StarLight - Exploring Embodied Interactions with Media Architecture and Public Audiences

Alexander Wiethoff[1], Jana Gerstberger[1], Sven Gehring[2]
[1]University of Munich, Germany, [2] German Research Center for Artificial Intelligence, Germany
alexander.wiethoff@ifi.lmu.de, J.Gerstberger@campus.lmu.de
sven.gehring@dfki.de

Figure 1. Experimental installations involving media architecture and the possibility for people to interact in front of public audiences, the focus of our research investigation in this work.

ABSTRACT
Interactions with *Media Architecture* such as lighting systems or façades can provoke rich experiences by both active users and spectators (see Figure 1). However, prototyping, studying and finding an appropriate method to investigate these systems is challenging. Till today there is little guidance literature on how to design such systems from scratch and the large amount of evaluation methods does not provide any cues which method to select. We present our system *StarLight*, our investigations during the event of a live music festival and reveal insights from a filed study *in the wild*. Our work includes a report on preliminary insights on how users perceived the interaction with an interactive lighting system in front of a large, public audience. To evaluate our system we have explored the usage of different UX methods in parallel and provide the lessons we have learned evaluating our system.

Author Keywords
Interactive lighting, evaluation, media architecture, public spaces.

ACM Classification Keywords
H.5.2 Interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Over the last years, urban environments and public places emerged as prime locations for deploying digital technologies [3,4,28,30,37]. With this, the role of public spaces drastically changed from ungoverned places of interaction between people, to controlled spaces, which are artificially designed by city planners to fulfill a particular purpose. Within this scope, the distribution of *Media Architecture* tremendously increased over the last decade. Haeusler et al. denotes the term *Media Architecture* to the illumination of a building in order to underline parts of the building or to create a certain atmosphere, including dynamic media [18,32]. With recent advances in technology, media architectural installations are often designed as interactive installations in which users can interact with the installation in order to control it. Since media architectural interventions are usually situated in urban spaces where the installation is exposed to large audiences, interacting with media architecture is in general considered as interaction in public or as a *performance* [3,4,5,6]. Along with the technical aspects of interactive media architecture, their exposure and the therewith-connected interaction in the public space affect the way users behave while interacting [11,16].

In this paper we investigate interaction with media architecture as a performance in front of an audience.

Within this scope, we explicitly focus on embodied interaction with media architecture installations in a public space, investigating the effect of the exposure of people's interactions to an audience and the users' experiences while interacting. To do this, we developed our interactive light installation *StarLight* for the *Electro Magnetic*[1] festival, an annual festival for electronic music with 12.000 visitors on average. With our installation, we allowed visitors of the festival to become an active *performer* by controlling the lighting installation on stage. They could, for example, dance on a stage to control the color and movement of the lights with their body movements. We report on our results addressing the applicability of different evaluation methods for such a public setting.

RELATED WORK

Besides media architecture and interactivity, we identified three further areas that are related to our work, namely (1) interaction in public spaces, (2) evaluating interaction in a dynamic context and (3) user experience (UX) investigations. To follow, we give an overview on relevant work from these areas and how this is related to our work.

Media Architecture

Media architecture [32] not only represents a novel type of architecture, but also a great source for interactivity [7,10,11,12,13]. The recently emerging field of *Urban Computing* is addressing the increasing availability of digital technologies in urban spaces, as well as their use [24,31]. The umbrella term of *Urban Computing* covers an interdisciplinary field, bringing together art, architecture, urban planning, geography, social sciences and computer science [24]. The combination of architecture and media or display elements [18] has been extensively investigated throughout the last decade. Haeusler, Bullivant and Schoch described how the façade of a building can be turned into a large public screen by equipping its outer shell with interactive, light-emitting elements [18,8,27]. As mentioned in the previous section, Haeusler provided a first approach to categorize existing media facade installations with respect to their technical realization and gave a first formal definition of media façades from an architectural perspective [18]. With the design intervention *Aarhus by Light*, human-computer interaction researchers created an interactive installation for the concert hall in Aarhus, Denmark [10]. The goal of this installation was to engage local citizens into new kinds of public behavior to explore the potential of digital media in urban life. With the general scope of interacting in public, their work revealed valuable insights around the themes of *interaction patterns*, *re-occurring patterns*, *initiation*, *how people engage with the installation*, *interaction style*, *how people interact*, as well as relation, denoting social interaction patterns.

For prototyping interactive media architecture installations, Wiethoff and Blöckner introduced *Lightbox* [34], a hardware toolkit aiming to provide designers a way to test the interplay of the particular technologies used to assemble a media architecture installation, as well as the input devices enabling interaction with the installation.

Interaction with Media Architecture in Public Spaces

Goffman analyzed the behavior of people in public places [16]. He investigated the interaction between people with respect to what happens when two or more people meet. He found that when people meet in public, a system of rules unfolds, which dictates the interaction and which cannot be lead back to the structure and norms of the society. The interaction spans its own realm of interaction. Hence, we should not understand behavior as behavior per se, but as a part of an interaction. As described by Goffman, whenever two or more people meet in a public place, a social situation evolves in which people tend to behave in a communicative manner, as if they were interacting with other members of that social situation. This behavior is independent of whether they are interacting or not. This behavior has a significant impact on the way people use interactive systems [6,25] – like interactive media architecture – in a public setting and it therefore needs to be taken into account when designing such systems [11,21,30,36]. In [15] Gehl categorizes activity in public environments into necessary, optional and social activities which are accompanied by slightly different behaviors. Since the belonging of an activity to one of these categories of activities frames people's behavior, the type of activity needs to be addressed when designing interactive systems for public spaces. Furthermore, technology should be designed to enhance and support these types of activities. In this vein Fischer et al. developed the SMSlingshot [13]. They provided a mobile, custom-built input device, based on the metaphor of a wooden slingshot. The aim of their installation was to create a digital slingshot with which people can throw information onto public screens.

Challenges Evaluating Interactions in Public Places

Compared to controlled experiments in the laboratory where HCI researches can select a variety of proven methods [22], evaluating the interaction with media architecture can be complex in many facets: For example, in our setting we were confronted with the following: (1) *Dynamic Conditions:* We conducted the evaluation during a public music festival involving a live, fluctuating audience and a large number of users. (2) *Limited Time:* The public setting limited timeslots for each user to interact with the prototype and participate in an additional questionnaire. (3) *Goal of the interaction*: The reason for users to interact with our system was not to test a specific function or achieve a goal as in case of [1,17], but instead the *experience* of the interaction itself.

[1] http://www.electro-magnetic.de/

To evaluate user experiences when interacting with media architecture, considering the previously described setting, we therefore investigated methods from UX approaches, which are discussed next.

User Experience & Evaluation

Evaluating interaction with media architecture can be complex in many ways as there is a fluctuating audience as well as a large number of potential users. A user's reason to interact with media architecture might be to achieve a particular goal, or the experience of the interaction itself. An important aspect when evaluating UX is to understand the user. Wright and McCarthy review emerging design and UX methodologies in terms of dynamically shifting relationships between designers, users, and artifacts [23,38]. They outline that if experience is central to designer-user relationships, emphatic methods have to be understood and used in an appropriate way. Forlizzi and Battarbee addressed the diversity of experience for interactive systems, where they characterize existing approaches to experiences and provide a framework for designing experiences originating though interactive systems [14]. Furthermore, they argue that for novel technologies, an experience-oriented design approach is the only way that user-centered design can have a valuable impact on the design.

Bargas-Avila et al. reviewed different methods for designing and evaluating UX [2]. They demonstrated that UX methods refer to emotional aspects of an experience when interacting with a system. To evaluate such matters, Hassenzahl et al. developed AttrakDiff, a scientifically-applicable tool for measuring the pragmatic quality, attractiveness, identity, and stimulation of the interaction with a product or service [19]. Burmester et al. described the valence method [9], an approach that evaluates the emotional quality of an interaction in two phases: (1) In the formative phase, the user records positive and negative feelings while interacting with a product or service. (2) In the summation phase, the interviewer asks participants about reasons for their actions during the interaction, using an in-depth interview method, until they can be matched to the underlying psychological need. This model is also based on Hassenzahl et al.'s UX model [20]. It reduces the complexity of UX with the help of positive psychological needs (such as the feeling of autonomy and competence). These practices originate from a different context; hence we needed to adapt existing approaches to the context of media architecture and the performance in front of an audience, where users interact with a novel system and in limited time-slots.

STARLIGHT INSTALLATION

Context

The undertaken experiment was conducted during a public festival, the *Electro Magnetic*, which is a annual European festival for electronic music with a total of 12.000 visitors. The installation setup for *StarLight* was situated at the "silent floor", an area where the music is distributed among the participants via wireless headphones: two disk jockeys where mixing tunes simultaneously and the festival guests were able to switch the channel on their headphones and listen to either one of them. Our installation was situated on stage in between the two disk jockey tables where we had a total area of four by four meters avalibale. The participants in our experiment could be seen from all angles by the audience on the dance floor (see Figure 2,3 & 4). We consider our described temporary setup as an experimental setup to investigate experiences that might occur when interacting in front of an audience as the case with interactive media architecture (see previous section).

Technical Setup

In order to track the participants arm movements we have mounted a Microsoft Xbox 360 Kinect[4] to a fence around the disk jockey stage (see Figure 2). The collected data was interpreted via open source software (libfreenect). We also implemented an interpreter in C# that converted the body movements of the users into commands that can be passed on to an open digital multiplexing (DMX) USB interface (Entec[2]). DMX is a common industry standard protocol to control stage and lighting equipment using a range of values between 0 and 255 on 512 individual channels. The interpreter supported 4 different channels for body movements of the participants (left arm, right arm, left leg, right leg). Each channel could be then assigned to a particular functionality such as color change, brightness, effects, etc. We made the interpreter of *StarLight* **freely accessible**[3] for engaging others to use similar setups to realize embodied interaction with media architecture in public spaces.

The DMX interface that we have used controlled twelve rotatable high power LED projectors, *Flash SC-108 Washlight Moving Heads 9* including 108 x 3 watt high-power LEDs per device, which were mounted facing the dance floor and thus, the festival audience (see Figure 2).

The tracking of the participants via the Kinect[4] was aligned to the Moving Head LED projectors in a pattern that the right arm controlled the spatial direction of the moving heads physical orientation and the movement of the left arm the changing of the different color patterns.

[2] http://www.enttec.com/index.php?main_menu=Products&pn=70303

[3] https://github.com/soirem/Moving-Light-Control.git

[4] http://www.xbox.com/en-US/kinect

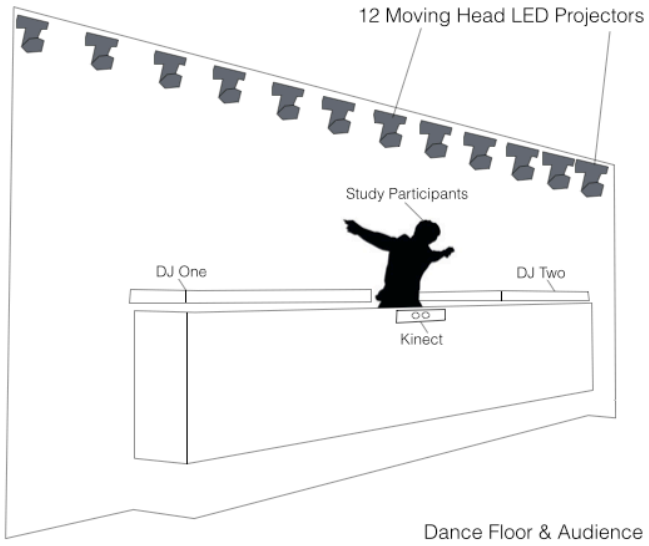

Figure 2. A schematic description of our setup at the festival: participants on stage were controlling the moveable LED projectors which were facing the audience.

For example if the right arm was moved horizontally, also the array of LED projectors made the same horizontal movement without any delays (panning). Analogue to the horizontal movement the LED projectors were moving up and down if the participants made a vertical movement with their right arm (tilting). If participants moved their left arm up and down they were able to *browse and select* through ten different colors. To support the conversion of the position of the arm to the matching DMX value of the color, the angle between the arm and the shoulder of the participant's body were calculated (see Figure 3&4).

Participants at the Festival

For the experiment we recruited a total of 17 participants (eleven male and six female) with an average age of 25.9 years. All participants were visitors of the previously introduced music festival and randomly selected by the experimenters.

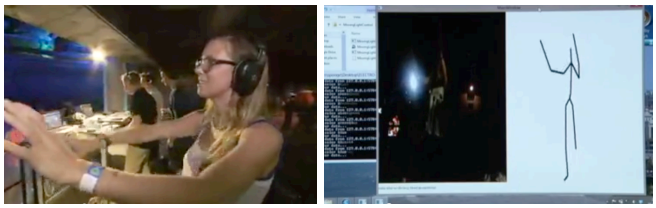

Figure 3. The technical setup of our experiment on stage: participants body movements (left) were tracked (right) and send to a DMX USB interface to control an array of moveable LED projectors.

Study Design and Research Instruments

The study was conducted as follows: First the participants received an oral instruction into the context, the technical setup of the experiment and our research instruments for exact 5 minutes. Next the participants were asked on stage (see Figure 4) and had 7 minutes time to explore the system freely by themselves without any further interruptions by the experimenters. All participants were wearing the provided headphones during this period and listened to one of the DJs during the interaction experience. At the time of the interaction experience 150-250 visitors were present and dancing in front of the participants. The experiment was conducted in the timeframe from 9pm till midnight. After the experience on stage we asked the participants to a separate area backstage where we handed out a UX questionnaire which took the participants on average 10 minutes to complete.

Figure 4. A view of the participants on stage embodied interactions, facing the audience (left) and the perceived lighting sequences and color changes by the audience, facing the participant (right).

The questionnaire was split into four parts and contained three different methods for the investigation of the participants experiences: after an initial standard section including demographic data we included a positive/negative affect (PANAS) scale [33] in the second part. The third section contained a UX word-pair investigation inspired by the Attrakdiff questionnaire [19]. In the final part we included open questions addressing the experience on stage and the perceived immediate usability of the system [22].

Analyzing the collected data was split into two parts. The first part considered data of the PANAS scales [33]: Analyzing the *negative affect* the majority of the participants (16 of 17) stated that they did not feel distressed, angry, hostile or irritated (see Figure 5) when they reflected on their experiences interacting on stage in front of the audience. Five participants stated that they felt *scared*. One participant stated that he felt *distressed* and *angry*. This was due to the circumstance that this participant had severe issues operating the system which was supported through the statements made in the open questions. Four participants stated that they felt *ashamed* and three *anxious*. This was further supported by their statements in the open questions section where they stated that they felt *nervous* throughout the interaction phase. Out of these four three stated that they clearly noted other people watching them which influenced their behavior and emotions. In summary

the *nervousness* and *negative affect* of the participants had a clear cause in the presence of an audience, not on the perceived usability of the system. The median of the *negative affect* was low with 1.54 in summary (on a 5-point scale, ranging from 1=very little to 5=very strong).

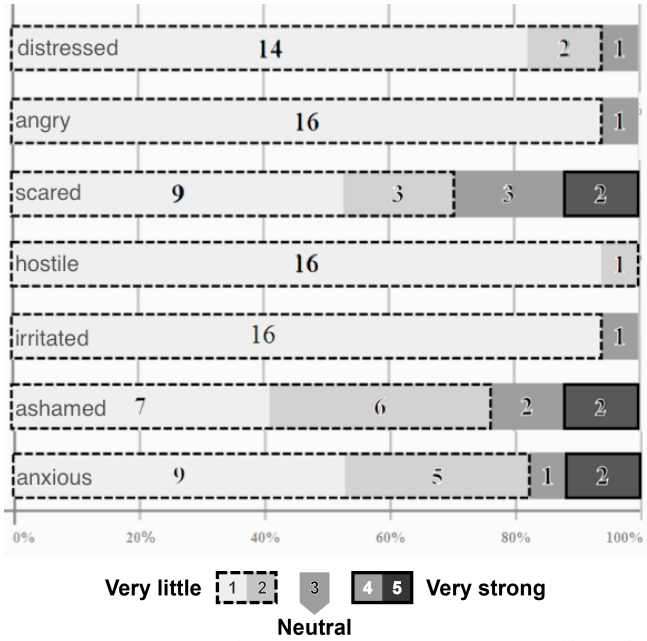

Figure 5. Results of investigating the *negative affect* of our experiment through the PANAS scales [33].

Considering the *positive affect* we acknowledged that the majority of the participants (15 of 17) felt *excited* and (16 of 17) *delighted* (see Figure 6) interacting with *StarLight*.

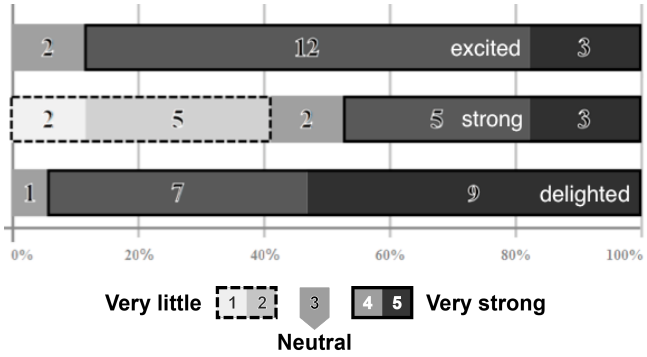

Figure 6. Results of investigating the *positive affect* of our experiment through the PANAS scales [33].

This was further supported in the open questions where participants stated that they had *fun* and considered the interaction as *great experience*. The median of the positive affect was 3.88 which reflects the general positive experiences of the participants (on a 5-point scale, ranging from 1=very little to 5=very strong).

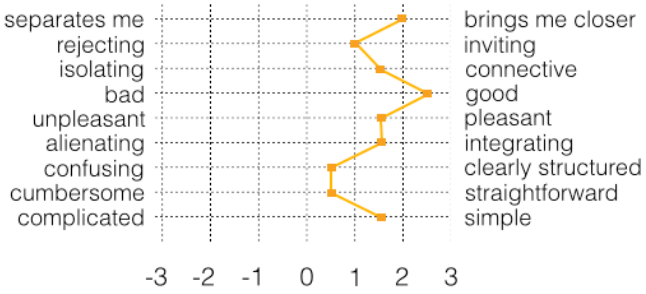

Figure 7. The median values of the word-pairs utilized for investigating the *hedonic quality*, *attractiveness* and *pragmatic quality* of our system inspired by AttrakDiff [19].

The design of the word-pair based UX investigation was split into three parts: The first part focused on the *hedonic* quality of the experience, the second part of the word-pairs focused on the *attractiveness* and the third on the *pragmatic* quality of the interaction experience (see Figure 7). We included only word-pairs of the original AttrakDiff [19] design, which made sense for our context. This was also done to shorten the time required for the participants to complete the questionnaire in a short time frame. The word-pairs *separates me vs. brings me closer*, *rejecting vs. inviting*, *isolating vs. connective* represented the *hedonic* quality. The median of the *hedonic* quality was 2.21 and (on a 6-point scale ranging from -3 to +3), hence the interaction experience was generally perceived as *positive* by the participants: the prototype brought audience and participants closer together and served for *connectedness*. The *attractiveness* of the prototype was investigated with the word-pairs *bad vs. good* and *unpleasant vs. pleasant* with a median of 2.0 (on a 6-point scale ranging from -3 to +3). The third part included the word-pairs *complicated vs. simple*, *cumbersome vs. straightforward* and *confusing vs. clearly structured* which investigated the *pragmatic* quality. The median of these word-pairs was 1.0 (on a 6-point scale ranging from -3 to +3) which indicated a general simple and easy usability of the system. On the contrary we have noticed that four participants had, especially in the beginning of the experience, issues controlling the system, which was stated to have an effect due to their *nervousness* in front of an audience.

In summary the scores of the word-pairs were ranging from zero to three without any outliers. The prototype was therefore rated as being *neutral* on the AttraktDiff investigation taxonomy [19]. Furthermore the data indicated that the system experienced in our setup allowed the participants to *express* themselves in front of an audience.

DISCUSSION

In summary we have conducted a study *in the wild*, investigating experiences of participants interacting with a lighting system in front of large audiences. The study was undertaken in the context of a public music festival. By doing so we aimed to investigate how users experience being widely visible on stage while interacting. A circumstance that occurs when participants are engaged in a public setting involving interactive media architecture [35]. In a previous investigation we have preliminarily utilized user experience evaluation methods based on valence marker [9] and a *need based* analysis set out by Sheldon [29]. In the here presented work we further examined if methods derived from the realm of user experience can reveal further insights into the perceived experience with interactive media architecture and, hence, gain a more holistic understanding of this context. Therefore we took two additional methods for this context into account: (a) the *positive/negative affect* scales (PANAS) [33] and a (b) word-pair UX investigations inspired by AttrakDiff [19].

Looking back at the utilization of the different methods we acknowledge in summary that the **PANAS scales delivered more promising insights** as they directly take into account a range of positive and negative emotions that pin-point towards a *finer granularity* of the perceived user experiences in front of large audiences which was more suitable for our purposes than the evaluation method inspired by the AttrakDiff [19] which lead users more towards the usability of our system. Apart from the obvious finding that the participants enjoyed using our system stated in the *positive affect* (see Figure 6), we found especially the exploration into the *negative affect* (see Figure 5), in combination with the open questions interesting. That is they were directly addressing the experienced interaction and not the usability which was not the main target in our investigation. Hence, we can only recommend to further substantiate the *positive* and *negative affect* through open questions (as in our case) which can then directly address the experience in retrospective and lead in summary to a better and more holistic understanding of the users positive and negative emotions in such a context.

Limitations: Due to the aforementioned challenges we were confronted conducting the study and the consecutive UX questionnaire within a very tight schedule. The UX methods we have utilized for our investigation were therefore adopted and shortened to suit our situation. As a consequence we only had few minutes for each participant being confronted with a new method. A setup in a controlled condition (i.e., a lab) would have allowed a more severe utilization of both user experience investigation methods in parallel with more time for each participant. On the other hand an investigation *in the wild* reveals first hand insights which is mandatory for our context. Hence, we can only provide preliminary insights into the suitability on a set of adopted UX methods, which were utilized in our experiment and cannot adequately judge the transferability to other contexts and situations.

CONCLUSION AND FUTURE WORK

In this paper we presented our system *StarLight*, which allowed us to investigate interaction with a media architecture installation from different perspectives. At first, we addressed the often-stated issue of people behaving differently when interacting in the public. While this is usually implicitly addressed when interacting with situated public displays or large-scale urban screens such as media façades, we explicitly asked the participants to interact with an interactive installation on a stage and in front of an audience. We then adapted different UX research methods to investigate the users experiences after interacting on stage. Although often stated that when interacting with digital technologies in public space, being exposed to the public or an audience can have negative effects on the user experience or the behavior of users, we observed a different result. The majority of the participants enjoyed the interaction and they stated that performing on stage as great an impressive user experience.

In the near future, we plan to apply our findings to different forms of interacting in public places. As mentioned before, we let users explicitly interact on a stage in front of an audience, what made them *active performers*. In further studies, we want to compare the results obtained in our study to interaction in public spaces with different *amounts of exposure*. This might include interaction with media façades, situated public displays, as well as interaction with smartphones in public places.

ACKNOWLEDGEMENTS

We would like to thank the University of Munich (LMU), the German Research Center for Artificial Intelligence (DFKI) and the organizers of the Electro Magnetic Festival for supporting this project.

REFERENCES

1. Alt, F., Schneegaß, S., Schmidt, A., Müller, J., & Memarovic, N. How to evaluate public displays. In *Proc. PerDis 2012*
2. Bargas-Avila, J.A., Hornbaek, K. Old Wine in New Bottles or Novel Challenges: A Critical Analysis of Empirical Studies of User Experience. In *Proc. CHI11.*
3. Böhmer, M., Gehring, S., Löchtefeld, M., Ostkamp, M. and Bauer, G. The mighty un-touchables: creating playful engagement on media façades. In *Proc. MobileHCI '11.*
4. Boring, S., Gehring, S., Wiethoff, A., Blöckner, M., Schöning, J. and Butz, A. Multi-user interaction on media facades through live video on mobile devices. In *Proc. CHI'11.*

5. Borries, F., Walz, S., Böttger, M. Space Time Play: Computer Games, Architecture and Urbanism: The Next Level. *Birkhäuser, 2007.*
6. Brignull, H. and Rogers, Y.: Enticing people to interact with large public displays in public spaces. In *Proc. INTERACT'03*.
7. Brynskov, M., Dalsgaard, P., Ebsen, T., Fritsch, J., Halskov, K. and Nielsen, R. Staging Urban Interactions with Media Facades. In *Proc. INTERACT09.*
8. Bullivant, L. Responsive Environments: Architecture, Art and Design*. V&A London*, 2006.
9. Burmester, M., Mast, M., Jäger, K., Homans, H. Valence Method for Formative Evaluation of User Experience. In *Proc. DIS'10*.
10. Dalsgaard, P. and Halskov, K. Designing urban media façades: cases and challenges. In *Proc. CHI'10*.
11. Dalsgaard, P. and Hansen, L. K. Performing Perception: Staging Aesthetics of Interaction. ACM Trans. Comput.-Hum. Interact. 15, 3 (2008), 1-33.
12. Fischer, P. T. and Hornecker, E. Urban HCI: spatial aspects in the design of shared encounters for media facades. In *Proc.CHI'12*.
13. Fischer, P. T., Zöllner, C., Hoffmann, T. and Piatza, S.: VR/Urban: SMSingshot. In *Proc TEI'10*.
14. Forlizzi, J. and Battarbee, K., Understanding experience. In *Proc. DIS'04.*
15. Gehl, J. Life Between Buildings: Using Public Space. *Island Press, 6th edition edition, 2011.*
16. Goffman, E. Behavior in public places: Notes on the social organization of gatherings*. Free Press*, 1966.
17. Greenberg, S., Boyle, M., Laberge, J. PDAs and shared public displays: Making personal information public, and public information personal. *Personal Technologies*, Springer, 1999.
18. Haeusler, M., H., Tomitsch, M. and Tscherteu, G. New Media Façades – A Global Survey. Avedition, Ludwigsburg, 2012.
19. Hassenzahl, M., Burmester, M., and Koller, F. 2003. AttrakDiff: A questionnaire to measure perceived hedonic and pragmatic quality. In J. Ziegler & G. Szwillus (Eds.), In *Proc. Mensch & Computer 2003.*
20. Hassenzahl, M., Diefenbach, S. and Göritz, A. Needs, affect, and interactive products–Facets of user experience. *Interacting with Computers*. Elsevier 2010.
21. Koleva, B., Taylor, I., Benford, S., Fraser, M., Greenhalgh, C., Schnädelbach, H., Lehn, D. v., Heath, C., Row-Farr, J. and Adams, M. Orchestrating a Mixed Reality Performance. In *Proc. CHI '01.*
22. Lazar, J., Feng, J.H. and Hochheiser, H. Research Methods in Human-Computer Interaction. *John Wiley & Sons, 2009.*
23. McCarthy, J. Wright, P.: Technology as Experience. *MIT Press* 2004.
24. Paulos, E., Honicky, R., Hooker, B. Citizen science: enabling participatory urbanism. *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City, 2009.*
25. Peltonen, P., Kurvinen, E., Salovaara, A., Jacucci, G., Ilmonen, T., Evans, J., Oulasvirta, A. and Saarikko, P. It's Mine, Don't Touch!: interactions at a large multi-touch display in a city centre. In *Proc. CHI'08*.
26. Scheible, J., Ojala, T. MobiSpray: mobile phone as virtual spray can for painting BIG anytime anywhere on anything. In *Proc. SIGGRAPH '09.*
27. Schoch, O. My building is my display: omnipresent graphical output as hybrid communicators. *Swiss Federal Institute of Technology, Faculty of Architecture, 2006.*
28. Seitinger, S., Perry, D.S. and Mitchell, W.J. Urban pixels: painting the city with light. In *Proc. CHI'09*.
29. Sheldon, K. M., Elliot, A. J., Kim, Y., Kasser, T. What Is Satisfying About Satisfying Events ? *Journal of Personality and Social Psychology*, 2001.
30. Sparacino, F., Davenport, G. and Pentland, A. Media in Performance: Interactive Spaces for Dance, Theater, Circus, and Museum Exhibits. IBM Systems Journal 39 (2000).
31. Struppek M. The Social Potential of Urban Screens, *Visual Communication*, 2006.
32. Tscherteu, G. Media Façade Online Catalogue, http://www.mediaarchitecture.org/mab2010documentation/, 2010.
33. Watson, D., Clark, L., Tellegen, A. Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. *Journal of personality and social psychology*, vol. 54, 1988.
34. Wiethoff, A. and Blöckner, M. Lightbox – Exploring Interaction Modalities with Colored Light. In *Proc. TEI'11*.
35. Wiethoff, A. and Gehring, S. Designing interaction with media façades: A case study. In *Proc. DIS'12*.
36. Williamson, J. R., Hansen, L. K., Jacucci, G., Light, A. and Reeves, S. Understanding Performative Interactions in Public Settings. Personal Ubiquitous Computing 18, 2014.
37. Winograd, T. Interaction Spaces for Twenty-First-Century Computing, *Addison-Wesley, 2001.*
38. Wright, P. and McCarthy, J. Empathy and experience in HCI. In *Proc.CHI'03.*