LightSet: Enabling Urban Prototyping of Interactive Media Façades

Marius Hoggenmüller, Alexander Wiethoff
University of Munich, Germany
marius.hoggenmueller@campus.lmu.de, alexander.wiethoff@ifi.lmu.de

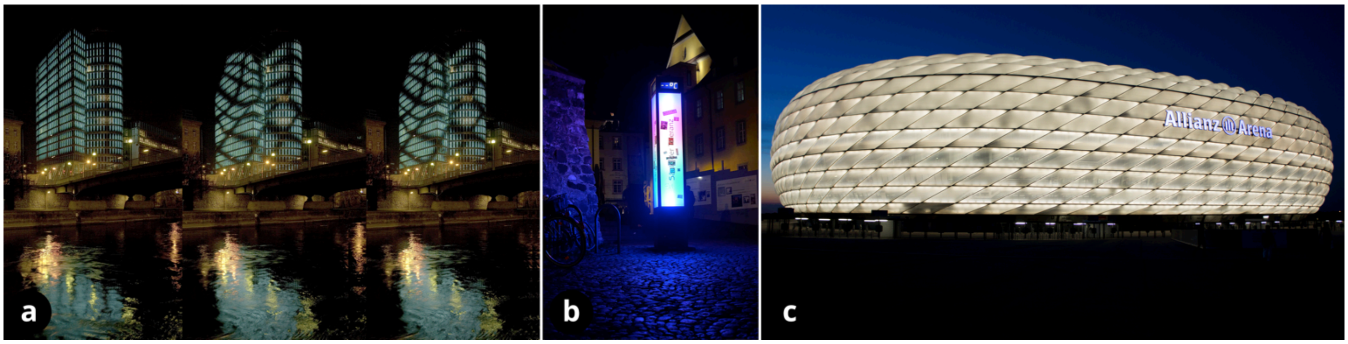

Figure 1. Media architecture in different locations: (a) Uniqua Tower in Vienna, Austria mediated by Mader, Stublić and Wiermann (Photograph © by Alexander Stublić) (b) Light sculpture in Freiburg, Germany (c) Allianz Arena in Munich, Germany[1].

ABSTRACT
In this work we present our approach for creating interactive media façades by using purpose-built tools. They are intended to create prototypes and conduct field investigations in this domain. We share our vision of an extended design process which describes ways to engage large user groups by *urban prototyping* and experience novel interventions in public places. Architects, designers and researchers can receive first hand insights into the suitability of their chosen interaction design concept for media architecture by using our tools and approach.

Author Keywords
Media Façades; Media Architecture; Interaction Design; Toolkits.

ACM Classification Keywords
H.5.2. **[Information interfaces and presentation]**: User Interfaces.

DIS 2014, June 21–25, 2014, Vancouver, BC, Canada.
Copyright ©ACM 978-1-4503-2902-6/14/06...$15.00.
http://dx.doi.org/10.1145/2598510.2598551

INTRODUCTION
The augmentation of urban spaces with technology [6, 13], commonly referred to as *Media Architecture* [17, 34] has created strong interest in the research community within the last few years. Furthermore, architects began to use digital media as *new material* apart from concrete, glass or wood to create buildings and structures (see Figure 1a). Such interventions which transform a building's outer shell into a giant public screen are commonly referred to as media façades [30]. Haeusler [15] presented a summary of different media façades and categorized them according to their size, shape and display technology. Prominent examples of these new generations of architectural designs include the Dexia Towers in Brussels, Belgium or the Allianz Arena in Munich, Gemany[2] (see Figure 1c). At the same time Human-Computer Interaction (HCI) researchers began to exploit the interaction opportunities between user and building, and hence bridge the gap between interface and architecture [32]. They, for example, investigated the use of adaptive mobile interfaces or stationary sensors to provide various interaction opportunities [2, 3, 4, 29]. However, those emerging technological possibilities can also provoke denial by users [21]. In recent news, for example, a media architectural installation provoked a strong sense of rejection by the population when the project was deployed at a public square in Freiburg, Germany (see

[1] Photograph by © Manuel Núñez Salinas. Reproduced under CC BY 2.0 License https://creativecommons.org/licenses/by/2.0/deed.en/

[2] http://www.allianz-arena.de/en/

Figure 1b) [23]. This case dramatically illustrated that media architectural installations in the urban environment demand careful design considerations that also involve potential users of these systems in the process. This matter raises the demand of a design philosophy coined by *urban prototyping* [35] methods which can potentially lead an interdisciplinary design team to more successful interventions in the public environment. Further, architects and designers might not always be able to prototype even early instantiations of interactive media architecture in a timely way, and explore the design opportunities that these systems provide, because till today methods and tools in this domain are hardly available and they still demand high technical expertise.

We share our design process approach using prototyping tools that help to co-design and pre-test interactive media façade installations in conjunction with potential users in their urban environment. The proposed toolkits allow fast replication and prototyping iterations while involving a broad audience to investigate what type of interface proposal has the potential to be successful.

Presenting our extended user-centered design approach which is based on common interaction design practice [22, 27] (see Figure 2), we aim to empower artists, designers and architects to express and pre-test their own ideas for interactive media façades rapidly by themselves.

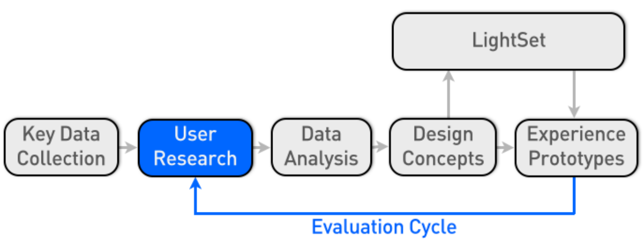

Figure 2. An extended user centered design process using *LightSet* as additional auxiliary means to explore design concepts for media façades.

In this paper we first present the technical aspects of our toolkits along with instructions on how to utilize them. Next we show examples of media façade interfaces that have been created with the help of our tools followed by a practical investigation in the context of an *urban prototyping workshop* where we explored interface concepts in conjunction with potential users. By providing these experiences we share our vision of how an integrated design process in this domain can look and how it can be practically applied.

RELATED WORK

Urban Interfaces

Under the umbrella term *media architecture* [34], an emerging interdisciplinary research field currently seeks ways to successfully design interactive media façades and integrate these installations in the urban environment [32].

Pursuing the approach of research-through-design [38], researchers in this context have investigated specific cases. After exposing a number of interactive media façades, Dalsgaard et al. identified eight key challenges that are crucial when designing media façades in the public environment [10]. They especially stress that media façades prompt new forms of interfaces since they strongly differ from traditional displays in several ways. On an application level Fischer et al. described how they designed *Spread.Gun* and subsequently *SMSlington*, a system allowing users to *shoot* digital messages on large urban projections, with the aim of enhancing embodied interaction [12]. They investigated the unique aspects of media façades and investigated various spaces that are directly influenced by an interactive installation [11]. Seitinger et al. proposed a network of so-called *Urban Pixels* encouraging people to control them [31], addressing the social potential of such interactive interventions [33]. In this vein, Chandler et al. proposed *Firefly*, a blended public display system, which consists of multiple single LEDs [8]. However, such unbounded *smart pixels* are still costly to produce, and currently not available for rapid prototyping.

Scheible et al. presented *Mobispray*, an application using a smartphone as a virtual spray can to *paint* on canvases projected on buildings [29]. Regarding the vast distribution of mobile devices, Boring et al. also investigated a smartphone-based interface that allows multi-user interaction through live video [3].

Individually manufactured portable devices, as proposed by Fischer et al. [12], limit potential users to a small number. On the contrary, interfaces based on smartphones are accessible to a large group of users, however, less technically-skilled users can be excluded from the community [33]. Interacting through smartphones requires a previous installation of project-specific applications and thus *spontaneous interaction*, as described by Dalsgaard et al. as *pass-by-and-use* [10], is not feasible. In our context we explicitly aimed to investigate a set of *urban interfaces* that enable (1) barrier-free and (2) spontaneous interactions.

Prototyping

Prototypes are commonly used in various design disciplines as early instantiations for future products. In architectural practice, for example, handcrafted models of future projects are created with digital tools and physical low-cost materials. During the past decade architects have begun also to evolve their design processes by integrating *Rapid Prototyping* techniques, such as 3D printing and scanning, to automate the creation of prototypes in terms of speed and versatility [26]. In HCI, researchers and designers tend to utilize a wide range of low- and high-fidelity methods and tools to build prototypes [7]. Usually variations of design concepts are created during different *fidelity* stages of the process [25]. Besides *fidelity*, Lim et al. identified *material* and *scope* as additional properties for prototypes, describing the aspects that are filtered and investigated during the design process [20]: based on the choice of the property, designers can choose appropriate methods for pursuing a specific goal with a prototype. Experience prototyping, as a meta design method has proven to be very helpful in expressing design ideas at early stages and initiating decision-making in an interdisciplinary team [5]. In summary, prototyping methods and tools can enhance communication in interdisciplinary teams, as well as supporting the design process in a time- and cost-effective manner.

While in the above-mentioned disciplines there is a high availability of tools and approaches, there is limited support for prototyping interactive media façades from scratch. As a consequence, researchers began to investigate methods and tools to pre-test content before the final implementation. Dalsgaard et al. raised the question how to prototype such systems [10] while Korsgaard et al. [16] stressed that due to the fact that media façades are large scale systems in the built environment it is pointless to rely solely on traditional prototyping methods derived from other practices (i.e., HCI).

One method of pre-testing content for media façades is to simulate, for example, a media façade's appearance in a three-dimensional model. In the project "Odenplan", by Korsgaard et al. [16] the authors present their experiences of creating design concepts for a media façade near a subway station in Stockholm, Sweden. During a design workshop they used a 3D-Model of the façade, which they projected into a 3D-cinema. As a particular feature, they *mapped* different light sources to the raw architectural model. This installation allowed potential users to experience various light intensities and colors from different viewing angles before the final implementation. In a further iteration, 3D models were projected onto a whiteboard, which enabled ideas and interaction concepts to be sketched directly onto the projection. Such a design approach copes with the demand for life-size scaled prototyping approaches, which they experienced as vital in the design process for interactive media façades [16]. In this vein, Gehring et al. provided a simulation toolkit for prototyping interactive media façades [14]. They stress that existing approaches are tailored to a specific façade and, therefore, much effort is needed to adapt prototypes to various projects. They summarized that for conducting research it is essential to implement a general toolkit for media façades. By strictly separating the building from the media façade and user interface, it is possible to emulate arbitrary interactive applications on various façade types and environments. On the other hand these approaches do not take into account the real social and physical surroundings and do not invite active participation and co-creation of potential users.

Wiethoff et al. [37] indicated the disadvantages of using rendering software to pre-test interactive content for light-emitting media façades. They argue that colored bright lights as in the case of LED driven façades generate stronger emotional experiences than simulating them on standard thin-film-transistor (TFT) screens. Furthermore, pre-testing hardware is crucial for the success of a façade and may not be taken into account with simulation tools. In introducing the experience prototyping toolkit *LightBox* [36], an attempt has been made to incorporate the issues, which cannot be tackled by computer simulation alone. In favor of mobility, compromises were made in the spatial dimensions, which differ strongly from the size of the actual media façade. Furthermore, they emphasized that it remains an open question how to transfer their approach on further projects that differ concerning the façade's form and display technology as well as concerning the interaction modality [37].

Based on the challenges [10] facing a media façade's design process and the limitations of the aforementioned toolkits [36], we distill the following design criteria for our approach. The resulting prototypes should deal with (1) the **life-size** of actual media façades (2) the **flexibility**, to transfer a toolkit to different locations and the ability to simulate non-planar structures. This means that the toolkit must be scalable in size and shape. Furthermore, the proposed interface concepts must be interchangeable. The hardware should be deployed as a mobile toolkit providing portability for quick assembling and disassembling. Thus, it should be possible to use it for development in the lab but also for evaluations *in the wild*. (3) The tools should be **easily accessible** to a **wide range of users** and invite also teams with limited technical experience and financial budget. In particular architects, who are usually less experienced in designing interactive media systems are a target audience for our toolkit.

LIGHTSET

LightSet, is intended to develop, test and evaluate interactive designs for light-emitting media façades. The tools are build using off-the-shelf soft- and hardware components. Based on the following description supplemented by the code, published via github[3], our software toolkit is freely available for download, installation and further development.

Since media façades differ considerably in size, resolution and shape [15], one consideration when creating *LightSet* was to modify the utilized hardware components to a more flexible façade solution (see Figure 3). We therefore developed a mounting system with adjustable pixel distances. In respect to the claim for a more architecture-friendly integration of screens [31], bendable LED panels were another design criteria. Flexible panels should allow the prototyping of new screens, which are less driven by conventional, flat design. In order to fulfill the demanding architectural requirements, the software should also provide

[3] https://github.com/HoggenMari/

non-rectangular screen shapes. Therefore, the mapping algorithm had to be more flexible than for ordinary screens with fixed aspect ratio.

Hardware

The utilized LED modules were manufactured by the company AHL[4]. Each module consists of 4 cascading stripes provides 96 pixels, assembled from 3 high power, 12V / 0.72W RGB LEDs. The spacing of the individual pixels is 30 centimeters. A single LED Unit works with 8 bit per color channel, resulting in a total of potentially 16.7 million different colors. For addressing the LED modules we have used the controller CP950 (AHL). The controller can be connected to a computer via a standard CAT5 cable. Since it is possible to cascade any number of controllers - each controller provides 8 ports - the resolution of the LED façade can thus be expanded almost indefinitely.

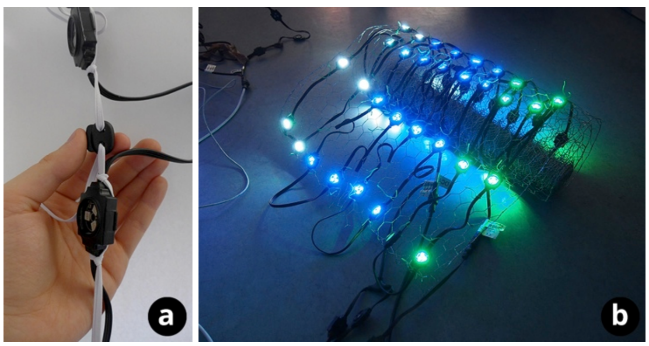

Figure 3. (a) Mounting system for variable pixel distance (b) Bendable LED-Mesh

Variable Distance of Pixels

Our flexible mounting system for variable pixel distance adjustment is easy to rebuild: the only two materials needed are standard cord-stoppers with two holes and elastic band (see Figure 3a). For n LEDs in a row, $n - 1$ cord-stoppers and elastic band with the length of the rolled out LED-stripe are required. The cord-stoppers are threaded onto the elastic band. The elastic band is attached to the elements of the LED-strip. In doing so, one can adjust the distance between each individual LED in the range from 5 up to 30 cm. Using elastic bands proved to be sufficient because of the total weight of a LED-strip. One should take into account that the amount of time and the costs increase proportionally with the number of pixels.

Bendable Mesh

The bendable LED-Mesh (see Figure 3b) is built using a common wire mesh that can be acquired in any do-it-yourself hardware store. The LED elements are attached to the desired distance with wire or cable straps. Due to the wire characteristics, the LED-Mesh can be arbitrarily deformed and still maintain its shape. Furthermore, the idea behind this proposal was that it is highly mobile and deformable while remaining in a particular shape.

[4] http://www.ledahl.net/

Software

The provided software serves as a central control unit of *LightSet* and has to fulfill the following tasks:

- Receiving the input that is provided by the different interfaces (see Figure 6).
- Creating animations that are triggered by the passersby input (see Figure 4).
- Calculating the generated graphics, mapping them on the initiated screen resolution and sending the RGB values to the connected DMX-controller.

The software was implemented in Java. For development, we have utilized the Eclipse IDE[5]. In order to create animations for the specific applications, we embedded Processing's core library. Processing[6] is a Java-based language that is particularly suitable for prototyping interactive animations quickly and easily [24]. In order to include less technically-skilled users, our software is supplemented by a graphical user interface (GUI) to control the toolkit without editing any code (see Figure 5).

Mapping

Since one requirement concerning the software was to support also non-rectangular *screens* (i.e. media façade output), a mapping algorithm that supports variable shapes was implemented. The algorithm works as follows: standard rectangular screens are unambiguously determined by the value of width and height, non-rectangular screens are defined by various heights per column (see Figure 4a and 4b). Multiple screens are supported, any desired two-dimensional geometric form can be created with the lighting hardware and mapped by the software. The required screen shape can be set up statically prior to starting the software.

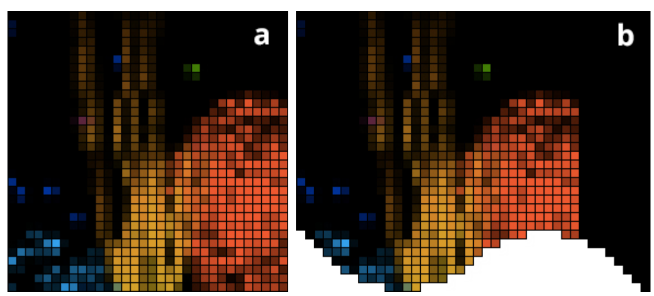

Figure 4. (a) Rectangular Screen (b) Variable shaped Screen

In order to simplify the use of variable shaped *screens*, the software part of *LightSet* is supplemented by an additional tool that helps to adapt the media façades resolution to the site-specific characteristics (e.g., window cut-out, door height and width). Instead of sketching a detailed plan for screen aspects manually, our *Mapping Tool* aids the

[5] https://www.eclipse.org/

[6] http://www.processing.org/

completion of this task by following these instructions: (1) load an image of the building, (2) paint the positions on which the surface should be covered with LED elements (see Figure 5). By specifying the maximum resolution in width and height, the *Mapping Tool* will output the computed media façades matrix. This simplifies prototyping of complex screens in particular for architects since they can easily integrate their conventional architectural sketches and renderings with our software.

Figure 5. The *Mapping Tool* helps defining a non-rectangular screen based on architectural images and models.

Initial Set of Interfaces

In order to demonstrate the use of our tools, we implemented a set of various interfaces. The interfaces serve as an example on how to rapidly prototype different interactive concepts in the urban environment. The resulting applications are influenced by related research projects as well as interactive artworks. Previously discussed challenges, such as **barrier-free** and **spontaneous use**, have been taken into account in implementing these urban interfaces.

Figure 6. Implemented set of interfaces.

(1) *Gesture Painting* is an example for a gesture and presence-based intangible interface. The application enables multiple users to *paint* on a media façade by moving their extremities using Microsoft's Kinect[7] (see Figure 6, 1).

(2) *Visual Turntable* is a playful tangible interface. The turntable, equipped with a webcam, plays painted records and transmits the footage to the façade's screen. Thus, it also serves as a tool to create own color schemes without requiring any programming skills (see Figure 6, 2).

[7] http://www.microsoft.com/en-us/kinectforwindows/

(3) Finally, the set is supplemented by the *Interactive Lighter*, which serves as a model for ubiquitous interaction with everyday objects. Using an infrared (IR)-sensor, a lighter's flame triggers a firework animation (see Figure 6, 3).

FIELD STUDY

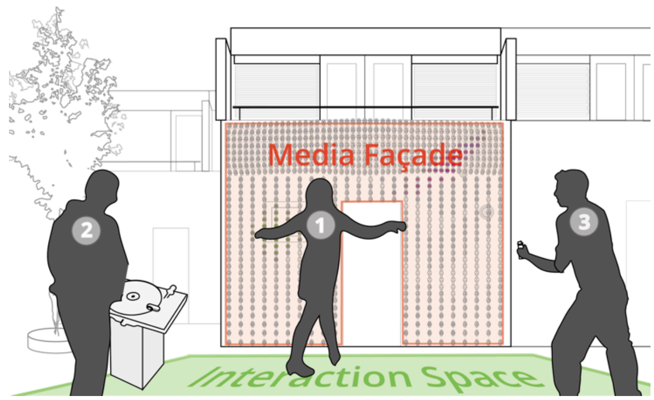

Figure 7. Envisioned scenario of the field study: interacting with (1) *Gesture Painting*, (2) *Visual Turntable* and (3) *Interactive Lighter*.

In order to provide practical experiences of how to use our tools, dealing with prototyping interactive media façades in life-size scale, we conducted a case study *in the wild*. In total 1152 LED pixels were mounted on a concrete front-façade (4 meters width, 3.5 meters height) of a two-storied bungalow (see Figure 7). The bendable LED meshes (see Figure 3b) were used for the upper section of the building, while the LED chains with flexible pixel spacing were fastened below (see Figure 3a). The sensors for the interaction to work were, apart from the *Visual Turntable*, attached to the front wall.

The field study was inspired by the *Urban Prototyping Community* [35] that describes itself as a "global movement exploring how rapidly-prototyped design, art and technology projects can improve cities." *Urban Prototyping Festivals* are being held in various cities around the world with the goal of presenting interactive project mock-ups and of receiving direct feedback from citizens. In the context of our own project we conducted a co-creation workshop to test the proposed interfaces and discuss further development in conjunction with potential users. Next, we ran an exploratory field study to gain additional insights concerning the practical usage of the provided interfaces. Both cycles were conducted consecutively during one evening. Because of solar reflection from surrounding buildings which would interfere with the utilized IR- Sensor and Kinect-camera, the study had to be carried out after dusk.

Urban Prototyping Workshop

In the workshop we involved citizens as active co-creators [28], providing them with our set of interfaces. The workshop was considered as an initial field trial in order to prove this approach for further investigations.

Setup and methods

During the event, we conducted three similar workshop cycles, each lasting one hour. The entire workshop session was held in front of the provided media façade installation (see Figure 8). In total 16 participants (six female, average age 25 years) were involved. The group size in each workshop cycle was ranging from 4 to 7 participants. The majority of the participants were students (except 4), eight of them from the fields of media-informatics and two students of the arts.

Figure 8. Practical utilization of *LightSet* in the context of an *Urban Prototyping Workshop*.

After introducing the research topic to the participants for five minutes, a short excerpt of the Blinkenlights Documentation Video [1] was shown to ensure that all participants had a similar understanding of the context. Next, a storyboard [18] was presented which outlined the task procedure of the workshop:

Part 1: After a short introduction to the previously described interface examples (see Figure 6), the participants had five minutes to experience them by themselves in order to become sensitive how interacting with an *urban interface* would differs from familiar interfaces, such as for example smartphones and laptops.

Part 2: In groups of two, the workshop participants designed content for the *Visual Turntable* with spray cans, acrylic colors, pencils etc. (see Figure 9a). At this point, the *Visual Turntable* was utilized as a medium for creating color schemes for the media façade without using a GUI based interface.

Part 3: Finally, the participants reflected with provided brainstorming materials such as Post-It notes, pens and flip-charts on the topic how they would improve the experienced interfaces as well as collecting own additional ideas (see Figure 9b).

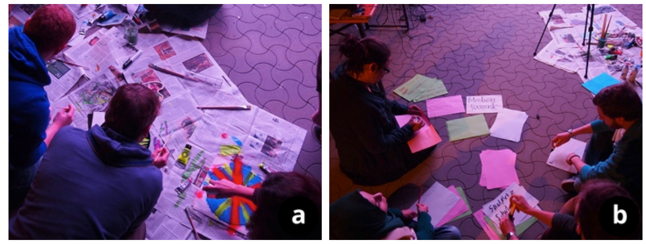

Figure 9. (a) Participants designing records for the *Visual Turntable* (b) Brainstorming Session

The workshop sessions were videotaped for later analysis and the gathered data analyzed via open coding and affinity diagraming [9, 19].

Preliminary Workshop Findings

The findings of the urban prototyping workshop highlighted that the provided interfaces prompted *creativity* by the participants: they emphasized that the *Visual Turntable* stimulated their creativity in particular, denoting “creation of own content” as a positive experience. In this context, public facilities such as schools or playgrounds were frequently suggested as potential usage sites of the proposed architectural interventions. Further, we have noticed reoccurring responses for additional participatory toolkits. For example for the *Gesture Painting Interface,* triggered additional supplemental ideas such as “color palettes” or “mixing colors”. In addition, it was repeatedly mentioned that “the traces of the *Gesture Paintings* should be saved” in order to view, edit and share the resulting images with others. In summary, we have noticed a strong demand by the participants to create individual content and share it.

Alternative Exploratory Evaluation

To gain further insights concerning the interfaces, we conducted an exploratory field study (see Figure 11). While for the co-creation workshop sessions the participants had to execute formal tasks, the exploratory study was organized more informally. Invited participants and passersby could interact with the media façade followed by a short interview. Here, our aim was to receive feedback regarding the new forms of interaction in order to identify key issues, considering a research-through-design approach [38]. Furthermore, we wanted to know if evaluating *urban interfaces* on-site would be practical for further research.

Setup and methods

In contrast to the workshop part, the second part of the user study was conducted without prior sign-up. We announced the study as *Urban Prototyping Party* and promoted it via social media networks. Due to the prominent urban location, passersby also joined the event. The study lasted form 9 pm till 1am, with a total of 70 guests.

During the event, the same interface applications as for the workshop sessions were utilized, namely *Gesture Painting*, *Visual Turntable* and *Interactive Lighter* (see Figure 10a, 10b and 10c). It was taken into consideration that the applications changed frequently at regular intervals. Lighters were freely distributed for the *Interactive Lighter* application. Participants who previously had been interacting with one of the interfaces and the façade, were asked for a semi-structured interview. The interviews were audio-recorded with their consent.

In total, we conducted semi-structured interviews with 13 participants (6 female, average age 26 years). Each semi-structured interview had a duration of 25 minutes and consisted of a framework including three topics. The interviews addressed questions regarding the (1) experience in general referring positive and negative user experience (UX) aspects, (2) the interactivity in the urban realm and (3) social aspects and acceptance of interactive installations in the specific district and in urban areas in general. To analyze the interviews, the audio recordings were transcribed via an open coding scheme [9]. For merging similar concepts and sorting the codes into categories, affinity diagraming was conducted [19]. Besides the interview data, the findings also included observational data in the form of memory minutes.

Preliminary Findings

Our analysis indicated five themes. An overview with a short description is shown in Table 1.

Stages of Participation: People quite differ in perceiving and using interactive media façades.

Communication: Interacting with media façades enhances communication between users.

Ambiance: There is interdependence between inter-active installations and its ambiance.

Saturation: After a period of time, attraction of interactive experiences in the urban space fades.

Concerns: Media façades in general have to cope with social, ethical and environmental concerns.

Table 1. Listing of categories resulting from user interviews.

Users differed markedly in their perceptions of the installation and, therefore, in triggering animations with the interfaces. One interviewee stated: “Tonight you could see very well - depending on how people are, depending on their cultural background - that they dealt quite differently with the given possibilities.” While reviewing the data three different **stages of participation** were identified:

(1) *Consuming* refers to a behavior in which participants mostly used the interfaces in the predefined way. They frequently mentioned that they first observed other people or asked them before they started to interact with the media façade. After triggering something, they returned to their role as spectators. One participant stated: “I preferred the lighter, because it rises a ’wow’ effect when the small flame created such a big thing. [...] the animation was very similar to a real firework”. Another interviewee emphasized the association of “sparking a firework animation” and sparking real pyrotechnic particles. It became obvious that due to the realistic, predefined and very restricted application, many participants felt comfortable in their role: the power of triggering a big spectacle that demands only a small impulse (see Figure 10c).

Figure 10. Users interacting with the three provided interface concepts: (a) *Gesture Painting*, (b) *Visual Turntable* and (c) *Interactive Lighter*.

(2) *Exploring* refers to a stage in which participants experienced the installation in a more experimental way. Two interviewees directly addressed the experimental interaction with light as an important and essential part of the installation differing from familiar interfaces, such as for example light-switches. One interviewee mentioned that she was impressed by the *firework animation* but annoyed of the weak flame of the lighter. Therefore, she used the flashlight of her phone for triggering the firework. In this vein, another participant was using a laser pointer and stated enthusiastically: “This façade and the interactivity arouse curiosity! First you are just observing, and then you start trying out to see what happens then.” While these interviewees used an *everyday object* for interacting with the façade, it could be also observed that a few people started *hacking* the *Interactive Lighter* interface: removing the protection cap from their lighter caused a much larger

flame and thus the probability of triggering the IR-Sensor increased.

(3) *Creating* denotes the most active participation stage. During the interviews, it was repeatedly mentioned that the media façade sparked their creativity: "It's a modern form to express oneself artistically." One participant with a background in art stated that "as an art student, it's fascinating that you can *paint* with your body on a (buildings) surface". He referred to the façade as a "digital canvas" on a "larger scale". Participants who suggested employing media façades for art in public spaces rather favored the *Gesture Painting* and *Visual Turntable* applications (see Figure 10a and 10b). They stated the ability to "develop own content" as a main reason. One participant stated that "while doing so, one is not bounded to any predefined (firework) animation". In summary, this stage of participation provided a more important role for the user. They were no longer just triggering predefined content, rather becoming active co-creators using the interfaces as tools.

During the user study we observed that the interaction with the façade also raised **communication** between the participants. This was reflected in the analysis of the qualitative data. One participant stated: "A young woman explained me the interfaces - in other words, we interacted." Other participants affirmed that first they could observe the happenings and then it was very easy to take part. Participants mentioned that the *firework* animation especially raised communication. One interviewee described one situation as follows: "We always asked each other: 'was it your or was it my fire?' Then everybody was in touch".

Obviously, there is interdependence between media façades and its **ambiance**. One participant stated that "if the media façade is well integrated into the existing architecture, it would definitely increase the symbolic value of a building" referring to vitalization of the urban realm. Another participant mentioned that "a media façade serves as embellishment" referring to aesthetical properties. In this regard, one interviewee pointed to the "special charm of the low resolution façade". One must avoid the mistake of measuring up to "existing high-tech solutions". Indeed, media façades can increase the vitality of the urban space, but on the other hand they are reliant on existing infrastructure. There was a general feeling that a media façade can only exploit its strengths in association with existing public places, for example bars or clubs, where the people primarily go for other reasons. One interviewee confirmed: "I would not come here just for (the sake of) the façade".

The user data indicated that interactive installations can cause a state of **saturation**. Most participants perceived the installation as a new experience in terms of lighting and interaction and expressed their admiration and enthusiasm: one participant who passed by chance with his bicycle stated that the media façade "magically" attracted him. However, or rather precisely for that reason more than half of the interviewees uttered that after a while they felt bored or that they imagined this could happen during a second encounter with the façade. One interviewee mentioned: "I think that the time you'll be busy with the façade is limited to 5 to 10 minutes maximum - then you'll move on." Others even claimed that the façade could become a matter of course in a negative sense. One drew a comparison to an acquainted urban phenomenon: "It's similar to graffiti: if it's new - it's wicked. But after a few times watching it, you know it." To reduce the impact of saturation, it was stated that a media façade could work as a carrier for interchangeable urban artworks by various artists.

Figure 11. Birds-eye view of the *Urban Prototyping Party*.

Further statements revolved around **concerns** regarding our installation, but also media façades in general. *Light pollution* was frequently stated; an attending architect mentioned that "especially extensive lighting projects require a critical analysis". Another participant living in the same district stated more specifically: "The light disturbs after a longer period of time [...] I would not want to have it permanently next door. It's too glaring for me". *Vandalism* was another concern that frequently appeared during the interviews. Especially the lighter application seemed to encourage abuse: "I would think that maybe a rowdy will try to torch the installation."

DISCUSSION

In summary we reported on our experiences developing the prototyping toolkit *LightSet*, designing several exemplary interfaces with it, conducting a co-creation workshop with potential user and investigating interaction with media façades to share how our toolkits can be practically applied.

Considering our prototyping toolkit, we summarize that it served its purpose as a supportive tool during the design process of an interactive media façade in a public place. Thereby, it was used at various design stages: (1) During the implementation phase in the lab, it proved particularly helpful that the developed animations were created on the actual light-emitting screen. Especially, low-res luminous facades differ strongly from computer screens so that an implementation that is entirely based on simulations is not feasible: The lower the pixel density, the more important is the successful interplay between colors, brightness and motion in order to design aesthetic animated content. (2) Due to mobility and flexibility, the toolkit could be quickly assembled at an urban location. With the adjustable LED mounting and mapping, we could carry out the final calibration on-site. Compared to a study setup in the lab, an evaluation setup *in the wild* revealed promising insights, e.g. *social aspects* and *ambiance* that are otherwise not feasible. (3) Considering the conducted workshop, the tools proved its communicative and stimulating purpose. Potential users without background knowledge in this domain were able to create content and explore further interactive concepts. In our future work, we will investigate how such tools can be applied to large-scale projects involving various professionals and stakeholders.

The flexible hardware and software solution of *LightSet* enables the prototyping of arbitrary light-emitting media facades differing in size and pixel density. Architects in particular could benefit strongly from such prototyping toolkits as they can help them to plan media façades in addition to their common tools that are limited concerning the mediation of media-related (i.e., sociological) aspects. Furthermore, experience prototypes are much more convincing when introducing concepts to potential clients. Our solution can especially support teams with limited technical know-how and limited financial budget. By using off-the-shelf hardware and software components, we hope to encourage others to utilize our toolkit or develop it further for their own projects.

Proposing an exemplary set of *urban interfaces*, we shared our experiences using our toolkits and demonstrated the systematic development of prototypes in this domain.

Considering the evaluation of the proposed interfaces, the conducted *Urban Prototyping Workshop* proved to be a good context-specific format for evaluating these experimental urban interventions. Due to open participation without any barriers, such as prior registration, a wide audience could be involved in the exploratory field study. Thus, people with a variety of different cultural and professional backgrounds could be interviewed. Random passersby and a high fluctuation were typical for any urban area. Since most of the interface concepts were a novelty, we addressed exploratory research methods for establishing a theory. At this point, we want to emphasize on the limitations of this approach, since due to the novelty bias results can also be driven by *first-use enthusiasm.* Finally, our installation lasted only one evening, so that longer studies should be carried out which we will do in the near future.

CONCLUSION AND FUTURE WORK

Media façades complemented by appropriate interfaces can transform a building's surface into a giant interactive screen serving as a *stage* for creative participation. In our work we took up the challenge of media façades being a new type of interface and the question how to prototype and evaluate those novel interfaces from scratch.

We proposed the prototyping toolkit *LightSet* that allowed pre-testing interactive content in life-size scale. We designed and evaluated a collection of *urban interfaces*, presenting an extended user-centered design process. We highlighted the importance of a sensitive intervention with respect to architectural as well as societal and user requirements. Therefore, we investigated the involvement of potential users in a co-creation workshop providing them with domain specific methods and tools. Documenting our approach and making the tools publicly available, we consider our work to contribute to further research and aid designers to tackle similar domain specific challenges.

In order to prove the validity of our approach, we plan to apply our toolkit to further projects, implementing different interactive concepts and applications. In this context, we will address the limitations of the preliminary evaluation in the near future: the conducted urban prototyping workshop initiated the building of an interactive light sculpture entitled "*Orchestrating the Depth of Light*". The resulting artwork will be presented during the *Luminale*, at a large lighting fair, the *Light+Building*[8] in Frankfurt, Germany. Relating to our media architectural intervention at *Luminale* in cooperation with architects, city planners, designers and HCI researchers, we plan a larger scaled field study over a period of several days to reveal further insights of the mid term (i.e., one week) utilization of interactive media architecture. Designing interactive media façades in accordance with a research-through-design approach, we share our vision of a tailored design process in this domain.

ACKNOWLEDGMENTS

We thank the University of Munich (LMU), the Media Architecture Institute (MAI) and the Studentenwerk München for supporting this project.

REFERENCES

1. Blinkenlights, 2001. http://blinkenlights.net/, accessed December 2013.
2. Böhmer, M., Gehring, S., Löchtefeld, M., Ostkamp, M. and Bauer, G. The mighty un-touchables: creating playful engagement on media façades. In *Proc.* MobileHCI 2011.
3. Boring, S., Gehring, S., Wiethoff, A., Blöckner, M., Schöning, J. and Butz, A. Multi-user interaction on media façades through live video on mobile devices. In *Proc.* CHI 2011.
4. Brynskov, M., Dalsgaard, P., Ebsen, T., Fritsch, J., Halskov, K. and Nielsen, R. Staging urban interactions with media façades. In *Proc.* INTERACT 2009.

[8] http://www.light-building.messefrankfurt.com/

5. Buchenau, M. and Suri, J. F. Experience prototyping. In *Proc.* DIS 2000.
6. Bullivant, L. Responsive Environments: Architecture, Art and Design. *V&A, London,* 2006.
7. Buxton, W. Sketching User Experiences: Getting the Design Right and the Right Design. *Morgan Kaufmann*, 2007.
8. Chandler, A., Finney, J., Lewis, C. and Dix, A. Toward Emergent Technology for Blended Public Displays. In *Proc.* UbiComp 2009.
9. Corbin, J. and Strauss, A. Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. *Sage Publications*, 2008.
10. Dalsgaard, P. and Halskov, K. Designing urban media façades: Cases and challenges. In *Proc.* CHI 2010.
11. Fischer, P. T. and Hornecker, E. Urban HCI: Spatial aspects in the design of shared encounters for media façades. In *Proc.* CHI 2012.
12. Fischer, P. T., Zöllner, C. and Hornecker, E. VR/Urban: Spread.gun - design process and challenges in developing a shared encounter for media façades. In *Proc.* BCS 2010.
13. Frenchman, D. and Rojas, F. Zaragoza's Digital Mile: Place Making in a New Public Realm. *City*, 2006.
14. Gehring, S., Hartz, E., Löchtefeld, M. and Krüger, A. The media facade toolkit: Prototyping and simulating interaction with media façades. In *Proc.* UbiComp 2013.
15. Haeusler, M. H. Media Façades: History, Technology, Content. *avedition*, 2009.
16. Korsgaard, H., Hansen, N. B., Basballe, D., Dalsgaard, P. and Halskov, K. Odenplan: a media façade design process. In *Proc.* MAB 2012.
17. Kries, M. and Kugler, J. Lightopia. *Vitra Design Museum*, 2013.
18. Kumar, V. 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization. *John Wiley & Sons*, 2012.
19. Lazar, J., Feng, J. H. and Hochheiser, H. Research Methods in Human-Computer Interaction. *John Wiley & Sons*, 2009.
20. Lim, Y.-K., Stolterman, E. and Tenenberg, J. The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. In *Proc.* TOCHI 2008.
21. Moere, A. V. and Wouters, N. The role of context in media architecture. In *Proc.* PerDis 2012.
22. Moggridge, W. Designing Interactions. *MIT Press*, 2006.
23. Popupcity.net blog. http://www.popupcity.net/freiburgs-tolerance-pillar/, accessed January 2014.
24. Reas, C., Fry, B. and Maeda, J. Processing: A Programming Handbook for Visual Designers and Artists. *The MIT Press,* 2007.
25. Rudd, J., Stern, K. and Isensee, S. Low vs. high-fidelity prototyping debate. *ACM Interactions*, vol. 3, 1996.
26. Ryder, G., Ion, B., Green, G., Harrison, D. and Wood, B. Rapid design and manufacture tools in architecture. *Automation in construction,* 2002.
27. Saffer, D. Designing for Interaction. *New Riders*, 2006.
28. Sanders, E. B.-N. and Stappers, P. J. Co-creation and the new landscapes of design. *Taylor & Francis,* 2008.
29. Scheible, J. and Ojala, T. Mobispray: mobile phone as virtual spray can for painting big anytime anywhere on anything. In *Proc.* SIGGRAPH 2009.
30. Schoch, O. My Building is my Display, In *Proc.* eCAADe 2006.
31. Seitinger, S., Perry, D. S. and Mitchell, W. J. Urban pixels: painting the city with light. In *Proc.* CHI 2009.
32. Sommerer, C., Jain, L. and Mignonneau, L. Media Façades as Architectural Interfaces. In *The Art and Science of Interface and Interaction Design, Springer,* 2008.
33. Struppek, M. The social potential of urban screens. *Visual Communication,* 2006.
34. Tscherteu, G. Media façade online catalogue, 2010. http://www.mediaarchitecture.org/mab2010documentati on/, accessed December 2013.
35. Urban Prototyping website. http://urbanprototyping.org/, accessed December 2013.
36. Wiethoff, A. and Blöckner, M. Lightbox: exploring interaction modalities with colored light. In *Proc.* TEI 2011.
37. Wiethoff, A. and Gehring, S. Designing interaction with media façades: a case study. In *Proc.* DIS 2012.
38. Zimmerman, J., Forlizzi, J. and Evenson, S. Research through design as a method for interaction design research in HCI. In *Proc.* CHI 2007.