Creating Shared Encounters Through Fixed and Movable Interfaces

Patrick Tobias Fischer and Eva Hornecker

Abstract Currently, our cities become more and more equipped with information and communications technology (ICT). Rarely do these systems provide a fit with everyday public life. They focus primarily on efficiency, security, safety and business. There are few system designs which support social aspects such as identification with the city and community, responsibility, everyday habits, leisure, pleasurable stay, social interaction, courtesy behaviour, play, etc.—in short, aspects of social sustainability. To outfit our future city with technology currently lacking the support of those qualities, we created several novel interaction designs to explore how to best merge ICT with the public space. This chapter presents some of our theory developed from our research-through-design approach and three case studies including suggestions for measures of success such as the number of shared encounters, average interactions per minute (ipm), or accumulated interaction time. We believe those hard facts are needed to argue for the need of playful ICT in our city that makes our public life more enjoyable.

Keywords Urban HCI · Humane city · Tangible and embodied interaction · Research through design in-the-wild · Prototyping

1 Introduction

Most of the information technology we encounter in public spaces nowadays consists of flat screens that take on the function of billboards, signage, information screens as well as mobile phone applications. The interaction model of public displays is information-push, at most, people will get their '15 s of fame' on Times Square

P.T. Fischer (✉) · E. Hornecker
Bauhaus-Universität, Weimar, Bauhausstrasse 11, 99423 Weimar, Germany
e-mail: patrick.tobias.fischer@uni-weimar.de

E. Hornecker
e-mail: eva.hornecker@uni-weimar.de

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Fig. 1 *Left* and *middle* New York's Times Square and a '15 s of fame' installation. *Right* High rises transformed into a nightly spectacle in China. Photo © Martin Hornecker with kind permission

(see Fig. 1). While displays may brighten up the city and distract from otherwise ugly architecture, they do not make a city more liveable and engaging. They seldom help people to connect emotionally and socially with their city and with others. Recently, the vision of 'smart cities' has gained traction (and funding), but this predominantly focuses on sensor systems, big data analysis, with the aims of automation, efficiency, convenience and security—the citizen and urban dweller is almost non-existent in this vision (cf. Poole 2014; Greenfield 2013) aside from being the target of sensors and recipient-customer of automation.

We believe that sociality is important for social cohesion in urban spaces. Information technology design often reduces opportunities of encounters and prevents sociality to flourish even though public spaces are inherently social spaces. They are often used by groups, e.g. families and friends going to the city. Moreover, they can become a shared affair that citizens have an interest in, as something they live in and enjoy. We are also familiar with the phenomenon of the 'familiar stranger' (Milgram 1977) that we meet time over time again. Given the right occasion and a talking point, we may finally strike up a conversation. Encountering people repeatedly can slowly build up trust, enhances the chances of social interactions occurring, and can help to reduce feelings of isolation.

In our work, we explore playful approaches for the creation of *shared encounters* in the urban environment. In this, we are partly inspired by the idea of the 'playable city' as discussed for the 'Making the City Playable' conference at the Watershed in Bristol (Watershed 2014; Baggini 2014). The hope is that playful public activities foster identification with one's city, support creative appropriation, and support community and active participation.

In our own design and empirical work on playful shared encounters, we focus on interaction types from the field of tangible and embodied interaction. We explore what kinds of configurations of technology and environment effectively support playful interactions in the city space and how they provoke social interactions. In

the work presented here, we focus on how to get people engaged with novel types of interactive systems in public spaces and with each other, turning these places into sociable places that support active engagement.

Usually the resulting prototype devices are content-reduced and abstract (no text or transmitted story, just, e.g. colour and light)—implementing kind of a separation of concerns, simplifying the design space (this also makes it easier to discern the attractiveness of interaction itself). We also work towards utilizing quantifiable concepts such as shared encounters in order to measure positive impact in a more objective way.

2 Background

In this article, we focus on projects that take a playful approach to fostering shared encounters in urban settings. The term 'shared encounter' builds on Goffman's (1966) observations of 'Behaviour in Public Places'. Willis et al. (2010) defined these as "[…] the interaction between two people or within a group where a sense of performative co-presence is experienced by mutual recognition of spatial or social proximity", i.e. people acknowledge each other's presence. A slightly more restricted definition by Schieck et al. (2010) limits those to "an ephemeral form of communication and interaction augmented by technology", that is, the encounter is facilitated by some technological augmented interaction.

Thackara (2005) revives Ivan Illich's notion of conviviality when he reminds us that a sustainable city needs to be "*a city of encounter and interaction*", where community is created through co-presence and the shared meaning which emerges from interacting with others in meaningful activities. The notion of shared encounters builds on the philosophical background that Thackara touches upon (Ivan Illich, Martin Buber), but in the absence of social organizations, puts its hope into everyday encounters via a 'talking point' that creates a social permission and invitation for talk. Shared encounters create a short intermezzo within our habitual routines, a dérive from the routines of how we use urban space and interact with other city dwellers. Playfulness can be one strategy for creating shared encounters, as we demonstrate in this chapter.

Few would dare to question the overall value of play nowadays, as play has been argued to be essential for learning and socialization (Brown and Vaughan 2009) and Huizinga (1955) categorized mankind as a playful creature, 'homo ludens'. But a playful approach can also help people to rediscover their surroundings by changing perspective. Precursor to attempts for a playful city can be found in the Situationist dérive and modern parkour. Place (the lived and experienced space) is changed through the interactions and social practices taking place in it. For this, Thackara (2005) refers to Malcolm McCallough, while de Souza e Silva and Hjorth (2009) trace this understanding to the philosopher Lefebvre (1991) who explained that 'place' is constructed.

There is a new interest in the value of play in the context of urban living. The notion of the 'playable city' is a counterpoint to the narrative of Smart Cities, emphasizing serendipity, hospitality and openness instead of efficiency, and offering permission to play to the public (Watershed 2014). In 2008 Droog organized an event on Urban Play in Amsterdam, showcasing playful design interventions for the public that constitute a new form of (often guerrilla, e.g. non-commissioned and permissioned) urban art (Burnham 2008). The Watershed's Playable City program, which culminated in a conference, commissioned various playful interventions and workshops that invited the entire city of Bristol to play and re-appropriate public spaces, e.g. with a giant water slide. At the 2014 Playable City conference, speaker Tine Bech emphasized that "physical play creates social bonds", and play designer Holly Gramazio described the value of play in public as "a great way to feel at home in a space, to experience it and to have a different perspective and feel you got some ownership of it". A guardian article summarized these and related arguments in the headline 'the city that plays together, stays together' (Baggini 2014).

Huizinga (1955) and most of the literature that followed him define play as separated from (serious) everyday life via the boundaries of the 'magic circle'. But this separation is increasingly challenged, in particular in the context of pervasive games and earlier movements that intentionally blur the boundaries between game/play and ordinary life (de Souza e Silva and Hjorth 2009; Montola et al. 2009). If we want to understand how urban spaces can become playful spaces, it may thus be useful to focus on 'casual play' (de Souza e Silva and Hjorth 2009), which helps people to immerse in and rediscover physical space. While pervasive games are one radical strategy for creating a different experience of the city and appropriating it, the playable city approach did not go as far, and picks up on game genres that are familiar to everybody and have less risk of tension, e.g. childhood games, group sports, performance, the new games movement.

3 Mutual Influences of Architectural Configurations, Public Life and Interaction Design

In some of our prior works, we have investigated how different physical setups of public installations (in museums) affect engagement and social interaction (Hornecker and Stifter 2006) and how novel interaction styles such as tangible, touch, and gestural interaction influence the user experience (Hornecker and Buur 2006), in particular, social experience. Given our systems are embedded in real spaces, and—in the case of media façades and urban installations—in large architectural scale spaces, it is important to think spatial, both in terms of dimensions, distances, and in terms of embedding, interactions and balance with the given environment (Fischer and Hornecker 2012). In particular, space can orchestrate human experience and social interactions, e.g. by modulating distances between people and their spatial configuration, which in turn may send out social signals (Hornecker and

Fig. 2 The movable interface SMSlingshot by VR/Urban. *Right* person shooting a message to a façade

Buur 2006; Kendon 2009; Marshall et al. 2011). Our approach to analysing urban interactions is influenced strongly by urbanism (see: Whyte 1990).

Much of the design and analysis work described in the following sections of this chapter are based on our experiences with the media intervention SMSlingshot (Fig. 2) and influenced by our Urban HCI Space Type Model (Fischer and Hornecker 2012), which we will now focus on.

Our model of space types and basic influences of architectural configuration (see: Fischer and Hornecker 2012) emerged out of experiences with exhibiting the SMSlingshot, a media-arts installation by the VR/Urban art and technology collective (that Fischer is part of). The idea of the SMSlingshot is based on the street art tactic of tagging with paint bombs. Users type messages on a keypad embedded in a slingshot and then aim and 'shoot' their message onto a façade projection or media façade. The interaction design of the SMSlingshot was already an iteration, based on experiences with a prior public intervention called spread.gun (Fischer et al. 2010) which had festival visitors type their messages at a public city terminal and then use a cannon next to the terminal to aim and shoot. Here, visitors began to queue at the screen and barely talked. The slingshot was intended to make people move around, and aimed to create a more flexible and dynamic situation in which people

are not hampered to mingle, make people feel subversive, and to foster expressive gesture.[1]

The SMSlingshot was exhibited in a variety of situations and locations around the world, mostly urban art or music festivals, but also in everyday situations. The team thus experienced the influence of diverse setups and settings on how the SMSlingshot was used, how the crowd behaved, how the public space itself came to be transformed, and also saw other installations at the same locations. We then began to utilize this to analyse how people appropriate and use space, and how architecture and public life interacts with the installation and with interaction.

A basic distinction of settings is between plaza and walkway, which create different situations. On plazas (city squares and civic places) people tend to meet with others, relax and often spend time. This means that plazas are suited for narrative structures that extend over time. A walkway on the other hand is characterized by a steady flow of people. Often, it is not possible to stop for an extended time, as one would become a hindrance for others. Thus, walkway situations lend themselves more to ad hoc, short interactions.

The spatial setup and setting influences visibilities, but also how people congregate in a space, where people position themselves for activities, and how the setting is experienced. We have summarized our insights into the space type model described in Fischer and Hornecker (2012) and shortly describe four of the seven relevant space types. The *Activation Space* (*AS*) encompasses all areas from where a display as well as the activity of a 'performer' (performer display) interacting with the system can be seen, resulting in an awareness of what is going on, but where one cannot yet interact. In the *Interaction Space* (*IS*), people actively interact with the installation. In the case of the SMSlingshot, the IS moves around with the person holding the slingshot—for the spread.gun it was fixed. The *Potential Interaction Space* (*PIS*) then comprises all positions, from where people can potentially interact—with the SMSlingshot, this is everywhere the device is still being picked up by the receiver and in direct line of sight to the façade. A *Social Interaction Space* (*SIS*) emerges where people congregate and are attracted by the system, which creates an opportunity for shared encounters. These can be created among *performers*, *participants* or *observers*. With the SMSlingshot, we observed that typing a message serves as a gestation point for social encounters, as people often discuss what to type, ask others about the device, or help each other, e.g. carrying their bag so they can use both hands.

Another important aspect of the SMSlingshot is its tangible nature, which calls for embodied interaction. The movable and untethered nature of the device means it can be easily handed over, supporting fluid shifts of control and allowing for shared use by, e.g. two people. It further integrates in natural group configurations keeping core requirements for social interaction intact. The metaphor of the slingshot is easy to understand. Users find the act of shooting a message very satisfying, as a combination of the bodily act of throwing and the sound of the rubber band.

[1]Note: We prefer to think of the SMSlingshot and our other systems as 'interventions' and not as installation. The term 'installation' indicates a static and immobile system and we rather aim at fluid urban interventions that create a dynamic situation.

The bodily experience of shooting with an oversized device not only reminds of child's play, but also carries elements of subversive, playful rebellion. We have further found that the act of shooting is highly performative and expressive, as the posture one has to take on is very visible and stands out from the crowd. Typing the message on the other hand is local and half-private, and only direct bystanders can see the screen of the device. This combination appears to have the effect of lowering thresholds for participation, while creating some social control over the content of messages.

The concept of 'people as display', resulting from the performative interaction design of the SMSlingshot, is another lesson related to our space type model (Fischer and Hornecker 2012) that strongly influences our work discussed here. Not only the projection on a façade constitutes a display, but the user turns into a highly visible 'performer display' which attracts attention. Additional 'people displays' generated by an intervention are the 'participant display', often mimicking the gesture of shooting without actually having the interface, and the 'observer display' (e.g. observers looking in one direction), providing cues for understanding what is causing certain effects.

4 Playfully Appropriating the City

In the following, we discuss a set of experimental projects that we conducted with our students to explore urban playful interaction. Most of these were based on 'content-reduced interaction' in term of utilizing abstract content (e.g. light and colour). This allows us to focus on interaction design decisions, and to simplify the development process. Moreover, it eases evaluation and analysis, reducing the number of factors that influence audience reactions.

A crucial question to answer when creating prototypes of public installations is: How to determine success? How many people should an installation attract into interaction and how many shared encounters should be generated? To have a benchmark for comparison, we studied a well-liked permanent installation in our home town Weimar, Germany. We next describe this benchmark study, before moving on to the experimental temporary projects.

4.1 A Benchmark Study of an Interactive Fountain

On a large square in Weimar (Herderplatz, GPS: 50.981213, 11.329813), a partially pedestrian zone with high foot traffic, but also used as a throughway for inner-city traffic, an interactive fountain installation is located. The principle is simple—one jumps on a block of stone to release a water jet. Only the smallest of the three blocks visible in Fig. 3 has this function. Depending on the pressure exerted, the water squishes higher. This installation is very popular, in particular with children.

Fig. 3 Interactive fountain in Weimar and 2 children playing

Sometimes two children collaborate or an adult helps smaller children by adding their weight. Frequently, a crowd of observers gathers. We chose it for systematic analysis based on informal observations. Being a well-liked and frequented installation, it provides us with a benchmark of how a successful installation performs in attracting people and generating shared encounters.

A team of our students was instructed with the Urban HCI space type model and the role types of performers, participants, and observers, based on Sheridan's Performance Triad Model (2005). Knowing a priori about the space type model in combination with the role types helped the students to define areas for which to count people. Furthermore, it helped them to develop a notation scheme for their counting sheet. In a first step, the space types such as SIS, IS, PIS were drawn on a map in the lab. Other space types, such as Comfort Spaces, AS required a site visit to sketch exactly. The site visit and a first pilot study of two 1-h time slots refined the sketched spaces and the counting sheets. To get a baseline, total passers-by were gate-counted. For the refined study design five 1-h slots, starting from the time children are on their way to school at 6:40 a.m., to the closing time of local shops at 7 p.m. and nighttime 11 p.m. The students trained another group of students in taking the role of counters with the notation scheme that categorizes individuals according to age, group membership and the role they take (performer, participant or observer) in 5-min quantified time chunks. Overall, the interactive situation was observed by two researchers per time-slot for 9 h 40 min in total, counting a total of 3586 people. More people were interacting in the afternoon when school closes and many finish work and return home or go shopping.

As expected, given the plaza is a central passageway and the fountain is located right next to one of the incoming streets to the inner-city, there were many passers-by's that did not stop. 81 % of all people just passed by. About 17 % gathered in the PIS. This number splits up in 6 % of 'performers', people actively jumping on the stone, and 11 % of 'participants' who stood right next to them, mildly engaged, mostly socially interacting. At the edge of the PIS, there was a smaller number of passively engaged observers (1 %). The low percentage of observers is a result of only counting those at the edge of the PIS as the plaza was too large to count observers

for the full Display Space (DS) of the installation. Finally, 1 % (approx. 38 people) of the total people counted experienced a shared encounter with apparent strangers that began talking or playing together. From this we recognize that actual interaction numbers are not high (Fig. 4).

Yet still, the installation has an effect on the plaza, and we know that some people play with it every once in a while. This means, that it may be unrealistic to expect much higher uptake with a digital installation. In public spaces, most people simply have a goal, may be in a hurry, or be preoccupied. In fact, low interaction rates have been found to be normal in public outside spaces and are much lower for mobile phone interaction with public displays. For example, Schoeter reports an average of 0.03 interactions per minute (ipm) with a public display in Schroeter (2012) similar to Linn et al. who also report 0.03 ipm (Linn et al. 2011). The ipm for the fountain is 1.08. This ipm value is a typical average for everyday-life situations for situated interaction. Situated interventions such as SMSlingshot with 2.4 ipm and LASER Tag (Graffiti Research Lab 2012) with 2.3 ipm show higher values, but were presented mostly in the context of media art festivals. This means, that for the eyes of the observers present on a plaza, a lot of action per minute is generated from situated installations, whereas for mobile phone interaction (as in the above mentioned examples), one has to wait approximately 30 min to observe an interaction and only gets limited 'performer display' that often is not very interesting to watch.

Counter to our preconceptions, we found more adults (55 %) to be interacting than children (32 %). Another 9 % of performers were older adults, and 4 % were categorized as teenagers. We further found that 84 % of those that interact are in groups. Being in a group appears to lower the threshold for interaction. Thus, it might be a good design strategy to design for observers (so that observation is interesting and that observers can play a role) as well as for multi-user interaction, supporting group dynamics.

4.2 Kick-/Flickable Light Fragments

In the Kick-/Flickable project (Fischer et al. 2014), we explored the potential of an interface cluster of formally similar interactive objects. From the SMSlingshot, we had learned about the benefits of movable interfaces, which create an elastic PIS and SIS that can move, vanish, form and re-form. With multiple objects we further enlarge the IS and create multiple access points (whereas just one object monopolizes interaction and creates a bottleneck). Moreover, we experimented with a different interaction style—interacting with your feet. We were further inspired by related work exploring the notion of 'light bodies' (Seitinger et al. 2009) and configurable pixels (Seitinger et al. 2010).

This project developed a family of objects that each reacts slightly different to physical interaction, in particular to being kicked (Fig. 5). The project group spent considerable time building differently shaped foam prototypes and exploring different travel characteristics for foot manipulation. Some could be easily

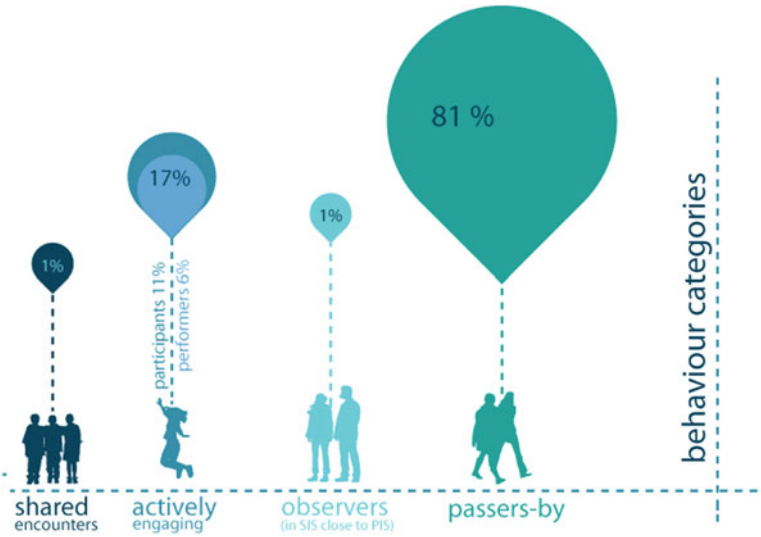

Fig. 4 Interaction count study around the fountain

appropriated as a 'football' or 'beer-belly', others provoked different interactions. Of the numerus forms, five shapes were selected, of which three were technically implemented. Moreover, each object was 'equipped' with an individual character, reacting with a different light behaviour to manipulation and proximity to other light fragments. This lends personality to the objects.

We placed the light fragments in a highly frequented pedestrian zone that also serves as a major connection path and observed for around 75 min at dusk on a warm October evening, after shops closed. From 307 people that passed by, 10 groups interacted with the light fragments, 16 people took the role of the performer while 10 were participants. This amounts to 8.5 % of people are actively engaging (5 % performers directly interacting) of all people passing-by. While this may first sound disappointing, our interactive fountain study informs us that this is not a bad result. Individuals at most made a detour to inspect the light fragments. Performers were all in groups, and frequently the rest of the group engaged as participants or distant observer, similar to what we found with the fountain. People of various ages interacted, from children over teenagers and young adults to middle-aged people, but young people (up into their 20 s) were the majority. The majority of interaction sequences lasted between a few seconds and 2 min. Most interactions were done with feet, indicating that our design was successful in terms of having clear affordances and invitations for foot interaction (Fig. 5).

Many people that went past the objects turned their heads to look at them. Observations and overheard conversations indicate that they felt compelled to sense-making, commenting on and describing the light fragments to each other. Depending on the time people spent, we can identify several levels of engagement, starting from

Fig. 5 *Left* The kick-/flickable light fragments. *Top* Two women kick one of the fragments back and forth. *Bottom* A couple walks past, inspecting the fragments visually, a child begins to explore them, and creative appropriation by a young man who picks a fragment up and puts it under his shirt

noticing and reacting (with a glance) and subsequent attempts to make sense of the light fragments, first by visual inspection and then via active manipulation. If people persisted beyond the first nudge, they would continue trying to understand the reactions, and comment on these or express their assumptions aloud. These steps of engagement so far are fairly similar to other engagement models for public installations, such as the audience funnel (Michelis and Müller 2011). But if people engaged longer with the light fragments, they began to appropriate them in creative play and to include the environment into their play, similar to the observations by Seitinger et al. (2010). For instance, one man picked the smallest light fragment up and put it under his t-shirt, imitating a colourful blinking pregnant belly, and a pair of young people began playing football, using nearby benches as goals. This integration of the environment into creative appropriation is specific for our system, as it features movable objects (Fig. 6).

Yet in some respects, we felt that the Kick-/Flickable light fragments did not yet constitute a really successful installation. While having three different objects worked to support group interaction, at several times we observed other groups waiting at a distance until the previous group left, to then quickly approach. We also observed this pattern with another installation and call it ‘hidden queueing’. Many people did not appear to realize that the light fragments were interactive. The reactions were not legible enough to be distinctive, and required more time for investigation than what most passers-by were willing or able to invest. And while some people had no hesitation to manipulate the Kick-/Flickables, others seemed to hesitate, possibly being afraid to touch (and possibly break) these beautiful objects that so clearly stood out from the normal pedestrian area. Moreover, no shared encounters were generated. Furthermore, the ipm of 0.18 was relatively small compared to the fountain. But this was partially due to a couple playing with the light fragments for about 20 min. If we only consider the time span before these two arrived, then the ipm is 0.2.

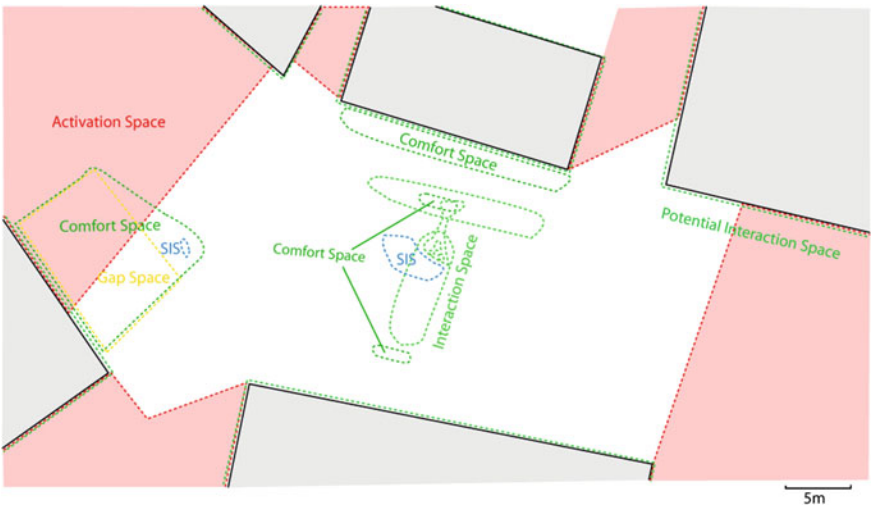

Fig. 6 Distribution of the urban HCI space types

4.3 PIPE—A Fixed Walkway Interface

With the PIPE project we explored a setup that contrasts on many aspects with the previous project. The initial idea was to utilize repeating architectural elements to increase the installation's DS and support people's ability to predict cause and effect. The custom-made display was designed to fit in a parasitic manner to rainwater pipes, which are thus augmented. Again, we decided to use coloured lights as output, and foot interaction for input. But in this case, input and output space were split up, enhancing long-distance visibility (= large AS) of our system, but sacrificing movability and with it a large PIS in return.

The student team built a light fixture that can be attached to a rain pipe, made from a chain of individually controlled multicolour LEDs. The individual segments are held in third-circle shaped elements that diffuse the light. For interaction, we had experimented with pneumatic pressure and built three tubes that people can step on.

The input mechanism thus has resemblance to the Dance Dance Revolution mats, but makes the air pressure mechanism noticeable. We wanted people to feel the tube, as this adds to the playful experience and also provides feedback of other users movements. Initial experiments with tubes resembling water hoses or bicycle wheel tubes indicated that most people would avoid stepping on these and that they could furthermore create a tripping hazard. We thus built the pressure beams depicted in Fig. 7, which create a small elevation that feels soft and a bit wobbly due to the internal air pocket. Their custom shape is created from rubber sheet material (thickness 1.5 mm), which is glued tight to a sealed wooden board. An internal sensor tracks changes of internal pressure. The IS of a single pressure beam was 1.30 m

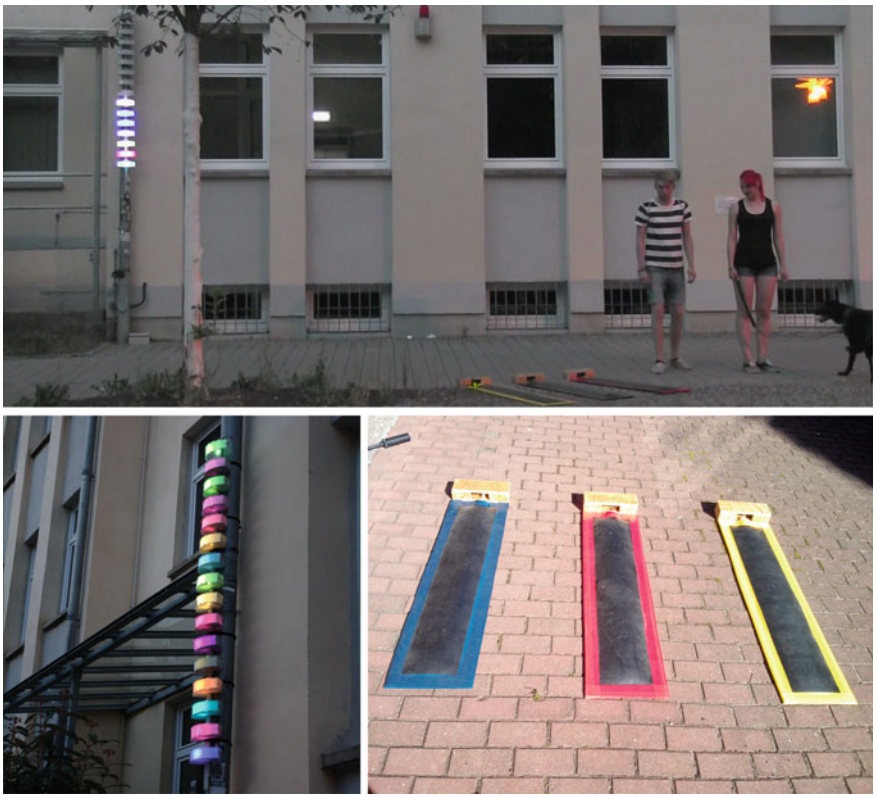

Fig. 7 The PIPE attached to a rain drain of a university building at a busy walkway and the input pressure tubes (for stepping on) on the walkway

long, as this would allow at least 2 people to stand on them simultaneously without coming into intimate distance (based on Hall's interpersonal space model).

The interaction technique of PIPE resembles a colour mixing game. The fixture on the rainwater downpipe filled up with a section of coloured light each time a person steps on one or multiple of the pressure beams. One element blinks initially to indicate the position that will change, and also to attract attention. Stepping on a beam decides on the element's colour, each beam resulting in a different colour (the beam casing is blue-red-yellow, see Fig. 7) or, if several beams are engaged, the colours are mixed. After the internal timer for the colour selection phase is up, the element remains lit in this color and after a brief pause, the next element begins to blink. When the final element at the top of the PIPE and the entire PIPE are lit up, the lights suddenly flow up twice from the very ground (which has been dark so far, where there is a hidden spotlight) up to the top of the PIPE, clearing all created colours. The assumption behind this interaction technique was that people like to tag or leave their mark, but it turned out, the "Ring the Bell" (also known as 'Hau den

Lukas', or Strongman) metaphor was stronger. This resulted in people being very eager to reach the top light to see what happens. Thus, curiosity seemed to outplay tagging behaviour.

On 3 evenings past 8 pm, when it became dark, the system was set up and observed by our team for 1–2 h (4 h in total). The pressure mats were placed in a row in front of the output unit, which by vicinity creates association so people can guess the two kinds of objects are related. The installation was positioned at a wider walkway, which we selected for our trials as this would avoid a bottleneck for passers-by.

Overall, the multi-user setup worked very well. The pipe attracted considerable curiosity from people passing-by. The pressure beams were correctly identified by most people as belonging to the installation and it appeared to be obvious that they are for stepping onto. This is probably because they are unusual, but sturdy and big enough to not cause hesitation. From our analysis of 2.8 h video material, we counted a total of 302 people passing through the AS, 84 engaging with the system (= 0.53 ipm) and 216 passing-by. Of the passers-by, 50 % at least glanced at the PIPE and 48 % did not seem to take note of it (did not stop or slow down, and did not turn their head to glance at it) 2 % stopped, but then went on. The accumulative interaction time of all performers during the 2 h 40 min was 1 h 18 min without the additional engagement durations of the participants and observers.

During our test setup, 21 % of passers-by (64 people) became performers, which is a very high number based on our comparison data from the fountain. 13 other people (4 %) stopped to observe performers. Of performers, 15 % were categorized as elderly, demonstrating that playful interaction can reach a diverse audience.

People who passed by in a group behaved markedly different from individual passers-by. Similar to what we found earlier, 92 % of engaged people were in groups. From the 216 people just passing-by (not engaging), 30 % were individuals, and the rest were in groups. Of the individuals passing-by, only 2 % interacted with the system, whereas 25 % of people engaged if they arrived as a group. Individuals were also far more likely to pass by without glancing at the installation than people in groups. This can be explained by the tendency of groups to observe and react to each other, similar to the 'landing effect' described by Müller (2012).

In this case, we found 3 % of all people passing-by had the chance to end up in a shared encounter. The average interaction time of a performer was 1 min 13 s, which is rather long as from our experience typical interactions usually are between 5 and 30 s.

To get an impression of the variety of playful interaction (Fig. 8) nurtured by curiosity and play, we shortly describe selected observations. This also provides an impression of different performer displays generated.

The lowest three elements are on and a couple passes by. They are at least middle-aged and very properly dressed: he wears a short white shirt and long trousers; she wears a dress and white heels and carries a handbag. They have seen the PIPE and now glance down at the pressure beams. He steps on one, while she watches. Then he walks along the beams, while she watches from a few steps distance. He begins to walk a little circle, and she joins him, making small explicit steps. He walks to the side, and she begins to make small trampling steps on one of the beams, walking

forward to the next beam. He walks behind her, imitating her movements. Past the third beam, she turns around, looks at the PIPE, while he is still stepping. She reaches her hands out to him and they begin to hold hands, facing each other, while stepping each on one beam, almost as if they would be dancing. They turn around each other while she looks up the PIPE again, where more and more lights have turned on. She walks to the side again and lets her partner continue to walk on the beams, watching. Then she returns to him, and walks around him in a little circle. They look at the PIPE more often now, as the line of lights comes close to the end of the PIPE. As the last light goes on, they move to the side, and she claps three times into her hands. The couple has interacted for 1.55 min with the installation (thus slightly longer than the average interaction duration). They have not filled all elements though, thus missing the finale.

The next example interaction features a group of four young people (2 men, 2 women) who quickly decipher how the PIPE works. The PIPE is almost fully lit up, as this group of four approaches, walking at a fast pace. They arrive briefly after another group has left, and thus might have seen something interesting going on. Two are carrying bottles, and they are wheeling two bikes along. One of the women walks ahead, and slows down to look at the PIPE. She stands on one of the beams, and jumps up and down, explaining "I jump", then moves to another beam and steps on it. One of the men joins the woman and they both jump. The PIPE suddenly lights up fully and the lights flow over it (the finale). The group watches: "OH!". The PIPE goes dark again, and the first element blinks. The man begins jumping on the beam again. The woman says "we need to (rest incomprehensible due to traffic noise and sound of steps)". A passing woman with a baby buggy who saw the PIPE lighting up stops to watch the group. Once a few more elements are lit up, she leaves. Now, one of the men stands with spread-out legs on two beams and jumps up and down to get the next element to light up (possibly trying to mix colours). A woman also jumps on the third beam. The other man joins and the three walk in a circle on the pressure beams, laughing. The other woman parks her bike and joins them. Their attention is focused down on the beams, but one of the women keeps looking up to the PIPE. They stop and bend down, inspecting the pressure beams and then all press down on the beams (apparently trying to maximize pressure exerted). Then they get up again, and three group members line up on two of the beams with wide-spread legs while looking up at the PIPE, stepping repeatedly left-right and shouting the rhythm. So far, they have created a pattern of a few blueish-green elements, a red, several blueish-green, another red, and more blueish elements (unfortunately only red is distinct in our video material). As the last element blinks, they pause and move to the other beam. From their behaviour, it is evident that they want to create a colour pattern and now work to create another red light (tagging behaviour). They all stand, watching up at the PIPE, and then all together jump on one of the beams, shouting 'one–two–three'. They laugh as the blinking light becomes a constant red, comment 'fantastic' and begin to leave. This group interacted for 3.05 min.

From the last group's behaviour, it is evident that they begin to understand how colours can be mixed, from initial slow experiments by two group members to concerted actions, e.g. all exerting pressure on one beam, or pressing on two or three

Fig. 8 Content-reduced installations can create a variety of 'performer displays'. *Top left* Team playing, standing in a row on one beam. *Top right* Middle-aged couple dancing. *Bottom left* Two performers running on the spot. *Bottom right* Two performers standing on two beams simultaneously to mix colours with a group of strangers observing

beams simultaneously. At the end it becomes clear, that their plan has been to create and leave behind a colour pattern. The first group (the middle-aged couple) did not appear to fully understand how colours are mixed, but still enjoyed the interaction.

In this case, a fixed interface was more successful than our previous movable and distributed system of the light fragments in terms of attracting many passers-by to interact for a considerable time. Both systems create a large PIS, allowing several people to interact. However, in contrast to the Kick-/Flickables, PIPE has an obvious and shared goal of making the light grow, which enhances motivation and encourages collaboration. It also impacts interaction durations, as with PIPE people play till the goal is reached.

Fig. 9 The Meiningen theatre-machine during setup, showing all three sections placed around the fountain (photos © Anke von der Heide)

4.4 Meiningen: Playful Interfaces in a Total Situation

Our next case study took place in the somewhat different context of a spectacle event, but also in the semi-public space of a city. Our University was approached by the city of Meiningen to prepare an event for the centennial celebration of the founder of modern theatre, Duke Georg II. Our idea included a façade mapping that enables visitors to interact with the projections. This was realized as an interdisciplinary project involving students and supervisors from MediaArchitecture and from Media-Computing [see for details Fischer et al. (2015)].

The aim was to engage the citizens of Meiningen with their city heritage, inside the historic courtyard of Georg II's castle Elisabethenburg. The castle has a curved façade, which was selected for the projection, as this provided a unique challenge for projection mapping, as well as potentially increasing the immersion effect. Different from the examples discussed so far, this installation was content-rich. In this case, the topic of the event governed content selection and we also had access to a large archive of historic images (Figs. 9 and 10).

On a technical level, the project combines the technology of façade mapping (or 'spatially augmented reality') with the interactivity of interactive media façades (Daalsgard and Halskov 2010).

Our design challenge was how to make the façade projection interactive in a way that would make it easy for people to interact, that would be inviting and enable active participation for as many people as possible, while fitting in with the entire space and with the story of the celebration. The spectacle consisted of distinct phases, starting with visitors entering the courtyard. Then, a 12 min projection show began. This was followed by children from city schools dancing in (3–4 min), carrying lighted objects that they positioned around a central fountain inside the courtyard. Once all objects were positioned, a previously dark structure lit up: the 'theatre

Fig. 10 The Meiningen theatre-machine at night with the projections, with the rope interface visible at the front (photos © Anke von der Heide)

Fig. 11 People of all ages had no hesitations playing with the projections using the rope interface (photos © Hesam Jannesar)

machine'. Now the audience could use this machine to manipulate theatre scenery backdrops from the Duke's own hands (from the museum archives).

We had aimed for a multi-user interface with the biggest possible PIS. Interaction should not be competitive and needed to be very intuitive, since the audience would need to learn how to use the interface from watching others and trying out. After some early experimentation on-site, we settled on the idea of a rope machine with which the scenery can be pulled across the wall. The machine consisted of three parts, each 3–5 m long, and controlling a different layer of imagery. It was set architecturally, being built around the fountain and making use of the existing pathways. The machine's shape was given architectural scale by adding a larger shell in the same style (Fig. 11).

Once people understood that they were allowed to use the machine (and that it was not just for children), they used it enthusiastically. People liked to explore the content of each layer (it took a while for the same images to re-appear), and generally enjoyed being able to have an effect on such a large projection. We were surprised how many mature and older citizens interacted, and how playful they were. Overall, the rope interface was very effective, and there was little hesitation to touch it. From observations and overheard comments, the low-tech design was an important factor for this, and people generally liked the 'feel' of the rope. We also observed considerable interaction across groups (i.e. shared encounters). Here it was important that each machine section had enough space along its rope for at least 2 groups (or 5–6 people) without crowding. The impulse to join in was then big enough, and even when several people had their hands on one rope, they found it easy to synchronize which way to pull. Moreover, people often began to explain to others how the machine works, and children from different groups played together. Again, we could observe the stages of engagement we have identified earlier, from initial sense-making and 'what happens if' experimentation, over systematic exploration of potential actions and their effects, to creative action in looking to achieve specific effects or, for example, holding pace with the scenery layer controlled by another section of the machine.

Overall, the low-tech and very easily observable interaction contributed to the machine's success. Here, the artistic and historic content also played an important role in keeping the audience's attention and creating delight.

In terms of numbers, the duration of the installations interactive part was in total 46.5 min and resulted in an accumulative interaction duration of 1 h 57 min. This is a 2.52 times multiplex created by the interfaces large PIS. The ipm is therefore very high with 140 performers using the rope, amounting to 3.01.

5 Conclusion

In this chapter, we presented four case studies with different situation designs that contain an interactive system and a context in a specific environment. The case studies explored fixed and movable interfaces, walkway and plaza environments and everyday-life and event contexts. To answer the question of "What kind of technology do we want to put in public places?", we propose the measure of shared encounters, a measure that can be counted and might be used to reason why a certain digital system provides value for the city and how good it is in doing so. Playful installations are one way to generate encounters. They triangulate and can create communication between citizens that are unacquainted to each other. This communication happens not just between the performers when they directly engage with the system, which might force them to coordinate to reach a common goal, but also between the other introduced roles of the participant socially engaging with the performer, giving suggestions or cheering for them, and the observers that passively engage with the action around the installation. After all, it is generating a lively

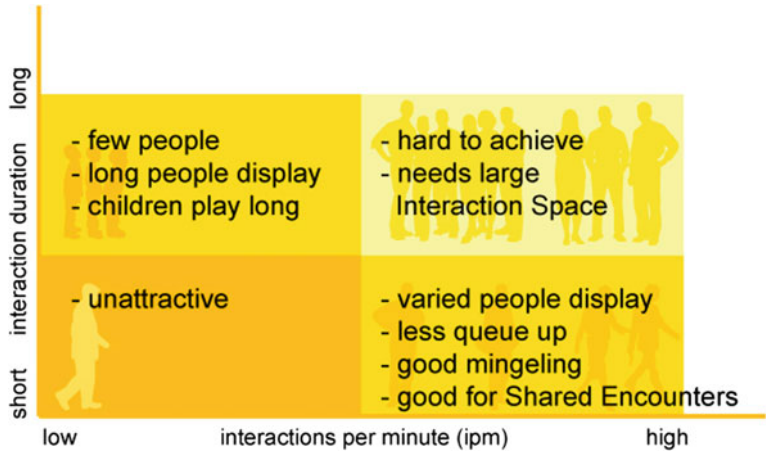

Fig. 12 Properties influencing situation designs

'theatre' to look at with entertaining value. Whyte (1990) discovered that what people like to do most in public space, is watching other people. Thus, we should always consider design for the observer. The concept 'people as displays' tries to facilitate this during the design phase.

While our studies have shown that we may be designing for a minority of people who are willing to play in public and to spend the time, this is not without effect for changing the relation to the city. Participation numbers of 5 % appear low, but many people are on their way somewhere else and may not be able to spend time. Moreover, seeing a permanent installation (like the fountain) repeatedly may create the impulse to try it out at the next occasion, and seeing others play creates the social signal that it is OK to play. Furthermore, playful designs allow a number of alternate uses. With PIPE we experienced a huge variety of 'people displays' and reactions. It is important to support these in the design as well as allowing different subjective interpretation to keep the installation sustainable (Fig. 12).

In addition to the number of shared encounters, along with the description of our case studies we have mentioned two other quantitative measures: ipm and interaction duration (also known as holding time). Both influence each other depending on the design of the system and the people present. If there are enough people present, a too long duration of interaction might decrease the value of the installation, as only few people play with it (limited throughput). They might rather queue up. For the role of the observer this does not make a big difference, as a people display is present with either few people playing long or with lots playing briefly. We have seen that ipm values between 0.1 and 1 are rather normal for situated installations and that values of 3 demand a total situation, which is event-like (the Meiningen case study). These values are good indicators for how well an installation performs in combination with multiplex factors, which indicate durations of interaction.

To increase the ipm, visibility, discoverability, and creating an interesting performer display for observers is advised. Sturdy and non-high-tech appearing input elements also seem to lower hesitations to participate. Furthermore, a large IS is also helpful to increase total interaction times.

Astonishing to us was especially the high numbers of adults, across all ages who participate and give the interactive system a try. This is against the stereotype and shows the fallacy of the assumption that these types of installations are only valuable for children. Our case studies show that older people are very well willing to engage in playful interactions.

The impulse to play is strongest in groups. Psychologically, being in a group provides some feeling of strength, and when the group 'authorizes' playful behaviour this provides permission to play. Also, in a group there are participants present so the performer has an immediate audience familiar with at the same time. For future research in public play, it might be of interest how to encourage individuals to play by reducing hesitations. Further research also needs to go into the question of "How to encourage inter-group interaction in order to generate more shared encounters?" Currently, we do not have any design factor identified which tells us why sometimes inter-group interaction happens (e.g. the fountain case and PIPE) and sometimes it does not (Kick-/Flickables). This could be because of a common goal that is easy to describe, in contrast to an explorative activity where one does not actually know what one is doing, but figuring it out on the go. With the Kick-/Flickables, the resulting effect was very much hidden and personal interpretation was strongly demanded. While a verbal externalization of one's own interpretation is easy with acquaintances, strangers might not understand each other's interpretation or be hesitant to share them.

With all our designs we aimed for multi-user support by increasing the PIS as much as possible. We also advice to support group dynamics and their fluid reformation. A physical artefact that can be handed around can increase performativity and also indicate who is playing. This is especially important for a design which aims to include the observer's passive engagement. It does provide pleasure for them, as well as explain the usage of the system. In the case of SMSlingshot, it also provided social control as inappropriate messages can be traced to the person posting it. In that way, social norms stayed intact.

With the proposed measures we do not want to undermine the importance of descriptive case studies. In fact, we believe rich descriptions may be the only way to understand why some playful situation designs for public spaces are more successful than others. However, some stakeholders can only be convinced by numbers. It is in that regard why we have to gain an understanding of what measures might be suitable for that task. Our cities need more playful digital situation designs. We have chosen to explore possible futures and encourage others to test their designs in-the-wild as well.

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