Enhancing Multisensory Environments with Design Artifacts for Tangible Interaction

Héctor A. Caltenco
Certec, Dept. of Design Sciences, LTH
Sölvegatan 26
223 62 Lund, Sweden
+46 46 222 08 77
hector.caltenco@certec.lth.se

Henrik Svarrer Larsen
Certec, Dept. of Design Sciences, LTH
Sölvegatan 26
223 62 Lund, Sweden
+46 46 222 40 38
henrik.svarrer.larsen@certec.lth.se

Per-Olof Hedvall
Certec, Dept. of Design Sciences, LTH
Sölvegatan 26
223 62 Lund, Sweden
+46 46 222 40 94
per-olof.hedvall@certec.lth.se

ABSTRACT

Even though multisensory environments (MSE) incorporate artifacts and technology to provide sensory stimuli, most of these artifacts are non-interactive. Twenty-four children with profound developmental disabilities from three MSE institutions have been involved in a research study. A handful of interactive design artifacts, which have been developed as a tool for ideation and to enhance the use of MSE by promoting children's engagement are presented. With these artifacts the children have shown us a vast topology of interaction and bodily engagement, showing a potential for haptic and audio interactive design fields to contribute to a more participatory MSE practice.

Keywords

Tangible interaction, disability, children, MSE, artifacts, interfaces, physical computing, arduino, capsense, Kinect

1. INTRODUCTION

The pedagogical Snoezelen practice, or multisensory environment (MSE), has been described as another world [5]. It does not rely on verbal communication, but instead incorporates sensory artifacts and environments to blend sensory stimuli, such as sights, sounds, textures, aromas and motion, with the purpose of enabling a child or adult with developmental disability to find the calmness or impetus needed to engage in the world. These artifacts are used to build an environment that initiates changes in arousal by affecting the relaxation process, reducing anxiety and/or pain (both physical and emotional). Currently, the artifacts found in MSE rooms are reactive, if at all, via push buttons and switches. Many of them only produce non-interactive dynamic stimuli. Very few of these artifacts are interactive by computational means, and the ones that are do not seem to have tight and co-located coupling and lack more elaborated behavior.

The purpose of this paper is to open up for dialogue and ideation with our colleagues in the haptics and audio interaction design fields to contribute to a more interactive and participatory MSE practice. A demo of the design artifacts is to be presented at the conference. This paper is based on a paper by Larsen and Hedvall [4], and on the ongoing work in the SID project (http://sid.desiign.org), in which twenty-four children with profound developmental disabilities and pedagogical staffs from three MSE institutions participate. The project tries to dive into exploring ways that continuous coupling interaction can involve tactile and proprioceptive senses of such children, therefore promoting and enhancing the children's engagement in the MSE. This is done by using interactive tangible computing artifacts to enhance the children's interactive experience. The project's design process has three foci [4]:

a) The use of proximal senses, tactile pressure, vibration, balance, etc. rather than solely the prevailing audio-visuals.

b) The use of co-located continuous (and gradual) coupling interaction, instead of the current binary (on/off) interaction found in the common MSE practice.

c) The use of an aesthetic perspective perceiving artifacts as entities with rudimentary agency, which is both predictable and yet never the same.

The three foci bring sensitivities and curiosities to the fieldwork. But they also bring delimitations derived from the need of a more narrow scope, leaving out fields such as scent, gaze tracking, wearable computing and speech recognition. However, the foci relate very closely to the field of haptics, there is a natural relationship between physicality and touch [1]. The inclusion of haptic and sound feedback as part of the MSE artifacts could provide a strong pillar for collaboration between haptic research and the MSE practice.

The current paper describes the design artifacts used as an integral part of the research process. These basic yet interactive design artifacts are not products to be introduced to the MSE practice, but tools for ideation, sketches that are continuously being reshaped and reinserted into the collaboration with the MSE institutions.

2. DESIGN ARTIFACTS

The design artifacts in the project are explorative interactive sketches aimed to enhance the children's interactive experience and participation. Mock-ups had to be ruled out, as participants in the project cannot take part in interplays that require pretending or abstract thinking and dialogues. Wizard-of-Oz prototypes [2] were also ruled out for the most part, as the children indeed paid attention to "*the man behind the curtain*", instead of to the actual interaction. Therefore the design artifacts have to be interactive yet should also be manifold and easy to alter as we learn from the children's actions. Some of the design artifacts are presented below. All of them explore various couplings of light to touch, push, grab and hug. Some of them provide vibration or movement feedback to the interaction. However, in some of them, audible response will also be added.

2.1 LivelyButton

The thought behind the LivelyButton is to explore spatial co-locatedness. It is a simple construct of a capacitive sensor controlling two RG LED-strips connected to an Arduino (www.aurdino.cc) board, and a stepper motor connected to another Arduino board via an motor shield. The motor spins two metal spirals below the surface of a semi-transparent fabric on the top-side of a wooden black box.

A sliding potentiometer can be used to set the sensitivity of the capacitive sensor so the LivelyButton reacts just before and at touch. When activated, the Arduino master board sends a cyclic pattern of PWM signals to the LED-strips, backlighting the soft surface in interplay of light and spiraling shadows. At the same time, the master board communicates to the motor board via serial port, and the motor spins the metal spirals under the soft surface accompanied by vibrations and the sound of the motor (Figure 1).

The LivelyButton has promoted relevant discussions and inspiration regarding co-location. A modified version is being developed, which considers different visual and tactile feedback behaviors depending on the type, degree and length of the touch-interaction.

2.2 LivelyForm

This design points beyond the existing MSE practice by introducing a moving object. The thought behind it is investigating if the interaction with such a moving object can promote the child's own movement. The construct is a worm-like elongated form that can bend (curl) and stretch. A 24V DC-motor pulling a curled plastic sheet which acts as a spring is connected to an Arduino master board. A capacitive sensor connected to an Arduino slave board detects if the LivelyForm is being touched. Another slave board drives an array of LEDs. The boards communicate via I^2C protocol. If touched, it stretches and light patterns run along its inner side depending on its current "openness" and the time elapsed since the touch started. If not touched, the LivelyForm returns to a curled position. (Figure 2).

It was observed that the children tend to continuously grab the LivelyForm rather than alternating between touch and look, a single sensor did not make sense. A modified version is being developed, which lets the LivelyForm react to being moved rather than being touched, and responds with different movement and light behaviors depending on the degree of manipulation.

Figure 1. Left: Open LivelyButton showing metal spirals, LED-strips and motor components. Right: child interacting with the LivelyButton.

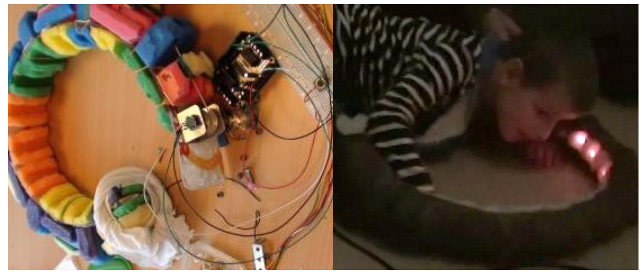

Figure 2. Left: Internal structure of the LivelyForm. Right: Child interacting with the LivelyForm, showing a capacitive sensing outer side with a semi-transparent lit inner side.

2.3 ActiveCurtain / ActiveSphere

The thought behind the ActiveCourtain was to relate the feel of one's body touching the material to color change where the child presses. The physical design artifact is basically a backlit projection of colored surface into a soft screen. A Microsoft® Kinect sensor is located behind the soft screen, detecting the location and depth of the "press".

On the first version of the ActiveCourtain, a colored and thresholded depth image of the Kinect is projected back to the screen. Therefore, pressing the surface of the screen changes the color of the indented area by an amount of thresholded steps, depending on the depth of the touch (Figure 3).

Based on the observed interactions and the deliberations with the staff, ways to make the design more inviting for interplays around simultaneous interaction are under investigation. A spherical version is being developed (Figure 4), which considers more elaborate temporal and spatial behaviors. It uses multipoint detection to send TUIO [3] messages to any TUIO clients, which project different animations (and sounds) to the ActiveSphere surface, depending on the type and degree of multi-touch interaction.

Figure 3. The first version of ActiveCourtain, using various ways of bodily engagement

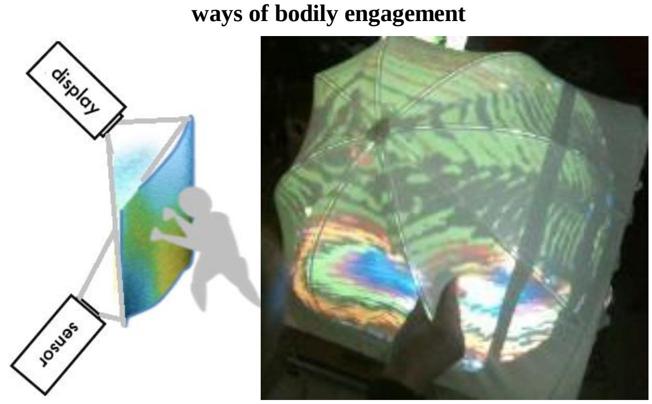

Figure 4. Left: ActiveCurtain/ActiveSphere components. Right: Example interaction with the ActiveSphere.

Figure 5. Child interacting with MalleablePillow, which responds with co-located gradual light-effects

2.4 MalleablePillow

The basic thought behind the MalleablePillow is to explore continuous and co-located coupling of actions and effects that are tightly connected to the child when using his or her body. The construct is a semi-transparent white fabric casing groups of LEDs distributed along three clusters of glass marbles, each with a microphone picking up the kneading sounds from the marbles. The signal from the microphones is filtered and pre-amplified and then used as an input to an Arduino board. The board controls the LED groups using PWM signals. More kneading gives more light intensity on cluster closer to where the kneading takes place (Figure 5).

The MalleablePillow has recently come out to the MSE institutions, and there have not been enough observations and learning yet. Another sensor setup using accelerometers is planned, which would make the artifact lighter and easier to carry. Moreover, it will give way to reacting to different ways of “malleability”, bending and manipulation. Sounds will be added as part of the interaction’s feedback.

2.5 HugBag

The thought behind HugBag was to make use of the child’s strong and gross motor based actions, while exploring continuous and co-located coupling of action and effect tightly connected to the child’s gross motor activity. HugBag is still currently under development. The construct is made of a semi-inflated ball resting on a semi-circular plate base. An accelerometer mounted on the base detects the tilt direction and angle while a Microsoft® Kinect sensor, also mounted on the base, detects the location and degree of deformation while being hugged, pushed or punched. These sensors control evolving light patterns and sounds as a response to interaction (Figure 6).

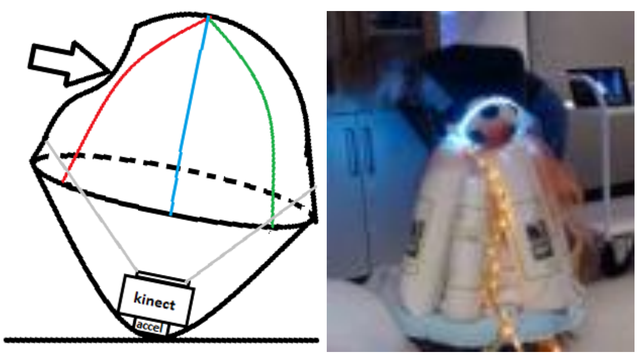

Figure 6. Left: Iustration of the HugBag with the Kinect and accelerometer on the base and LED-strips on the semi-inflated ball. Right: Early sketches of HugBag prior to the one currently under development

3. DISCUSSION AND CONCLUSIONS

A handful of interactive design artifacts, whose interaction is gradual and co-located, have been presented. These artifacts are used as a tool for ideation and to expand the MSE practice by promoting and enhancing the children’s engagement in MSE. To achieve this, the artifacts should not only be evocative, but also fairly simple to build and alter [4].

The artifacts have evolved as they travel between the three MSE institutions. The evolution takes place based on the observations from the children’s interaction and interpretations from the institution’s pedagogical staff.

The project is explorative in a manner of letting the children affect ideation in the design process. The artifacts enable us to ask “questions” so the children give generative feedback. With these artifacts the children have shown us a vast topology of interaction and bodily engagement: from putting the cheek on the LivelyButton to full upper body immersion into the ActiveCourtain, and even a finer motoric interaction when grabbing the MalleablePillow.

This exploration has opened up for novel ways of engagement inside the MSE practice. Yet, this is only the beginning of a change in the use of tangible computing technology for the already existing MSE practice. With this paper we hope to open up for dialogue with our colleagues in the haptics and audio interaction design fields to contribute to a more interactive and participatory Snoezelen practice.

4. ACKNOWLEDGMENTS

Our deepest thanks go to the children and staff participating in the project, for their inquisitiveness and engaged participation.

5. References

[1] Bianchi, A., Oakley, I., Lee, J. K., Kwon, D. S. and Kostakos, V. Haptics for tangible interaction: a vibro-tactile prototype. In *Proceedings of the fifth international conference on Tangible, embedded, and embodied interaction.* (Funchal, Portugal, 23-Jan-2011). ACM, New York, NY, USA, 2011, 283-284.

[2] Buxton, B. *Sketching user experiences: getting the design right and the right design.* Morgan Kaufmann, San Francisco, CA, USA, 2007.

[3] Kaltenbrunner, M., Bovermann, T., Bencina, R. and Costanza, E. TUIO: A protocol for table-top tangible user interfaces. In *Proc. of the The 6th Int’l Workshop on Gesture in Human-Computer Interaction and Simulation.* (Vannes, France, 5-Jan-2005). France, 2005, 1-5.

[4] Larsen, H. S. and Hedvall, P. O. Ideation and ability: When actions speak louder than words. In *Proceedings of the 12th Biennial Participatory Design Conference.* (Roskilde, Denmark, 12-Aug-2012). ACM, New York, NY, USA, 2012.

[5] Verheul, A. and Hulsegge, J. *Snoezelen another world.* Rompa, United Kingdom, 1987.