Design for Social Interaction in Public Spaces

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Abstract. The merge of the Web of People and the Internet of Things leads to a shift from technology-push product or system oriented design to data-driven service centric design. The growth and development of social computing have dramatically increased the complexity but also offer new opportunities and solutions in the societal context. We look into the challenges in designing for social interaction in public spaces, in particular in cities and professional environments. With several examples in designing interactive public installations, we present the design techniques and practices used in these examples, as well as the evaluation methods that have been found to be useful in evaluating the user experience such as social connectedness and inclusion.

1 Introduction

In the era of social networking and computing, the merge of the Web of People and the Internet of Things leads to a shift from technology-push product or system oriented design to data-driven service centric design. Products have become the terminals of the services and systems have become the platforms to deliver the services. Social computing started in late 1990's and early 2000's serving as platforms not only for sharing online content and conversation, but also for processing the content of social interaction and feeding back into systems [1], driven by a flattened and bottom-up social structure. The growth and development of social computing have dramatically increased the complexity, on other hand, bring up new solutions against the complexity, towards social innovation, by harvesting the collective intelligence from the Web of People, including the designers, the users and the organizations, and the collective intelligence from the Internet of Things, in order to realize greater value from the interaction among people and things, which in turn, inventing innovative and hopefully also sustainable ways of living.

In this paper we will look into the challenges brought up by social computing, in designing for social interaction in public spaces, in particular in cities and professional environments. Currently the cities are coming to life in the digital world. How this digital city becomes meaningful to us remains to be seen but the first signs point towards visual solutions that augment the buildings, bridges, statues etc [2]. The augmented layer can be used as decoration, but also as public media where the social interactivity can take pace. One of the ways to approach these challenges is for example interactive public installations. The current development in digital public installa-

tions involves a significant amount of new carriers in not only material, but also in technology, resulting new dynamic and interactive forms that require the artists and designers to construct their work from a system view and with a good understanding of human-system interaction. It is no longer about carving stones and casting bronze; it is time to sculpture the interactive experience with the public participation [3, 4].

With several design cases of interactive public installations, we will not only present the design techniques and practices of these examples, but also try to present our attempts in evaluating the experience of interacting with the installations, such as the feeling of social connectedness and inclusion.

2 Design cases

2.1 Moon rising from sea

This installation is designed for the city of Taicang, China. The installation is roughly 10 by 10 meters on its base and 8 meters high. On top of the base are constructions that give the impressions of a large sail, and the moon rising from the waves. On the surface of the sail are reliefs of Taicang's sea culture. Images, animations and videos can be projected onto the inner surface of sail in the evenings (**Fig. 1**). One of the concepts to utilize this platform is to allow the public to contribute their photos from social media, for an interactive photo show, to induce the feeling of social connectedness [5-7], and to reinstate the historical values of Taicang as port to the world.

Fig. 1. Moon rising from sea

2.2 Leave your mark

With the installation "Leave your mark", people can "draw" and leave their mark behind on the public space, to express themselves (**Fig. 2**). The concept involves projection mapping to digitally augment buildings. A person walks by, grabs a piece of "chalk" and starts drawing or writing on it, leaving their mark. In some locations the installation will be provided with a camera. The feed of this camera will be projected onto the installation at another location. If a person walks by this second location, she could possibly see someone, a complete stranger, leaving the mark on the first installation. The goal is to increase feelings of inclusion and connectedness of the citizens of the city to each other and to the public space they are in [5].

Fig. 2. Leave your mark

2.3 CONNECT

Nowadays professional social connections are mostly maintained in the digital world using e-mail or social media. The use of these media is less personal and therefore less confrontational. CONNECT is a tool which a participant shows her attending by presenting a designed badge from an event to a wall and shares her professional connections in the digital social networks to other participants (**Fig. 3**). By means of this information, it triggers conversations among the participants [8]. Sensors are used to detect the badges and projection mapping techniques are used to leave portraits and to create lines representing connections from social media.

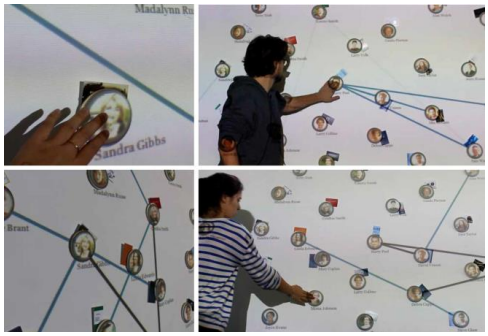

Fig. 3. CONNECT

2.4 Flink

FLink is a service that motivates people in a public shared and flexible work space to have more social interaction. It is a combination of physical objects (tokens and the Meeting Point), and a Mix & Match service (**Fig. 4**). The token is part of the check-in system at the entrance. The Meeting Point is the (eye height) physical object located next to the coffee machine. By fitting the token to the Meeting Point with its “Mix” side, photos of the other flexible workers with complementary expertise will show up in the cells of the Meeting Point. By fitting with the “Match” side, the token will show matching expertise of the others [9]. Sensors are used to detect the tokens and their sides, and back projection is used to display matching or mixing profiles.

Fig. 4. Flink

2.5 Blobulous

Blobulous allows participants to interact through projected avatars, which react to their movement and body signals (**Fig. 5**). Blobulous uses a large public display to show abstract avatars, blobs of dots, one for each participant and moving around slowly. The movement is connected to the participant's movement. The participant's heart rate is mapped to the color of her avatar. The mapped colors range from blue (cold, low engagement) to red (warm, high engagement) [7, 10]. Wireless heart rate sensors are used to capture and send heart rate data from users and a Zigbee network is created to handle communication between sensors and the projected avatars.

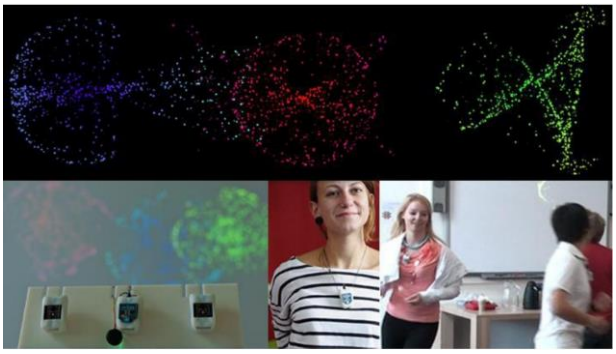

Fig. 5. Blobulous

2.6 Oeco

Oeco (Office ecosystem) links the individual work space to a common room by sharing the pictures on social media in an artistic manner (**Fig. 6**). These pictures are represented by dandelions. A user can be immersed in his work; other people can see the crawling dandelion from outside the working cell and it is better not to disturb. The

florets of the dandelions follow the user when coming to the common room. When people meet, their dandelions blows up and come together, opens into shared pictures among them, to trigger their memories and conversations [11]. These dandelions are displayed within a screen, or projected into the walls or furniture when floating away or towards theses screens using projection mapping techniques.

Fig. 6. Oeco

2.7 Strijp-T-ogether

Strip T is an old industrial area rebuilt to accommodate and foster creative industries. However there is hardly any social interaction among people from different companies. Strijp-T-ogether is designed to stimulate the social interaction. It consists of a mobile platform and a projection in the main entrance hall (**Fig. 7**). The photo of a space is used on the mobile as the background and an addition can be made by drawing or adding other graphical objects. These additions will be projected into the space and will also be shown on the mobile of the others as background. People can then react on each other's drawings and additions to trigger social interaction [12].

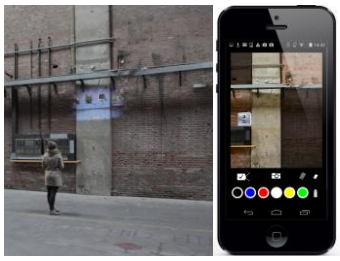

Fig. 7. Strijp-T-ogether

Fig. 8. Delightia

2.8 Delightia

Next to providing social experience, public installations may also have a specific purpose for a target user group. Inspired by the lighting, music and reminiscence theapies, this design is to use light and sound to help the elderly to get rid of dull and passive feelings at an elderly care center (**Fig. 8**). By interacting with the installation, the dementia elderly perceive the stimuli that resemble their memories of natural lighting and the sound of water drops with calm background sound of a brook [13].

Interacting together or observing the others interacting may trigger conversations among the elderly themselves or between the elderly and the caregivers.

3 Techniques and practices

In the design process of above mentioned projects, many design techniques were found to be useful. These techniques are summarized in the following, but it is not our attention to make an exhaustive list of useful design techniques for designing social interaction in public spaces. Rather, we share our experience and observations in applying these techniques in a real-life context with intercultural design teams.

3.1 Inspired by cultures

The projects "Moon rising from sea", "Leave your mark", CONNECT, Flink and Oeco are direct or indirect results of the international workshops "Interactive Patina of Culture" (IPoC), in Taicang, China, by Eindhoven University of Technology and Jiangnan University in 2013 [14]. The concept of IPoC is in the space between cultural studies, experience design and human-computer interaction. In interaction design we know that culture matters [15, 16]. "Patina" conveys the understanding that time and use of artifacts will result in ageing, in becoming closer to the person and cultural identity of the user, also known as "graceful ageing". It is however not limited to the designed artifacts: design practice and the designer will – over time – work in, with, and for a cultural context. The assignment of the workshop was to design a series of interactive public installations and the concept of IPoC acted as a mechanism to bring qualities of the two cultures together.

3.2 Inspired by traditional dynamic arts.

Dynamic art forms and interactive public installations have much in common: both have a time core to drive the dynamics; both have to manage inside a public space and the space has to be carefully structured for functions and interactions; both have to accommodate active or passive participants with different roles and goals. Traditional dynamic arts have much to offer and it is time to explore how the elements and techniques could contribute to interaction design. During the IPoC workshops, one of the efforts was paid to apply performance techniques and elements from dynamic art forms in the design process and to investigate how the installation would blossom when approached from a performance art perspective that essentially includes the users as well as a broader physical or social context [17, 18].

3.3 Sensitizing workshops

Designing in inter-cultural teams is a challenge, not only to align the content-wise aspects of the design task at hand, but more so the way of working together. Every design process has phases that go smoothly, but also phases that need focus, persever-

ance and determination. While this can be already hard for design teams that share a cultural background, intercultural communication complicates this issue. Professional intercultural design cannot be taught or learned in a short amount time. Explicit interest in socio-cultural aspects of design is needed so that mixed design teams can fluently work together. Establishing a common ground for understanding and reducing potential friction simply by bringing team members closer together will help.

One approach, called "sensitizing workshops", is to facilitate a low-threshold design activity that combines several related (technical) aspects of a more serious design task to be executed later on with an exploration of senses. The reason is two-fold: (1) techniques, technology and materials to be used later on can be tried in an explicitly low-risk setting, and (2) exploration of senses uses the human body and how we feel and naturally act as a "natural" common ground for discussion and collaborative design. The combination is a short workshop that involves the design team on many levels, but also anchors their shared experiences in a positive common achievement.

During the IPoC workshops, this technique was introduced early on and resulted in significantly more momentum and better results during the first phases, which led to conceptually deeper results in the end, improved the overall confidence of team members and established a natural flow of activities as all team members understood their strengths and weaknesses better which allowed them to make better decisions.

3.4 Cardboard modelling

Installations in public spaces are three dimensional, or if we take time into account because of the dynamic nature of interaction, four dimensional. Cardboard modelling, especially when integrated with advanced mechanical and electronic techniques and components, is a powerful tool for tangible or rich interaction [19, 20]. In the IPoC workshops, this was the key technique used for exploring and demonstrating design space and the concepts. **Fig. 9** shows the cardboard models of earlier concept of "Moon rising from sea" (left) and "Leave your mark" (right).

Fig. 9. Cardboard modelling

3.5 Acting out

When designing for social interaction in public spaces, the interactive nature of the design requires conceptualizing, visualizing and communicating the dynamics of the interaction. The integration of industrial design processes and software design pro-

cesses is often necessary [15, 21]. The acting-out design approach [22] utilizes the designers body to simulate the elements and the behavior of the design, providing and communicating the insights at earlier stages of a design process when a prototype is not yet available. It may also provide a good bridge that helps to make the transition from a general concept to an engineering level smoother. This approach is used in the the IPoC workshops in projects such as Flink, CONNECT and StrijP-T-ogether.

3.6 Video prototyping

High-fidelity prototyping of installations in a large scale or for a big or busy public space is often costly and challenging, if not impossible. Video prototyping allows the designers to create simulation of the installation and the interaction using simple materials and equipment [23]. Interface elements can be created using paper, cardboards, pens, acetates and other materials, allowing for experiencing the interaction by viewing the video simulation at earlier stages of the design with minimal requirements of resources and materials. This technique was used in the conceptual phase of both Strijp-T-ogether and Oeco.

A combination of video prototyping and acting out can be also used in context with the help of portable projectors: prepared video prototypes are projected onto artifacts and objects in the real-life context using projection-mapping techniques. This serves as documentation for evaluation, but also as input for further design iterations.

4 User experience evaluation

Here it is not to extensively review the literature how user experience shall be evaluated in public spaces. Instead, we present the methods that were used for evaluation in the projects mentioned earlier and that were found to be handy for designers.

4.1 Qualitative methods

Mood boards. They are often used at the conceptual phase to generate ideas and concepts that is after certain styles or the overall “feel” that the designers are trying to achieve. But in the project Delightia it is also found to be useful to reflect the user’s emotion and attitude towards certain concepts or products, especially when the users find it difficult to express themselves [13]. In the evaluation of Delightia, participants in the evaluation were asked to make choices from a restricted selection of images for certain aspects, which gave a good insight of how they felt about the design.

Interviews with experiential prototypes. Interactive installations for public spaces have to be experienced in the actual space for the users to understand the design and to give valuable input or feedback. In the project Flink, prototypes from the iterations were placed in the targeting environment and controlled in a manner of Wizard of OZ. Users in the environment are interviewed after they have experienced the design for their input for next iteration of the design [9]. In the project Delightia, it would be impossible for the elderly with dementia to image the design without a prototype in

place, although it was easily understood by the caregivers. Interviewing the elderly without actually experiencing the prototype would have been an effort in vain [13].

Co-reflection. In the project Strijp-T-ogether, co-reflection was used as a qualitative and constructive approach on evaluating whether the installation triggers social interaction [12]. Co-reflection can be defined as a "collaborative critical thinking process involving cognitive and affective interactions between individuals who explore their experiences to reach new intersubjective understandings" [24]. "Co-reflection sessions can be developed in three parts: exploration on the current situation, ideation through a discovery process and confrontation between users and designers. Each part builds upon the next" [25].

Observations in context. It is important to observe in the context when design for public spaces in order to understand the situations and to get a good grasp of the problems to be solved or the opportunities to be identified. Observations can be done by not only the designers themselves, but also the users [12], the experts [13] and other stakeholders [9, 12] by giving them explicit tasks and instructions. Observing in context has demonstrated its effectives not only to get the input for the ideas and concepts, but also in evaluating whether the design has achieved its goal – but in the latter case, a prototype would be necessary.

4.2 Quantitative measures

Connectedness. Social Connectedness Scale Revised (SCS_R) questionnaire [26] was chosen to evaluate the level of social connectedness of participants in the projects "leave your mark", Blobulous and Strijp-T-ogether. SCS-R is based on an earlier version of Social Connectedness Scale [27]. SCS-R consists of 20 items (10 positive and 10 negative). The negatively worded items are reverse scored and summed with the positively worded items to create a scale score with a possible range from 20 to 120. Then, the mean score with a possible range from 1 to 6 is calculated by dividing the total scale score by 20 (or 20 scale items). A higher score on the SCS-R indicates a stronger feeling of social connectedness.

Social Inclusion. The Inclusion of community in self scale [28] is a simple yet effective pictorial measure consisting of six pairs of circles. Each pair of same-sized circles overlaps slightly more than the preceding pair (**Fig. 10**). Each circle on the left of the pair represents the participant, while the circle on the right represents the community. Connectedness to the community at large is assessed by the participant marking the pair of circles that best describe her relationship with the community. It is found to be useful in projects "Leaving your mark" and "Strijp-T-ogether".

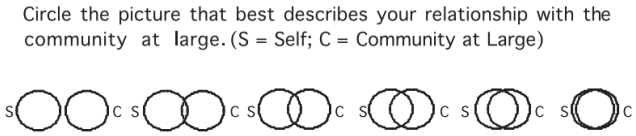

Fig. 10. Inclusion of community in self scale [28]

Attractiveness. AttrakDiff [29] is an instrument for measuring the attractiveness of interactive products. With the help of pairs of opposite adjectives, users can indicate their perception of the product. These adjective-pairs make a collation of the evaluation dimensions possible (**Fig. 11**, rigt). The following product dimensions are evaluated: Pragmatic Quality, Hedonic Quality - Stimulation, Hedonic Quality - Identity and Attractiveness. Hedonic and pragmatic qualities are independent of one another, and contribute equally to the rating of attractiveness and they are mapped into a visual output (**Fig. 11**, left). This method has been used to measure the attractiveness of Blobulus [10] and Oeco [11].

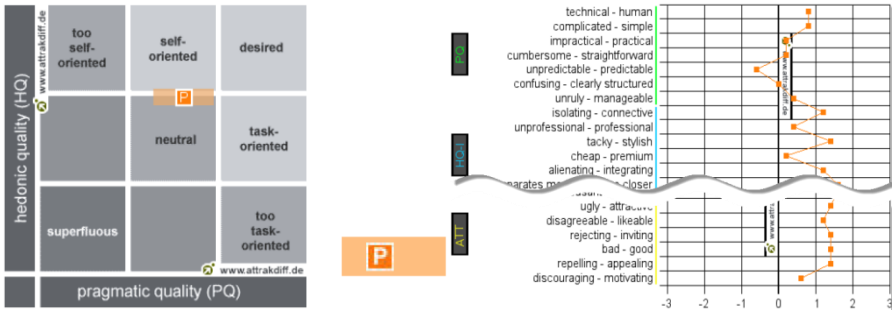

Fig. 11. AttrakDiff

Communication. Many public installations might have a goal to facilitate the social communication (for example in our design cases, “Moon rising from sea”, “Leave your mark”, CONNECT, Flink and Strijp-T-ogether). It is important to understand the emotional benefits and costs of such an installation. The Affective Benefits and Costs of Communication Technologies (ABCCT) [30, 31] could come in handy. It provides the measurements that are valuable to know for public installations, such as Emotional expressiveness, engagement and playfulness, opportunity for social support and threat to privacy.

5 Concluding remarks

We presented eight design cases of interactive installations for social interaction in public spaces. The targeted spaces and user groups, design concepts and implementing technologies vary, aiming at different social experiences. However the design techniques and the user experience evaluation methods overlap and many of these techniques and methods have been found to be useful. The effort in designing for social interaction in public spaces is to be continued – we consider it to be an interesting and promising area in design research on social computing, especially in the era of the merge of the Web of People and the Internet of Things that leads to a shift from technology-push product or system oriented design to data-driven service centric design.

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References

[1] T. Erickson, "Social Computing," *The Encyclopedia of Human-Computer Interaction, 2nd Ed.*, 2013.

[2] C. Bartneck, J. Hu, B. Salem, R. Cristescu, and M. Rauterberg, "Applying Virtual and Augmented Reality in Cultural Computing," *IJVR*, vol. 7, pp. 11-18, 2008.

[3] J. Hu, F. Wang, M. Funk, J. Frens, Y. Zhang, T. van Boheemen, *et al.*, "Paticipatory Public Media Arts for Social Creativity," presented at the Culture and Computing 2013, Kyoto, Japan, 2013.

[4] F. Wang, J. Hu, and M. Rauterberg, "New Carriers, Media and Forms of Public Digital Arts," *Culture and Computing*, pp. 83-93, 2012.

[5] S. Brenny and J. Hu, "Social Connectedness and Inclusion by Digital Augmentation in Public Spaces," in *8th International Conference on Design and Semantics of Form and Movement (DeSForM 2013)*, Wuxi, China, 2013, pp. 108-118.

[6] D. Le, M. Funk, and J. Hu, "Blobulous: Computers As Social Actors," in *Experiencing Interactivity in Public Spaces (EIPS), CHI'13*, Paris, 2013, pp. 62-66.

[7] M. Funk, D. Le, and J. Hu, "Feel Connected with Social Actors in Public Spaces," in *Workshop on Computers As Social Actors, co-located with 13th International Conference on Intelligent Virtual Agents (IVA 2013)*, Edinburgh, UK, 2013, pp. 21-33.

[8] T. Elfferich, "Design for Social Interaction in Public Spaces," Department of Industrial Design, Eindhoven University of Technology, Report M11 2013.

[9] Y. Arslan, "Flink!," Department of Industrial Design, Eindhoven University of Technology, Report M11, 2013.

[10] J. Hu, D. Le, M. Funk, F. Wang, and M. Rauterberg, "Attractiveness of an Interactive Public Art Installation," in *Distributed, Ambient, and Pervasive Interactions*, N. Streitz and C. Stephanidis, Eds., ed: Springer, 2013, pp. 430-438.

[11] J. Gu, "Oeco. Office Ecosystem," Department of Industrial Design, Eindhoven University of Technology, Report M11 2013.

[12] J. Janmaat, "How to stimulate soicial interaction within a working area," Department of Industrial Design, Eindhoven University of Technology, Report B32 2013.

[13] J. Gu, Y. Zhang, and J. Hu, "Lighting and Sound Installation for Elderly with Dementia," in *International Conference on Culture and Computing*, Kyoto, Japan, 2013, pp. 169-170.

[14] J. Frens, M. Funk, J. Hu, S. Zhang, K. Kang, and F. Wang, "Exploring the Concept of Interactive Patina of Culture," in *8th International Conference on Design and Semantics of Form and Movement (DeSForM 2013)*, Wuxi, China, 2013, pp. 211-214.

[15] J. Hu, "Design of a distributed architecture for enriching media experience in home theaters," 2006.

[16] J. Hu, C. Bartneck, B. Salem, and M. Rauterberg, "ALICE's adventures in cultural computing," *International Journal of Arts and Technology,* vol. 1, pp. 102-118, 2008.
[17] Y. Zhang, J. Gu, J. Hu, J. Frens, M. Funk, K. Kang, *et al.*, "Learning from Traditional Dynamic Arts: Elements for Interaction Design," in *International Conference on Culture and Computing*, Kyoto, Japan, 2013, pp. 165-166.
[18] Y. Zhang, J. Frens, M. Funk, J. Hu, and M. Rauterberg, "Scripting Interactive Art Installations in Public Spaces," in *16th International Conference on Human-Computer Interaction*, Creta Maris, Heraklion, Crete, Greece, 2014.
[19] J. Frens, "Cardboard modeling studio: a designerly exploration tool for rich and embodied interaction," in *Proceedings of the fifth international conference on Tangible, embedded, and embodied interaction*, 2011, pp. 365-368.
[20] J. Frens, J. Djajadiningrat, and C. Overbeeke, "Form, interaction and function, an exploratorium for interactive products," in *Proc. of Asian Design Conference*, 2003.
[21] J. Hu and L. M. Feijs, "An Adaptive Architecture for Presenting Interactive Media Onto Distributed Interfaces," in *Applied Informatics*, 2003, pp. 899-904.
[22] J. Hu, P. Ross, L. Feijs, and Y. Qian, "UML in Action: Integrating Formal Methods in Industrial Design Education," in *Technologies for E-Learning and Digital Entertainment*. vol. 4469/2007, ed: Springer, 2007, pp. 489-498.
[23] M. Bojic, A. Goulati, D. Szostak, and P. Markopoulos, "On the effect of visual refinement upon user feedback in the context of video prototyping," in *Proceedings of the 29th ACM international conference on Design of communication*, 2011, pp. 115-118.
[24] J. Yukawa, "Co-reflection in online learning: Collaborative critical thinking as narrative," *International Journal of Computer-Supported Collaborative Learning,* vol. 1, pp. 203-228, 2006.
[25] O. Tomico, J. W. Frens, and C. Overbeeke, "Co-reflection: user involvement for highly dynamic design processes," in *CHI'09 Extended Abstracts on Human Factors in Computing Systems*, 2009, pp. 2695-2698.
[26] R. M. Lee, M. Draper, and S. Lee, "Social connectedness, dysfunctional interpersonal behaviors, and psychological distress: Testing a mediator model," *Journal of Counseling Psychology,* vol. 48, p. 310, 2001.
[27] R. M. Lee and S. B. Robbins, "Measuring belongingness: The Social Connectedness and the Social Assurance scales," *Journal of Counseling Psychology,* vol. 42, p. 232, 1995.
[28] D. Mashek, L. W. Cannaday, and J. P. Tangney, "Inclusion of community in self scale: A single-item pictorial measure of community connectedness," *Journal of Community Psychology,* vol. 35, pp. 257-275, 2007.
[29] User Interface Design GmbH, "AttrakDiff Tool to measure the perceived attractiveness of interactive products based on hedonic and pragmatic quality," ed. http://www.attrakdiff.de/en/Home/, 2012.
[30] S. Yarosh and P. Markopoulos, "Design of an instrument for the evaluation of communication technologies with children," in *Proceedings of the 9th International Conference on Interaction Design and Children*, 2010, pp. 266-269.
[31] S. Yarosh, P. Markopoulos, and G. D. Abowd, "Towards a Questionnaire for Measuring Affective Benefits and Costs of Communication Technologies," in *CSCW'14*, Baltimore, Maryland, USA, 2014.