

Towards a Design Space Explorer for Media Facades

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ABSTRACT

Collaborative design projects are often complex affairs in which a number of resources, concerns, and sources of inspiration are brought into play in the shaping of future design concepts. This paper presents *the Design Space Explorer*, a framework for managing these multiple sources of information and domain concerns in collaborative design projects. The Design Space Explorer captures and gives an overview of design materials and forms, domain locations and situations, interaction styles, and content types. Furthermore, it provides a platform for designers to combine these aspects into scenarios for design concepts. We present and discuss the use of the Design Space Explorer in two specific design cases in the domain of interactive media façades, part of the emerging field of digital urban living.

Categories and Subject Descriptors

H5.m. Information interfaces and presentation.

General Terms

Design.

Keywords

Media façades, digital urban living, design space

1. INTRODUCTION

The spread of digital technology into urban areas with social and cultural practices different from the ones known from the workplace setting, and with new kinds of spatial and material circumstances, challenges the way designers address domain concerns, as well as interaction forms. When designing for new settings, like urban areas, it is particularly crucial to get an overview of the key aspects of the design space, and how design moves in one area of the design space affect the potentials of other parts of the design space. In this paper, we focus on one particular kind of urban computing, *Media façades*, which is the general term for incorporating displays as an integrated part of a building's façade [1].

In the beginning of the design process, a large quantity and variety of information is often identified as forming what may be called a *design space*, within which designers strive for an understanding of potential avenues to pursue in the course of the project. The design horizon may vary to a great degree across projects, depending on the frame and scope of

the project, the kind of stakeholders involved, etc. In many innovative design projects, it is the case that the design horizon is very broad indeed, comprising a large number of concerns that the design team needs to overview and manage. In the case of multiple stakeholders being involved in the project, who need to align their understandings and efforts, this task can be more daunting still.

The principal contribution of this paper is what we call a Design Space Explorer for media façades, which offers a systematic approach to identifying key aspects of media façades: material, form, location, situation, interaction, content, purpose, and experience. The Design Space Explorer is a tool which can help gain an overview of the design space, conceptualise key aspects of interaction design, and support communication and discussions among design team members, as well as facilitate communication with clients and other kinds of partners. Moreover, The Design Space Explorer provides a platform for combining these aspects into a use scenario. Figure 1 represents an extract of a Design Space Explorer, which consists of two parts: *aspects* listed in the top row and a number of *options* for each aspect, in the columns below. The presentation and discussion of the Design Space Explorer in this paper is part of our ongoing research in the area of supporting reflection on design processes. The current version of the Design Space Explorer is a paper-based tool, which obviously in a subsequent version could be implemented as software tool with flexible lists.

The Design Space Explorer is related to, however not fully congruent with, the study and practice of design rationale, [11,14]. Horner & Atwood, [11], consider design rationale as a scaffolding for documenting and communicating the rationale underlying the design process and decisions made in that process. The objective of the Design Space Explorer is somewhat more modest in that the method does not necessarily capture all aspects of the design process (e.g. in the cases presented in this paper, we have not mapped out collaborative aspects), nor does it in itself explicate the reasoning and argumentation underlying specific design decisions. Such endeavours are complex and go beyond what can be captured in a schema as straightforward as the one we present. There are however numerous similarities between the Design Space Explorer and design rationale approaches, among these the structured overview of the design space, the possibility to investigate design alternatives, the documentation of the key facets of the design challenges, and last but not least the use of the tool as a vehicle for communication between designers and collaborators.

Our approach to exploring the potential of the development of a Design Space Explorer for media façades has been one of conducting *research through design* [22], based on two design cases. The first case in which the Design Space Explorer was initially developed was the collaboration between interaction design researchers (the authors) at CAVI, and BIG

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Material	Form	Location	Situation	Interaction	Content	Purpose	Experience	?
LED Projection	Matrix Line	Corridor Wall	Arrival Exploration	Touch Gesture	Guidance Ornaments	Information Branding	Playful Solemn

Figure 1 The Design Space Explorer for media façades

	Design Space Explorer	A pattern language	User interface pattern	Design pattern	Digital experience	Maps for design reflections	Maps for system development
Domain	Media façades	Architecture	Interfaces	Software	Experience design	Design research	Process management
Purpose	Overview	Solutions	Suggestive	Specific solutions	Inspiration	Reflection	Reflection
Structure	High	High	High	Medium	Low	High	High
Content	Low	Rich	Rich	Rich	Rich	Minor	Minor

Figure 2 The Design Space Explorer and related work

(Bjarke Ingels Group, a young Danish architectural firm), in the development of a proposal for an architectural competition to build a new modern art museum in Warsaw, Poland. The second case, in which we further elaborated the Design Space Explorer throughout the process, was the collaboration between CAVI and 3XN (3XNielsen, one of the largest Danish architectural firms), for an extension of the headquarters of the Confederation of Danish Industry, in an invited architectural competition. In both cases, our involvement was specifically concerned with the integration of interactive technologies into the building's façade and interior.

The structure of the paper is as follows: First, we present work related to the framework within the field of interaction design. This is followed by a presentation of the cases in which the Design Space Explorer was developed and employed, in order to give a foundation for understanding the framework and the problems it addresses. We present our findings arising from its use in the specific cases, and move on to discuss our findings arising from using the Design Space Explorer. Finally, we discuss potential future revisions and uses of the framework.

2. BACKGROUND

The Design Space Explorer is related to and draws upon a number of established design traditions, ranging from architectural design to software engineering, and HCI to experience design. Most of these are based on an extensive amount of materials, whereas the Design Space Explorer is an attempt to organize a certain kind of design knowledge in a new area, media façades.

A principal source of inspiration for our approach is Christopher Alexander [2], who, on the basis of extensive studies of architectural theory and practice, has created a theoretical and methodical foundation for architecture. Based on an immense pool of buildings and towns representing several decades of architectural practice, Alexander has created and described a *pattern language* consisting of more than 250 individual patterns:

The elements of this language are entities called patterns. Each pattern describes a problem which occurs over and over again in our environment, and they describe the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice [1 p x].

Alexander's idea is that the pattern language is a pool of knowledge where it is possible at any point to go in and look up any problem, find out in what larger sets of problems

it is inscribed, gain an understanding of the problem, find an operative solution in the form of instructions, and finally, see what other problems are embedded in it.

J. Tidwell [21] draws directly on Alexander's work, though it is situated within the realm of interface design, rather than architecture. These patterns are based on an analysis of a large pool of interfaces and interface guidelines, leading to a rich pattern language for user interface design. Tidwell's pattern language provides detailed and specific suggestions about how to design a graphical user interface. Alexander's basic idea of patterns has also been a source of inspiration for design and software engineering, most prominently in the case of Gamma et. al. [9], in which *design patterns* for re-applicable object-oriented software are developed.

Also related to the Design Space Explorer is *digitalexperience.dk*, a web resource for interaction and experience design, which consists of more than 300 cases or applications. The entries are organized sequentially, as they have been entered and tagged with overarching categories like 'Art', 'Leisure', 'Interaction', and 'space'. The web site is intended as a source of inspiration for designers, and has been used as a pool of sources of inspiration for Halskov and Dalsgaard's Inspiration Card Design technique [10].

Maps for design reflection [7] is a set of design artefacts intended to support design researchers in capturing, analysing, and reflecting upon design processes. The maps focus on reflection with respect to the role of sources of inspiration and design materials in the emergence and transformation of design ideas and concepts. Maps for design reflection build on Lanzara and Mathiassen's *maps for systems development* [13], which are intended to support systems developers' reflections on critical aspects of project management. These maps include diagnostic maps, which relate a project situation's perceived problems to their sources, as well as the general conditions of the project, and ecological maps, which relate the situation to the conditions that shape the circumstances in which people are acting [3]. In contrast to the diagnostic and ecological maps, the Design Space Explorer is, however, not a map of the complete design situation, but rather a visualization of the key design concerns and inputs that may be combined to form design concepts.

In Figure 2 we summarize these related approaches alongside the Design Space Explorer, with regard to the methods' domains of interest, their overall purpose, the level of structure, and the scope of the content, which they present.

Material	Form	Combination	Location	Situation	Interaction sensing	Interaction style	Format	Content
Water Electricity Air	Tile Dot Tube Wire	Matrix Line	Plaza Metro Parking lot Entrance Exhibition space Corridor Wall Floor Ceiling	Passing by Arrival Resting Self-expression Departure Playing Observing Exploring Sharing	Autonomous Passive Active	Movement Gesture Touch Input device	Film Image Text	Information Ornamentation Guidance Data visualization Reflection

Figure 3 The Design Space Explorer for the Warsaw MoMA

Concerning domain, The Design Space Explorer addresses elements from architecture and interface design as well as experience design, and in contrast to the two kinds of maps, which focus on the design process, The Design Space Explorer, together with the other approaches, addresses product aspects. Whereas The Design Space Explorer only provides an overview of the design space, the other product oriented approaches offer or suggest design solutions based on a rich pool of content. As will become clear in the subsequent case histories, the Design Space Explorer is a loose and open structure, which the designer can tailor to the specific design case.

3. CASE 1: WARSAW MOMA

The case in which the Design Space Explorer was first developed and applied was the combined effort of interaction design researchers at CAVI, and the architecture studio BIG, to make a proposal for the architectural competition to construct Warsaw's new museum of modern art (the Warsaw MoMA).

Specifically, the involvement and mandate of CAVI concerned the development and integration of interactive technologies into the building's façade and interior. Thus, we conducted much of our work in parallel to the architects' development of the overall architecture of the building. Our approach to the project was to assemble a large quantity of information, materials, and sources of inspiration, early on in the process (see [10]). This included information about the site and the location of the future building, the surrounding context, the specific constraints and requests of the competition, related projects of possible interest, materials and technologies that would function on a massive scale, etc. This multitude of information was assembled in collaboration with BIG. Upon this, we arranged a collaborative ideation workshop in which key elements of the future site of the MoMA in Warsaw were combined with sources of inspiration from architecture and interactive installations. We will not go into details of how this workshop unfolded, but instead focus on the outcome, namely that it was agreed that CAVI should explore the potential for integrating so-called *thermo-chromatic concrete* (TCC) into the building, as a central interactive component. TCC was invented by Glaister, Mehin, and Rosén [www.chromastone.com], and utilizes a current applied to a heating element placed inside the concrete to make the temperature rise, thereby causing it to change colour, a process made possible by the presence of a heat sensitive ink mixed into ordinary concrete. In other words, TCC enables a seemingly ordinary concrete façade to become a display with a very distinct visual expression.

3.1 The Design Space Explorer in Case 1

The decision to focus on the interactive potentials of TCC was made roughly halfway through the project. Our efforts at CAVI at this point turned to exploring the material properties and potentials of TCC, the format and content of

expression afforded by this material, and the interaction forms that were feasible. It was at this point that the Design Space Explorer was developed. Part of the specific instantiation of the Design Space Explorer for the Warsaw MoMA is shown in Figure 3.

The Design Space Explorer represents nine aspects of the use of TCC in this specific case, which may be divided into four main groups:

Material, form and, combination: These aspects concern the physical materiality of TCC, with respect to which materials may be used to control the temperature of the concrete (e.g. through using electric currents to generate heat), the form of these materials (e.g. metal wires), and the visual expression that these may have, in combination (e.g. lines across a concrete surface).

Location and situation: These aspects refer to specific locations in which the TCC may be employed (e.g. on the

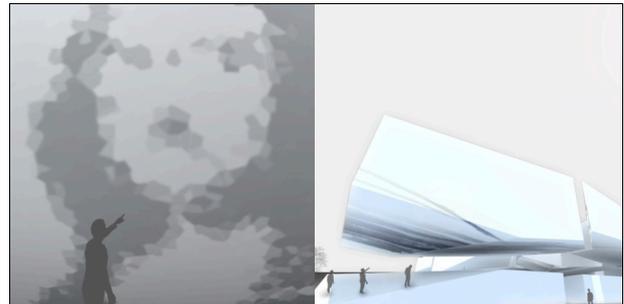


Figure 4 Two concepts for the Warsaw MoMA

exhibition floor) and the use situations which may be affected or transformed by the use of TCC (e.g. as a means for museum visitors to communicate or express themselves).

Interaction sensing and style: These aspects refer to potential interaction forms regarding interaction sensing (e.g. do visitors have to actively and deliberately initiate interaction, or is it based on large-scale patterns of movement?) and the interaction styles (e.g. controlled via gesture).

Format and content: These aspects refer to the format of the information presented through TCC (e.g. still images or video) and the type of content presented (e.g. guidance of visitors through the building, or architectural ornamentation).

3.2 Resulting Design Concepts

The overview afforded by The Design Space Explorer is definitely a benefit in the design process, and we have found the main strength of the Design Space Explorer to be the way in which you can use it to quickly explore, present, and compare potential design concepts, by creating paths of inter-

Material	Form	Combination	Location	Situation	Interaction sensing	Interaction style	Format	Content
Electricity	Tile	Matrix	Exhibition space Wall	Passing by Observing	Autonomous	None	Image	Ornamentation Data visualization

Figure 5 Concept 1 in the Design Space Explorer

Material	Form	Combination	Location	Situation	Interaction sensing	Interaction style	Format	Content
Electricity	Wire	Line	Plaza Entrance	Passing by	Passive	Movement	Image	Ornamentation Guidance

Figure 6 Concept 2 in the Design Space Explorer

related options through the schema. By selecting one or more instances from each of the nine aspects, you can create a design concept. And by using the Design Space Explorer to schematize your design concepts, you can gain an overview of which aspects are covered, and which have been ignored. We shall exemplify this with two of the design concepts that were integrated into the final competition proposal for the Warsaw MoMA (it is worth noting that a number of other design concepts were explored along the way, covering almost the entire design space, however describing these is outside the scope of this paper). The two concepts are visualized in Figure 4

Concept 1 represents the idea of using TCC in a tile structure on the outer walls of exhibition spaces to show imagery and visuals of the artworks on display within that space. Figure 4 (left) illustrates this principle in a 3D rendering. Represented in the Design Space Explorer, this concept can be visualized as in Figure 5.

Concept 2 uses a wire-system for heating the TCC integrated into the floor and ceiling of the museum, to peripherally visualize traces of the visitors as lines that reflect visitors' movement through the museum. This can be used both for purposes of guidance and to give museum-goers an awareness of how other visitors move through the museum, and what they find most interesting. Represented in the Design Space Explorer, this concept can be visualized as Figure 6.

Summarizing our work with the Design Space Explorer in the Warsaw MoMA case, we found the following characteristics of using the method especially influential in our design process.

Structured overview. First and foremost, the method addressed our need for a structured approach to getting an overview of the design space at hand. Whereas many of the aspects and options may seem commonsensical, it was highly useful to have a tool for gaining an at-a-glance overview of them, in combination.

Interrelated options. Furthermore, tracing the design concepts as specific combinations of options made clear the potential interrelations among aspects and options, since outlining a design concept implies not only making specific design moves by selecting viable options, but also deselecting other potential options.

Constraints and options. One main challenge of the MoMA project was, for us as designers, coming to terms with the constraints posed by the early choice of TCC as the main interactive component, and to explore these in the broader scope of the project. The Design Space Explorer was beneficial in that it guided our attention towards the numerous combinations and concepts that were in fact possible within the framework of the project.

Concurrent exploration and reflection. The method supports design reflection on two levels: first, it prompts reflection on the act of selecting the salient aspects of the process and exploring the options available; second, by tracing the concepts in the specific MoMA Design Space Explorer, it is clear that these only cover a specific range of possible issues. In reflective analysis of the design process, this provides us, as design researchers, with an overview of the design moves and choices made in the process, both inclusive and exclusive.

Sketching concepts. The method worked well for outlining a design concept as a path through the grid, however this is by no means sufficient for describing the concept (i.e. the same path may denote different design concepts), and neither does it indicate the viability or quality of the concepts.

4. CASE 2: INDUSTRIENS HUS

The second case is a collaboration between the same group of interaction design researchers as in the first case (the authors) and the architecture studio 3XN, regarding an extension of *Industriens Hus*, the headquarter of the Confederation of Danish Industry. The location of *Industriens Hus* is in the busy centre of Copenhagen, the capital of Denmark, and has neighbours like *Tivoli*, the most visited Danish amusement park, as well as *Rådhuspladsen*, Copenhagen's main square.

The collaboration with 3XN was based on more or less the same kinds of activities as in the collaboration with BIG. The initial meeting between 3XN and CAVI was used for aligning the partners' interests, by presenting earlier projects and different sources of inspiration. 3XN showed their newly built headquarter for Deloitte in Copenhagen, a linear and cubic building, together with examples such as *Articulated Cloud* by Ned Kahn, a more organic building covered in thousands of mechanically hinged planes that move in the wind. CAVI responded by showing *Wooden Mirror* by Daniel Rozin (see e.g. www.digitalexperience.dk/?p=168) as an interactive counterpart of hinged planes. The collaboration continued by focusing on aspects and options of media façades, through field studies and ideation workshops between 3XN and CAVI, as well as a number of internal meetings and workshops at CAVI. Thus, the concepts for media façades integrated in *Industriens Hus* went through several iterations and transformations, and ended by focusing on the potentials in using LED panels in combination with different sensors and input devices, enabling interactive possibilities in relation to the building.

Despite the fact that the team members focused on a specific site, and that the design horizon was narrowed to working with LED panels as the display technology integrated in the façade, and in relation to a series of specific situations, the number of aspects and their possible options in the collaborative design process grew to an unmanageable amount of information that called for structure.

4.1 The Design Space Explorer in Case 2

To get a better overview of the large number of aspects present, we developed a case-specific Design Space Explorer with the purpose of helping the team members to keep track of the possibilities (see Figure 7).

Location	Situation	Purpose	Content	Interaction
Main square	Meeting activities	Entertain	Information	Passive
Main road	Member activities	Brand	Ornaments	Active
Main entrance	Finance activities	Inform	Advertise	
Niche	Traffic	Engage	Logo	
Inside	Passers-by	Transparency	Art	
Tivoli	Arrival	Dialog	Data	
		Play		

Figure 7 The Design Space Explorer for Industriens Hus

The Design Space Explorer above represents five aspects unfolded as a list of options, and in relation to the specific case:

Location. This aspect concerns the specific location in which the media façade or the interaction with the façade may take place (e.g. the façade facing the *main square*, or maybe interactive possibilities *inside* the building). This aspect is especially concerned with integrating the interactive media into the architecture and the nearby context.

Situation. This aspect refers to different situations in which people can interact with the building, and what kinds of activities can inform the building (e.g. *finance activities* that can be illustrated as living graphs, and *passers-by* who can actively influence the building's expression). Here, this aspect illustrates the variety of situations and inputs that can have an effect on the building - from concrete physical action to digital exchange in databases, etc.

Purpose. This aspect refers to potential purposes of the media façade (e.g. whether the façade is to be *entertaining*, or whether it is supposed to *inform*). This aspect exemplifies a range of approaches - from the more closed use of advertisements targeting narrow segments, to more open-ended artistic expressions in curated screening sessions, all in different configurations of relations between senders and receivers.

Content. This aspect refers to the type of content to be presented on the media façade (e.g. *art* on the façade or digital *ornamentation*). The aspect is concerned with the actual subject of matter - the specific message, news, sign, etc.

Interaction. This last aspect refers to the type of interaction, and whether it is going to be passive (e.g. the influence of members' activities on the visuals of the media façade) or active (e.g. people aware of and responsible for input). This aspect focuses on how actively the interaction has to be understood - covering direct and active manipulation, as well as simple presence.

4.2 Resulting Design Concepts

In contrast to case 1, the MoMA project, the aspects and the related options of the Design Space Explorer in case 2, Industriens Hus, are far more general. For example, it contains no technical aspects or options relating to media or structural details. Whereas the Design Space Explorer was especially used as an internal design tool for examining configurations and potentials of the MoMA, it was to a great extent used as a tool for communicating ideas and possibilities

to 3XN, the confederation, and the municipality, as to why a broad framework was needed.

The general nature of the Design Space Explorer in the case of Industriens Hus inherently leaves more room for interpretation of the individual aspects and options, and in some cases with a certain overlap. Furthermore, the final media façade proposals for Industriens Hus take shape as wide-ranging scenarios; what shows in the use of the Design Space Explorer, in which it seemed natural to let more options remain open, in most cases. We exemplify this with two design concepts that were included in the final proposal and presentation for Industriens Hus (see Figure 8).

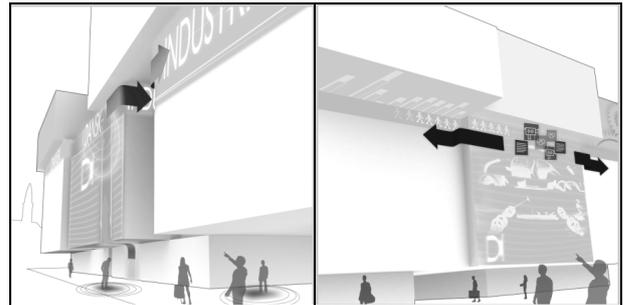


Figure 8 Two concepts for Industriens Hus

Concept 1 represents the idea of letting the citizens of Copenhagen interact with the façade of Industriens Hus, for instance by *engaging passers-by* in an *active* and *playful* interaction with a large valve near the *main road*, that opens and closes for an *artistic* flow of particles that will pass through vertical displays that intersect and interfere with crossing horizontal displays showing *logos* of the *members* of the confederation; see Figure 9.

Location	Situation	Purpose	Content	Interaction
Main road	Member activities	Entertain	Ornaments	Active
Niche	Traffic	Brand	Advertise	
	Passers-by	Engage	Logo	
	Arrival	Dialog	Art	
		Play		

Figure 9 Concept 1 in the Design Space Explorer

Concept 2 represents the idea of making today's existing logos come to life by representing them as animated, behavioural entities that pass across the media façade. For example, by letting the façade at the *main entrance* represent the *activities* of the *members* of the confederation as animated *logos* moving across connecting horizontal displays that trigger *advertisements* and member-relevant footage when it reaches the large display areas that are distributed over the façade (see Figure 10).

Location	Situation	Purpose	Content	Interaction
Main square	Meeting activities	Brand	Information	Passive
Main entrance	Member activities	Inform	Advertise	
Tivoli	Finance activities		Logo	
			Data	

Figure 10 Concept 2 in the Design Space Explorer

The use of the Design Space Explorer in the Industriens Hus case builds on our experiences with the Warsaw MoMA case, and summarizing the Industriens Hus case makes it clear that most of the characteristics of the Design Space Explorer in the Warsaw MoMA case are also present in Industriens Hus: *Structured overview, interrelated options, constraints and options, concurrent exploration and reflection, and sketching concepts*, see section 3.

In addition to the above-mentioned characteristics, we have identified strong foci on:

Communication. The design process has been dominated by many players, which is why it has been important to find a common platform to communicate ideas between professional competences and interests. In this situation, the structure of the Design Space Explorer was used for explaining relations across the aspects and options (i.e. the *interrelated options*) and demonstrated to be useful for communicating and explaining the concept.

Alignment. As a side-effect of the communicative potential, the Design Space Explorer has been actively used for aligning the players' interests in the different design concepts. In addition to making *constraints and options* clearer and more operational, we found that the framework gave the players a better insight into the complexity of the design, and thereby a better understanding of the outcome, which also provided the involved parties with a better foundation for discussing alternatives.

Comparison. A final characteristic we found by when using the Design Space Explorer in the Industriens Hus case, based on the strong relations between the two concepts, was an easy way to compare different ideas, and simply create an amplified understanding of their differences, as well as strengths and weaknesses.

5. FINDINGS AND DISCUSSION

In the following, we discuss our findings from using the concept of the media façade Design Space Explorer in the two cases. These will touch upon topics that span the two cases, as well as ones that are case-specific. We will then use this discussion as an off-set for presenting a generic model for a Design Space Explorer, and discuss how it may be used in future projects.

5.1 Structured Overview of Design Spaces

The most obvious benefit of using the Design Space Explorer is that a multitude of aspects can be presented in combination, in a simple and straightforward visualization. At a glance, it is possible to draw together issues relating to design materials, domain concerns, interaction, and content. We found this to be of great value in both cases: within the CAVI design group, it provided a shared point of reference and guided our explorations in covering the most important concerns; in our collaboration with the architects from BIG, it provided a schema for conveying the scope and depth of our work, as well as pointing out specific areas of interest during joint discussions, which is also recognized in our work with 3XN, the confederation, and the city planners from Copenhagen, as communicative properties to be discussed later.

Having mentioned these benefits, we must, however, also point out that the use of the Design Space Explorer for overview purposes must be regarded with a degree of reflective suspicion: the Design Space Explorer represents not an exhaustive list, but a construction of what we as designers deem to be the most salient concerns in the project, a selective and focused overview that intentionally leaves out a great deal in order to reduce the complexity of the process to a manageable scope. As such, it inherently directs attention away from aspects that, if not represented in the Design Space Explorer, may be ignored.

5.2 Reflective Classification Work

So far, we have presented two different types of Design Space Explorers developed for the specific purpose of supporting building-scale interaction design collaboration. We do not suggest that the aspects laid out in the two cases are equally suited to all interaction design projects, rather we recommend that, if other designers take up this approach to managing the multiple concerns, it is necessary to devote time and effort to initial classification work in discussing and establishing the salient aspects of the specific project. Since the two different Design Space Explorers represent selective and focused overviews of ostensibly relevant elements, it implicitly ignores many aspects, and this combination of focus and ignorance begins with the establishment of classification aspects.

The classification work that goes into establishing the specific aspects for a Design Space Explorer prompts a structured approach to exploring and selecting relevant aspects. This structuring of designers' inquiries can be a clear benefit in a complex design process; however, it prompts caution with regard to the work that goes into establishing the classification schema. The initial creation of the classification schema (the nine aspects in the Warsaw MoMA case and the five aspects of the Industriens Hus case) is as important as populating the table with options for the specific design case. In other words, the work that goes into making the specific Design Space Explorer a reality is highly selective. In selecting the classification criteria and the specific aspects and associated options, designers must thus establish a balance, for leaving out too much will result in missing out on interesting opportunities, whilst including too much will blur the overview.

5.3 Concept Design Within Constraints

It is a basic premise for most design projects that a number of parameters are fixed and beyond the control of designers, e.g. in both cases presented in this paper, aspects such as location and scope were determined in advance, prior to our involvement, and in the Warsaw MoMA case, the basic technology to be used, TCC, quickly became a fixed constraint. These constraints can lead to initial frustration in design teams ('if only we were able to set the terms for the design ourselves...'). However, constraints inspire creative inquiries within a fixed design space. In our use of the Design Space Explorers for media façades, we have found it fruitful to first establish the fixed constraints of the design assignment, and work from there to open up the space for possible combinations within this space. For example, the decision to solely focus on TCC seemed daunting and limiting at first, but the process of developing the Design Space Explorer for the project opened our eyes to the large number of possibilities within this space leading to three design concepts, of which two are presented in this paper, out of a pool of promising ideas.

5.4 Starting Points for Design Inquiry

Although Design Space Explorers are intended to help structure the design process, any given aspect in a framework may serve as a starting point for design inquiry, depending on the nature of the project at hand. The focus on TCC in the Warsaw MoMA case presented the aspects of material, form, and their combination as natural starting points, in that we needed to perform very specific experiments regarding the properties and forms of expression of the technology, in order to gain insights into what was feasible on a building-size scale. In contrast,

aspects of location and situation were natural starting points for exploring the design space at hand in the case of Industriens Hus, which prompted design experiments at a much higher level of abstraction.

5.5 Communication and Alignment

The higher level of abstraction in the Industriens Hus case was mainly due to the fact that the Design Space Explorer was used for communicating the concepts and their motive across professional practices, as well as aligning the players' interests. Whereas the Design Space Explorer was primarily used within the interaction design group for design inquiries in the Warsaw MoMA case, and only secondarily as a means of communicating with the architects from BIG, it was used for both internal communication and development, as well as having a strong focus on the media façade, design-wise, external partners and players. In the Warsaw MoMA case, the Design Space Explorer was only used as a reduced and simplified version in a meeting with BIG, whereas in relation to all parties in the Industriens Hus case, it was used more systematically, and was even found in the final presentation.

The clarity of the externally oriented communicative potential seems to risk supporting the previously mentioned, too-simple framework that leaves out too many interesting opportunities. One way to handle this could be to work with more Design Space Explorers with different levels of detail. For example, as mentioned in the Warsaw MoMA case, we used a more complex and fulfilling framework in relation to the internal design processes; throughout, technical aspects and options were left out in meetings and workshops with BIG, but were amplified and dominant in discussions with technical staff.

6. THE FUTURE OF THE DESIGN SPACE EXPLORER

Based on our findings from the two cases presented in this paper, as well as our ongoing work in other projects, we propose that the Design Space Explorer might serve as a valuable approach for designers within the field of media façades. As is clear, the aspects and use of the framework varied substantially in the two cases, and we are currently employing and refining the Design Space Explorer in other design projects in which we include different aspects. Based on analyses of these cases, we find it pertinent to include aspects that span abstract aspects such as the purpose and intention of a concept (e.g. branding, entertainment, public service announcements) to technology-specific aspects (e.g. display resolution). We therefore advise that the eight different aspects represented in Figure 1 serve as a sound touchstone for developing project-specific Design Space Explorers.

We have intentionally left the media façade specific content of the navigator model empty for two purposes: 1) the field of media façades is in its early stages, which means that we cannot rely on established and proven patterns - as do, for instance C. Alexander and J. Tidwell [2,21] - as they are only starting to emerge; and 2) the very act of filling out the navigator is in itself a crucial aspect of the value of the method. Moreover we see a potential to expand the scope of the Design Space Explorer to include other areas of urban life.

The eight aspects in the model represent a spectrum broad enough for designers to move from general project concerns

to specific aspects of designing interactive systems. We have included a ninth column in Figure 1, headed by a question mark, to indicate that these aspects serve as a starting proposal, rather than a fixed list. Insights may spring from reflection upon and discussion of the aspects, as well as of the content that goes into them. In the following, we shall briefly describe the proposed aspects. The aspects are not listed in this specific sequence in order to prescribe a desired starting or end point; the sequence is instead a list, moving from concrete towards abstract aspects.

Materials. Materials refers to the physical materials from which the expressive elements of the installation are made. In some cases these may be 'traditional' components such as LED displays; however they may also consist of less conventional components, such as wood and micro-actuators, as in the case of Wooden Mirror, (www.digitalexperience.dk/?p=168). It is worth noting that we do not use this category to refer to the digital materials as seen in other contexts [15].

Form. Form denotes the shape taken by the materials used to compose the installation. Again, this may be conventional in many cases, e.g. a rectangular display in the case of LEDs being used to present visuals, or it may be innovative, as is the case of the above-mentioned Wooden Mirror, which takes the shape of a circular matrix of tilting wooden tiles. A number of resources addressing aspects of form in relation to emerging technologies are available to designers [4, 5].

Situation. Situation refers to the practice and context in which the installation is placed. The inclusion of situation emphasizes the importance of recognizing the habitual setting into which new technologies are placed, and which they affect and potentially transform. Depending on the specific project, situation may be defined broadly, as does McCullough [18], who defines thirty situational types, referring to lived situations such as idling, gathering, and walking, or it may be defined more narrowly as a specific situation within a given habitat.

Location. Location refers to the specific type of setting in which the installation is introduced. Location is closely related to situation, but refers to the spatial arrangement rather than the practice taking place within it, e.g. an airport lounge, a public restroom, or a boardwalk.

Interaction. Interaction denotes the ways in which the installation registers input and represents output. Whereas a number of widespread interaction types are well-documented in Human-Computer Interaction (HCI) literature (e.g. [19]), the design of media façades often relies on unconventional interaction types, e.g. using a combination of camera tracking of by-passers as input and interconnected lights behind building windows as output.

Content. Content broadly refers to the information represented and conveyed by the installation. Digital technologies may be used to represent earlier types of media and content (e.g. to show a movie on a building-scale, low-resolution monochrome LED display), or it may result in new media, which to some extent rely on, or break the mould of earlier content types, as thoroughly explored by Manovich [16]. Depending on the specificity of the design project, content may denote this level of media abstraction, or it may be more specific and refer to information about user movements, time-keeping, or weather conditions, for example.

Intention. Intention denotes the overall purpose for creating the installation, in line with the definition presented in [6]. Intention may be construed functionally, in the sense that it answers the question of why the installation is designed, and its intended use in the setting; for instance, a media façade for a corporate building may serve the intention of branding and attracting attention of passers-by.

Experience. Experience refers to the continuous or punctuated perceptual, cognitive, and emotional encounters that the installation is intended to bring about for users, through its presence or through interaction. Experience is closely related to intention, in that it denotes a part of the reason for creating an installation; in some respects, it may be thought of as a specific effect of the installation in use. Again, depending on the nature of the design project, experience may be expressed in various degrees of abstraction ranging from e.g. *fluent co-experiences* [8] to *enchantment* [17].

In conclusion, the Design Space Explorer represents a structured approach to gaining an overview of salient aspects of the design situation, ensuring that identified important design aspects are explored, and combining and comparing multiple design concepts while keeping the overall scope of the project in the foreground. The Design Space Explorer is generic and developed to maintain a balance between malleability and stability, in that collaborators in the design process can use it for varying purposes and ascribe differing meanings to the aspects and content, yet it is still rigid enough to form a shared point of reference and a platform for negotiation among stake holders of the design process. Thus, we suggest that it can serve as a boundary object [20] between design collaborators.

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