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The Stone Age trail: A mobile outdoors computer game for nature experience

Technology can assist people as they pursue different kinds of nature experience. Some systems developed have been made for learning, social activities, and leisure. Our aim is to explore how to make use of the theoretical frameworks of embodied interaction and technology as experience in the design and reflection process of creating an interactive system that have the potential to augment visitors' experience of Tyresta national park. Design activities included contextual inquiries, sketching, prototyping and user testing. Two handheld computers and physical information boards were used in the prototype of a mobile outdoors game. The theoretical frameworks were used to set design objectives that could guide the design. When designing for nature experience we argue that one should design for an activity. The designed system should also be open for diverse ways of usage

Keywords: Interaction Design, Human-Computer Interaction, Outdoors computing, Mobile computer games, Nature experience, Embodied interaction

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It is long since the first computers became mobile and left the office and even the home. This opens up for outdoors computing, where the computers potentially can blend into many different kinds of activities. Our current project, which we pursue together with Tyresta nature reserve and national park, explores how to design for nature experience.
A problem for Tyresta national park is that they, despite their relative proximity to Stockholm, have rather few unique visitors. An earlier study has shown that visitors to the national park would like to have more activities and more guided tours (Fredman & Karlsson, 2003). An overarching goal for our present project has been to develop methods for designing interactive systems that have the potential to augment visitors' experience of Tyresta national park.

Technology for assisting people outdoors has always been used. Examples include the compass, maps, marked hiking trails, GPS, etc. Recently there have also been attempts at designing advanced computer technologies for augmenting or assisting people as they pursue different kinds of nature experience. The systems developed has had different purposes and characters, some were made for learning experiences (Randell et al., 2004; Rogers et al., 2004), others has aimed at making passive viewers more involved in joint activities (Esbjörnsson et al., 2004; Verhaegh et al., 2006), others have focused more on leisure (Arvola et al., 2007). Common to many of these projects has been the aim of making the technology part of the bodily activities people engage in outdoors; making interaction embodied (Dourish, 2001). We take departure in the concept of embodied interaction to consider how to design technology as part of nature experience. This means that we embrace a view on technology as experience (McCarthy & Wright, 2004). Our aim is to explore how to make use of the theoretical frameworks of embodied interaction and technology as experience in the design and reflection process of creating an interactive system that have the potential to augment visitors' experience of Tyresta national park.

This article has the following outline. Firstly, the design of our final product will be described. Then the theoretical underpinnings of the design are introduced. This is followed by the methods (i.e. the design activities that were performed) that were used. The results in terms of what happened during the design process are then presented. Finally there is a discussion of the results.

Designed Product: The Stone Age Trail

For Tyresta National Park, the design process ended up in an outdoors gaming activity where the players walk a trail in the National Park. The prototype system contains information about the Stone Age and is accordingly called The Stone Age Trail[1]. When visiting Tyresta National Park, a pair of visitors gets to borrow one handheld computer each. The handheld computer also has a barcode reader. The Stone Age Trail has a number of physical information boards that are placed out in the woods along the trail. Some boards are placed visibly and others are hidden out in the forest to encourage exploration. The information

boards contain some information, and they also have a barcode that the visitor can scan to get more information in their handheld computer (Figure 1).

Figure 1 and 2. The user gets information both on physical boards and on the handheld computer. A board is to the left above, and screens from the handheld computer are to the right. Some boards depicts only the tools they represent.

The players choose characters and information is given by text, sound, images and movie clips. The trail that they should follow in the game is marked on a map on the handheld computer. The players are encouraged to find tools represented on information boards in the landscape and scan their barcodes.

Every board along the trail gives the visitor a chance to pick up the tools shown on the boards. Information is also given in film sequences with animations and music. At some boards, the players must answer a question in order to get the tool, and if one of the players already has take the tool it can no longer be picked up. At other boards, the players must cooperate and read the same barcode both to get the tool. The tool appears on the screen when it has been picked up, and more information about it is given if the player selects it (Figure 3). During the film sequences the players are often encouraged to search for more tools since they are needed in the final part of the game.

Figure 3. The user interface contains for example a map and collected tools.

When the players finally have collected the tools they want, they get to play a final game where the tools are used to catch fish, hunt and keep the fire alive to cook a good stew. In terms of mechanics, the players need to run between three places to collect as many fishes, pigs and wood logs as possible and bring them to a cooking pot. The places are approximately three meters apart. In terms of narrative, the characters are cooking food and the fire must be kept burning (Figure 4).

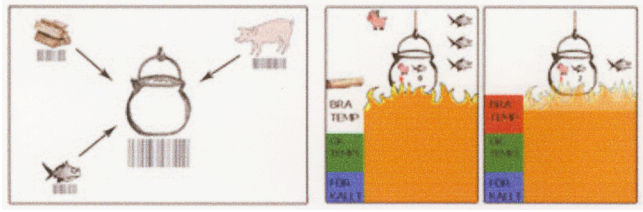

Figure 4 and 5. The players must run between four different places that are approximately three meters apart. Both handheld computers show the fire and the amount of food in the pot, and the players need to cooperate to keep it cooking.

An icon is shown onscreen when a player scans the barcode for fish, wood or meat. How many icons that are shown depends on what tools the player has. For example, if a player has the fishing hook an extra fish is caught, and if the player also plays the character Tora yet an extra fish is caught (she is a fisherman).

Collected ingredients or wood is left by the pot by scanning the barcode at the board depicting the pot, and choosing what to leave by pointing and dragging the icon on screen to the pot. The progress is shown on both handheld computers (Figure 5): what ingredients they have collected, how much food is in the pot, and how hot the fire is. The speed with which the fire gets cold is constantly increased and this means that the game constantly is paced up. The game ends when the fire gets below the "too low" temperature.

Theoretical Framework

We will now turn from the design of the game to the theoretical underpinnings behind the game concept. The first theoretical frame for the game is embodied interaction.

Embodied Interaction

The integration of the prototype in the environment of the activity can be seen in terms of embodied interaction (Dourish, 2001). The notion of embodied interaction has its roots in phenomenology where an artefact in use is seen as a part of our bodily space, and the meanings of artefacts are given based on the contexts bodily and social contexts which they are part of. We, as people, are tightly coupled to our world. Coupling is the degree to which we are coordinated with the world, and how that coordination is maintained. We are primarily engaged in the world at which our tools are ready-to-hand for action. We do not primarily perceive the tool in itself but rather the activity of using it. For example, when using a hammer to nail down some nails we do not focus on the hammer, but rather on the nails and the activity of hammering. When there is a strong coupling between person, hammer, nail and board a coupled system is created. Then the entire system may be ready-to-hand in higher-level actions for example fastening a board or even higher level of for example setting up a new wall. Coupling and embodiment thus works on multiple levels, and we ascribe meaning to objects accordingly; at one level I speak of hammers, nails and boards, and at another level I speak of walls.

We are currently seeing a trend toward tangible computing where computer usage is moved from screen interaction to interaction with the world surrounding us, which we as people are better adapted to (Ishii & Ullmer, 1997). This will make the user interface less abstract, which can make a computer system easier to understand, and make it easier to focus on the activity at hand rather than the tool for our activity.

Actions become meaningful in relation to other participants in a particular context, as well in relation to our body. Dourish conceive the notion of 'embodiment' in terms of the physical body, our skills which we use to understand situations, and the culturally based abilities to understand our world. The world is revealed to us as already meaningful as we engage physically with it and interpret it.

Technology as Experience

The second theoretical frame for the game is the view on technology as experience. Much of human-computer interaction (HCI) practice and research has moved from individual cognitive models for understanding users and use to viewing users as social actors (Bannon, 1991). In this process there is however, a risk of forgetting the experiences of the individual as he or she interacts with technology. If we want to understand a person's experiences and felt life, we need to look more closely at the fears, hopes and dreams of that person

(McCarthy & Wright, 2004). Experiences are constantly created and changed, and an aesthetic experience appears when a person finds meaning in all elements of the current situation. The experience is also molded in dialogue with the world, including other people (Battarbee , 2003; McCarthy & Wright, 2004).

Design Objectives

The theories do not provide any models for how to proceed with a design process. For the design project, we therefore set a number of design objectives based on the two theoretical frames of embodied interaction and technology as experience. The design objectives describe overarching properties of the future design solution. The two theoretical frames share the view that an artefact is part of a social context that can augment or interfere with the experience of an activity. The most prominent design objective has accordingly been to design the product to be a natural part of an activity rather than merely an informative system. The other objectives are in fact instrumental to that end.

The interactive system will:

(1) Be part of an activity
(2) Be used outdoors
(3) Encourage exploration
(4) Have low level of abstraction and low learning threshold
(5) Encourage people to cooperate
(6) Make use of the meaning already existing in the outdoors environment and not interfere with the nature experience

The Design Process

In design, as with all wicked problems (Rittel, 1973), there are no right or wrong solutions but rather more or less appropriate ones. Design objectives are then a way to assess and understand how a design solution is used. Setting up the design process to focus on the objectives above has been an important part of the design process. However, the objectives says nothing about how the future design solution should be designed, but they have rather worked as structuring principles in the development of the vision (Löwgren & Stolterman, 2004). Working with sketching towards a set of objectives made it easier to make divergent solutions. The objectives above are however, not only based in the theory but also in contextual inquiries.

Contextual Inquiries

To understand the motives for spending time outdoors, contextual inquiries (Beyer & Holtzblatt, 1996) were made. Six qualitative interviews with younger visitors (15–30 years) were made to complement an earlier study, since that study showed that this group were more open to trying out new kinds of activities at the national park (Fredman & Karlsson, 2003). The goal of the interviews was to determine what qualities people want from a visit and what they experienced as negative. Superintendents at the national park also gave two talks, which informed the design. The talks concerned what national parks are, what visitors can and cannot do, and organisational goals for the park. Laws and regulations, as well as information about Tyresta National park have been studied to further deepen the knowledge. We have also hiked several trails in the park.

The results from the contextual inquiries can be summarized in two categories:

(1) The outdoors can work as an arena for socializing with family and friends. Visits of this character are often spontaneous and can include hikes or picnics.
(2) The outdoors can work as a provider of an object-oriented activity, for example fishing, mushroom picking, or outdoors teaching. These goal-oriented activities do not exclude social activities but the main motive is not the social activity.

It was decided to aim our design project at the second category. It is also worth noting that informants did not find the idea of technology to be fully compatible with nature experience, despite their interest in new kinds of outdoors activities.

The contextual inquiries together with theories of embodied interaction and experiences have formed a basis for design goals 2 and 6, which means that the systems shall be used outdoors, and that it should enhance the meaning and experience of the visit to the national park. Design objective 4 involves that we should aim at designing a system that has low level of abstraction with a low learning threshold. This is important to ensure that the users do not have to spend time to learn how to use the technology, and that the technology should not interrupt the outdoors activity.

From Vision to Prototype

Design work can be described as an oscillation between vision, operative image and specification (Löwgren & Stolterman, 2004). The vision for the Tyresta project soon became "involve to inform" and was based on the earlier mentioned design objectives. Making the interactive system part of an activity (objective 1), would make it meaningful and information about the stone age and Tyresta National park would become more interesting as the users become involved. During the work on the operative image divergent solutions were sought in sketching and storyboarding, and the work would lead up to a specification in the form of a prototype. Sketches were continuously evaluated to take care of qualities of earlier solutions and move the design process further. Sketchy alternatives are necessary to avoid getting stuck on a single solution (Gaver & Martin, 2000). At this stage of the process it can be described as branching exploration and comparison (Buxton, 2007). Plus and minus lists were made in the sketches to evaluate the ideas socially, aesthetically, practically and technically. This clarified qualities and consequences of the different alternatives.

The sketches, storyboards and prototypes were initially very varied and simple but were always made in relation to the design objectives. New objectives came up that had not surfaced before and other were left out when they did not seem relevant. This means that the design process moved back and fourth between operative image and vision.

The first sketches explored different kinds of interaction with the system despite that we yet did not know what it was going to be. Designing for embodied interaction and low level of abstraction (design objective 4) involves feeling for yourself as a designer how the interaction that the sketch depicts, will be experienced. To do this, simple sketches gave rise to prototypes. During sketching and storyboarding this interaction seemed interesting but we could not know how it would feel. Therefore we built simple prototypes, and explored ideas using RFID, data gloves, and gestural control with a gyro input device.

Storyboards has been a way to communicate how ideas would work in use, to understand usage, and to get new ideas. Buxton's (2007) sketching techniques has enabled us to put technology into a situation of use and work towards design objective 3, which involves put the system to use outdoors.

As the design process progressed, the sketches became more detailed and took the form of

simple flowcharts. The focus moved from sketching interaction with technology and social use of the technology, to sketching the structure of the interactive system we were going to build. At this later stage of sketching the centre of attention was user interfaces, technology and organisation of interaction. This means that a specification based on sketches was created, at which the final prototype could be developed. During the prototyping, new kinds of problems emerged; the sketches depict turn taking and interaction, but say nothing about time, delay and the experiences people will have of the product.

Testing of the Stone Age Trail

An important part of testing an interactive system is to understand what meaning the users find in it. We used cooperative evaluation and think-aloud (Preece, Rogers & Sharp, 2002; Ericsson & Simon, 1993). Three user tests were made, and in the first test two users, who we call Anna and Beth, used the prototype. Anna and Beth were both around 20 years old and knew each other since before and had never visited to location of the test before. The test was performed outdoors where some information boards were place nearby a trail and others were more difficult to find and placed further away in order to encourage exploration of the surroundings. The trail resembles our envisioned trail for Tyresta National Park but is at a smaller scale with fewer information boards. We allowed the users to read the first information board, which was meant to describe how the system would be used. Two test leaders walked with the two testers since the design was to make the persons using the system move about. The testers were encouraged to talk aloud when they did not understand something concerning the system, and they were given help if they got stuck.

One test leader in cooperation with one test person made a second user test. The game was played indoors to test how the cooperation around the finishing game worked, and to find usability problems.

The third test was analytical (without users) and performed as a cognitive walkthrough (Preece, Rogers & Sharp, 2002) to identify usability problems and discover possible uses of the system. This test was made in the forest environment and we as analysts tried to walk in the shoes of the users.

The test results are summarized below in four headings that describe important aspects of how the system was used during the tests.

Competition Rather than Cooperation

In the first test both Anna and Beth read the first information board, after which both scanned the barcode on the board. The handheld computer now showed the menu for choosing character. Anna chose character first and Beth chose her character quickly thereafter. Earlier, when both had been reading the first information board, Anna had noticed a board out in the forest. After the animation that described her character she ran to that board and scanned its barcode. Beth followed running and also scanned the barcode. Beth's handheld computer then told her that Anna already had been there. After this event they stopped following each other and spread out instead. They now started competing and wanted to find tools before the other. The design work had aimed for cooperation rather than competition (design objective 5) and animations shown on the handheld computer emphasised this. However, Anna and Beth did not look at the animated film sequences when the situation was characterised by competition.

Exploration

When Anna and Beth used the prototype their focus was on their outdoors surroundings and on boards placed in the forest. This supports that the prototype succeeded in encouraging exploration of the area (design objective 3). During a sequence in the beginning of the trail, Anna ran towards an information board and scanned its barcode. An animation was shown on the handheld and she focused on that for about ten seconds, but got tired of it before it had reached the end. The most interesting part seemed to be the exploration of the surroundings. To begin with Anna and Beth were more interested of the film sequences, and also said so themselves, but later on during the test their main goal was to get first to every tool rather than watch the animations. It seemed like there was no need for long animations to encourage continued play.

Easy to Understand

The basic interaction of walking up to found information boards and scan barcodes was easy to understand. The interaction with the handheld computer was however not as interesting and the users could easily miss information that was important in the Stone Age Trail. For example, at one of the tool boards in the first test, Anna missed answering a question asked on the handheld computer, and if she had answered correctly she would have gotten the tool. Instead of waiting for the question she just ran off in search for more boards to scan.

Cooperation and Communication

The finishing game sequences had a very simple plot but was still an engaging game where the interaction with the system worked well. The interaction of the participants was more about coordinating cooperative work rather than understanding the system in itself. The participants put up strategies and gave each other assignments like: “Go and get wood, while I get fish and pigs!” In our own tests and walkthroughs of the game we realized that we had to communicate to coordinate the cooperation. That coordination was performed by talk as well as gestures, and it is worth noting that the handheld computer was no hindrance in this coordination.

Discussion

Embodied interaction (Dourish, 2001) and technology as experience (McCarthy & Wright, 2004) are both theoretical frames that imply that it is not possible to foresee how a system will be used. For us, forming and working towards a set of design objectives, became a way of understanding how the two theories can complement each other and be applicable in a design process. Our fundamental design objective was to design the system to be part of an activity rather than merely an informative system (design objective 1). Designing for an activity means that we as designers focused on the meaning of spending time outdoors for people, while still having the technical artefact in mind. For example, the nature experience is enriched by the focus of the Stone Age Trail on the surrounding outdoors environment. A strictly informative system would not provide this focus. The other design objectives were used to put up a framework for the activity that we were designing for. They describe important aspects of design for nature experience. The design objectives have been formed and developed with a basis in the theories, but also by the contextual inquiries, the sketching and the prototyping.

Design objectives give something to work towards during the design process, but they are

also means for evaluation. The tests of the prototype indicated that the users understood the system easily, and this was a means for making the system part of their activity where they could place focus on other things than the system. Design objective 4, that the system should have low level of abstraction and low learning threshold, is based on our reading of embodied interaction. A way of creating such a system is to allow people to make use of their surrounding world and real tangible objects (Ishii & Ullmer, 1997). The hidden boards that we had placed out were a way to create a system with low level of abstraction that provided an enriched meaning to the visit in that environment. The Stone Age Trail played a central role in the activity. They did not have to constantly focus on searching for information boards, if they did not want to. Instead, they were free to explore their surroundings outside the computer system (design objective 3).

After reading the first information board the users understood the basic interaction with the system, they knew that boards gave information and that scanning of barcodes gave more information in the handheld computer. The intention of using the system became then to find boards to move on. A strong coupling (Dourish, 2001) between surrounding environment, other people, board, scanner, screen, hand and body would make the entire game to be ready-to-hand and thus make it possible for the user create higher-level actions to fulfil their intentions and create a meaningful activity.

We observed that users in the Stone Age Trail changed between coordinating the final game by for example saying “Go and get wood, while I get fish and pigs!”, and in the next step focusing on the handheld computer and the game. This is an example of how people could traverse through multiple layers of coupling in the game system (including environment, other people, board, scanner, screen, hand and body), without being breakdowns in interaction.

The test users found their own ways to use the Stone Age Trail. During sketching, we believed that the search for hidden tools in the forest would be made through cooperation (design objective 5), but in the tests Anna and Beth were instead competing. It is good that the Stone Age Trail can be used in different ways, but since this was not expected the users missed important clues and functions. If the animations had been shorter and less interaction would be performed on the screen of the handheld this problem would probably not occur.

Randell et al. (2004) also describe how the Ambient Horn was used in unexpected ways. Instead of listening to place specific sounds, which was the general idea, the users started collecting sounds to listen to later. All users are unique and bring earlier experiences to the situation of use, and will therefore meet the system with a different set of expectations (McCarty & Wright, 2004). The culture also affects how people use technology (Dourish, 2001). Users in a culture characterized by competition can understand the use of the system as a competition rather than a cooperative activity.

Sketching and storyboarding are ways to constantly do design with people in focus (Buxton, 2007), but they do not convey the whole picture of what the usage will be like. Testing prototypes involves learning more about how the conceived system is used in terms of cooperation and co-experiences. We need to see what people actually do with the system.

To conclude we wish to emphasise that setting up overarching design objectives was a way of understanding how the theories of embodied interaction and technology as experience could complement each other and be applicable in the design process. When designing for nature experience we argue that the objective should be to design for an activity rather than merely designing an informative system. In order for a system to be part of an outdoors activity, it needs to have a low level of abstraction (we used physical information boards and

barcode scanners). Embodied interaction and tangible user interfaces contribute by creating a low level of abstraction and the users can instead focus on what they want to do which provide for a shared nature experience. A designed system for nature experience should also be open for diverse ways of usage. This diversity is difficult to foresee and creating and testing prototypes is hence of central importance.

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Notes

1. See the demonstration video: http://www.youtube.com/watch?v=1NgAffhs3pU

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