Arduino in Museum Exhibition: Lessons Learned When Working With Design Students Inexperienced in Coding

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Abstract
This work-in-progress paper describes the lessons learned when introducing Arduino and Processing programming into a museum exhibition design course. 20 information design students from Sweden, with no previous knowledge in programming, participated in the course. The students' task was to create five interactive exhibition stations at a museum in five weeks. As an experiment, Arduino and Processing programming was introduced into the course in 2014. The ambition with the experiment was to enlarge the information design students' repertoire and find ways to develop the interactive aspects of the exhibition medium.

The aim of the paper is to identify and discuss challenges and strengths when introducing code as design material in information design education. The findings presented are based on the students' reflection stories. This work is in progress and we aim in the future to 1) continue the analysis of the material 2) with the findings develop the information design education further and 3) explore the relation between tangible and intangible experience of interactive museum artifacts from a designer's and a museum visitor's perspective. We consider this to be an important matter with branches into the TEI community. We appreciate any feedback on our work.

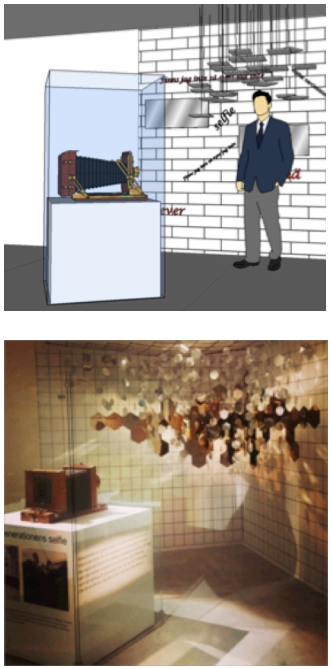

Figure 1: "Self-image" A sketch (top) and the final design at the museum (bottom) ©Sophia Lindroth, Amellia Franzén and Cecilia Engblom. Photograph J.Schaeffer

Author Keywords

Museum exhibitions; Design Education; Cultural Heritage; Arduino

ACM Classification Keywords

User Interfaces; Design Tools and Techniques

Introduction

In a project called "The stored things come to life", BA-students in an exhibition design course and two design researchers collaborated with a County museum in mid-Sweden. 60.000 objects the storage of the County museum were used as a starting point for a design process. One of the goals for the project was to integrate sensor technologies and audio with text, lights, and the stories with the stored objects in an exhibition.

The course included literature studies and lectures on exhibition design and on interaction, reflection writing, supervision, visits, and lectures by sound artists and researches. In 2014, Arduino and Processing programming was introduced in the course as an experiment to enlarge the students' repertoire. The students had no previous programming experience. For the activity of coding, the course provided two 4 hours introductory workshops and additional 1-2 hours per group supervising-on-demand thereafter. The two introductory workshops for the Arduino were designed to be open and driven by one common denominator of the groups: using a sensor signal to trigger a sound. The students used the Arudino as an I/O device connected to Processing on a computer to enable audio output. As a result of the workshops the students had a boiler-plate system as raw material to tinker with for their proposed designs.

One of the basic assumptions in the paper is that not only programmers can have access to, and work with the material of code. This assumption is a result of our previous studies of programming language code as a design material [8]. Another input were initiatives of using the Arduino microcontroller for inexperienced designers [3], in museum settings [6] and in education [1]. The Arduino have made it possible for designers to work with digital materials and designing digital artifacts without "armies of computer scientists" [9].

The museum domain's awareness of artifacts and the context in which they are presented resonance with the attention to materiality within the TEI community [10]. In addition to the growing research on interactive artifacts in museums [4,5,7], the education for the exhibition designer is an important area for the TEI community that has been less in focus. This paper contributes to focus on the role of the design education for digital artifacts in the museum context.

Aim, Objectives and Research Question

Our long-term objective is to contribute to an update of the Swedish design education, by enlarging the exhibition design students' repertoire. The long-term objective is also to study the effects of "code interventions" on the user experience of the exhibitions, and the effects of treating code as a design material in experience design on different levels of the design process.
The aim of the paper is to identify and discuss challenges and strengths when introducing code as design material in an information design education.

Our approach was inductive. The empirical data consist of the students' reflection stories, observations, films, photographs, and discussions with the students during

”Self-Image”

In the design process, one group wanted to make a camera from the museum collection come to life for the visitor by linking to ‘selfies’ of yesterday and today.

On the podium an image and text describing one of the first selfies in the world was placed. In front of the camera they created an immersive bathroom environment with mirrors, intended to draw the visitor in front of the camera (see figure 1).

The sound was a multi voiced discussion. Three young women were in a club toilet taking selfies and talking about themselves and how they looked. The sound was activated by a sensor placed on the floor that reacted on movement when a visitor entered into the toilet.

Text encouraged the visitors to take their own selfie and upload it to the museum hashtag.

the course. The initial investigation of the data was done with the intention to formulate interesting areas for research and find theoretical approaches relevant to the material.

Combining initial findings and theory, we formulated a research question for this paper:
How do the students express their experience of familiarity and unfamiliarity of the new situation when introducing code as design material in their information design education?

To answer the question, the method was to read the reflection stories and find how the students express their experience of familiarity and unfamiliarity of the new situation. We marked excerpts of the text, discussed them, and compared the different excerpts with each other in order to find out if there were any similarities that could be generated from the particular experiences.

Theory

In accordance with Donald Schön’s (1983) discussion of design, we see design as a reflective conversation with the situation. One theoretical key to the approach used (to introduce the digital interactive technology into the course) is the notion of ‘repertoire’ by Schön [11]. We consider the students as practitioners that have already built up a collection of images, ideas, examples and actions that they can draw upon. Schön saw this as central to reflective thought, and that the repertoire is constantly enlarging on the bases of the unfinished:

> When a practitioner makes sense of a situation he perceives to be unique, he sees it as something already present in his repertoire. To see this site as that one is not to subsume the first under a familiar category or rule. It is, rather, to see the unfamiliar, unique situation as both similar to and different from the familiar one, without at first being able to say similar or different with respect to what. The familiar situation functions as a precedent, or a metaphor, or… an exemplar for the unfamiliar one. [12]

Following the reasoning of Schön [11] the students as practitioners do not have a full understanding of the new situation, but when in action, they bring fragments of both familiarity and unfamiliarity into play. In the reflection stories they begin to verbalize and reflect on familiarity and unfamiliarity in the new situation.
From more recent research, related to design action, the theoretical concept of ‘thinkering’ is discussed by Fernaeus and Vallgårda in 2014 [2]. The tinkering with materials is an important process in making interactive artifacts and implies negotiations between physical form, temporal from, and the interactive gestalts through bricolage of materials.

Findings of familiarity and unfamiliarity

Below we present the findings of the experience of familiar and the unfamiliar in the design situation reported in the students’ reflective stories. One student reacted on the unfamiliarity of the Arduino:

> Around the same time, we were introduced in the Arduino world. There, we were thrown into the programming, wiring and choice of sensors. It was new knowledge and new challenges to master. Here I began to feel that we worked well in the group and was able to cooperate with each other and the whole thing ran on even when we ran into problems. The second day of the Arduino workshop I felt terrible good when we got together a difficult programming and connected a crystal display. Here we began to understand how the codes fit together and how we would connect the various wires to carry the current correctly.

Arduino is here described as a “world”. It could imply that in that world there are unknown languages, arti-

facts and ways to be with the material. The expression of "thrown into the programming", is a way to describe the meeting with the unknown. Based on this student's reflections, things that made it work where the group working together and the feeling of solving tasks successfully. This contributed to a state that the student describes as "began to understand how the codes fit together". This could be interpreted as the expression of understanding and recognizing code *as a material* was a way to connect to the unfamiliarity and recognizing the possibility to understand how code could be fitted together.
Another student recognized the familiarity of immateriality in the unfamiliar situation:

> It made me think about the invisible environment - the atmosphere, which we humans create in a room or in a place. How we can choose and actively work with the atmosphere. I have through my former job as a plant technician visited innumerable office spaces where the invisible environment is as tangible as the physical. [...] Parts of the presentations of the Arduino kit and software program processing was as understandable to me as if they had been held on a Extraterrestrial language. […] I like to take on new technological challenges. But conducting a technical challenge, fun, one you can still see, touch and understand. Then software processing, no, it felt unattractive and I let another technical talented and interested group member do it. The decision was probably the most favorable for the project but maybe a loss of knowledge for me personally.

The student could find a familiarity with her previous design repertoire, related to "the invisible environment". The student reports the importance of creating atmospheres for spatial experiences. It appears that this familiarity did not help the student, and eventually the student did not participate in the programming. The reflection show that the *immateriality of code* made the technological challenge "unattractive" and that the group setting made it possible to *avoid* to go into interaction with the newly introduced material.

Another student found the coding as an experience described as being in the dark, but was helped through the metaphor of knitting - described as a little a light in the dark (knitting is a mandatory subject in all Swedish undergraduate schools).

> What caught my interest and made me see little light in the dark was when Rikard alleged that programming works much the same way as a knitting description. This interest defaulted with time, and the group became more and more frustrated and not content with the technology and finally we even put ideas down because of technology hassles and incomprehension. We poked along during the workshops with different exercises and programmed and were pleased when we managed to do some exercise. In the workshops on Arduino and programming, I have almost always been a question mark. I have heard the words that had been said but I had no connection to them, or what was said. Fortunately, we had a team member who hung in during the instructions and understood.

"Poke along" indicated that the students were tinkering with the technology to get it working, and when it did, the student describes a feeling of satisfaction. However, the unfamiliarity in this situation made it difficult for this student to use the new knowledge in the project.

One student related to the fact that the sound and the digital interactive aspects of the course did not come to life when visiting sound artists studios and installations in the course; it was just "boring". But at a museum visit there was possibility to understand the new unfamiliar situation from the familiarity with the exhibition context.

> Over the weekend I was at the Technical Museum with the family, where there was a bed that was yawning and snoring. This gave me more a sense of how sound can be used in exhibitions. The bed was appealing and attracted visitors. Many tried to lie down in bed to see if it would happen any more. Unfortunately it did not. It had been possible to use simple sensors that react when someone lay in bed. It had worked to split the audio to yawn, played to attract visitors and snoring when someone

> tried to go to bed. […] Sound in information design feels like it should have a clear thought to help the viewer to understand the design. Here lies the importance of information and the ability for the visitor to take part of it.

In the description it seems like the museum context gave an understanding of how the unknown coding could be used when embodied in an exhibition, and that was in similarity with almost all the refection stories. The familiarity with spatial design also seems to make the experience to work with lightning design (a part of the course also new to their repertoire) more unproblematic:

> The light laboration was very interesting and educational, because I never worked with light, it was cool to try hands-on and you learn a lot by getting the try things out instead of just having theory. It's very interesting how the light affects the perception of an object or a person. Previously, I know the using the backlight but had no idea how to use a head light and a lifting light. Light can affect the perception of a room to an incredibly extent which is important for us when designing in the museum. The light can completely change the mood and thus the experience of what we design.

This quotation shows that the student's familiarity with the situation helps to understand the techniques for lighting, and gives ability to reason about detailed concepts of lighting, which were not occurring in the reflections on digital technology.

Reflections/ Lessons learned

The course content is broad and range from a discussion about art versus design, technical aspects of exhibitions, archive excursions, processing programming and practical design work. The students learned enough during the course to present 5 functioning interactive exhibits at a museum, but the repertoire was more enlarged for some students then for others.

The students strived to find examples in their previous repertoire that could serve as an example for the new one, and some seems to support the students ability to enlarge the repertoire and some not. Our findings indicate that it is important to carefully identify *what* in the previous repertoire to connect to. Activated previous experience of immateriality did not help to understand coding whereas previous experience of materiality, of for instance knitting, did. There was a tendency that the things that explained the way code could be touched, felt, and smelled were supportive. One student described code as "unattractive" on the base of its immateriality. The students that recognized the inherent materiality based on familiarity in their previous repertoire, started to understand the relations behind the coding and were able to enter into the coding with more successful results.

The reflection stories show that sometimes the new situation was in a way too different, so the students tended to identify other aspects of the task than the Arduino and Processing coding that were more familiar to them and thus spend time to explore those aspects. Time and effort was instead spent on sketch the whole space, discussing construction and placement of text - a reflection in action. But, for these students the reflection in action for coding, to understand it as a material that could be altered and generate variations that could be tested, did not develop during the course.

We are interested in how to link the unfamiliar to the familiar and recognizing the unfamiliar in the light of the familiar. This is where the learning takes place and the repertoire can be enlarged. The strengths in the course are that the some students enlarged their repertoire. One lesson learned is to introduce the task more

clearly in advance and in that do a tighter connection to the familiar of the students' previous repertoire. The challenge is to find ways to relate to their previous repertoire when introducing Arduino, maybe by metaphors or relating to how they think of material in their previous education. Another possibility to try out is to design the course in a way that give the students more time to experiment and test programming and one way could be to in fact reduce the familiar elements in the course the use of light, texts etc. but still relate to them when introducing Arduino.

Future work

The future work is first to continue the analysis of the material. We have for instance left out the theory of social constructivism in this paper. Second, with the findings we aim develop the education further. For instance in information design we will strive to introduce the Arduino and Processing programming more in line with the students current repertoire. Furthermore, we will also seek ways to improve the education in computer science in the basic programming courses. Third, we will explore the relation between tangible and intangible experience of interactive museum artifacts, from the designer's experience of the design process, the designer's intended experience for the museum visitor, the museum visitor's experience of the artifact, and museum visitor's experience as designer.

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