

Ecologies of Spaces for Enjoyable Interactions

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Abstract— In this paper, interplay of diverse factors related to the space where public interactions take place is discussed. The technology itself, the physical space, activities and social interactions around them are all important for the user experience, particularly so when enjoyable interactions are in focus. We call this plethora of factors and relations between them the ecology of an interactive space. Concepts such as visual immediacy, impetus and impedance, related to exhibits access and entry points are introduced in order to discuss engagement with installations, but also the space and social interactions. We illustrate this using the installation for enjoyment that we designed, implemented and subsequently evaluated in three public settings. Drawing on our findings from the experience with the exhibit, as well as conceptual and practical research related to interactive exhibits, we conclude that the concept of ecologies of spaces is useful for deeper understanding and design of public interactions.

Keywords— *interactive installations; play; public space interaction; user experience; Kinect; ecology.*

I. INTRODUCTION

Public spaces are increasingly also interactive spaces [1]. Small portable devices such as i-beacons, large and small interactive screens, diverse sensors, mobile and tangible devices enable design of interactive zones in public spaces relatively easily and inexpensively. Consequently, interactivity in public space is becoming ubiquitous. Some interactive installations have a specific functional purpose, e.g., touch based information boards, check inn points, etc. Others are more geared towards inspiration, reflection, art or entertainment. Interactions in this latter group are often designed for specific places, e.g., museums (Fig. 1), bookstores, cafés (Fig. 2) or galleries, often with no other purpose than to provide enjoyable experiences.



Figure 1. The New Children's museum in San Diego offers an interactive DJ table with graphic display. Photo: Culén.



Figure 2. Funky Forest exhibit at Moomah café in New York offers young visitors an interactive experience of a forest ecosystem, photo from [2].

These places differ in how they engage their audiences. The galleries often focus on sensory experiences and wow factors, museums on new learning and knowledge constructing opportunities, while cafés and bookstores may extend a more commercial variety of offerings.

An interesting new arena for enjoyable interactions is a workspace. There is increasing evidence that mood and creativity are deeply intertwined, see an analysis of a 25 years long study on this relationship in [3]. Supporting good work environment seems to facilitate creative processes and collaboration [4][5]. Thus, many companies, e.g., Google [6], are trying to lighten the mood of their employees using playful and enjoyable interactions, and capitalize on heightened employees' creativity. A likely future trend is expansion beyond museums, galleries, workspaces etc. into hospital waiting rooms, centers for elderly, airports, elevators and all other less grand public places where people may benefit from lightening up.

Thus, as multi-sensorial, playful interactions enter the public sphere, it makes sense to look into what kinds of public space configurations are suitable for interactive installations that provide enjoyable, open-ended experiences and co-experiences. In [1], Rosseland, Berge and Culén discuss how user experiences with an interactive installation were influenced by the contextual setting of the installation. The installation was designed to provide multiple, co-located users with an enjoyable audio-visual experience in response to gestures and bodily movements, and was tested publicly in two different settings: a university library and a Mini Makers Faire at a science museum. The success of the installation was measured in terms of engagement time.

This paper uses the same case as Rosseland, Berge and Culén's paper [1]. The novel contribution presented in this extended paper is that of a conceptual framework, which can be used to discuss the design and evaluation of enjoyable interactions in public spaces. To this end, we propose the concept 'ecology of interactive spaces'. The term is used to denote the complexity of material and social relationships that exist in any public setting with interactive technology. The paper aims to start a dialogue that examines the role of the material space and social practices when designing for enjoyable and social public space interactions.

The structure of the paper is as follows: in Section II, we provide some background needed to understand how our framework relates to previous research in the field. We also discuss the work related to enjoyment, pleasure, play and games. Entry and access points to installations are briefly discussed. In Section III, we present our concept of the ecology of interactive spaces, with physical space attributes, technologies, activities, people and values as central components of the proposed concept. Section IV provides details from our case study of enjoyable interaction. In Section V, the concept of ecology is applied to the described case. Discussion and conclusion follow in Sections VI and VII, respectively.

II. THE BACKGROUND

The concept of the ecology of interactive spaces was conceived under the influence of Nardi and O'Day's work [7], our previous work, and work by others, most notably [8]–[13]. From [8], we take with us the importance of designing beyond products and including activity spaces around interactive products into consideration. From [9][10] we learn to pay attention to entry and access points and that tangible interactions can enrich interactive spaces. Papers [11][12] address issues of understanding experiences and defining a concept of co-experience. Co-experiences are defined as user experiences through social interactions, and are central for public space interactions. From [13], we understand how even simple chaining of displays into different shapes influences by-passers and users, single and in groups Fig. 3.

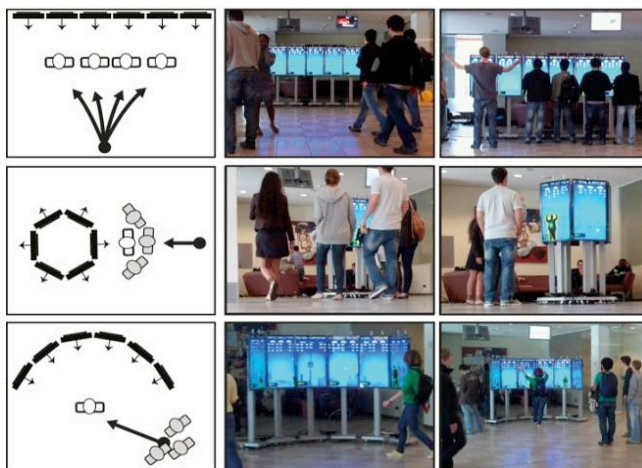


Figure 3. Diverse screen configurations lead to different behaviors, [13].

A. Enjoyment: Pleasure, Fun and Play

In order to design installations for public spaces that build on fun, pleasure and play, a co-located presence of other people, both acquaintances and total strangers, becomes an important factor for engagement. HCI research in this area may draw on social science research within the museum field such as [14], as well as on HCI research related to shareability [10] and enjoyment, e.g., Blythe and Hassenzahl's work [15], where the semantics of pleasure and fun is discussed. We consider the enjoyment first.

Enjoyment can be thought of as an experience fleeting somewhere between distraction and absorption, where, on one end, fun represents distraction, and pleasure represent the absorption side of the scale. In short, fun is described as the counterpart to seriousness. As a distraction, it represents a spontaneous escape from the tasks and worries of everyday life. The self, the hedonic 'be-goals' of UX, does not matter in this short-lived break from reality, but fun still satisfies an important psychological need.

Pleasure is found on the opposite end of the enjoyment scale, taking on the role of absorption. It represents a deeper, longer lasting, more meaningful experience. Here, the connection to people's inner self is made through immersion and devotion to an activity. Elements of challenge, progression, and demand for absolute concentration can be present, and thereby overlaps with Csikszentmihaly's concept of flow; see [16] and [17].

Play is another fuzzy term to corner, as illustrated quite well by Sutton-Smith who has dedicated a whole book to this topic: "We all play occasionally, and we all know what playing feels like. But when it comes to making theoretical statements about what play is, we fall into silliness. There is little agreement among us, and much ambiguity", [17, p. 1].

Although the term play represents a myriad of experiences, it has been broadly described as a "free movement within a more rigid structure" [18].

Some of the most influential work on play is done by the French sociologist Caillois. He divides play into four forms and two types of play [19]. The four forms of play are competition, chance, simulation and vertigo, and the two types of play are free play and formal play [20].

Playful behaviour is described as an oscillation between exploration and engagement [21]. Playful behaviour starts with exploration, and play occurs when the unfamiliar becomes familiar [22]. When the familiar gets boring, the focus returns to exploration. In this context, the goal of exploring is best described by contemplating "what can this object do?" The goal of play, though, is related to the question "what can I do with this object?"

Games, as opposed to play, have a structure, as well as an objective to reach. It has been shown that play and playful design, including games and gamification, have a large effect on users' motivation and engagement [23].

B. Entry and Access Points Re-visited

In [10], Hornecker, Marshall and Rogers discuss the concept of shareability. Shareability is defined as a design principle that refers to how a system, interface, or device engages a group of co-located and co-present people with the

same content or the same object. The authors propose entry and access points as the aspects of shearability. These concepts are related to two levels of user engagement: the user needs to 1) be motivated to use the installation 2) know how to use it.

Entry points denote “design characteristics that invite people into engagement with a group activity and entice them to interact. Access points denote characteristics that enable the user to actually interact and join a group’s activity” [10, p. 3].

However, rather than distinguishing different components of entry and access points as described in [10], e.g., honeypot effect, minimal barriers, perceptual access and others, we propose a somewhat different approach, starting from the work of Gardner. According to Gardner’s theory of human intelligences, [24], people possess unique combinations of visual–spatial, verbal–linguistic, logical–mathematical, bodily–kinaesthetic, musical, interpersonal and intrapersonal intelligences, which orchestrate our understanding of the world and define our actions in it. So, naturally, these will have effect on how each person enters and accesses the sharable space. When entering a shared interactive space, the visual-spatial input would be of highest significance [24], as an overall assessment of the space, and activities in it. However, in the case of the installation that we describe in Section IV, it is easy to see that musical, body–kinaesthetic, intra and interpersonal intelligences strongly relate to the experience of the installation.

In discussing entry and access points, we propose the use of concepts of *immediacy*, *impetus* and *impedance*, as well as *fluidity of sharing* introduced in [10, p. 3,9]. Visual immediacy, see [25][26], is proposed as a characteristic of visual–spatial intelligence, to help reason around interactive space initially. Immediacy gives the first impression of the space in terms of safety and appeal, as well as the initial understanding of the activities taking place within the interaction area. Impetus gives a nudge to engage in activities and impedance represents barriers, resistance or hindrances to enter the interactive space. Thus, the honeypot effect, for example, may be considered as a factor that gives impetus to majority of people to enter an interactive space. Lastly, in contrast to affordance, a design characteristic referring to just those action possibilities that are readily perceivable by an actor, impedance is a characteristic related to action possibilities that are difficult to perceive due to the existence of barriers, hindrances or resistances.

Given that interactions in public spaces are strongly influenced by other co-located and co-present people, we need to consider both experiences and co-experiences. Fluidity of sharing captures how easy it is for people to engage in joint interaction and creation of co-experiences.

C. Interactive spaces

The spaces that come to mind in relation to public space interactive installations that have been already researched to some extent are museums, libraries and workspaces.

Museums are increasingly involved in providing digitally responsive exhibits, as part of their strategy to attract visitors.

These exhibits, as Heath and Lehn point out in [14], often involve diverse displays enabling either individuals or groups to promote thinking and discussion around material presented in the museum, thus providing additional possibilities for learning and understanding. Enabling learning is often the main goal of museums. Consequently, museums’ approach to evaluation of their interactive exhibits favours standard methods used in the museum field: focus groups, interviews and questionnaires, focusing on the learning outcomes. Thus, the experiences and co-experiences during the interactions are usually not the focus when applying the above methods. In addition, although people often come to the museum in groups, very few exhibits are explicitly designed for co-experiences [27], [28], or, as mentioned, for pleasure.

Similarly, workspaces are also increasingly focusing on playful and enjoyable experiences at work, reasoning that such experiences may increase satisfaction with the work place, increase productivity and provide an easy entry point for people to meet each other [29].

In their paper [8], Kaptelinin and Bannon propose for the field of interaction design to move beyond design of products and into design of technology-enhanced activity spaces. The article presents three related arguments. The first one has to do with the fact that technological development so far has provided more support towards extrinsic rather than intrinsic human practices. This concern is related to opening the space for practices that are initiated by users. This leads to the second argument, the one concerning the ‘ecological turn’, nudging the field of interaction design to develop methods that allow intrinsic practice transformations. This is raising some of the same concerns as those in [30], employing the ‘semantic turn’, focusing on meaning of technological design interventions in the real world. The third argument is a direct invitation for the field of interaction design to expand to include creating technology-enhanced activity spaces.

The word ecology and related concepts such as habitat, species and environment, has been used in HCI for a while. After information ecology was introduced in [7], it became a common metaphor for describing complex relations between local environments, technology and people.

III. THE ECOLOGY OF INTERACTIVE SPACES

Taking up the challenge presented by [8] to engage with design of interactive spaces, we choose to use the concept of ecology.

When considering *ecologies of spaces* for public interaction, we propose five main components:

- *Space* - including its properties such as materials, spatial layout, acoustics, light, and aesthetics, as well as the larger space of which it is part of, e.g., a hospital, a museum etc.
- *Technology* - the installation itself, but also technology that is either part of the environment or brought in by people, e.g., smart phones, sensors in the room.

- *People* – who use and inhabit the space; decision makers/owners of the space; designers and other stakeholders
- *Activities* - that are conducted in the space, using the installation, the space and other people to create experiences and co-experiences.
- *Values* - the explicit and implicit values, norms, rules that co-exists within a given location.

In terms of design for public installations, each of these five main components of the ecology opens for new design opportunities. Being aware of all five, and that they need to work well together, may help designers to design better installations for enjoyment in public spaces. For example, the above mentioned paper by Hornecker, Marshall and Rogers [10] introduces shareability as a design principle for design of interfaces that engage co-located, co-present users in shared interactions. More concepts such as that of shareability are needed in order to generate a set of design principles covering all aspects of the ecology.

In terms of evaluation, we do not know of any previous work concerned with evaluation of an installation as a whole, including all components of the ecology. What we find in the literature are frameworks for evaluation of diverse aspects of interactive installations, e.g., [20], [28]. Furthermore, in [28], it is pointed out that there are no frameworks for evaluating social interactions and co-experiences in museums, and we find this to be true for other public spaces as well. Yet, public interactive spaces are designed for technology supported social interactions, see [31] as an example. We are unaware of any framework for evaluating installations as a whole. Our previous paper also focuses only on the comparison of spaces, and only based on the length of time that participants engaged with the installation. In this paper, we take initial steps towards a broader and more systematic view when evaluating the installation, a view supported by the introduced concept of the ecology of interactive spaces.

We now present details of how the installation was designed and tested in the lab, as well as what we learned from the lab testing, much along the lines presented in [1]. In Section V, we relate introduced concepts, not only as they pertain to the interface, but also the space, activities, people and the social component of the ecology.

IV. THE CASE OF AN INSTALLATION FOR ENJOYMENT

We now describe the basic set up of the installation. The set up description is followed by results related to the concepts of fun, play and pleasure (as discussed in the Section II) from user evaluation of the installation in the lab.

The installation was designed to give a pleasurable experience. It did not solve a problem, nor did it aspire to help people reach meaningful life-goals. Its purpose was, ultimately, to be a research tool and give us as designers and researchers the opportunity to observe, evaluate and learn something about user enjoyment and behaviour in both public (library and museum) and a more private context of the lab. The installation was designed for pleasure, to be enjoyed individually, or with others, familiar or total strangers.

The installation consisted of:

- A long and narrow table placed by a wall.
- Two Kinect sensors mounted on the table on top of each other.
- One Shake 'n' Sense device [32], fastened to one of the sensors to eliminate interference.
- A wall-mounted screen, either a flat screen TV or a canvas lit by a projector.
- Two amplified speakers placed on the table on each side of the screen.
- Two Mac laptops placed outside of the installation area, one running the audio and the other the visual system.

In all locations, the installation was exhibited in the setup as shown diagrammatically in Fig. 4, and in the actual space in Fig. 5. Each of the locations had, at least, an area of four by four meters in front of the Kinect sensors. The installation consisted of two completely separate systems, one controlling the audio and one controlling the visual display. The systems were tuned to work together and appeared for the user as a single installation.

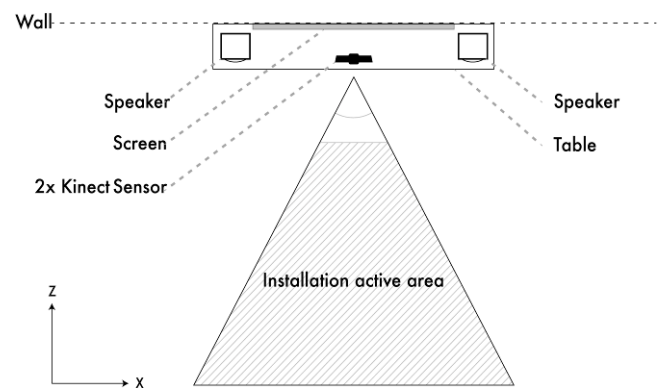


Figure 4. Diagram representing the physical setup of the installation.

When a user, or several users, walked into the range of the sensors, the system automatically identified them, and started tracking their movement and playing music.



Figure 5. Actual setup of the installation in the museum during the Maker Faire, with interaction area marked on the floor. Photo: Berge.

The main way a user could interact with the installation was by extending an arm away from their body. More specifically, a horizontal hand movement away from the chest would trigger the system and start the calibration processes, engaging both audio and visuals.

Before testing the installation in a public setting, we conducted lab evaluations to get some feedback on how the installation was perceived by users who had never seen it before, as well as identify opportunities for improvement. The lab, as a space, is a large room, with a single door access, not allowing any view of activities from the outside when the door is closed. Thus, it was ideal for private and personal exploration of interaction, allowing it to unfold without having to consider how the process looks like for others. We invited people in pairs in order to see how having to share the same interaction space affected the participants. All kinds of explorations were welcome, both on an individual level and in pairs.

The ten participants were all either current or former students at the Department of Informatics. The sessions were videotaped, and the participants were interviewed immediately after finishing the test of the installation.

Through the analysis of our evaluation sessions in the private lab context, we located many statements indicating an enjoyable experience. In this section, we want to look at aspects of the participants experiences related to the concepts the terms enjoyment, as discussed in Section II.

A. Fun

The installation in itself was described by most as ‘fun’. Blythe and Hassenzahl defined fun as a short-lived distraction from everyday life [33], coinciding well with the way the word is used in describing the experience by the participants. But what exactly was fun about the installation? The participants’ answers point first and foremost to the exploration of the installation and its functionality, and then secondly, to the immediate responses the installation gave to movement, and the sensory aesthetic experiences these movements resulted in.

Pleasure was never mentioned directly by the participants, but several interviewed participants described an experience of ‘flow’ [34] when they were interacting with the exhibit, which can be linked to pleasure [15]. These experiences were described in terms of being ‘lost’, mesmerized, having a break from thinking and entering a relaxed ‘kind of mode’. The majority of the participants agreed on this being an essential part of their experience. It is worth noting that some of the participants pointed out, both explicitly and implicitly, that this flow-like state disappeared over time as the participants ran out of elements of the installation to explore.

B. Play

Several of the participants described the installation and the experience as playful. Their descriptions indicated that they placed the experience more in line with the definition of free play, rather than structured play (game).

The playfulness that the installation enabled was deemed as very important, and the participants linked it strongly to

the exploration and the open-endedness of experience, but also to the lack of control. The openness of the installation was described as an advantage, in the way that it encouraged interpretation and exploration. The lack of control was described as not important by one participant, as the point is not to steer something, but to play with the system and get responses from it, which resulted in a ‘good feeling’. In relation to the concepts of goals, rules, and competitive elements of play, even the self-proclaimed ‘competition-focused’ participants acknowledged that those concepts were not the point of this installation.

In the playful behaviour there is an oscillation between exploration and play, where play is triggered by learning or discovery and exploration is triggered by boredom [21], [22], [35]. We found multiple instances of this in the way participants described their explorative behaviour, which strongly resembles the process of playful behaviour, emphasizing the strong relation between playing and exploring: “*It is just exploring, really. Until you feel you master (the installation) a bit, then it’s really exciting and makes you want to continue. You never know if you have explored everything and that’s positive, you never reach an end.*”

C. Aesthetics

In terms of aesthetics, both the audio and the visuals were described as fascinating, atmospheric, different, beautiful and soothing. The participants thought the combination of the two fit well together and resulted in a coherent expression and created a good ambiance. It was also pointed out in a positive manner that the expression was kept to an abstract nature. That way it became easier to accept the audio-visual expression, in comparison to trying to depict or simulate something concrete.

D. Exploration

As stated earlier, exploration was the main activity that the installation was designed for, and the experiences during the exploration were deemed to be the most important, successful, aspect of the installation. Several of the participants expressed bluntly that exploration *is* the installation. The exploration was fuelled by the responses given by the installation and their abstract, mysterious, unknown nature. Or, to put in other words, the immediate responses to movement and actions, combined with lack of explanation, made the participants curious and eager to investigate. Their descriptions also highlighted one of the common characteristics of the human brain, namely the constant search for patterns and connections, which was described as an essential part of the process of exploring.

E. Discovery, learning and understanding

On some aspects of the experience, the participants were quite divided in their opinions. One of these aspects was the lack of explanation, or guidance, in the user interface of the installation. The majority of participants highlighted the absence of explanations as something positive. It was seen as a catalyst for, and a component of, exploration. However, some found it confusing, frustrating and incomprehensible.

One of the participants, who favoured minimal explanations, pointed out that an installation such as ours would not be suitable for people who are not interested in exploring.

The discovering and learning were described as closely related to exploration. For example, one participant described discovery as a direct result of the exploration.

The process of understanding was the challenging part of the installation. When exploration led to discoveries and understanding, the participants had a sense of progress and achievement, giving them motivation to continue to explore. However, the lack of 'new things' to discover and explore eventually led to boredom and loss of interest.

F. Progression

Progression was the aspect of enjoyable user experience that was originally overlooked in the design process, but which surfaced through the evaluation of the prototype as the most important missing aspect of the participants' experience. As mentioned earlier, Blythe and Hassenzahl link the concept of pleasure to the concept of flow, but they also argue that pleasure can in fact be thought of in terms of progression [15]. In retrospect, this actually comes across as self evident, when comparing our findings to the overlapping definitions of flow and pleasure, as a longer lasting, more meaningful and immersed experience devoted to an activity.

The participants wanted more depth to the experience. They wanted more to explore, with gradual increase in variation and difficulty. When they felt they had exhausted their possibilities for exploration, they became bored, and this coincided with the earlier mentioned loss of the state of flow.

G. Control

The second most sought after aspect was control. On this point, the participants of the prototype evaluation were close to unanimous. They expressed frustration over not getting the expected responses from the system, and this put limitations on what they could do. It prevented them from being creative and expressing themselves through the installation, both in terms of visual and audio expression, and this was considered to be of large importance for them. Some acknowledged that they attained a certain degree of control, but they expressed that the threshold for gaining this control should be much lower in order to make this aspect of the installation accessible to more people.

The lack of control linked very strongly to the absence of mastery, and on this point the feedback from one of the users was quite direct: "[The installation] *lacks possibility for mastery.*" And another user on the same topic: "*I don't think I would master it more if I used it for another 20 minutes.*"

The feedback we got from the participants brought forth the distinctions between the second and the third paradigm of HCI [36], and between usability and user experience. In our phenomenological approach, the focus was on enjoyable user experiences, and not so much on usability and ease of use. Also, the explorative and abstract nature of the installation meant that it was difficult to define specific usability criteria for it.

This is not to say that control was not a focus in our design, but the lack of precision in the tracking data from the Kinects, and our experiential focus led us to design a system that, we thought, did not need very specific and precise controls. Nevertheless, our findings clearly show that lack of control detracted from the experience.

The first public test of our installation, apart from one exhibit in the lab open to general audience, was at the Science Library at the University of Oslo, in two different locations. Subsequently, the installation was tested in a museum setting during the Makers Faire days. We now present our findings from these public exhibits of the installation and from the perspective of ecologies of interactive spaces.

V. ECOLOGIES OF SPACES FOR ENJOYABLE INTERACTIONS

A. *Ecologies of space for enjoyable interactive installations in an academic library*

The science library actively encourages students to develop and use different kinds of systems and technologies, in the library. We were invited to set up our installation in the foyer on the ground floor of the library building for three consecutive days. This provided a good opportunity to observe how people react to and interacted with the installation in the wild, in the realistic public setting where the exhibit could be a more permanent one.

1) *The space*

The Science library is a large three stories high brick building, with lots of open space just across the main entrance into the building, see Fig. 6.



Figure 6. The entrance area is used as a café, a stage, for sharing information etc. The screen used for the exhibit is marked. Photo: Juell.

The facade and doors on the ground floor on the entrance side are covered with floor-to-ceiling windows, providing ample daylight and allowing people from the outside to see what is going on inside. Fig. 7 shows the exact position of the installation during the first two days of observation. This is a location directly opposite the main entrance and part of the very open area, as shown in Fig. 6.



Figure 7. The installation at the open space, across from the main entrance into the building, giving a different perspective of the space. Photo: Culén.

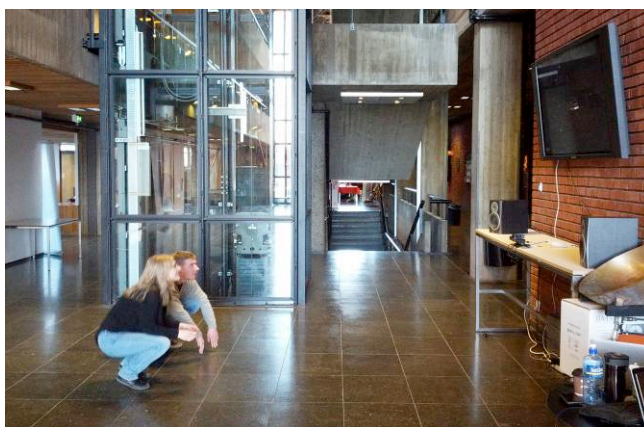


Figure 8. The same local environment, the library, with different exhibit space – less exposed to others. Photo: Berge.

On the third day, a more secluded area of the library was used, see Fig. 8. This was done, in part, to allow people to feel freer when exploring the installation.

2) *The people*

The people frequenting the library are mostly students, and some faculty and other staff. They are either alone or clustered in small groups of 2-5 people. On the third day set for our observations, there was an event for graduating high-school students on the ground floor. During the event, the area filled up with 70-100 pupils, but relatively few found the installation, and only 10 pupils actually engaged with the installation.

The predominant kinds of relationships between the people at the library include friends, classmates, strangers, the significant other, colleague, employee, faculty, student, and the occasional sibling / parent / spouse.

3) *The activities*

Typical activities in the ground floor of the library include eating, studying / working, socializing, flirting, waiting, and walking. Most people were preoccupied with their own activities, and were not paying much attention to what other people were doing. They were there because they

had some business there, either going to or from a lecture or the library, or to kill time until the next activity on their schedule.

However, the activities in this space can change quite dramatically, with little or no warning for its unsuspecting regular visitors. A good example of such a change is the infusion of scores of high school seniors, which influenced the usual activity patterns. Thus, the open area on ground floor of the library is not entirely predictable space in terms of the activities that may take place there.

4) *The technology*

There is very little technology in the library foyer that is part of the normal inventory. There is the usual set up at the stage, see Fig. 6, with a projector and diverse points to connect laptops and mobiles in order to show presentations, movies and mediate discussions. Otherwise, there are just a few computer terminals and a few large screens, two of which were used for the installation.

The TVs on the wall were hanging there permanently, usually displaying information regarding activities in the library, and the visitors were quite used to their presence. Our installation introduced a table with two speakers at either end, and two Kinects mounted above each other in the middle of the table. This constituted a fairly unnoticeable change from the usual setting.

5) *The values and norms*

There are numerous rules, norms, and values about how to conduct oneself in a particular public space. The library is no exception. Here, though, most of the norms are implied, rules unwritten, and are only enforced to the extent that people feel bound by them. Prevalent values at the library can be described as: be cool, different, similar, attractive, helpful, friendly, tolerant, competent and capable, curious and inquisitive, do not disturb others, be quiet, apply yourself, but do not overdo it.

6) *Findings from the library*

During the three days period when interactions with the installation were observed, we have spent a total of 7 hours 49 minutes, distributed as follows: 2h on the first day, 2h 36m on the second, and 3h 13m on the third day. 52 interaction sessions were observed, some of them involving groups. The participants were mostly in the age group between 17-40 years old, with few older exceptions.

The granularity of time-registration was not fine enough to draw any certain conclusions regarding time spent with the installation, other than that hardly anyone spent more than three minutes. However, when comparing the average time spent on group vs. individual interactions, we see that groups spent more than twice as much time then individuals interacting with the installation alone (1.2 minutes vs. 0.5 minutes in average).

Perhaps in contrast to the usual absence of music in the library, people soon learned that whenever the music started, there were people interacting with the installation. This allowed them to look up whenever the installation was in use, thereby slowly building an understanding of how it worked. This also allowed them to build both curiosity and courage to engage with the installation. We saw several

examples of people coming up to investigate after having observed others interacting with it for a while. There were also examples of single persons and groups of people who were hanging around in the background, queuing when others were interacting with the installation. As soon as the people using the installation left, they would walk up and give it a try. This worked like a honeypot effect, a positive feedback loop, where use attracted attention and instigated more use. However, the installation was unable to keep people's interest for more than a minute or two, which meant that there would have to be a constant stream of people to keep the installation in continuous use. When the installation was allowed to go into standby mode, people quickly returned their attention to whatever they were otherwise doing.

In terms of the level of engagement, people who explored the installation together with others seemed to get more out of it than those who were alone. They would talk to each other and explore cooperatively, discovering more functionality. There were also several examples of people who had been interacting with the installation earlier came back with friends.

Verbal reactions were usually immediate and short, perhaps also because the observers were hidden, looking just like everyone else, so people were more or less talking either to themselves or to their friends:

"Awesome! Motion sensor, cool!" – Man X

"Shit! Wow!" – Girl A

"Very cool!" – Man Y

"Pretty cool!" – Man Z

There were also more reflective statements:

"It responds to my movement." – Man W

After exploring for a minute, one man, of about 60 years old, exclaimed: *"One could stand here all day, fooling around!"* – Man P.

Many participants explicitly mentioned the word cool. Coolness of technological objects may be an important factor for their acceptance, as well as a design goal, see [37].



Figure 9. The Maker Faire takes place in diverse locations within the Norwegian Science Museum. Photo: Juell.

B. Ecologies of space for enjoyable interactive installations science Museum / Maker Faire

The second public test took place at the Norwegian Science Museum, at the Mini Maker Faire in Oslo, Fig. 9.

In the Museum, we observed users just one day, for 42 minutes. During the observation time, 33 individuals interacted with the system, some alone and others in groups, see Fig. 10 and Fig. 11. The age span of participants was from ca. 1 year old to elderly well over 70.

1) The space

The Norwegian Science Museum is a large museum, receiving about 250 000 visitors per year. The museum offers many different exhibits in exhibit rooms and in open areas. Similar to the library, the main entrance leads into a large open area with a reception directly in front of the entrance, a cafeteria to the right, and an open area to the left leading into diverse permanent exhibit areas.

During the Oslo Mini Maker Faire, this open area was the main exhibition area, and was filled with tables and stands with a plethora of different projects and technologies on display for visitors to explore.

The area that our installation was set up in was within the area for permanent exhibits, in a D-shaped room, see Fig. 10.



Figure 10. Interacting with the system at the Norwegian Science Museum. Photo: Culén.

We used a projector to project the graphics onto the straight wall, and mounted the Kinects on a table directly below the projection area. We used black tape on the floor to delimit a triangular interaction area corresponding to the horizontal field of view of the Kinects, in order to make it more comprehensible for the visitors where they needed to stand to interact with the installation. Furthermore, in anticipation of visitors arriving in small groups of friends or families, we placed small sitting cubes along the sides of the interaction area where onlookers could sit down and wait while their friends / children / grandchildren explored the installation.

2) The people

Typical visitors at the Norwegian Science Museum are families with children in the pre-, primary-, and middle school ages, as well as classes from schools around the city.

However, during the Oslo Mini Maker Faire, which we were a part of, the visitors included a wider mix of people. This was to a great advantage for the evaluation of the installation, as there were more people with expectations to be surprised and engaged. There were university students, researchers, volunteers, model train enthusiasts, people dressed in medieval and science-fiction costumes, and makers and tinkers of all ages.

The predominant relationships among the people in this space were family, friends, or strangers. There were some colleagues, classmates, neighbours, and other acquaintances, but visitors mostly arrived with family and friends, in small groups of 2 to 6 people. To them, practically everyone else was a stranger.

1) *The activities*

People come to the museum to experience, learn, and enjoy themselves. But within the Maker Faire context, there is much more focus on the social, there is more noise, more exploration and interaction, and more of hands-on experiences, when compared to permanent exhibits. In part, the focus is on innovation and mastery of do-it-yourself variety.

Regarding the installation, before arriving to the exhibit area, there was not much that deterred attention. If one chose to follow the way to the opening of the room with the installation, one was usually drawn in to engage with the exhibit, or, to sit and observe others engage with it.

2) *The technology*

The museum on the day of the Faire had many new makers projects utilizing diverse types of technologies. Permanent installations, mostly around technology, were also present.

Our installation utilized different display than in the library. Rather than using a TV display, we used the projector and the white wall in this space. The remaining

technological components of the installation were not changed. Here, as in the library, people had their own mobile phones, cameras, headphones and other small mobile devices.

3) *The values and norms*

In contrast to the library, there are fewer norms to follow, in particular during the Mini Makers Faire days. The values are different and oriented towards innovativeness, creativity, mastery, joy, play, experience and socialization.

4) *Findings from the Maker Faire*

In terms of the level of engagement, people have been engaged with the exhibit for a longer time than in the library, even when interacting alone, as was the case of a young boy, ca. 5 years of age, who spent 5 minutes exploring. For groups, spending 4-5 minutes was common. The group members would talk to each other and explore cooperatively, indicating, in line with the library observations, that it was fun to share. Here too, there were examples of people who came back with friends or family.

Verbal reactions were similar to those at the library:

“Cool!” – Boy X

“This was fun!” – Boy Y

“This was really fun!” – Boy Z

“Do I influence the music? ... Oh, I see, I do!” – Lady A.

Comparing the engagement with that in the library, we found also that people had a lot lower threshold to join someone who was already exploring the system. It was interesting to observe that intergenerational interactions were not uncommon. Children would freely join adults whom they did not know. Very young children also tried the installation, as shown in Fig. 11.

We are now in a position to present overall findings from our exploration of this installation, focusing primarily on the space, and measuring engagement in terms of the length of engagement.



Figure 11. The installation engaged all age groups, also frequently the children shared the space with adults, even when they did not know them. The child on the right hand side of the photo, was under two years old. Photos: Culén.

C. Overall findings related to differences in enjoyment between the library and the Maker Faire

Most of our interviewees from prototype testing sessions in the lab readily admitted that they would restrain their involvement with the installation in a public setting, if they would be willing to interact with it at all. The most central reason they gave for this was the fear of breaking social rules and norms, and of “behaving like an idiot”, as one participant put it. It was their fear of being perceived by others as doing something people do not normally do in public that would keep them from getting too involved. There were also comments to the opposite effect, indicating that breaking social rules and norms can be liberating and empowering. However, the prevailing notion was that social rules and norms would have a dampening effect on people’s level of involvement with such an installation in public settings. Some participants consistently underlined that they would be less likely to interact with the installation on the street or in the shopping center, than a destination like a museum or a gallery. One of the participants expressed this as follows: “*It would be a lot more socially acceptable in a museum to interact with it. I would say my experience would have been much better in a context like that. If the installation were set up in Karl Johan [note: central shopping street in Oslo] I wouldn’t have stopped to check it out, also because I’m going somewhere*”.

This concern seemed particularly evident at the library. The openness of the location and the number of people in the surrounding area seemed to make people self-conscious and vulnerable when they triggered the installation, particularly if they were alone. At the museum, there was clearly more headroom for expansive and un-impeded behaviour. Many of the permanent museum exhibitions are designed for interaction and exploration, and the wide variety of strange projects taking part in the Maker Faire clearly made people less concerned about how their behaviour would be perceived by others, as this behaviour was expected in this context. Nevertheless, there were examples at both locations of people showing an interest in the installation but being too shy to try it for themselves. But by having the opportunity to watch others interact with it and build an understanding of how it worked, the shyness was sometimes overcome by curiosity, i.e., the impetus to engage became stronger than the impedance.

Our initial approach to grasp differences between the two locations and experiences people had while interacting with the installation in the library or at the Makers Faire, was to use grounded theory and coding. The main method was passive observation with coding. Three coders were used, two in the library, and a third person in the museum. This was done in order to minimize subjectivity. Furthermore, the coding schemas and outputs were compared and discussed among the three coders. Only data where there was agreement between all three was taken into account. Some measurements, such as taking time, were relatively straightforward. The main difficulty there was in keeping track of people getting in and leaving interaction space during one interactive session. The other measurements were

more complex, such as recording people’s facial expressions and body language.

In terms of time spent by participants interacting with the installation in the two locations, we found out that the time spent at the museum was significantly higher. At the library, no one spent more than three minutes with the installation, 41% spent less than one minute and 72% of the observed spent two minutes or less. At the museum, the time spent with the installation is spread much more evenly across the intervals noted: 59% spent two minutes or more interacting, and some people seen outside the time frame of observations were exceeding the intervals noted significantly.

Looking at the distribution of facial expressions observed in the two different contexts (Fig. 12 and Fig. 13), expressions of a positive nature are the predominant ones in both settings, but at the museum as many as 86% were smiling and even though 5% were noted as indifferent, 95% of the observed were deemed to have a positive experience.



Figure 12. Body language and facial expression distributions at the library.

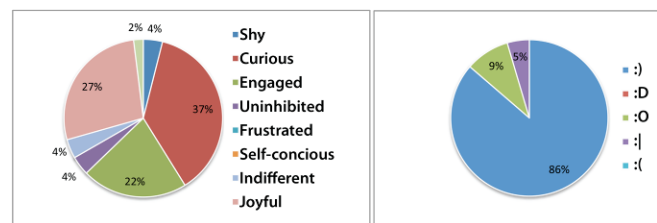


Figure 13. Body language and facial expression distribution at the museum.

Comparing the observations of body language between the contexts, a high degree of curiosity is observed in both settings, with 47% recorded as displaying a body language suggesting curiosity in the library setting, while 37% were recorded at the museum. The most striking difference between the library and the museum contexts was the high percentage of joyfulness (27%) and the low percentage of shyness (4%) of the museum setting, contrasting the low degree of joyfulness (3%) and high degree of self-consciousness (15%) and shyness (5%) (combined 20%) seen at the library. The reason for combining self-consciousness and shyness is that they are very similar traits. Seen in retrospect, separating these terms into two coding categories might have been unnecessary, considering their similarities and the fallibility of observation.

If we look at the distribution of the differences observed in the body language, it seems that the library context was perceived as a less comfortable one. The given percentages may be directly related to impetus (curiosity, joyfulness, engagement) and impedance (shyness, self-consciousness, inhibitions), as these various attributes are just diverse

aspects of impetus or impedance. What we can then see at once is that nearly a third (33%) of participants in interactions at the library experienced some form of impedance, vs. only 8% in the museum.

Whole 95% of people who participated in the museum had expressions of satisfaction, vs. only 79% in the library. On the other hand, the percentage of those who found themselves fascinated was 41% in the library, vs. only 9% in the museum. This might suggest that fascination was expected to happen in the museum, while it was unexpected in the library.

VI. DISCUSSION OF THE GENERAL FINDINGS

The previous paragraph described our best effort at the time to evaluate suitability of spaces for our installation and measure differences in terms of the time spent on the installation at different locations. Here, we take a look at how considering ecologies of interactive spaces (with space, people, technology, activity and values as main components) through the use of concepts of immediacy, impetus, impedance, and the fluidity of sharing, may give a richer perspective on design and evaluation of installations for enjoyment in public spaces.

A. Immediacy

Entering the library, the installation, unless in use, was not immediately noticeable. Thus, the space itself did not provide for immediacy. As noted earlier, the visitors were used to information screens that were used for the installation, and physical changes to the space were minimal.

Display blindness is a term used to describe the phenomenon where people can selectively ignore screens. *Interaction blindness* refers to the fact that it is difficult for people to understand whether a given display is interactive. Houben and Weichel [33] have described how display blindness and interaction blindness can be overcome by use of curiosity objects, e.g., objects that are designed to draw attention by sparking interest and curiosity. The term we use, impetus, is closely related to curiosity objects, being defined as all that (by design) nudges curiosity, interest, and activity.

When the installation was in use, people entering the library would have immediate understanding that something different is happening in the open area. The music and the interactive movements are, normally, not part of the library experience.

The situation was different at the museum during the Makers Faire. The installation was the only activity happening in the room. It was immediately understandable that there was an activity available in the room by observing the triangle on the floor, the lit-up screen and the sitting blocks (see Fig. 6). Thus, even if the installation was not in use at the moment of the entry to the room, the understanding that some activity is available in the room was immediate. An overview of the situation in the room was available at a glance, whether the installation was in use or not.

The two different spaces that were used for the installation within the library illustrate the importance of

considering how immediacy, in relation to understanding the space, influences interaction with installation.

Immediacy can also be used to address the interface and its properties: is it easy to understand what one should do to engage with the system? Are activities in the space properly understood at the glance?

While it is not clear how to apply immediacy to values, one can pose the question when designing for a specific location: who are the people frequenting the location and what are their values? Is this information available at a glance at this location, or, are these aspects something that has to be found out gradually?

B. Impetus

The sound, graphical design and body movements are considered to be the most important, designed, ways of providing impetus for this installation. Perhaps in contrast to the usual absence of music in the library, people who were sitting in the open area, for example, in the café, soon learned that whenever the music started, there were people interacting with the installation. This allowed them to look up whenever the installation was in use, thereby slowly building an understanding of how it worked. This also allowed them to build both curiosity and courage to try the installation for themselves. We saw several examples of people coming up to investigate after having observed others interacting with it for a while. There were also examples of single persons and groups of people who were hanging around in the background, queuing when others were interacting with the installation. As soon as the people using the installation left, they would walk up and give it a try. This worked like a honeypot effect, a positive feedback loop, where use attracted attention and instigated more use. So use was also an impetus, a call for engagement. However, the installation was unable to keep people's interest for more than a minute or two, which meant that there would have to be a constant stream of people to keep the installation in continuous use. When the installation was allowed to go into standby mode, people quickly returned their attention to whatever they were otherwise doing.

Further impetus was provided for by-passers by starting the system whenever someone came into the detection range for Kinect devices.

In the museum, further nudging was provided by clearly marking the interactive space on the floor, so it was easy to understand that there was enough space for more than one person, and this feature has enabled more group interactions than we observed in the library, also with total strangers, see Fig. 11. It was also clear that the norms and values in two places were different, the level of impetus that people needed, was lower in the museum than in the library.

Impetus, thus, can be a part of design considerations when developing the interface, reflecting over the physical location of the installations, and as part of the activities the installation provides. If successful, the use of installation increases the positive effects.

C. Impedance

The two locations at the library were exposed and crowded, particularly the first one. This meant that anyone interacting with the installation would draw attention from not only the immediate surroundings, but also from galleries on the floors above. The sounds naturally draw attention from the surroundings. Thus, for many people this attention from the surroundings is not desirable and prevented them from engaging with the installation. The people who interacted with the system in the library on the third day, in a bit more protected area, often took the elevator shaft as some sort of extra protection from onlookers, see Fig. 8.

Other impeding factors in the library were related to the activities, the lack of time, sense of the work environment, as well as the norms and values related to the space.

The space we were assigned at the museum during the Maker Faire was partially confined, making it close to impossible for others to observe the installation, or the people interacting with it, from afar. This seemed to give participants a sense of privacy and allowed them to let themselves get more carried away than at the library. Also, having sitting blocks for onlookers to sit on was very beneficial, Fig. 5. It allowed the ones who did not want to try the installation to sit down and relax, but still be able to communicate and take part in the experience with their friends who were interacting with the installation. Thus, impedance was minimized by providing sense of privacy, safety, some level of comfort and ability to participate, even when sitting on the sidelines.

D. Fluidity of sharing

The system used for our installation was designed with fluidity of sharing in mind. Kinect naturally enables multiple users to interact with the system, but our application used abstract graphical interfaces, allowing, ideally, everyone to enjoy interacting and sharing. In addition, we observed that the fluidity of sharing was much higher in the museum. There, we could observe strangers interacting (see Fig. 11) along the side of those who were friends or family, while the group interactions in the library involved mostly friends. This suggests that fluidity also depends on the norms and values of the space.

VII. CONCLUSION

We have defined the ecology of interactive spaces as a function of the physical properties of the space, people, activities, technologies and values and norms associated with the location for the installation. Looking at the ecology of interactive spaces is both timely, as public space interactions are becoming ubiquitous, and desirable since concepts for evaluating experiences are still few and divided by disciplines, e.g., social sciences, HCI. Combining the technical, social, architectural and human aspects of the space for which interaction is designed, significantly increases chances to succeed in creating enjoyable interactive installations in the public room. In order to facilitate reflection and design of ecologies of interactive spaces, we have introduced concepts of immediacy, impetus, impedance and fluidity of sharing as aid in “getting the big

picture” first. We believe that if we had this framework at the start of our own design process, the outcome of that process would have been different, and better. It would aid understanding and study of relationships between the space, people, technology, interaction with it and values.

Our hope is that the concept will grow and get to be better defined through other examples and studies, yielding a set of principles and guidelines not only for design, but also for the evaluation of interactive installations in public spaces.

REFERENCES

- [1] R. Rosseland, S. Berge, and A. L. Culén, “Publicly Displayed Interactive Installations: Where Do They Work Best?” Proceedings of the Seventh International Conference on Advances in Computer-Human Interactions, 2014, pp. 1–8.
- [2] “Design I/O - Funky Forest Moomah.” [Online]. Available from: <http://design-io.com/projects/Moomah/>. Accessed on Dec. 5, 2014.
- [3] M. Baas, C. K. W. De Dreu, and B. A. Nijstad, “A meta-analysis of 25 years of mood-creativity research: hedonic tone, activation, or regulatory focus?” *Psychol. Bull.*, vol. 134, no. 6, pp. 779–806, Nov. 2008.
- [4] S. Doorley and S. Witthoft, *Make Space: How to Set the Stage for Creative Collaboration*, 1st edition. Wiley, 2012.
- [5] A. P. McGinn, K. R. Evenson, A. H. Herring, S. L. Huston, and D. A. Rodriguez, “Exploring Associations between Physical Activity and Perceived and Objective Measures of the Built Environment,” *J. of Urban Health*, vol. 84, no. 2, pp. 162–184, Mar. 2007.
- [6] “Do Google’s playful perks spark creativity?” *SmartPlanet*. [Online]. Available from: <http://www.smartplanet.com/blog/bulletin/do-googles-playful-perks-spark-creativity/>. Accessed on Dec. 5, 2014.
- [7] B. A. Nardi and V. L. O’Day, *Information ecologies: using technology with heart*. Cambridge, Mass., MIT Press, 1999.
- [8] V. Kaptelinin and L. J. Bannon, “Interaction Design Beyond the Product: Creating Technology-Enhanced Activity Spaces,” *Human-Computer Interaction*, vol. 27, no. 3, pp. 277–309, 2012.
- [9] E. Hornecker and J. Buur, “Getting a grip on tangible interaction: a framework on physical space and social interaction,” Proceedings of the SIGCHI conference on Human Factors in computing systems, 2006, pp. 437–446.
- [10] E. Hornecker, P. Marshall, and Y. Rogers, “From Entry to Access: How Shareability Comes About,” Proceedings of the Conference on Designing Pleasurable Products and Interfaces, New York, NY, USA, 2007, pp. 328–342.
- [11] K. Battarbee, “Defining Co-experience,” Proceedings of the International Conference on Designing Pleasurable Products and Interfaces, New York, NY, USA, 2003, pp. 109–113.
- [12] J. Forlizzi and K. Battarbee, “Understanding experience in interactive systems,” Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques, 2004, pp. 261–268.
- [13] M. T. Koppel, G. Bailly, J. Müller, and R. Walter, “Chained displays: configurations of public displays can be used to influence actor-, audience-, and passer-by behaviour,” Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, New York, NY, USA, 2012, pp. 317–326.
- [14] C. Heath and D. von Lehn, “Configuring ‘Interactivity’ Enhancing Engagement in Science Centres and Museums,” *Social Studies of Science*, vol. 38, no. 1, pp. 63–91, Feb. 2008.

- [15] M. Blythe and M. Hassenzahl, "The Semantics of Fun: Differentiating Enjoyable Experiences," *Funology*, M. A. Blythe, K. Overbeeke, A. F. Monk, and P. C. Wright, Eds. Springer Netherlands, 2005, pp. 91–100.
- [16] M. Csikszentmihalyi, *Flow: the psychology of optimal experience*. New York, N.Y.: Harper Perennial, 1991.
- [17] B. Sutton-Smith, *The ambiguity of play*. Cambridge, Mass., Harvard University Press, 1997.
- [18] K. Salen and E. Zimmerman, *Rules of play: game design fundamentals*. Cambridge, Mass., MIT Press, 2003.
- [19] R. Caillois, *Man, Play, and Games*. University of Illinois Press, 2001.
- [20] B. Costello and E. Edmonds, "A Tool for Characterizing the Experience of Play," *Proceedings of the Sixth Australasian Conference on Interactive Entertainment*, New York, NY, USA, 2009, pp. 2:1–2:10.
- [21] B. Costello and E. Edmonds, "A study in play, pleasure and interaction design," *Proceedings of the conference on Designing pleasurable products and interfaces*, New York, NY, USA, 2007, pp. 76–91.
- [22] J. N. Lieberman, *Playfulness: its relationship to imagination and creativity*. New York: Academic Press, 1977.
- [23] J. Ferrara, *Playful Design*, 1st edition. Rosenfeld Media, 2012.
- [24] H. Gardner, *Frames of Mind: The Theory of Multiple Intelligences*. New York. Basic Books, 1983.
- [25] A. Karabeg, M. N. Akkok, and K. Kristensen, "Towards a language for talking about information visualization aimed at presentation on the Web," *Proceedings of the Eighth International Conference on Information Visualisation*, IV 2004, 2004, pp. 930 – 937.
- [26] A. L. Culén, "Visual Immediacy for Sense-Making in HCI," *Proceedings of the international Conference on Interfaces and Human Computer Interaction*, 2014, pp. 265–270.
- [27] F. Garzotto and F. Rizzo, "Interaction Paradigms in Technology-enhanced Social Spaces: A Case Study in Museums," *Proceedings of the Conference on Designing Pleasurable Products and Interfaces*, New York, NY, USA, 2007, pp. 343–356.
- [28] R. Castro, "Var det alt? En studie av brukeropplevelser i TV-studio på INSPIRIA science center," M.S. Thesis, University of Oslo, 2014.
- [29] S. C. Bolton and M. Houlihan, "Are we having fun yet? A consideration of workplace fun and engagement," *Employee Relations*, vol. 31, no. 6, pp. 556–568, Oct. 2009.
- [30] K. Krippendorff, *The Semantic Turn: A New Foundation for Design*. Boca Raton: CRC Press, 2005.
- [31] "The Royal London Hospital Play Space | Room to Bloom." [Online]. Available from: <http://www.room-to-bloom.com/blog/the-royal-london-hospital-play-space/>. Accessed on Dec. 5, 2014.
- [32] A. Maimone and H. Fuchs, "Reducing interference between multiple structured light depth sensors using motion," *Proceedings of IEEE Virtual Reality Conference, VRW 2012*, 2012, pp. 51–54.
- [33] S. Houben and C. Weichel, "Overcoming interaction blindness through curiosity objects," *Extended Abstracts on Human Factors in Computing Systems, CHI '13*, New York, NY, USA, 2013, pp. 1539–1544.
- [34] "Go With The Flow." [Online]. Available from: http://www.wired.com/wired/archive/4.09/czik_pr.html. Accessed on Dec. 5, 2014.
- [35] B. M. Costello and E. A. Edmonds, "Directed and emergent play," *Proceedings of the Seventh ACM conference on Creativity and cognition*, New York, NY, USA, 2009, pp. 107–116.
- [36] S. Harrison, D. Tatar, and P. Sengers, "The three paradigms of HCI," in *Alt. Chi. Session at the SIGCHI Conference on Human Factors in Computing Systems*, San Jose, California, USA, 2007, pp. 1–18.
- [37] A. L. Culén and A. Gasparini, "Situated Techno-Cools: factors that contribute to making technology cool and the study case of iPad in education," *PsychNology Journal*, vol. 10, no. 2, pp. 117–139, 2012.