidence to move from information providers and observers, as in Bookworms project, the library employees embraced the design thinking and the possibility to co-create, as in BookMotion, making them (co-)own ideas and products. That opened room for design-driven (or, more correctly in our case, designerly-driven) approach to innovation, and made the library into a proper living lab.

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