In: Proceedings of the 8th International Conference on Interaction Design and Children (IDC) 2009. New York : ACM. ISBN 978-1-60558-395-2. pp. 226-229

WeWrite: 'On-the-Fly' Interactive Writing on Electronic Textiles with Mobile Phones

Thomas Winkler
IMIS, University of Luebeck
Ratzeburger Allee 160
23538 Lübeck
+494515005176
winkler@imis.uni-luebeck.de

Martina Ide
IQSH
Schreberweg 5
24119 Kronshagen
+4943154030
m.ide@gmx.de

Christian Wolters
IMIS, University of Luebeck
Ratzeburger Allee 160
23538 Lübeck
+494515005101
wolters@imis.uni-luebeck.de

Michael Herczeg
IMIS, University of Luebeck
Ratzeburger Allee 160
23538 Lübeck
+494515005100
herczeg@imis.uni-luebeck.de

ABSTRACT
In this paper, we describe the background of the design and the new possibilities of interaction for teenagers with *WeWrite*, a JAVA-based interaction tool for mobile phones. *WeWrite* opens up new possibilities for interacting with self-designed and programmed wearables, using the Lily-Pad, the iconic programming interface *Amici*, as well as IDE Arduino. *WeWrite* has been designed and developed by three university students in close cooperation with teachers and thirty-one 10th grade students. *WeWrite* enables its young users to experience and reflect on e-textiles as creating new modes of communication, interaction and identity construction while writing letter strings. Using LED matrixes, animated forms of digital writing can be displayed on clothes (e.g. jeans and sweatshirts). Furthermore, LEDs can be attached to gloves that create the impression of air letters when moved quickly in darkened rooms.

Categories and Subject Descriptors
K.3.0 [**Computers and Education**]: General; H.5.2 [Information Interfaces and Presentation]: User Interfaces; C.3 [Special Purpose and Application-Based Systems] microprocessor/ microcomputer applications, real-time and embedded systems

General Terms
Design.

Keywords
Wearable computing, e-textiles, programmable environments, mobile phones, learning, iterative design, user centered design.

1. INTRODUCTION
The KiMM initiative has concentrated on the design and development, testing and evaluation of digitally enriched interactive learning environments for children and teenagers ages 4 to 19 for more than eight years [14]. We focus on whether young people can learn to design and program interactive systems themselves or by using novel interaction tools, designed in an iterative process within their day-to-day classes, and whether an additional pedagogical benefit emerges. Furthermore, we study effects on the joy of learning, especially in regard to science and technology, as well as general effects on identity construction and the critical reflection of novel interactive technology for everyday life. It is important that the learning scenarios are created and evaluated with children and youngsters and can easily be-come part of daily practical teaching at schools. This means that the employed technology is inexpensive and easy to handle. Additionally, the technology and the associated learning scenarios are meant to be directly incorporated into teacher education.

IDC 2009, June 3–5, 2009, Como, Italy

2. RELATED WORK
2.1 Letter Displays on Wearables
To enable interactive writing, a text display is needed. Electronic textiles may be combined with wearable displays which convert the front or back of a shirt into a projection area for arbitrary patterns like the *Philips Lumalive* does (Figure 1) [10]. Unfortunately, these t-shirts are not publicly available. Alternatively, artists like *Barbara Layne* integrate wearable LED-matrices into their fashion. In her *Jacket Antics* project, unique texts and designs scroll through the LED-array on each of the backs. If two people wearing the shirts hold hands, the LED-arrays present a third, synchronous message that scrolls from one person to the other, establishing a new pattern of communication (Figure 2). The capacity for interactivity in the animated cloth displays extends the narrative qualities of cloth and provides new possibilities for dynamic social interaction [15].

Figure 1. Philips light emitting *Lumalive* T-Shirt, 2006 [10]

Figure 2. Layne, *Jacket Antics*, 2007 [15]

The disadvantage of both, the *Lumalive* and Layen's creations, is that they can only play back patterns programmed in advance.

2.2 Wireless information transfer between handhelds and wearables

Leah Buechley also utilizes LEDs which are sewed to tex-tile surfaces via conductive yarn and which are driven by simple microcontrollers. Depending on the choice of micro-controller and available memory, simple animated patterns and text tickers can be programmed [7]. In cooperation with Nwanua Elumeze, Buechley developed a *Game of Life* cellular automaton for her LED tank tops, in which the initial state of the automaton is set via PDA and IR interface.

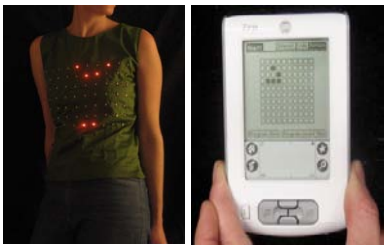

Figure 3. Tank Top; Programming cellular automaton with PDA, Buechley, 2006 [7]

This prototype of practical wireless information transfer between handheld computers and wearables (Figure 3) is not likely to be used in classrooms. Her vision was that the same basic PDA interface could work with a variety of de-vices. Her immediate goal with this work is to develop a general purpose e-textile display programming tool that, perhaps after setting a few parameters defining the size and shape of the display, would be able to send relevant information to any such device [6].

Inspired by Leah's vision of an on-the-fly programmable tank top, we looked for a data transfer solution from popular mobile devices (e.g., mobile phone) directly onto e-textiles. The availability of Bluetooth technology in mobile phones offers new ways of interacting with self-designed wearables. Furthermore, wireless connections via Bluetooth are less influenced by environmental conditions than infra-red connections.

2.3 Lettering displays in contemporary arts

Jenny Holzer's work serves as an example of the role of lettering in contemporary visual arts. Her text designs mainly consist of general public "wisdom" like »AN ELITE IS INEVITABLE« or »GOVERNMENT IS A BURDEN ON THE PEOPLE«. What appears as playful, amusing and sometimes provocative emerges as a form of critique on present life and society. Jenny Holzer's textual messages have appeared in numerous ways since the 1970s, e.g. as printed posters, on t-shirts (Figure 4), but also on

Figure 4. Holzer, *Truism* 1984 [9]

electronic display panels and tickers in public space.

Holzer's work is characterized mainly by its examination of language as a picture, in her early works as classical prints interestingly applied to clothing, which enables the wearer to carry the writings to different places [13].

3. INTERACTIVE LETTERING IN ARTS EDUCATION

3.1 Teenagers using new patterns of interaction and communication

Nowadays teenagers increasingly develop an understanding of the world by using language in unique ways. More and more, they use linguistically flexible association chains to communicate socially (e.g., IM abbreviations). Not tied to the physical space, they post comments in chat rooms or discussion forums. In contrast to the traditionally finalized usage of language that emphasizes the process of writing, the written word has become more democratic and exists in the form of a process-orientated social dialogue. In contrast to Holzer, the written word becomes more like a liquid.

In addition, teenagers of the 21st century reassess the physical when interacting with digital interactive media. Not only the mere extension of digital and virtual spaces, but also the digital enrichment of physical space is becoming more and more important [16].

3.2 Writing on wearables as performative process

The reflection of the surface of the body as an inter-active interface is based on what we wear on our bodies, clothes and jewelry expressing our personality. Teenagers, who practice flexible and non-linear identity constructions, recognize the creative potential of wearables as self-programmable interactive interfaces that can be used to extend their possibilities of expressing their bodies as parts of an outward-orientated identity.

A simple first scenario occurs when students can "write" words or abbreviations on their shirts and by this means initiate a situation-based communication. A possible and more ambitious scenario would be for the wearers of the e-textiles to be the projection spaces of other people's thoughts. This creates an artistic creative performance space for playfully exploring their identity.

4. TEENAGERS AS DESIGN PARTNERS FOR ROGRAMMABLE TEXTILES WITH TEXTUAL INTERFACE

Driven by the above-mentioned scenarios, we looked for an opportunity for the students to be able to alter the coding while wearing the e-textiles. Drawing on the results of Leah Buechley's work [4], methods for on-the-fly interaction with wearables were explored and developed.

Being guided through the process by their teachers, students acquired basic knowledge about electronics, programming and textile design. In regard to the technology, the design is based on the iconic programming environment *Amici* [1] and microcontrollers that can be sewed into fabrics (*LilyPad Arduino*) [2]. The *Arduino*-based iconic programming environment *Amici*,

developed within the European project *EduWear*, helps simplifying the students' first contact with programming.

4.1 Structuring the design process

The following questions guided the design process: What can lettering look like in the context of interactive programmable clothes? Which meanings should be conveyed and what should the displayed letter strings look like? Which ways can and should be used to interact with the written word in the context of clothes in a performative way? And finally, what kind of organizational and technological background is needed to put the ideas into practice?

Figure 5. LED-array on shirt

In regard to the display of letter strings, two possibilities turned out to be of special interest. The first involves sewing small LED-arrays (5 x 5) on a sponge rubber board. These 25 LEDs are sufficient to display letters and are a manageable project for the students working in groups. Small groups ensure a high level of participation in the process. Sponge rubber boards are less flexible than fabric and can be easily attached to different items of clothing (Figure 5).

An additional variety that incorporates the necessary movement within the physical realm has been developed drawing on MiniPov [18]. Sewed to both sides of a glove, the microcontroller (LilyPad) flashes 8 LEDs. The power supply and the microcontroller are unobtrusively attached to the wrist like a wristwatch, while the LED line is sewed to the palm of a glove to display text through waving (Figure 6).

Figure 6. Glove with a) *LilyPad*, upper side and b) LED-column on the reverse side

4.2 The Design of WeWrite: on-the-fly lettering

WeWrite has been designed by three university students to enable teenagers to control previously developed applications remotely. It does not replace the necessity to program the *LilyPad*, but allows the possibility to choose the letters displayed on-the-fly. To develop a real-world solution, *WeWrite* can be used with mobile phones. As these have become everyday gadgets, each student of the learning group at least owns a mobile phone that is equipped with Bluetooth. Mobile phones prove to be ideal devices to control wearables. Equally, there is the advantage that there is a Bluetooth modem within the *LilyPad* equipment. The Bluetooth modem can be activated via a serial interface of the *LilyPad* controller. The software for the mobile phone has been developed in *Java*, due to our equipment for the S60 platform used by *Nokia*. The solution works cross-platform since the features have been kept independent from the platform. On the side of the remote device, the university students provide a code developed in *Aduino*. This functions as a frame that embeds the programs developed by the students with *Amici* at school. The *LilyPad* processes the text received from the mobile phone and displays the text on the wearable (Figure 7).

Figure 7. Interface of *WeWrite* and long-exposure picture of the glove-mounted LED array

4.3 The students at school as design partners

Within the process of designing the user interface, the teenagers and the computer science students jointly developed a concept that focuses on a simple handling and is an example of a user-centered development process. The design process was accompanied by a pre-evaluation that studied the students' needs and habits when using mobile phones for writing instant messages.

The teenagers were able to initiate communication in the noisy and darkened environment of a disco by lettering from wearables (e.g. glove). Additionally, wearables have been programmed to ensure that certain strings of words only become meaningful within a group and depend on the physical location of the individuals. An additional form of usage is to provide trespassers with a means of using their mobile phones for writing text messages to interact with the performers wearing LED-arrays. The performers respond by positioning themselves in a specific spatial constellation to one another while creating new meanings with the received strings of words. Thus, *WeWrite* can be turned into an interaction tool that enables complex social interactions in the form of dialogues and permits creative processes in the physical realm.

5. EVALUATION

The ongoing evaluation is designed as a long-term activity. In November 2008 a first pre-evaluation was conducted and in May 2009 a comparative post-evaluation will be done. During the iterative design process there are continuous formative usability evaluations for *WeWrite*.

The pre-evaluation as well as the post-evaluations consist of forty-four questions pertaining to four subject areas:

1. Possession, availability, and use of digital technology;

2. Knowledge regarding awareness of and skills in using digital technology;
3. Possession and use of clothing;
4. Reflections about the relations of *fashion and identity* as well as *fashion and communication*.

The most significant results are so far: all of the 10th-graders have their own up-to-date mobile phone and almost all of them regularly send text messages. Before becoming involved in the design processes, all of the students had no programming knowledge. They predominantly believed that their choice of clothes influences their body feeling and expresses personality and identity, but they did not understand it as a means of communication.

6. CONCLUSION

The basic requirements for the development of *WeWrite* have been defined in close cooperation between students, teachers, computer science students and scientists. Based on current experiences, we assume that the relationship between items of clothing and their meaning cannot be reflected easily. The students initially found it hard to imagine that ways of programming could initiate complex interactive processes.

WeWrite enables lettering on wearables so that students can establish digital dialogues immediately, which means that they transfer performative writing experiences back to the physical realm. By a loose, flexible, playful, and adaptable cooperation between the students supported by wearables during a performative process, mental reflection can occur.

It is evident that the students need to understand the meaning of bidirectional and complex communication within social structures. That is the foundation for developing the creative potential necessary for the joint design process of *WeWrite* and the design of interaction and communication applications for wearables. In summer 2009, a first post-evaluation will show whether these hypotheses that have been derived from observation can be verified. What we do know now is that students show a high level of engagement regarding the technological challenges and are currently in the process of developing an interactive theater performance using this technology.

When students wear t-shirts or gloves with interactive lettering, they act in a digitally augmented space. Their actions are self-determined as well as interactively and communicatively related to others in an open physical space.

7. REFERENCES

[1] Amici. http://www.dimeb.de/eduwear.

[2] Arduino. Available: www.arduino.cc.

[3] Berzowska, J. (2005). *Electronic textiles: Wearable computers, reactive fashion, and soft computation*. Textile, 3(1): 2–19.

[4] Buechley, L., Eisenberg, M., Catchen, J., Crockett, A. (2008). *The LilyPad Arduino: Using Computational Textiles to Investigate Engagement, Aesthetics, and Diversity in Computer Science Education.* CHI 2008 Proceedings: Aesthetics, Awareness, and Sketching. Florence, Italy.

[5] Buechley, L. and Eisenberg, M. (2007). *Fabric PCBs, electronic sequins, and socket buttons: Techniques for e-textile craft*. Personal and Ubiquitous Computing.

[6] Buechley, L., Elumeze, N., Eisenberg, M. (2006). *Electronic/Computational Textiles and Children's Crafts*. Proceedings of the 2006 conference on Interaction design and children. Tampere, Finland.

[7] Buechley, L. (2006). *LED Clothing. Make a programmable tank top.* CRAFT Magazine, Journal of Architectural Design. Vol. 1. pp 54. http://web.media.mit.edu/~leah/grad_work/diy/diy_tank.html.

[8] Davis, F. (2006). *Fashion, Culture, and Identity.* University of Chicago Press.

[9] Drozdek, J. (2006). *Looking to the Left: Politics in the Art of Barbara Kruger and Jenny Holzer*. In: Kritikos, Vol. 3. http://intertheory.org/drozdek.htm.

[10] Harold, P. (2006). *Creating a magic lightning experience with textiles*. Password: Philips research technology magazine. Issue 28, 6-11.

[11] Heartney, E., Posner, H., Princenthal, N. Scott, S. (2007). *After the Revolution: Women who Transformed Contemporary Art.* Prestel. London, United Kingdom.

[12] Igoe, T. (2007). *Making Things Talk*. O'Reilly.

[13] Joselit, D., Salecl, R. (1998). *Jenny Holzer*. Phaidon Press Ltd. London, United Kingdom.

[14] KIMM: www.kimm.imis.uni-luebeck.de.

[15] Layne, B. (2007). *Jacket Antics.* Fashion Show at Siggraph 2007, 7-9 August, San Diego, CA, USA.

[16] Manovich, L. (2006). *The Poetics of Augmented Space. Learning from Prada*. In: Visual Communication. Vol. 5. 219-240.

[17] Mellis, D.A., Banzi, M., Cuartielles, D., Igoe, T. (2007). *Arduino: An Open Electronics Prototyping Platform.* CHI 2007, April 28 – May 3, 2007, San Jose, USA.

[18] MiniPOV: *An Inexpensive Persistance of Vision Toy* (2008).

Fig. 1: Philips light emitting Lumalive T-Shirt, [10].

Fig. 2: *Jacket Antics* by Barbara Layen. http://subtela.hexagram.ca/Pages/Jacket%20Antics.html.

Fig. 3: Tank Top; Programming cellular automata with PDA, Buechley, 2006 [6].

Fig. 4: Photo of a *Truism* of Jenny Holzer on a T-Shirt: The Art History Archive. http://www.arthistoryarchive.com/arthistory/contemporary/Jenny-Holzer.html.

Fig. 5-7: by the authors.