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Experiential Design: Findings from Designing Engaging Interactive Environments

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1. Introduction

The objective of this chapter is to present an overview of experiential design through cases which can guide designers in understanding relations between design values, use context concerns, and interactive potentials when designing experience-oriented interactive installations and environments. Experiential design projects are complex affairs in which a number of resources and concerns are brought into play in the shaping of future design concepts. For this reason, the chapter presents *an experiential design schema for interactive environments* which provides designers with a tool for capturing and comparing these concerns, as well as relating them to the scope and objectives of designing specific experience-oriented projects.

Recent years have seen an increasing interest in experience-oriented aspects of HCI, and research contributions have presented a range of approaches to integrating features of user experience in interface design. Being an emergent field of study, these approaches are however quite diverse and without a persistent formal body of knowledge. This is due to the interrelated issues that the subject can be addressed from a number of perspectives, and that it is continuously evolving as new technologies are being brought into use in ever-more use domains.

This chapter presents a practice-based approach to the field of experiential design by outlining key facets of experiential design on the basis of the author's experiences from designing seven diverse interactive installations for knowledge propagation and marketing in cooperation with public institutions and private companies. These key facets are combined in the experiential design schema for interactive environments which encompasses underlying design intentions and values, domain locations and situations, interaction styles, content types and means of engaging users.

The case installations range in scale from walk-up-and-use single-user installations to building-size responsive multi-user environments, and the use domains cover a spectrum from trade shows to open, public spaces. The common denominators for the cases discussed are a shared focus on creating engaging experiences through innovative use of interactive technologies in collaborative design processes that involve interaction designers, domain experts, and end users.

These cases are examined through the lens of a pragmatist perspective on experiential design, which is outlined and discussed on the background of recent contributions to

experience-oriented interaction design. This perspective provides a theoretical foundation for exploring the interrelations between experience, interaction and engagement.

2. Background and related work within experience-oriented HCI

The increasing focus on experience-oriented aspects of HCI is the result of a combination of trends: on a societal scale, researchers and consultants have been exploring the impact of the *experience economy* (Pine & Gilmore, 1999) for a number of years, and companies as well as public institutions governments are increasing their endeavours to reap the benefits of this trend; on a technological scale, *new technologies* with the potential to expand and enrich user experiences are constantly being developed, and the experience-oriented potentials of existing technologies are being re-examined; and finally, interactive technologies are being employed in ever-more *domains* that transcend the workplace, moving into public spaces, the entertainment industry, cultural institutions, leisure activities, and not least into users' homes. With this diversity in mind, it comes as no surprise that the research community's response to addressing experience-oriented aspects of interactive technologies is highly varied. Given the intrinsic complexity of the subject, Davis (2003) contends that "experiential systems design must be radically interdisciplinary" and combine efforts and insights the fields psychology and the arts and humanities, as well as engineering and computer science. *Three approaches to experiential design* are especially relevant for the theme of this chapter, namely those that focus on products, aesthetics, or theories of experience: First, approaches such as those of Jordan (2000) and Norman (2004), take as their starting point the notion of *pleasurable products* and their design. Product-centered approaches often have their main focus on the features and qualities of the interface itself, that which can be described and studied in ostensibly objective terms. A rather different approach is to take as a starting point the notion of *aesthetics* and explore what constitutes an aesthetics of interaction, as do Petersen et al. (2004), how to engage in aesthetic criticism of interfaces, as do Bertelsen and Pold (2004) or to examine what might come from designing post- or suboptimal technologies with special regards to aesthetic qualities, as do eg. Dunne and Raby (2001). Yet another approach is to establish *theories of experience*, either by drawing on existing theories from psychology, by radically expanding or modifying these theories, or by defining new ones altogether. Proponents of this approach include Alben (2004), Forlizzi and Battarbee (2004), and Forlizzi and Ford (2000). These approaches are primarily concerned with experience as it unfolds in human-computer interaction, or in computer-mediated human-to-human interaction.

The pragmatist perspective on experiential design presented in this chapter lends partly from the first of these approaches with reference to the concern for designing engaging interactive systems, partly from the second approach with regards to an interest in exploring the aesthetic aspects of interaction. However, it is mostly aligned with the third approach through the definition and discussion of salient aspects of experience in interaction. Within the theory of experience approach, Forlizzi and Battarbee (2004) provide a more fine-grained sketch of the field of experiential design by making a distinction between *three ways of modelling experiences*: First, *product-centered models* that focus on the qualities of the interface, such as those explored in Desmet & Hekkert's 'Framework of Product Experience' (Desmet & Hekkert, 2007) which examines the interrelations between aesthetic, meaningful and emotional experiences of products. Second, *user-centered models* of human capabilities and motivations such as Hassenzahl's exploration of the user-product relation (Hassenzahl,

2003). Third, models that focus on the *interaction-centered models* in a systemic perspective, as do Forlizzi and Battarbee themselves in their understanding of experience (Forlizzi & Battarbee, 2004) as well as Petersen et al. (2004) in their call for a holistic understanding of aesthetic interaction. The pragmatist perspective on experiential design presented here is best characterized as an interaction-centered one. It is for this reason that I employ the term *experiential design*, rather than *experience design* which in some instances lends the belief that the experience itself can be designed. In contra-distinction, experiential design stresses the notion that designers may seek to imbue interactive installations and systems with certain experiential qualities, but that experience is ultimately a subjective encounter in which the experiencing user is a co-creator. This is not to say that designers cannot design with the intent of bringing about specific kinds of experience, rather it is an echo of Petersen et al.'s proposition that "aesthetic is not something a priori in the world, but a potential that is released in dialogue as we experience the world." Thus, a reflective combination of understandings of users, use context, and technology in the design process may result in products and systems that invite comparable experiences among a multitude of users, their subjective past experiences notwithstanding.

In addition to the abovementioned contributions, a research perspective that has heavily influenced the work presented here is that of Participatory Design (eg. Greenbaum & Kyng, 1991) which stresses the importance of integrating knowledge of users and use context in the design process. The experiences from engaging in the seven design cases has however made clear that traditional Participatory Design, which is rooted in understanding workplace challenges and concerns, is also challenged by the emergence of experiential design. In particular, methods and techniques for involving users and gaining insights into use domains conventionally employed within this tradition are in need of revision or replacement when designers move beyond the workplace. One promising recent method for gaining experiential insights is Gaver et al.'s Cultural Probes (Gaver et al., 1999) which are intended to provide designers with user-centered inspiration. The experiences drawn from designing the seven cases presented in this chapter mirror Gaver et al. who propose that user inputs are best regarded as a one of several sources of inspiration that designers draw upon, somewhat downplaying the importance of specific user inputs and instead emphasizing the role of the responsible and reflective designer whose job is to coalesce a number of experiential concerns and resources in the final design.

Moving from theoretical sources of inspiration for this paper to case-oriented ones, Bullivant has presented the most comprehensive compilation of interactive installations and environments in (Bullivant, 2006) which presents cases ranging from responsive building skins through interactive rooms to artworks. There is a clear trend in interaction design to partake in design of large-scale environments as evidenced by eg. the Urban Screens conference (www.urbanscreens.org). On a smaller scale, conferences such as Tangible & Embedded Interaction (www.tei-conf.org) are primarily oriented towards installation-size interactive systems. Manovich (2006) addresses this new domain of integrating interactive systems into environments, which he dubs *augmented space*. Interestingly, Manovich argues that some of the best examples of augmented spaces, namely Cardiff's Audio Tours and Liebeskind's Jewish Museum in Berlin, are in fact not in themselves interactive, but rather shaped by sensitivities towards digitally augmented spaces.

3. A pragmatist perspective on experiential design

Based on experiences from practical experiential design projects as well as extensive literature surveys, I propose that *pragmatism* may serve as a sound foundation for establishing a framework for addressing experiential design and highlighting key concerns across experiential design projects. First of all, pragmatism has at its core an understanding of the reciprocal, interactive process of experiencing, thinking and acting through situated inquiry and experimentation (Dewey, 1910) which can shed light on the design and use of engaging interactive environments. Second, although pragmatism emerged long before interactive systems, it has influenced a number of fields such as aesthetics and architecture, and several recent contributions to the field of interaction design have employed pragmatist concepts, which means that there are a number of sources to draw upon in developing the framework. Of particular interest here are Schön's studies of the reflective design process (Schön, 1983), McCarthy and Wright's (2004) and Petersen et al's (2004) approaches to aesthetics of interaction, and Dalsgaard's (2008) concept of inquisitive use of interactive systems.

Pragmatism originated in the United States around the end of the nineteenth century. The movement was founded by Charles Sanders Peirce, William James, and later on John Dewey. Though their works share many standpoints, they are not fully congruent, for which reason it must be emphasized that this chapter will refer to Deweyan pragmatism.

Pragmatism is so labelled due to the *primacy of practice* principle, a foundational pragmatist proposition which holds that the meaning and "truth" of concepts and ideas are to be evaluated on the basis of their consequences and implications in practice. In this light, our theories and conceptualizations can be thought of as tools or instruments for coping with the world; if they help us navigate and manipulate the world they have proved themselves in practice, although we must always be open to the possibility that they may be replaced by better-functioning theories. Pragmatism views the world as being in flux, "brimming with indeterminacy" (Shalin, 1986, p. 10), and it is through the ongoing efforts of our thinking and acting in practice that we establish order in concrete situations. In this respect, pragmatism presents a highly situated perspective on human interactions. Just as we are situated and draw upon our repertoire of habits and experiences, so are other phenomena around us situated, most notably other human agents, but also technologies and spaces which have also been shaped as tools and instruments for coping with the emergent phenomena of the world. Deweyan pragmatism has been employed to address a number of diverse domains ranging from education and art to democracy. Given the scope of this chapter, I will however focus on pragmatist understanding of aspects of special relevance for developing an experiential design schema for interactive environments, namely the closely inter-related concepts *experience*, *interaction* and *engagement*.

Experience

Dewey makes a clear distinction between *experience*, which is the constant stream of experience of being in the world, and *an experience*, a discrete event that stands out on the background of continuous experience. Distinct experiences often stand out because we perceive of them as being either especially *problematic*, in that they disturb our traditional understanding of practice, or *aesthetic*, arousing a sense of fulfilment. Interestingly, problematic and aesthetic experiences are often convergent, since the process of overcoming a problematic experience can result in an aesthetic experience. Both types of experiences are

highly situated in practice: continuous experience because it is that which ties us to and makes us understand our history of being and acting in the world, and distinct experiences both because we give them special notice on the backdrop of our existing experience and because they are related to situations we are currently facing. The notion of distinct experience is of special concern for experiential design, in that designers within this field often seek to bring about specific and remarkable encounters through framing and shaping interaction.

A pragmatist understanding of experience has several implications for design: The continuous flow of experience prompts designers to integrate interactive systems not just into the context of physico-spatial surroundings, but also into the flow of users' experience. The notion of aesthetic experiences prompts designerly explorations into what may constitute such experiences for intended users, and which types of interactions may bring them about. Furthermore, the notion of problematic experiences prompts examinations into whether it may be preferable to present users with problematic situations (since overcoming them may ultimately lead to aesthetic experiences), and into how to design problematic situations which do not scare off users before they engage in interaction.

Interaction

In the broadest sense, interaction can be defined as a person acting in a situation in order to effect certain changes while drawing upon personal and external resources. In Deweyan pragmatism, *situation* is the assemblage of the user, other human agents, physico-spatial surroundings, available technologies, and the established socio-cultural meanings and structures in the domain: "Situations are an intimate, interconnected functional relation involving the inquirer and the environment." (Dewey, 1938, p. 108) In this respect, resolution of a problematic situation involves changes in one or more of these aspects. This occurs over the course of time, and interaction can thus be understood as a transformation of components in the assemblage and shifts in their relations.

With specific regards to experiential design of interactive environments, a pragmatist understanding of interaction is thus highly systemic. This implies in that designers should address not just the immediate human-computer interaction at the interface, but the whole situation of interaction including the experiencing person, the physical environment (including artefacts, technologies and spaces, man-made or otherwise), socio-cultural norms and meanings, as well as other people whose intentions and actions may influence the situation over the course of time. A key interaction concern when designing engaging interactive environments is to thus to simultaneously frame a situation that invites or provokes a user to interact and to scaffold this interaction by offering access to certain resources. These resources may be inherent in the interactive system (eg. ways of controlling visual elements such as characters in a game), or they may take the form of computer-mediated access to other resources (eg. offering communication with other users). Inviting or provoking interaction is dependent on the connection between situation and the user's experience, and an effective strategy for establishing interaction is to frame a situation which stands out for the user as something which is problematic and needs to be resolved in order to achieve an experience of fulfillment.

Engagement

Based in a Deweyan understanding of experience and interaction, engagement can be understood as a focused form of interaction in which the user enters into a reciprocal

relationship which potentially effects changes in both the user and the situation. Engagement relies on a certain mode of experiencing the world, namely *inquiry*: "Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituents distinctions and relations as to convert the elements of the original situation into a unified whole... The resolution of a problematic situation may involve transforming the inquirer, the environment, and often both. The emphasis is on transformation." (Dewey, 1938, p. 108) Engagement can thus be defined as a a mutual process in which the user in an interactive environment encounters a problematic framing of her experience, leading to inquiry into the situation through interaction with the intended outcome of transforming the perceived practice. This change may be understood in a very literal sense, eg. that an agent transforms her physical surroundings, it may be relational – eg. that new social structures are established between people in a situation – or it may concern aspects internal to one party in the situation – eg. that an agent gains new knowledge about the situation which transforms it from problematic to comprehensible.

The notions of inquiry and transformation as key aspects of engagement prompts designers to consider the ways in which they can challenge users – eg. through evoking curiosity or establishing a competition between several users – and to examine to which extent the different parts of the situation assemblage can be altered through interaction, either literally, relationally, or internally.

This outline of a pragmatist understanding of experience, interaction and engagement serves as the basis for the experiential design schema for interactive environments presented and exemplified in the following sections.

4. A experiential design schema for interactive environments

The experiential design schema can be understood as a translation of the theoretical insights from the previous sections into an instrument that can scaffold understanding and designing engaging interactive environments. The schema contains the following salient aspects of experiential design ranging from tangible to conceptual concerns: *Scale, domain, users, situation, interaction input, interaction output, intentions, values, content* and *means of engagement*. The first aspects are very concrete, eg. it is fairly trivial to describe the scale of an interactive installation, whereas the latter aspects, particularly intention, values, content, and means of engagement, are more abstract, eg. it may be a considerable challenge to define the experiential values that an interactive environment is to evoke among users. The aspects can be understood in the following way:

- **Scale** denotes the magnitude of the installation or environment. The cases presented in this chapter range from medium-sized interactive installations to huge building-sized environments.
- **Domain** denotes the setting in which the installation or environment is placed. In this chapter, the case domains range from trade shows to public parks.
- **Users** denotes the number of people using or experiencing the situation, in the case examples ranging from 1 to 1000.
- **Situation** denotes the circumstances under which people will encounter the installation or environment. In the case examples, this spans serendipitous encounters when walking down a main street to consciously exploring museum exhibitions.

- **Interaction Input** denotes the ways in which users can affect or control the interaction, in the case examples ranging from facial camera tracking to tangible interaction.
- **Interaction Output** denotes the interface response, in the case examples ranging from audio of spoken words to image visualization using color-changing concrete.
- **Intentions** denotes the concrete purpose for creating an installation or environment. In the cases, this ranges from grabbing bypassing people's attention to promoting autonomous learning in museums.
- **Values** denotes the experiential qualities that an installation or environment is meant to bring about through interaction. In the cases, the experiential values range from playfulness to conveying solemn moods.
- **Content** denotes the subject matter presented in the installation or environment, in the cases ranging from simple opacity-changing windows to complex visualization of electricity production and consumption.
- **Means of Engagement** denotes the mechanisms and strategies employed to promote engagement with the installation or environment, in the cases ranging from social engagement to presented fragmented narratives that invite puzzle-solving or storytelling.

The experiential design schema for interactive environments may be used for several purposes: First, it may be used to document and compare a number of projects, as will be done in the subsequent sections of this chapter. Second, it may be employed in the design phase in order to capture and explore the relations between salient aspects of one or more design concepts. As stated, the latter aspects in the schema are more specifically related to experiential qualities, for which reason they will receive the most attention in the remainder of the chapter. When I chose also to include generic aspects of design such as size and domain, it is because aspects captured in the schema are to be construed systemically as parts of a whole. This implies that changes in one aspect will most likely cause ripples throughout other aspects in the schema. Employed actively in a design process, the schema scaffolds the crucial design competence of moving from the part to the whole and vice-versa. In capturing key aspects of a design in a compact form, the schema furthermore supports shared overview and communication, both among design team members, and between designers and other stakeholders in a design project. Viewed as a whole, the schema implies that experiential design of engaging interactive environments should entail the following design inquiries:

- Determining the over-all intentions for creating the installation or environment
- Establishing an understanding of the physico-spatial surroundings
- Establishing an understanding of potential users
- Establishing an understanding of the situation in which users encounter the installation or environment, including the habitual structures and practices
- Determining the experiential values that the installation is intended to evoke
- Exploring the potential for interactive installations to convey the intentions and values to users through the means of engagement available to them

Table 1 contains the experiential design schema for the seven cases of engaging interactive environments which will be presented and discussed in more detail in the remainder of this chapter:

	GUM FACADE	SALLING FACADE	BALDER'S PYRE	ENERGY TABLE	SILENCE & WHISPERS	AARHUS BY LIGHT	WARSAW MOMA
SCALE	Medium: Wall	Medium: Facade	Medium: Corridor	Medium: Room	Large: Tunnels	Large: Facade	Huge: Building
DOMAIN	Trade show	Dept. store	Literature center	Science centre	Cultural heritage site	Concert hall	Art museum
USERS	1-10	1-5	1-5	1-6	1-10	1-15	1-1000
DURATION	30 sec-5min	5 sec – 2 min	30 sec-5 min	5-30 min	5-30 min	1-15 min	1 min – 3 hr
SITUATION	Passing by (trade show)	Passing by (main street)	Obligatory exhibition passage point	Exhibition installation	Lingering in park	Concert hall visit or lingering in park	Museum visit or passing by
INPUT	Facial camera tracking	Movement- based camera tracking	Floor pressure sensors	Tangible interaction	Audio / Speech	Silhouette- based camera tracking	Movement- based camera tracking
OUTPUT	User- controlled spheres in 3D space	Dynamically transparent window with varying opacity	Multiple video projections (of fire engulfing users)	Responsive table display coupled with exhibited devices	Audio / Speech	Silhouettes rendered on large-scale LED facade	Thermo- chromatic concrete
INTEN- TIONS	Attention Stand out	Attention	Convey atmosphere Pause for reflection	Promote autonomous learning	Convey atmosphere and richness of place Promote story sharing	Alter perception of architecture and place Social interaction	Alter perception of architecture Seamless yet outstanding integration of IT
VALUES	Playfulness Hi-tech impression	Finesse Cutting edge technology	Solemn mood Narrative coupling	Playfulness Participation	Curiosity Respect Participation	Playfulness Participation	Subtle transformations
CONTENT	Simple: Spheres in 3D gum universe	Simple: Dynamically transparent window	Simple: Visualization of fire	Complex: Visualization of electricity production and use	Complex: Place-specific stories	Medium: Creatures Cityscape	Complex: Navigation Artwork and data visuals
MEANS OF ENGAGE- MENT	Mirroring Gameplay Social interaction	Mirroring Surprise	Immersion Narrative relations	Gameplay Learning	Curiosity Narrative unfolding	Mirroring Gameplay Social interaction	Tracing Curiosity

Table 1. The experiential design schema summarizes salient experiential design aspects for the seven interactive environments cases

5. Case presentations

The seven cases are represented in the experiential design schema in table 1. The cases have been selected on the following grounds: they all fall into the category of experiential design; they employ interactive technologies to bring about engaging experiences, often in innovative ways; the author has been involved in their design and thus has access to first hand information; and finally, they represent a broad spectrum of uses of interactive technologies for experiential purposes, for which reason they lend themselves well to comparisons as well as to establish a broad overview of the field. In the following sections, each environment is presented in the sequence of their scale.

The author has participated in the development of all of the cases, and with the exception of Silence and Whispers, these have been developed in collaboration with colleagues at CAVI, the Center for Advanced Visualization and Interaction, at the University of Aarhus, Denmark. Several of the cases have been developed in collaboration with external partners from industry, as described in the individual case presentations.

Four of the cases, the Gum Facade, the Salling Facade, Balder's Funeral Pyre and Aarhus by Light, have been produced and been put into use as final products; Silence and Whispers was developed and tested at a prototype level; the Energy Table was developed as a video prototype; the Warsaw MoMA was developed as part of a comprehensive proposal for an architectural competition. Due to these incongruences, as well as the very diverse scope of the installations and environments, no directly comparable evaluations have been carried out. Rather, each environment has been evaluated on its own specific domain- and experiential-related terms.

With the scope and aim of this chapter in mind, the presentation of each case is kept at the length of one page; several of the cases have been treated in greater detail elsewhere, and this is noted in the respective sections. The descriptions focus on presenting the function of the environments as well as intentions, values and means of engagement. This is done to provide adequate grounds for discussing and comparing experiences from the cases later on.

5.1 The Gum Facade

The Gum Facade (also treated in Dalsgaard & Koefoed, 2008) is an installation developed for and in collaboration with Gumlink, a large, international chewing gum research and manufacturing company, for their booth at the world's largest annual candy and sweets trade show in Cologne, Germany.

The gum facade is placed along one of the exterior walls of the booth. It consists of four screens connected to form one large display. Above the display, a camera tracks people who approach or walk past the stand. The video feed from the camera is processed by software that identifies faces. The images of faces of passers-by are then captured and represented live, in the shape of orbs on the display. The orbs exist in a 3D space showered by small gum tablets. By moving around in front of the display, users control the orbs that interact with the showering tablets and other orbs. The purpose is to create attention and attract visitors who may otherwise not notice the stand, and the intended use-time for the console is 30 seconds to 5 minutes.

The main intentions for creating the installation was to catch the attention of bypassing convention visitors while providing a brief an introduction to Gumlink products and services.



Figure 1. The Gum Facade in use at a trade show

The use context for the installations, the sweets convention, is characterized as being simultaneously bustling and somewhat serious and restrained: A large number of visitors are present, however they are all there for business purposes (the convention is professional and not open to consumers), and as such observe certain formal behaviours, both relating to dress-codes and behaviour. The users and the use context, coupled with the Gumlink company values, thus put certain constraints on the type of installations that would fit into the domain, and the experiential values defined as conveying an image of a serious company while emphasizing Gumlink's standing as hi-tech company driven by innovation. The means of engagement employed were fairly straightforward, namely mirroring the face of bypassers in the spheres, providing a simple gameplay, and inviting social interaction among passers-by. The Gum Facade was moderately successful in that it functioned quite well technically and served well as an ornamentation of the Gumlink stand; however, few visitors engaged in interaction, likely due to concerns about losing face in a professional business environment.

5.2 The Salling Facade - Dynamically Transparent Windows

The Dynamically Transparent Windows is a facade installation developed for and in collaboration with Salling, a major Danish department store. The Dynamically Transparent Windows are installed in a 5 meter section of the main street facade of Salling and respond to movements of people passing by. Using a camera, passers-by are tracked, and the data is processed by a system that controls custom-built interactive windows on the facade. The windows are fitted with electro-chromatic foil that can change from opaque to transparent when an electric current runs through it. By using thin strips of the foil, narrow bands on the facade change in order to reveal what is on display in the store when people walk by in a five-by-two-meter zone outside window. The facade uses various interaction modes in order to lure the by-passers near and make them explore the display, primarily through hiding the displayed items until people walk by.

Arguably the simplest of the installations presented in this chapter, the main intention of the facade is to attract the attention of potential shoppers. The main values guiding this process is to convey a sense of finesse and cutting-edge technology to by-passers. The main means of engagement is the element of surprise to see a window that has the until now unseen opacity-changing property, and in a straightforward sense the mirroring of by-passers: the

facade is opaque, but when you enter in front of it, the it 'opens up' of you by making the strips in front of you transparent. The installation was in place at Salling for five weeks, during which we made a number of observations. The intentional use of the installation was quite limited, one likely reason being that the strategy of obscuring the items until display was overwhelmed by almost every other display on the main street, which in contrast screamed out for attention. As such, the Dynamically Transparent Windows were largely unsuccessful when employed in the main street setting.



Figure 2. The Salling Facade – images from a prototype and from the actual installation

5.3 Balder's Funeral Pyre

Balder's Funeral Pyre (also treated in Dalsgaard & Halskov, 2006) is an interactive environment designed for and in collaboration with 7th Heaven, an organization whose objective is stimulate reading among children. The environment was custom designed for a centre for Scandinavian children's literature as part of a series of interactive installations in which visitors experience settings and moods of the stories from Norse mythology. The Balder's Funeral Pyre installation is a 7 meter long and 1.5 meter wide corridor, in which one of the sides is a 6 meter long and 2 meter high rear projection of fire. The fire is digitally produced using a particle system with hundreds of bit map images of fire, which together with 14 on/off pressure sensors in the floor enable interaction with the fire. When no one is in the corridor, the flames glow low above the floor, but when someone enters the corridor, a larger fire erupts where the person is standing. As the person proceeds down the corridor, more explosions erupt near them, and eventually the person is immersed in flames.

The main intention of the environment is to Convey the story and mood of Balder's funeral at sea. Balder is a god figure from Norse mythology, in which his death marks a dramatic narrative event: Balder is killed, and this spells the beginning of the end of the mythological world, culminating in the apocalyptic Ragnarok that lays waste to the heavens and the earth. At his funeral, Balder's body is placed upon a ship that is ignited and set off to sea.

The experiential values were developed to underscore this story in collaboration with 7th Heaven: Convey an atmosphere that instils a solemn mood to emphasize the importance of the story and provide provide room for reflection upon what it means in the broader context of Norse mythology. The most direct means of engagement is the concrete

experience of being slowly immersed in flames when entering and moving through the corridor. A more subtle means of engagement was in part shaped by 7th Heaven, who operate with a general strategy of conveying moods and atmospheres and hinting at story elements rather than retelling stories word by word; this is intended to encourage children to read the stories themselves. Thus, the environment creates a link to users' pre-existing knowledge and experiences, partly by employing the imagery and evoking the mood of the specific story, partly through placing the installation as a passing point at the middle of the childrens' movement through the literature center, mirroring how the story is in the middle of the over-arching narrative of Norse mythology. The environment was moderately successful: users responded very well to the final concept in testing, however the final production was marred by a limited budget for which reason it was perceived as somewhat unfinished.



Figure 3. Users explore Balder's Funeral Pyre

5.4 The Energy Table

The Energy Table (also treated in Dalsgaard & Halskov, 2006) is a video prototype developed for The Danish Electricity Museum, a science and cultural heritage museum. The museum hosts varying special exhibitions and a number of permanent exhibit varying from a fully functional water plant to large Tesla coils, small experimental setups, electrical machinery etc. The museum visitors are include school classes and private visitors who attend lectures, follow guided tours, and explore the museum's exhibits on their own.

The Energy Table is a full-room environment. At the centre is a table, above which are mounted a camera and a projector. On the table are six miniatures of power generators, e.g. a windmill and a water power plant. Additionally, there are five to ten miniatures of devices that correspond to full-size devices placed around the table. When visitors stand next to a miniature power generator, they activate it, indicated by a glowing aura projected from above. They can now use physical icons, Electricons, to create flows of energy on the table by physically placing and moving the Electricons on the table. They can lead energy to the miniature devices on the table, thus activating the full-size devices in the room. The devices require different amounts of energy, and visitors can collaborate by combining flows of energy. The various Electricons function as switches, resistance, batteries etc., allowing for the execution of a wide variety of scenarios. The table can also

be set up for the visitors to meet certain objectives, thus acting as a board for playing power games.

The intentions behind The Energy Table was to provide visitors with information about natural and technological phenomena that are invisible to the naked eye, primarily energy production and consumption, and to engage visitors in a manner which invites them to explore exhibits on their own. For these reasons, the guiding values were to instil a sense of playfulness and participation, and to evoke a sense of coherence between the installation and existing museum artefacts and surroundings. The primary means of engagement are on an installation-specific level to establish a gameplay structure for producing and consuming energy and to foster curiosity for learning about these phenomena, and on a social level to foster visitor-to-visitor interaction. Since The Energy Table was not put into final production, it is not known whether or not the product will be successful.



Figure 4. Images from The Energy Table video prototype

5.5 Silence and Whispers

Silence and Whispers (also treated in Dalsgaard, 2008) is a conceptual mixed reality installation created in 2006 as a cross-disciplinary collaboration between four interaction design researchers, including the author. Silence and Whispers was developed and located on Suomenlinna, a series of islands in the Helsinki harbour entrance. Suomenlinna served as a naval fortress and 1748 until the end of World War I, and simultaneously the islands housed detention camps. Today, there is a close-knit community of inhabitant on the islands that also serve one of the most popular public recreative area in Finland. Furthermore, Suomenlinna hosts an open prison facility. The primary intention underlying the design of Silence and Whispers is to collect and convey stories that reflect this multi-layered cultural history. Near King's Gate on the southern island of Gustavssvärd, faint whispers emanate from a shadowy cave. When visitors step inside the cave, they hear audio fragments of ominous stories and folklore from Suomenlinna. These stories, collected from resident islanders and visitors with strong relations to Suomenlinna, tell of events and myths not presented in official historic documentation. In addition to the audio fragments, stories and rumours are written in chalk on the cave walls. Some written fragments retell the same stories as the audio snippets.

The values underlying the design were to bring about a brooding atmosphere, to evoke a sense of respect for the history of the place, and to bring about a sense of co-participation. A primary means of engagement is to play on curiosity through the fragmented unfolding of narratives - the further visitors move into the darkness of the cave, the more disturbing the stories, and in order to view the gloomiest stories, visitors can light matches to reveal them in short glimpses. Another means of engagement is the option for visitors to contribute themselves: Pieces of chalk are left in the cave, and visitors can write down their own stories. In this way, the installation evolves and expands over time as old stories are erased or washed away and new ones are added to the cave walls. It was planned but not implemented to include an audio input option for visitors to tell their own stories, which would then also be fragmented and spread throughout the caves. As an experiential prototype, *Silence and Whispers* was relatively successful, in that users responded very well to the atmosphere and means of engagement inherent in the environment; we are currently exploring the possibility of realizing the final concept in a different setting.

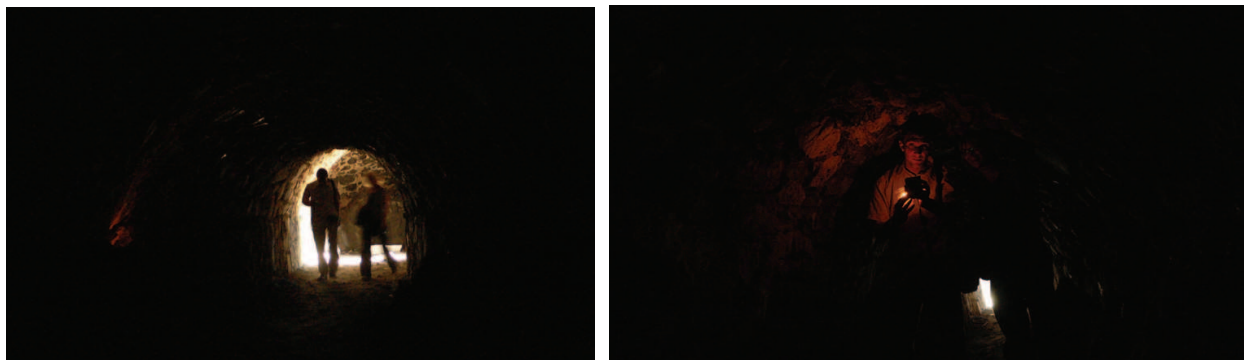


Figure 5. Visitors explore *Silence and Whispers*

5.6 Aarhus by Light

Aarhus by Light was an interactive facade developed by CAVI for Concert Hall Aarhus, Denmark, in use in February and March 2008. The interactive facade consists of 180 m² LED displays which are highly transparent and can be arranged in 2x2 meter sections. The displays form an organic shape that becomes part of the distinct architecture of the concert hall. Luminous creatures live in the facade on the backdrop of an ever-transforming skyline that mirrors Aarhus. On the path towards the concert hall, a number of sensors capture the movements of passers-by and transform them to silhouettes on the facade. In this way, users can contact and play with the luminous creatures, eg. they may push them around or wave to them, and the creatures may respond by kicking or waving back. The tracking and animation software has been programmed from the ground up for the occasion by CAVI in C++. MaxMSP/Jitter was used extensively during prototyping of interaction and tracking. The character animation (done by animation company Wall of Pixels) as well as the Skyline was made in Flash.

The intention behind *Aarhus by Light* was to alter the perception of Concert Hall Aarhus (which has traditionally appealed to either children or middle-aged and old people, demographic groups which the concert hall seeks to expand) and the park surrounding it (primarily used as a transit zone in the city rather than a place for resting and relaxing), as well as to experiment with the newly developed LED displays. The intended values were to promote playfulness and participation, which was primarily addressed through the

possibility of interacting with the luminous creatures in the facade. In continuation of this, the means of engagement were the gameplay potentials and the social interaction in the interaction zones. Furthermore, the mirroring of users as large silhouettes on the facade served as a prominent and straightforward means of engagement. Aarhus by Light was very successful in several respects: almost all visitors interacted with it, and a large majority enjoyed it, it generated a lot of attention and press of benefit for the involved stakeholders, and finally it served as a fruitful research experiment both with regards to technical and user-oriented concerns.



Figure 6. Aarhus by Light in use at Concert Hall Aarhus

5.7 The Warsaw Museum of Modern Art

This concept (also treated in Dalsgaard et al., 2008), which contains three interactive elements, was developed by CAVI as part of a complete proposal for an architectural competition for a new modern art museum (MoMA) in Warsaw, Poland developed by BIG (Bjarke Ingels Group), a Danish architectural firm.

The interactive components of the museum all make use of thermo-chromatic concrete (TCC), a material which has the property of enabling a concrete façade to become a display in its own right. Simply put, this is a type of concrete that slowly changes color as it is heated, and through controlling heating elements the building itself can act as a display. Three concepts were developed for the use of TCC in the Warsaw MoMA: 1) Visualization of exhibited artwork on ceilings and floors, 2) traces on ceilings and floors of visitors' movements throughout the museum, and 3) schematic visualizations on walls of visitor data and statistics. The concepts are illustrated in figure 7:

The intentions for the concepts were to examine the properties of TCC to create a seamless yet innovative and outstanding integration of interactive systems to visualize exhibition contents and to guide visitors through the traces which would indicate the most popular exhibitions as well as 'hidden treasures'. The main values guiding this process was to present subtle transformations of the building through the use of TCC to alter the perception of architecture, and ultimately to convey the feeling of a living and mutable museum building responding to what goes on inside of it in terms of exhibitions and visitor actions. Due to the size and number of potential users, the means of engagement were primarily non-participative in the form of immersion and intrigue, although visitors would also see their movements as traces in the building (as per concept 2).

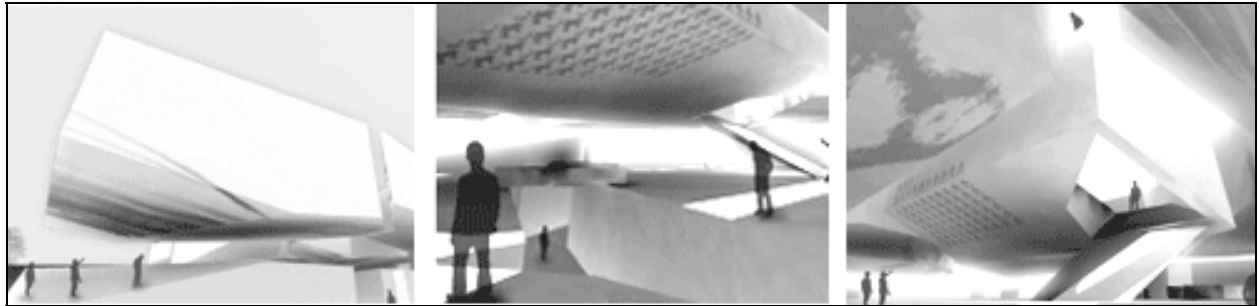


Figure 7. TCC used in three way in the Warsaw Museum of Modern Art

The BIG/CAVI proposal entered the final round of selections for the MoMA competition, but ultimately another proposal was selected; the TCC concept is however being refined in collaboration between CAVI and BIG. For this reason the environment may be considered a moderate success, however on the basis of the information available at the present time, it is not possible to determine how well the final product would be received.

6. Findings from designing engaging interactive environments

Some design disciplines are well-established, for which reason it is possible to observe and extract successful patterns for design. Examples of this include Alexander's pattern language of architecture (Alexander, 1977), or the Alexander-inspired patterns for interface accumulated by Tidwell (2005). Since this field of experiential design of interactive environments is emergent, such endeavours are in all probability premature within this field. In some instances, this is because the phenomena you wish to study as a researcher are not yet present, for which reason you have to engage in design projects to create them; eg. Aarhus by Light sprang from a research agenda of studying how social interaction and the perception of public places might be affected or transformed by media facades, a phenomenon which did not become observable until the environment was designed and put into use in practice. In other instances, it is because access to interesting aspects of cutting-edge environments and installations are not accessible to researchers due to designers' disinterest in divulging their trade secrets. The seven design cases are markedly diverse and as such they do not lend themselves to direct comparative evaluation. Rather, they offer a background for analyzing and discussing general experiences from engaging in in-situ design experiments carried out to explore the field of experiential design. In doing so, I shall focus on issues of success and failure, interrelations between values and intentions, place-specific concerns, and means of engagement. These discussions are summarized in a series of general experiential design considerations in the conclusion.

6.1 Success and failure of experiential interactive environments

Evaluating the success and failure of the installations is no mean feat: first, they are intended for different domains and situations; second, they are not all final products and as such not directly comparable; third, it is not always straightforward to define success and failure of experiential environments. With regards to final products, Aarhus by Light was without a doubt the most successful. It was a hit with users, it achieved the objectives and intentions posed in advance and delivered on the intended experiential values, and finally it served as a rich source for research insights. However, it may be more interesting to look at the Salling Facade, the least successful of the cases. The installation was thoroughly tested technically,

and the prototype was user-tested in other settings, including a stand at a technology convention, before being deployed in the main street setting. Nevertheless, in situ observations coupled with analysis of recorded video revealed that it did not meet the intention of grabbing the attention of by-passers, and very few people would stop to interact with it. This finding led our attention to the general behaviour of by-passers on the main street, and studies of their behaviour revealed that very few people would actually stop to study what was presented in regular window displays. Even though not very many people interacted with the installation, it did likely generate a bit more interest than a non-interactive window display. In this manner, the project can be seen as quite successful in terms of generating research insights, although unsuccessful in practice. The relative failure of the Salling Facade however also led us to compare it to the success of Aarhus by Light: the main street offers people a great number of inputs, many of which appear quite similar the Salling Facade at first glance, whereas Aarhus by Light was immediately recognizable to people, both because of the scale and because it stood out on the backdrop of people's past experiences. As a means for stimulating immediate interest, this indicates that installations and environments should stand out, but in a recognizable way. This points to the highly situated nature of experiential design: determining the failure and success of installations and environments is done in practice, and there can be a number of influential factors which may not be known in advance.

6.2 Working with intentions and values

A distinctive feature of the process of developing the seven cases was the work that went into integrating intentions and values into the design process. Intentions and values were in most cases identified in the early stages of a project, often in collaboration with other stakeholders and based on studies of the use domain and situation. This was done to establish guiding tenets for design decisions. The process of designing Balder's Funeral Pyre sheds light on how this can take place in practice. Based on the nature of the myth of Balder and discussions with stakeholders from 7th Heaven, we sought to convey emotional qualities and a sense of slowness, which guided the design toward a subtle interaction with very simple content, the fire. During the design process, a more complex visualization, with dissolving imagery from Norse mythology, was discussed as an alternative that would stimulate children to play with the fire. A number of user tests of prototypes were carried with children in order to evaluate use patterns and the impact and impression of the installation. These tests made it clear that the more complex visualization would encourage playful interaction from visitors, whereas the simple version would result in a relatively passive and reflective usage. The established values of instilling a solemn mood and making room for reflection consequently made it clear that we should opt for the simple version of the installation. In the case that several stakeholders are involved in a project, it can be particularly valuable to take the effort to define the intentions and values, first because this establishes a common ground in between the stakeholders, and second because it empowers designers with foundation for making design moves and decisions without constantly seeking the consent of other stakeholders.

This being said, it is often a challenge to determine values that are specific enough to form a foundation for making informed design decisions. One strategy that worked well in several projects was to include anti-values in design discussions, ie. statements that reflect the opposite of the intended values for the installations. Although we have not worked with anti-

values in a systematic way, retrospective analyses indicate shared anti-values were formulated and referred to throughout many of the design processes. One example of an anti-value can be found in the case of Balder's Funeral Pyre, in which we deliberately steered clear of the anti-value "Spirited playfulness" since it would likely conflict with the solemn and reflective values that we aimed for.

6.3 Place-specific concerns

Based on the insights from evaluating failures and successes of the environments and using values as design guidelines, it is evident that an understanding of the *place* in which an environment or installation is located is essential. Drawing on geographer Yi-Fu Tuan (1997), Harrison and Dourish (1996) define place as follows: "... a place is a space which is invested with understandings of behavioral appropriateness, cultural expectations, and so forth."

In a pragmatist understanding, place may be construed as the assembly of shared socio-cultural meanings attributed to a space and the situations which habitually play out in it. The notion of places in combination with technology is thus of particular interest to interaction designers, for these are the materials which may be formed through design. Places and technologies embedded in them play a twofold role in that at the same time as they are framing and shaping our experience, they also provide means to transforming it since they scaffold our knowing and doing. Spaces and technologies also carry with them past histories and potential future trajectories since they are crystallizations of prior practice and contain latent possibilities for future events.

This makes it clear that the designer's understanding of place is of great importance for the outcome of experiential design of interactive environments. It can be argued that the relative failure of the Salling Facade, and to a certain extent of the Gum Facade, are due to a lack of understanding of the place-specific practices into which they were placed. In contrast, much effort went into examining the place into which Aarhus by Light was located with respect to architecture as well as to the understandings and practices associated with the concert hall and the park surrounding it. This expands both the role and responsibility of the interaction designer beyond the immediate interface to encompass the whole situation, "the assemblage of the user, other human agents, physico-spatial surroundings, available technologies, and the established socio-cultural meanings and structures in the domain" as presented in section 3.

6.4 Means of engagement

The consequences of this expansion of the designer's role entail increased demands, but they also offer new possibilities and open up the design space. One area of experiential design in which this is the case is with regards to means of engagement. In some of the cases, the means of engagement pertain to aspects of interaction design which may be regarded as traditional, eg. establishing a suitably challenging gameplay through the design of interface and content in the case of the Energy Table. In other cases, however, the means of engagement are about framing situations which include further aspects of the situation, eg. in the case of Aarhus by Light, an important means of engagement is social interaction, in the sense that exploring the environment is often inspired by and done in collaboration with others.

The means of engagement presented in this chapter only scratch the surface of what is possible within experiential design of interactive environments. Designers may look for further examples both within interaction design, eg. Dalsgaard (2008) who presents a number of strategies for promoting inquisitive use of installations, and the Digital Experience blog (www.digitalexperience.dk) which is a repository for hundreds of inspiring experiential design projects, or within other disciplines such as architecture, film-making and education, eg. Arnone (2004) who presents numerous strategies for fostering curiosity in learning situations.

Proper means of engagement are also closely related to the scale and content of the environment or installation. A general trend in the cases described here is that there is an inverse relation between the scale and number of users and the complexity of the content: The larger the environment and the higher the number of users, the lower the potential complexity of the installation. This may change as the field evolves and interaction designers explore and develop new modes of interaction and content dissemination. The complexity of the content is of course also related to the situation and the potential time of interaction, eg. it would make little sense to convey complex information in the Salling Facade case, since many by-passers are only briefly exposed to the installation.

7. Conclusions and future work

The interest in exploring and developing experience-oriented aspects of HCI is growing, and numerous approaches and perspectives on the field are emerging.

This chapter has aimed at providing a practice-based overview of one part of the field, namely the design of engaging interactive environments, based on insights from participation in and evaluations of concrete design projects. This participation in concrete projects has allowed for insights into not only the function of the designed environments, but also into their becoming.

The central component of the chapter is the experiential design schema for interactive environments, which comprises the following key concerns: scale, domain, users, duration, situation, input, output, intentions, values, content, and means of engagement. The schema can be used analytically to gain an overview of the field, and to focus on interrelations between key concerns. It can also be used in the design process, both as a source of inspiration using the cases presented, to capture and relate aspects of the concrete design process, or to compare multiple avenues for design.

The components of the design schema are based on a pragmatist perspective on experiential design. This perspective stresses the situated and reciprocal processes of experiencing, thinking and acting, and presents a framework for understanding the relations between experience and interaction through engaged inquiry.

The experiential design schema has served as the common ground for presenting and discussing seven cases spanning a wide range of interactive environments design. Although these cases represent but a minor fraction of the field, the findings from them offer informed insights into some of the main issues facing interaction designers venturing into this field. As is evident from the discussions of the cases, a well-substantiated theoretical approach combined with practice-based experiences is no guarantee for creating successful designs, and there are still many open questions beckoning examination by thoughtful design researchers. On the basis of the cases, there are however a number of key considerations to take into account when designing engaging interactive environments:

- *Designing with the entire interaction situation in mind*: Interaction unfolds in a situation that encompasses the experiencing agent, other agents, the physical environment, socio-cultural structures, and technologies; all of these interrelated aspects affect the experience of interaction and can be leveraged to present occasions for specific experiences to occur.
- *Establishing connections between past, present and future experience*: Distinct experiences occur on the backdrop of existing histories of experience, and establishing connections between distinct and continuous experience is a key concern.
- *Tapping into the meaning of place*: Installations and environments are often brought into places that carry with them well-established consensual meanings and practices which the designer should bring into the design process, whether the objective is to establish a fit into the place or to stand out.
- *Integrating values into design*: Integrating discussions and definitions of intentions and values can guide experiential design from early phases throughout the process - consider which ways of doing so are suitable.
- *Utilizing means of engagement beyond the interface*: A number of strategies may be used to encourage inquiry among users; consider both those situated at the interface and those beyond, and whether they may be combined.
- *Employing curiosity and occasions for social interaction and reciprocal change as motivational dynamics*: Of particular success for inviting inquiry and interaction seem to be the arousal of curiosity, the potential for social interaction, and the experience of reciprocal change in which both the experiencer and the situation are transformed. All of these may be brought about through a wide array of strategies.

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