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Experience Design for Interactive Products: Designing Technology Augmented Urban Playgrounds for Girls

Aadjan van der Helm*♦, Walter Aprile♦ and David Keyson♦

♦Industrial Design Engineering
Delft University of Technology
(Netherlands)

ABSTRACT

Recent technological developments have made it possible to apply experience design also in the field of highly interactive product design, an area where involvement of non-trivial technology traditionally made it impossible to implement quick design cycles. With the availability of modular sensor and actuator kits, designers are able to quickly build interactive prototypes and realize more design cycles. In this paper we present a design process that includes experience design for the design of interactive products. The design process was developed for a master level course in product design. In addition, we discuss several cases from this course, applying the process to designing engaging interactive urban playgrounds.

Keywords: *Urban, Prototyping, Exercise, Sport, Serious Game, Gender, Obesity, Experience Design*

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1. Introduction

The design activities we report on were carried out in the context of the Interactive Technology Design (ITD) course offered at Delft University of Technology, Master in Industrial Design Engineering, Design for Interaction. The designers were teams of students with some experience in user centered methods. The design problem was in the domain of urban playground facilities: traditional urban playgrounds have issues as the playgrounds don't seem to attract children to the proper extent. The children stay at home playing computer games that deprive them of physical exercise and real world social skills. These problems are especially apparent in the disadvantaged urban

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* Corresponding Author:
Aadjan van der Helm
Faculty of Industrial Design, Room 10-2A-11 to 23, Landbergstraat 15, 2628 CE Delft, The Netherlands
Phone: +31 15 2783029
E-mail: a.j.c.vanderhelm@tudelft.nl

areas. In light of the health problems this causes, many initiatives have attempted to develop solutions (de Vries, Bakker, van Overbeek, Boer, Hopman-Rock, 005).

Experience prototyping can be a useful tool for involving users in the design process at a level where they can contribute meaningfully to the project. We believe that it is particularly useful for design spaces where emotional involvement and enjoyment are of fundamental importance.

Buchenau and Fulton give an operational definition of an experience prototype as "…any kind of representation, in any medium, that is designed to understand, explore or communicate what it might be like to engage with the product, space or system we are designing" (Buchenau & Fulton, 2000). The focus is "the experiential aspect of whatever representations are needed to successfully (re)live or convey an experience with a product, space or system" (ibid.)

When involving children as well as other user groups in the design process, it is useful to clarify what is expected of them. User involvement can run from a brief prototype field validation to conceptual and brainstorming input in the ideation phase. (Druin, 2002) describes four different roles that children may have in the design of new technologies: user, tester, informant and design partner. In the project at hand, namely the design of interactive playgrounds for girls, we choose to involve children as *informants*. This means that their input was sought from the beginning of the design process; however there were no children operating as team members in the design teams. The choice of this specific role was dictated by our desire for early and profound user involvement in a project whose user population was initially quite unknown to the student design teams, balanced by the logistical issues of involving children in design work, and by the curricular necessity of producing a technology-based solution.

When involving interactive technology in the design process it is important that it is *ready-at-hand*[1] for the designers to use. Designers should be able to work with sensors, actuators and simulated product functionality in a sketchy manner (Buxton, 2007). They make many 3D sketches to study the complex interdependent relationships between products, users and context. This is made possible by using high-level programming tools and modular sensor systems (Hummels, Overbeeke, & Klooster, 2007). In this way design iteration can be performed quickly steering clear of complex and time consuming engineering work.

[1] A tool that is ready-at-hand (zuhanden) enables the designer to concentrate on the content of his task and not on the technology tool that he is using. For example, for a typical user a computer mouse is ready-at-hand. This concept, originally Heidegger's, was applied to the design context and brought to the fore recently (Dourish, 2001).

From a method point of view, the purpose of our work is to develop a system that solves a specific problem that we will detail below. Similar to (Jensen & Skov, 2005), our design approach has an *engineering* purpose, i.e. to develop a system that solves a specific problem. The design by experience approach applies the methods of *field study*, *action research* and, more importantly, builds on the notion of *applied research*. Applied research is defined as "…research where intuition, experience, deduction, and induction are used to analyze a specific research problem [through] trial and error based on the capabilities of the researcher" (ibid.)

In this paper a detailed description of a design process developed for the Interactive Technology Design master course is presented. Student design examples of the resulting projects for urban interactive girl playgrounds are presented. Finally, conclusions are drawn about the application of the described design process.

2. Design Brief

Several Dutch municipalities have observed that the extent of physical activity of children in city playgrounds has reduced in recent years. This phenomenon has major health consequences for children and thus for the future adult population. In 2006, the Dutch Ministry of Health, Welfare and Sport commissioned TNO, a Dutch research organization, to study this problem and find the success factors that make urban playgrounds attractive to primary schoolchildren. The study involved observing children and measuring their energy expenditure at six playgrounds in various disadvantaged neighborhoods in big cities of the Netherlands (Bakker et al., 2008). The study delivered a set of recommendations of which TNO selected two for the design brief to the ITD students. Firstly, it was suggested to involve interactive technology in the urban playground facilities to provide a closer match to a generation of children accustomed to computer games and interactive products. Secondly, it was suggested to pay more attention to make the playgrounds attractive to girls because this group was underrepresented at the existing urban playground facilities.

TNO's design brief was used in the ITD course along with other briefs on very different topics. Apart from involvement in the launch of the assignment and in the final design reviews, staff from TNO has played an ongoing role in providing expert feedback. Students were instructed to consider many possible categories of design solutions: wearables, portable devices, cell phones or web-based services and of course site installations. In instructing the students it was made clear that the fact that the design brief was related to a specific class of locations did not mean that the solution had to be an intervention on the physical space of a playground. Nonetheless, the majority of the student teams chose this type of solution.

At the same time, students were instructed to use interactive technology in developing their concepts, as part of the course requirements. Although this is not a technology-driven project and no specific technology was imposed, one of the objectives of the course is to increase the students' skills in the area of interactive prototypes: this requires, among other things, knowledge of and exposure to certain technologies. Lastly, we asked the students to focus on experience rather than on context, background and historical precedents.

3. Design Process

The experience driven design process was divided into 3 periods, the first lasting one month, with a focus on physical tinkering and making experiential prototypes in many short iterations. The second, also lasting one month, involved using interactive technology, and it required several iterations of slightly longer duration. Lastly, the third lasted two months, with a focus on involving children in two sequential user-tests. The threefold division of the design process was mainly based on educational goals so as to expose the students to using sensors and a software development tool. The changing of pace in the three periods, from short to longer iterations, reflects the progressive clarification of the concept and the increasing depth and fidelity of the experiential prototypes

In the first period hands-on workshops were held with students to introduce the students to the interactive technology tools e.g. Phidgets and Max/MSP. Throughout the whole semester the students worked on their design brief making experiential prototypes, testing these, reflecting on the outcome and redesigning the concept. This process was repeated again and again in sync with each stage of the course.

Throughout the entire semester in addition to working on their design brief, the students were provided with lectures focusing on aspects of interaction design. Faculty members as well as outside experts gave talks, for example on cultural aspects, child play, aesthetic aspects, and other interaction design cases.

3.1 Physical Experiential Prototypes

The first assignment for the students was to create a booklet. The approach was based on work by (Aprile, Boland, & Mirti, 2006). In this assignment the process considered most important was: understanding user needs, getting acquainted with where to find material, tools, and workspace, forming workgroups. The deliverable was a physical booklet for storing notes about the project or even better with some meaningful relationship with the design brief.

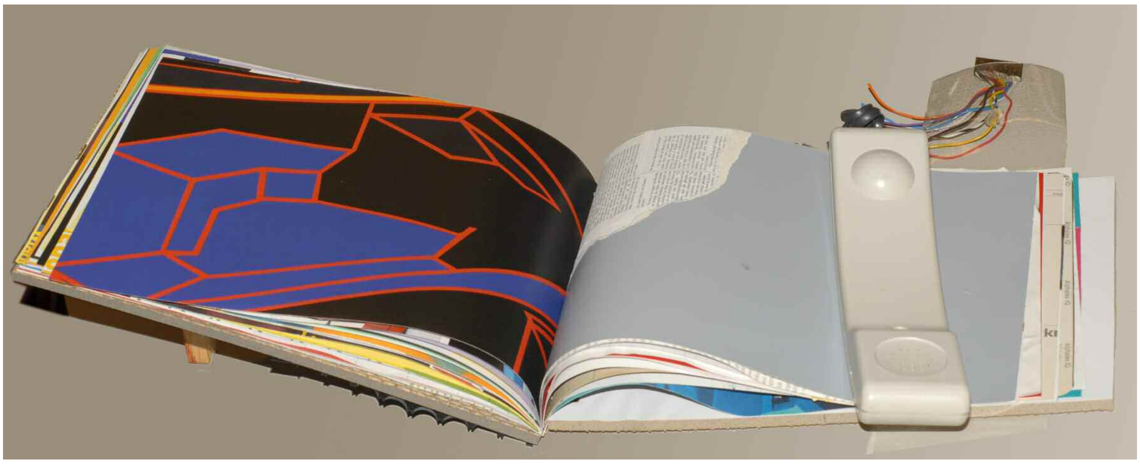

Figure 1. A collage project scrapbook with communication capabilities.

The students were then asked to design a concept and present it by including physical prototypes and video/audio prototypes in their presentation. The physical prototypes underwent several iterations, testing occurred with each group of students. To communicate the dynamical aspects of their concept we asked them to present a video prototype (Vertelney, 1989) or use playacting (Boess, Saakes, & Hummels, 2007) or Wizard-of-Oz techniques. The period finished with a plenary presentation and discussion of all projects.

3.2 Involving Interactive Technology

The second period of the design process focused on the actual design of interactive prototypes. During the previous period the students were familiarized with Phidgets and Max/MSP: Phidgets is a modular system of electronic sensors and actuators that requires no technical skills for assembly and interfaces with Max/MSP; Max/MSP is a visual dataflow programming language that is easy to use for non-programmers. Students were also provided with a collection of Max/MSP-patches that helped them to interface the Phidgets and perform basic sensing and control tasks. The students were instructed to use these tools to develop their interactive prototypes.

The design phase concluded with plenary presentation and discussion in which each group first described their concept, followed by a demonstration and a short test by a student not from the presenting group.

At the end of this part of the design process, students were asked to evaluate their work thus far and come up with a redesigned concept that would be delivered as an A5 postcard sent to the teaching staff, see Figure 2.

Figure 2. The postcard format, applied in our lab in the past by Pieter Jan Stappers, enforces a concise and economical presentation of a concept.

One side of the postcard could be used to visually explain the concept, while only part of the other side could be used to explain the concept in words - the rest was for the stamp, recipient and address information. In addition the students had to send in a second postcard of a technical nature, featuring a diagram of the required technology on one side and a parts list on the other. The technical postcard forces students to assess realistically what it takes in terms of time, money and equipment to build their intended prototype and it is useful for the teaching staff to assemble a shopping list of parts and assess the load on the lab personnel.

The staff worked on the principle of providing a technology array that the students could choose from: it was felt that the proper selection of the technology set to use, with its attendant limits, availability of local expertise and practical difficulties was an educational part of process.

3.3 Involving Users

The third period began with feedback from the teaching staff on the delivered postcards to further refine the concepts and tune communication about the technical aspects of the concept. During the first two months of this phase user testing was conducted. This allowed the students to evaluate their interactive prototype with children, giving rise to a further iteration. We invited 8 girls in the age range of 8-12 who participated with consent from their parents and without compensation. The girls played 9 different games in groups of 2 for a period of 2 hours; we rotated the groups every 15 minutes so each game was played by at least 3 different groups.

The students were then asked to provide a plan for building a prototype for the final user test at the end of the period. They were given a small budget and had to specify a building plan for a prototype that could withstand the children use for one afternoon. During the construction process the students were assisted on technical matters.

The students were instructed to finalize the prototype one week in advance to allow for some testing and tuning.

3.4 Final Prototype

To arrive at the final prototypes, two more technologies were introduced to the students: Flash and Arduino. Though no formal instruction was given in class about Flash or Arduino, lab assistance was provided for the students that wanted to use the technologies. Many students already had some level of knowledge of Adobe Flash (formerly Macromedia Flash), but none had worked with Arduino. Arduino is a physical computing platform that allows hobbyists and students to build simple interactive prototypes: it consists of an electronic board that includes an AVR microcontroller, and a simplified cross-platform IDE that hides the complexities of the AVR toolchain. The Arduino programming language is basically C.

With Arduino and Flash on the stage concurrently with Max/MSP and Phidgets, the staff and the students engaged in a process of iterative fitting of the technology to the prototype according to the student's abilities. This process included critical *technology clinics*, consisting of brief, 15-minute sessions focusing on specific prototype issues, moments of *triage*, during which it was decided which features of the concept would survive into the prototype and *technological escalation*, when the staff suggested that a simpler technology (like hacking a USB keyboard) was not sufficient any more, and that the group should escalate to something more powerful and complex. Iteration was absolutely necessary, because the students were building up their technological abilities as the course progressed, refining their tools while working on the prototype itself – in accordance with the principles of situated learning.

4. Evolution of the Design

In the following section four example student projects are presented. The projects have been chosen because they represent very different angles of attack to the same design brief, namely urban girls in the Netherlands not doing enough exercise. We are going to discuss a wearable device, a portable device, a stationary device and a site installation to show a variety of possible approaches.

4.1 S'Buzz, a Wearable

The S'Buzz group chose to design a wearable product to support a non-verbal dance game of "follow the leader". After the initial physical tinkering (see Figure 3), the team abandoned the idea of high resolution motion analysis and decided that the two players would communicate only through movement and haptic feedback through vibration. In this case, an explicitly low-resolution approach was chosen, based on the team technological expertise and on initial user testing that revealed that a significant level of enjoyment could be obtained with simple movement detection.

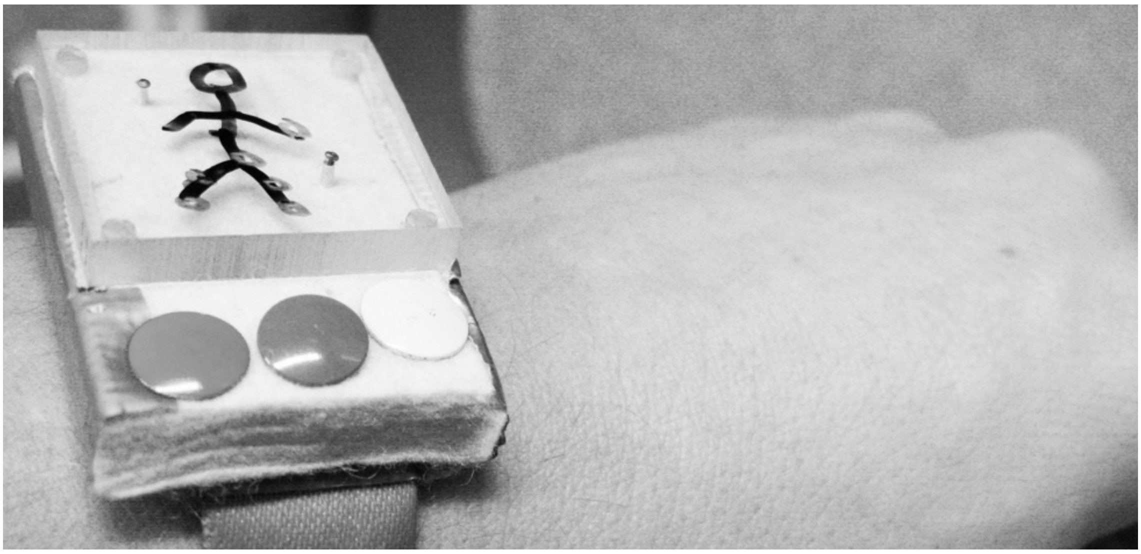

Figure 3. A very early prototype of S'Buzz still includes a screen that was later rejected.

The finished product will use shock sensors to detect the leader's movements, and cell phone vibrators to convey game hints to the other player. This project underwent significant change during its development: initially the sensors and vibrators were mounted on the ankle and knee joints. Sensing was done via accelerometers and there was an idea to capture dance movements and approximate motion capture. Subsequent prototypes use simpler shock sensors instead of accelerometers, employ a more abstract representation of movements and move the knee sensors to the wrist to capture a broader range of body motion. The experiential prototype was tested on users through a Wizard of Oz prototype in order to validate the concept without making a substantial investment in a specific technology, see Figure 4.

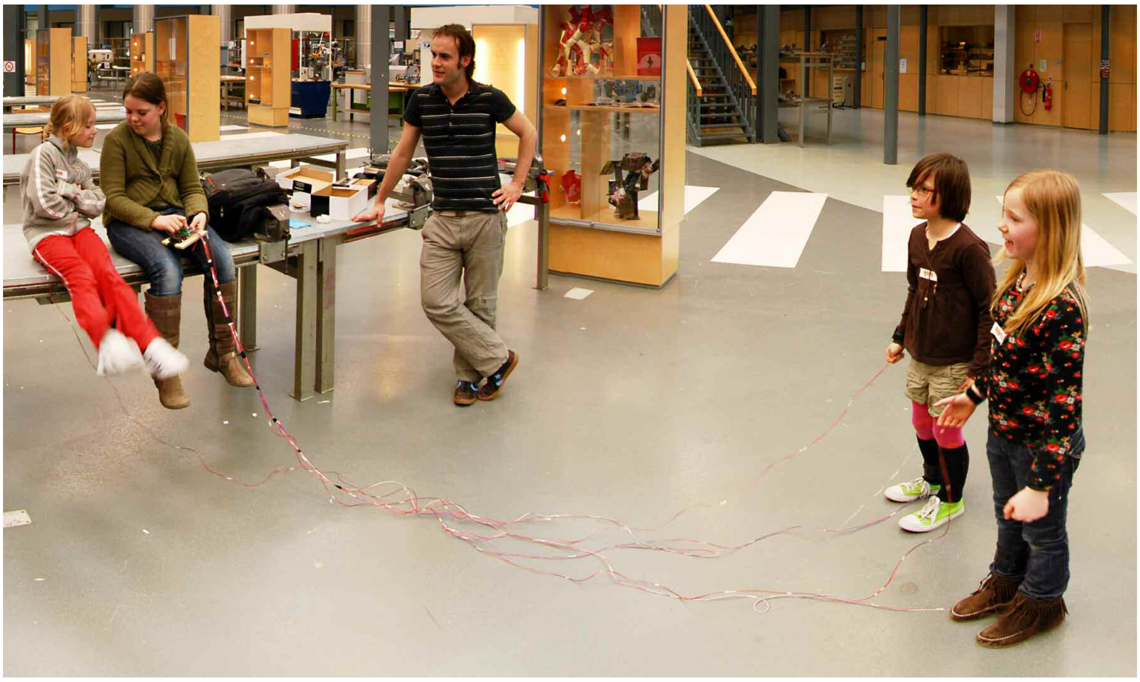

Figure 4. Users from the target group found original ways to use the prototype, in this case by splitting the vibrating bands between two girls.

The final prototype of the S'Buzz project will use two Bluetooth Arduino boards communicating directly between themselves.

4.2 Nelson, a Portable Object

The group that designed Nelson concentrated on adding emotional and relational aspects, normally associated with a pet or with a zoomorphic plush toy, to a very common object: a ball. The team considered that soccer, particularly in the version played inside the panna cages, is a fast, competitive and aggressive game.

Nelson was designed to emphasize the social and relational aspects of play, and to remove the competence threshold that –it was found in early field studies - is one of the factors that prevents girls from wanting to use the urban sport facilities, see Figure 5. The field studies additionally show that the girls indeed go to playground areas but they don't join the boys in the football games.


Figure 5. Nelson presents itself as a friendly/familiar object endowed with a playful, childish, behavior.

Acceleration and shock sensors inside Nelson allow it to sense whether it is being rolled around, thrown, spun or kicked. Limited computing abilities (a remote PC in the experiential prototype, a fully embedded Arduino system in the final version) allow it to retain state information and to guide the user through a progression of more complex ball-playing activities.

Nelson expresses its state and communicates with its users through a color LED and cute nonverbal sounds. By exploiting the child's aptitude for make-believe play and for imbuing objects with life-like attributes (see Figure 6), Nelson bases its interface on emotions: you don't play to reach a high score, you play to make Nelson happy!

4.3 Leo, Urban Furniture

The Leo groups set out with the clear targets of attracting girls to the playground and improving their soccer skills. It also stated that forcing the girls to play with the boys was not an objective. After some user research, the group decided to go for an unisex solution and to shift the focus from winning to playing.

LEO (Light Emitting Objects) presents itself as a blobby, tree-like addition to the playground. It stands outside of the formal game areas. The skin of Leo is covered with impact sensors: the sensors can be activated by ball impact but also by a hand hitting the surface, see Figure 7.

Figure 6. Nelson depends critically on evoking a strong emotional response.

Figure 7. Leo final prototype: its large physical form and large array of sensors permit easy and satisfying multiuser interaction.

The behaviors proposed are all intentionally simple and generic: the group is not prescribing a specific game or even a mode. Players can e.g. decide to play collaboratively at slapping Leo to turn on all its lights in the shortest time: or that the game consists of one team trying to turn on all the lights, and another one trying to turn them off.

One fixed behavior is that Leo starts in a dark mode, with all the lights turned off. This was done in accordance with user testing that revealed that turning the lights on was associated with “growth” and “making the object beautiful” and thus created positive emotional connotations.

Leo has no additional interface elements such as buttons: it can be reset or sent into another game mode by sending the ball through portions of it like a hoop or a tube built into the base.

4.4 AudioPlay, A Site Intervention

The AudioPlay group decided to concentrate on the 4-12 years old age group. As at this age fantasy play is a strong attractive, the group decided to explore imaginary environments such as the Jungle, the Waterworld and the Forest. From the beginning, this group decided to concentrate on acting on the space that is *outside* of the existing panna cage or football court, in order not to create conflict with other users of the *inside* space. Because of the well-known technological and logistical difficulties with displaying images, even at low quality, in outside locations, the group decided to work strictly with sound; in a similar vein, it was decided to go for a concept that could stand the use, abuse and extra-intentional use that any public installation must face.

The initial concept was, in abstract term, a sensitive surface containing a grid of floor-tile sized pressure sensors or switches connected to a processing unit that can output spatial sound through a system of four speakers, see Figure 8. This would be a platform for at least three different games, one based on chasing frogs, one where the player crosses a stream using stepping stones, and a third one based on performing a Native American rain dance.

This concept remained stable through the evolution of the project: although though a process of progressive narrowing in scope only the frogs-squashing game was developed, the hardware and part of the software remain generic enough that the other games could be implemented as well, see Figure 9.

The possibility of upgrading the software and introducing new and seasonal games to a stable hardware platform is an important feature in a concept that implies the building of rather costly and stable infrastructure in a public area. In other words, this project addresses the issue of *content* and makes possible to retain a feeling of novelty and excitement.

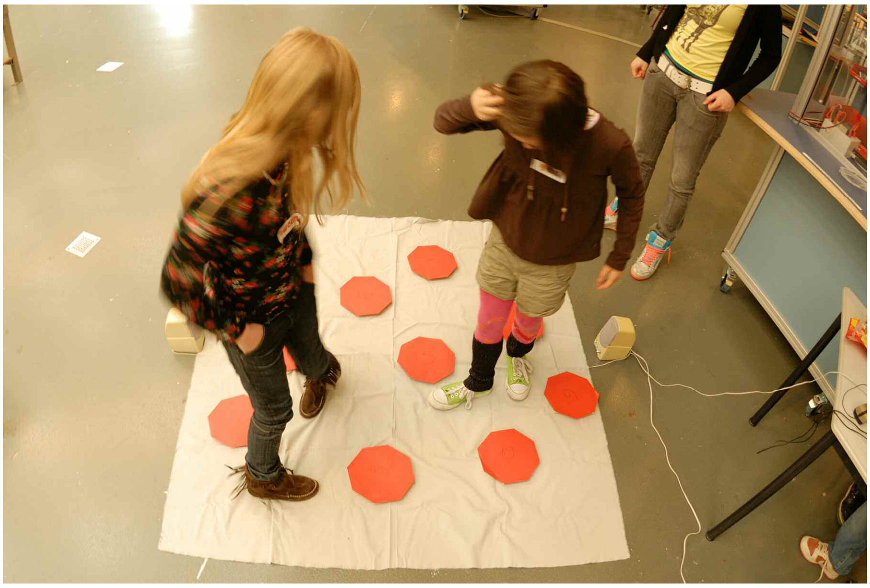

Figure 8. Early user testing: the physical structure of the board is undefined and only two of the four planned speakers are present, but useful user observations can already be made.

Based on user input and observation, scoring was left out intentionally: girls can enter and exit a game of Frogs at any moment, and more than one girl can be playing at the same time. This was done in accordance with the perceived user group reluctance at engaging in excessively rigid, performance-based games.

Figure 9. The final prototype being tested hard by typical users. The game can be played by one to several girls at the same time.

5. Conclusions

In comparing the design by experience approach to more formal top-down methods, in which for example user requirements are formalized and then translated into design concepts via a task model, the ED (Experience Design) method appears to be particularly well suited to the design of products in which the sense of creativity and engagement are central to the product. Given the wide range of design possibilities afforded by interactive technology when applied to physical environments such as an urban playground, and the inherent resulting design complexity, the ED method offers the possibility to rapidly develop and test ideas via a rapid iterative trial and error approach, accompanied by actual experience. This very process appears to further lead to new ideas that may have otherwise not been conceived. Underlying the approach is the use of rapid prototyping tools such as Max/MSP and modular hardware kits such as Phidgets. Research is currently being conducted towards developing a middleware toolkit that will further enhance the reusability of software-hardware combinations, while still striving to maintain the freedom of a creative and experimental design space.

Figure 11. The BeatBox installation features a physical interface to sampling and remixing capabilities.

Although the mentioned high-level tools have proven beneficial to the early stages of the design process allowing the designers to quickly iterate over design ideas, it turns out that applying these tools to later stages of the design process is sometimes problematic for concepts that require e.g. small form factors and wireless communication. To build experiential prototypes for these types of concepts one must make a technology shift from easily programmable, familiar, personal computer platforms to the more difficult class of embedded platforms. This takes the designer out of the loop and involves engineers with a consequential loss of designer influence.

One may conclude that, despite the demonstrated appeal of interactive playgrounds, current design practices may cause the lack of widespread real-world implementations. In this context the current paper aims to pave a new way that may assist urban designers to think and design “out of the box”.

Several points can be made about the structure and the various stages of the outline design process. The postcards worked well to force the students to be brief and clear about their concept. The technical version was a good tool to tune the communication between teaching staff and students. Finishing the prototype one week in advance of the user test gave the students an excellent opportunity to play with the prototype they had been working on for the whole semester.

6. Acknowledgments

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