Challenging Architects to Include Haptics in Design : Sensory Paradox between Content and Representation

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Abstract. Architectural design is characterized by a visual bias, as evidenced in architectural theory and design research. Also in design practice non-visual sensory aspects are often neglected. Consequently many built environments are not sensory accessible for a diversity of people. The paper reports on a workshop with professional architects to evaluate a framework of haptic design parameters. The framework is developed to support architects in paying more attention to the role of touch during design, by informing them about the haptic implications of their design decisions. Additionally design techniques are suggested to assess haptic qualities during the design process. Characteristics of both framework and techniques are based on the expertise of people born blind as they are more attentive to non-visual information, and professional caregivers working with them. Feedback suggests that the architects quickly picked up the idea of the framework, and recognized its relevance, but that the framework’s representation confronts us with a sensory paradox: while the parameters question the visual bias in architectural design, they are meant to be used by architects, who are used to think, know and work in a visual way. The paper concludes with suggestions for the possible role that CAD may play in stimulating and inspiring architects to implement haptic parameters and assess a design in terms of haptic qualities.

1. Introduction

Architects—like other designers—tend to think, know and work in a visual way. In design research, this way of knowing and working is highly valued as paramount to design expertise [1]. In case of architecture, however, it is not only a particular strength, but may as well be regarded as a serious weakness. The
absence of non-visual features in traditional architectural spatial representations indicates how these are disregarded as important elements in conceiving space [2]. This bias towards vision, and the suppression of other senses—in the way architecture is conceived, taught and critiqued—results in a disappearance of sensory qualities [3] and creates a gap between the mental world in which architects design and the physical world in which they build [4]. Creating built environments without bearing in mind their user-friendliness, multisensory qualities and functionality, results in "distorted spaces" [5] that lack physical or mental accessibility.

If architects design with more attention to non-visual senses, however, they may contribute to more inclusive environments. Indeed if an environment offers a range of sensory triggers, people with different sensory capacities are able to navigate and enjoy it. Rather than implementing as many sensory triggers as possible, the intention is to make buildings and spaces accessible and enjoyable for more people, in line with the objective of Inclusive Design [6], Universal Design [7] or Design for All [8].

Within this overall objective, we developed a framework of haptic design parameters to stimulate and support architects during design. The framework offers inspiration and information to pay more attention to the role of haptics, i.e. the sense of touch, by informing about the haptic implications of design decisions. After briefly introducing the notion of haptic design parameter, the framework, and the proposed techniques to assess the haptic qualities during design, the paper reports on a workshop with professional architects to evaluate the usability for design practice.

2. Defining haptics in the built environment

Haptic perception involves connections between movement and touch [9]. Géza Révész [10] first introduced the term "haptics", whose origins can be traced back to the Greek haptein, "able to touch," and haptesthai, "able to lay hold of" [11]. In relation to the built environment, haptic sensation involves active, dynamic and passive touch [12]. Whereas active [13] and dynamic touch [14] require movement from the body, passive touch arises from movement in the environment [13]. When crossing a square, for instance, you actively feel the texture and form of the cobblestones you are walking on, while you dynamically feel the dimension of the square when sliding your feet along its boundaries and you passively feel the wind blowing through the streets adjacent to the square, which consequently informs you about the connection between the square and the surrounding environment.

To identify haptic qualities and obstacles in the built environment, we combined a literature review with empirical studies. For the latter the expertise of
people born blind is called in, as they are more attentive to non-visual information [9, 12, 15]. The findings of these studies suggest that haptic qualities and obstacles in the built environment are perceived in terms of surfaces. A line is never felt as a line in the way it is perceived by a sighted person, but as a meeting between two surfaces.

3. A framework of haptic design parameters

Based on the triangulated results of the literature and empirical studies a framework of haptic design parameters is developed. In order to understand the evaluation itself, this paper briefly introduces the ideas behind and structure of the framework, and the techniques to assess the haptic design parameters during design. For a detailed explanation of the framework, we refer to [16].

The term "parameter" is new Latin dating from 1852, derived from the Latin prefix "para" and Greek "metron" or measure. It is mostly used in mathematical studies and computer sciences. Related to the built environment, architects rely on parameters when solving technical problems or using design software as part of their design language or representation. Most design related aspects are not translated into parameters, however.

Ehud Kroll and al. [17] understand parameters as critical issues within the design process that need to be solved, i.e. any issue, factor, concept, or influence that plays an important part in developing an understanding of the problem and pointing to potential solutions. Ultimately their approach to conceptual design aims to help designers to "think better," c.q. be more creative and innovative, and do it faster. As this ties in with our research aim to support an inclusive design attitude, the definition of Kroll et al. forms the basis for our framework of haptic design parameters.

In the context of this study haptic design parameters are described as variables that can be decided upon by architects throughout the design process, and the value of which determines the haptic characteristics of the resulting space.

3.1. Perception in terms of surfaces

Following the classification of haptic sensation into active, dynamic and passive touch, the built environment respectively unfolds into three kinds of perceptual surfaces: movement planes; e.g., a floor in the underground or the steps of a staircase; guiding planes, e.g., a handrail or a fence next to a footpath; and rest planes, i.e. surfaces people can sit, sleep, relax, lean, or hang on. A movement plane can be a guiding plane as well as a rest plane, or a rest plane can be part of a movement or guiding plane. It is assumed that the more a movement plane offers dynamic and passive characteristics, the richer the actual experience.
3.2. Materials and shape

Materials, shape and context are the categories blind people may rely on when perceiving the environment in a haptic way [10]. Whereas architects may have little impact on the context, they are used to work with materials and shapes. Therefore the haptic design parameters are categorized according to material and shape characteristics, and variables are differentiating between body parts and skin, dependent on the regions of sensitivity.

**Materials** give the surfaces an identity through their *temperature, texture, density, permeability, light reflection* and *elasticity*. These constitute the different material parameters.

*Temperature* is traced back to the material’s coefficient of conductivity (e.g., steel feels much colder than wood) and radiation. Unlike what one might assume, *light* experience is very important for haptic experience. Light can be haptically experienced through fluctuations in temperature. Materials can also reflect or let through *air*, one of the most typical experiences for touch. Air that caresses our skin informs us about the structure of the environment. Materials can breath as well. You can feel this difference in summer when nestling yourself in a textile garden chair. The textile lets the air through; a rubber mat does not and makes you sweat. *Texture* gives direction, reflects light and defines the way a material is felt. To support active touch, movement is encouraged by a rough texture for the feet, while hands and other body parts demand smooth surfaces. When relaxing, on the other hand, the body prefers smooth textures for hands as well as feet. *E.g.*, rough stones are excellent for staircases, but to be avoided for walls that are regularly touched. *Elasticity* is the extent to which a material practices a counterforce or is transformed under external forces. A material is considered elastic if it returns to its original form when no forces are performed. If active touch has priority, e.g. in public buildings, non-elastic materials are preferred. A judo mat may be experienced as very pleasurable on a playground, yet in a public building it is inappropriate. Although it does feel nice and soft, people yet risk twisting their ankle. By contrast, a grass surface next to a hard surface may form an ideal guiding plane next to the run line.

**Shape** characteristics cover how surfaces take part in the larger built environment and define the composition of surfaces based on *form, openings, configuration* and *dimension*. The latter two parameters have underlying sub-parameters. *Configuration* is determined by the surfaces’ connection and rhythm, the corners formed in relation to other surfaces and the number of surfaces in the actual configuration. *Dimension* describes the surfaces’ scale, mass and direction. The latter indicates the way in which the surfaces are placed in relation to the user and his/her body (movement). For active touch orthogonal surfaces are preferred, whereas a walk in the park ideally happens along curved paths.
3.3. Techniques to assess haptic qualities

The framework and its parameters do not intend to prescribe, nor to impose a particular design method. Instead they seek to facilitate a more inclusive design attitude by informing architects and helping them to think differently. The parameters are defined in such a way that they can be consulted and assessed at any time in the design process. This assessment relies on well-known spatial concepts in architecture and focuses on accentuating and clarifying the purpose of a space.

To assess to what extent orientation is possible or active touch supported, architects are advised to check whether the space to move is conveniently arranged by drawing the inverted space; this emphasizes the places where people move through instead of the designed surroundings and makes the structure clear.

Support for dynamic touch can be checked by drawing the run lines onto the plans. If run lines are supported by spatial elements, especially on decision points, dynamic touch is likely to be well supported.

Passive touch is more difficult to represent as it is caused by movement in the environment. Nevertheless designers can encircle the fields meant to be rest places and check whether these are not diagonally crossed by passage ways.

4. A workshop with professional architects

4.1. Participants

To evaluate the usability for design practice of the framework of haptic design parameters and the techniques to assess them, we set up a workshop and focus group interview with professional architects. To this end, we collaborate with an architecture firm specialized in design for the healthcare sector. The firm has 50 employees, spread over the headquarters and two satellite offices. Besides an architecture department and administration, the architectural office has an R&D department to stimulate and support innovation. In agreement with the partners, seven employees participate in the workshop: three persons work as architect, one as interior architect and three at the R&D department. Having studied architecture (4), interior architecture (1), engineering architecture (1) or Italian studies and design (1), they all work full time at the firm with on average five years working experience. Three have an additional Master degree in urban studies. Six of the seven participants are women; ages range between 26 and 37, with an average age of 30.
4.2. Set up and approach

The workshop takes place after work in a meeting room at the firm’s headquarters. The workshop consists of three parts: an introduction, time for exploring and implementing the parameters in the context of a design project, and a focus group interview with all participants to evaluate the framework. At the start of the workshop all participants receive a folder containing the framework of haptic design parameters in a table overview, hand-outs of the PowerPoint presentation used during the introduction, floor plans and sections of a particular design project (see further), white sheets and a drop off list.

The framework of haptic design parameters is introduced in an oral presentation of half an hour. After a short introduction on the haptic sense, each parameter is briefly defined and illustrated. A combination of diagrams, quotations from interviews with people born blind, examples of haptic perception, pictures of well-known buildings and sketches of the built environment are used to illustrate the parameters. This combination allows asking for preferences in representation techniques afterwards.

Subsequently, the architects are asked to try out the framework in the context of a particular design project, making use of their folder and large prints of the floor plans. The project at stake is the office’s design of a psychiatric center for children. The building will accommodate 27 children. Its preliminary design started in 2007 and the overall design has already been finished. The construction would start that same year, but architects are still designing the interior. For the client the building should reduce mental and physical thresholds, and be a pioneering example for other centers in the province and region. The concept proposed by the firm aims at providing a healing environment, paying special attention to the relation between interior and exterior. The building is elegantly integrated in the landscape and has the form of three intertwined roller coasters embedded in the surrounding undulating hills (Figure 1). Between each loop the center gives room to a specific group of children. On top of the center a transparent layer houses the public access.
This project was chosen together with the project manager for several reasons. Regarding the program, research shows that people with acute mental health problems feel safe in multisensory environments [19], thus introducing haptic qualities in this project may be beneficial. From a methodological point of view it is less time consuming to let architects work with a known design project as it is not the design itself that has to be evaluated, but the usability of the framework and techniques. All workshop participants are familiar with the design of the psychiatric center for children, but two have not worked on the project before.

After a short break the moderator starts a focus group interview to question the usability and content of the framework of haptic design parameters.

The whole workshop is videotaped and audio recorded. Afterwards the focus group interview is transcribed and analyzed together with the folders and floor plans used by the architects.
4.3. Findings

4.3.1. Experience and knowledge on haptics

Most participants find research on haptics useful and all agree that particular buildings need to be user friendly and include insights on haptics, e.g. public buildings or buildings for a particular group (schools, housing for older people or people with dementia, places for children, hospitals, and libraries). However, some participants find that these characteristics cannot be implemented for all buildings: "Yes, in a museum, you would expect something like a tour that gives you rest while walking around and then you do not start with smaller spaces of two times the length of your arms, and then you really want huge spaces, ...that... that breathe air and light...". This is quite surprising as the framework of haptic design parameters intends to endorse these qualities and is not meant to limit the dimension of spaces nor to restrict the experience of air or light, on the contrary. This statement thus suggests that some participants regard the parameters as restrictions rather than sources of information offering opportunities and possibilities. Only two participants are convinced about all the opportunities of the parameters. According to one participant, the idea to insert a path-rooting system (run lines) for guiding planes encourages thinking in different "motion" steps and thus can help to clarify a design. Three participants have heard about haptics in architecture before. During their studies, two of them analyzed a building by blinding themselves and filming the result. However, the integration of this knowledge in design is still difficult as the results of the workshop show.

4.3.2. Parameters: A different and difficult approach to start

The workshop reveals that architects find it hard to think in a different, non-visual way. Only few participants recognize the possibilities and do try to think differently. Most stick to their visual habits and find that the parameters force them to choose between vision and other senses. Even before the participants make the effort to go through the information, one person immediately asks whether we can help her to get started. She finds it difficult: "as the parameters make you check to design what and where and if it is still relevant there...and...and...Yes it becomes a difficult mental exercise". Asked whether she can explain the difficulty, she responds that the framework is a very extreme way of thinking as it does not fit an exact science: "it's harder because you ... you know ... it's actually no such thing as an exact science. ... and yes architecture isn't that either but still ... this is very ... I find it extreme, well because you just said: you have different haptic qualities and maybe you can implement those here and that one there ... not that we need exactness but you should have more feeling with what when ... because eventually you want to use different qualities which make you work unruly. So what do you use where and when ...Is there a form of guidance or some kind of theory ?". This opinion is immediately questioned by
other participants who affirm that they do appreciate that the framework does not impose prescriptive guidelines.

The participants do not think that their attitude or design thinking has changed after the presentation as all shape and material characteristics are well known; even classical design techniques are incorporated, be it from a different perspective. The notion of inverted space, for example, is familiar to most participants, but not its interpretation in terms of haptics.

4.3.3. **The content of the framework**

All participants agree that the parameters offer inspiring elements for the design project: for example, the different planes (movement, guiding, rest plane) are found to be usable and effective. The entire group agrees that the knowledge of the parameters did improve the design of the psychiatric center for children and encourages them to change things. When implementing the parameters as an instrument with inverted space and the path–rooting system, the participants realize that the entrance hall and connecting circulation show considerable room for improvement. Focuses of attention are the corridors, while the entrance hall lacks the feeling of "place" and orientation, and contains a lot of unused space. The staircase, for example, seems to be put in the middle of the hall for no particular reason and in an oblique direction. When the participants analyze the inverted space, it becomes clear that orientation on the first level is very poor and this part needs to be redesigned. One participant explains that round shapes are inserted as landmarks. However, the round shape of the elevator leads you to nowhere and in this configuration it can impossibly function as a haptic landmark.

To support movement in the entrance hall the idea grows to extend the parapets, but in fact the whole structure or configuration of the building needs a review as shown in Figure 2.

This analysis of their own design project invites the architects to dwell upon haptic perception. One participant states: "I do think that some of those main things [referring to the framework] that those…that you would…if you would now read that plan that it will force you to read it consciously". The key concept that most participants picked up is "movement"; when thinking about movement, they would design the plan differently: "then we look (at the plan) and we see that it has a nice shape and maybe we need to put it this way, but then it is just a visual point of view, from from…but indeed if you have to think more in extending lines and and…movement". Besides changing the entrance hall and corridors, all participants agree that they would connect the interior more with the exterior; although the initial concept aimed at this connection, the building has a rather introvert character. Moreover they recognize the importance of the choice of materials. One participant explains that she always considers a plan in a visual manner and now she really thinks about the materialization too: "and materials as well because everything is here in [concrete] …in fact we have to know by now
in which materials this will be built. I think that if we look to the plans now, we are all thinking, how it will ...really is going to look like”.

One participant remarks that many parameters are already integrated intuitively during design. However the analysis of the psychiatric center reveals the striking visual dominance. For example the staircase in the entrance hall is designed primarily for visual experiences as it offers descending users a nice view on the landscape. Besides, although all participants have their own folder with floor plans, sections and white paper, nobody is drawing a single line during the workshop. Few participants point at the plans while discussing whereas the others
are all staring at them. This suggests that knowledge on haptics is present, but integration in the design process is yet something else. Although participants are convinced that they did not learn new things, the analysis of their design process shows that they are thinking in a different way now. This is evidenced by the fact that although the design was considered to be finished and construction works already started, they will make additional changes.

4.3.4. Sensory paradox between content and representation

During the introduction, we consciously chose to use different methods of representation to illustrate the framework, parameters and techniques. All participants agree that examples were very useful to understand, but that few contemporary buildings integrate these aspects. One participant remarks that: "it is not that we see much innovative projects, I think. Well...for blind people I mean. Like the example with the sliding walls\textsuperscript{1}, I had never seen that before and so...well most offices are not dealing with this and sometimes, I think, you more easily pick things up because you see...well, you know...". The images are not considered as prescriptive, but more as sources of inspiration; not as an enumeration, but more as a way in which designers can interpret the parameters. The importance of the fact that these illustrations are visual is repeatedly stressed. A table explaining the variables and use of different parameters was used by only few participants. One participant explicitly argues that this scheme is too much text. The other participants agree: the table does convey a lot of information but it is too theoretical, too much text. At that time the firm just started to work with visual technical built specifications. The participants propose to work with icons and to look for a narrative to work with the parameters without being prescriptive.

One participant thinks that the more you can apply these parameters, the more you will take them into account unconsciously. None of the participants has ever worked with this kind of design approach before. It may require some training before you can apply this framework of haptic design parameters intuitively.

The question at what point in the design process the parameters need to be implemented, participants cannot immediately answer. The discussion suggests that parameters can be used throughout the design process and that, depending on the design concept, different parameters might appear sooner or later.

5. Discussion and conclusions

In order to assess to what extent the framework of haptic design parameters may support architects during design, we conducted a workshop and focus group

\textsuperscript{1} This person refers to the "Backbone wall" in the Hazelwood School for the Blind in Glasgow.
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interview with professional architects. Although most buildings are being investigated after construction, rather than in the process of design [20, 21], analyzing a project in terms of the haptic design parameters during design yields interesting insights.

Findings suggest that architects acknowledge the importance of haptics in the built environment and the usability of the proposed framework. Regarding the content of the framework most of the participants agree that the parameters do not limit their creativity and are very useful. Moreover our analysis indicates that architects who are informed about haptics analyze and design a building plan with more attention for movement and haptic experiences in general.

As far as the representation is concerned, our approach to challenge architects to design with more attention for haptics still requires some adaptation. First the narrative of the framework of haptic design parameters seems to be unclear, while a narrative may help people to imagine realistic experiences. For Juhani Pallasmaa the most significant thought during his architectural education was a single sentence by his professor, Aulis Blomstedt: "For an architect, more important than the skill of fantasizing space, is the capacity of envisioning situations of human life" [22]. This envisioning may be facilitated by using a narrative.

The framework of haptic design parameters aims to support designing in line with the Universal Design Principles (UDP) : equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use [23]. The framework is considered to be useful and marketable to a range of designers (UDP 1). However, its evaluation reveals that the parameters themselves lack cognitive accessibility for architects. Interestingly, the participating architects demand a more visual representation, meaning that the parameters need to be translated into a visual language. According to the participants, a visual scheme complemented with icons would provide a more "simple and intuitive use" (UDP 3). Providing choices and being non-prescriptive (UDP 2) is another condition that is required. In general the architects agree that the parameters have a descriptive form, however accuracy and precision in their application is lacking (UDP 2). When translating this framework into a visual scheme, we need to pay attention to the legibility of the perceptual information (UDP 4). The parameters’ tolerance for error (UDP 5) might be intercepted for the shape characteristics by drawing the inverted space and path-rooting system or encircling potential rest places. The materials, on the other hand, require different ways of evaluation during design. For this it is suggested to think about the materials already early in the design process. Applying the haptic design parameters should be easy, without requiring any (physical) effort (UDP 6). Architects complain about the difficulty of reading the parameters. Reading text is too strenuous and a visual representation would help to design with the parameters in a more comfortable way. Besides the actual
application, the scheme itself needs to have a proper size for approach and use (UDP 7). And last but not least the framework of haptic design parameters needs to fulfill the needs of as many architects as possible, meaning to accommodate an equitable use and to provide audible, tangible as well as visual information.

To conclude, the reactions of the participating architects suggest that they immediately picked up the idea of the framework of haptic design parameters, and recognized its relevance in relation to the design project at stake, but that its representation confronts us with a sensory paradox: although the haptic design parameters question the impact of the visual in architectural design, they are meant to be used by designers, who are used to think, know and work in a visual way.

Acknowledging this paradox is important in further tuning our approach to design practice. For one thing, the techniques we suggest to assess haptic qualities are thought to be applied to sketches or drawings by hand. In real-world design practice, however, Computer-Aided Design (CAD) tools are strongly integrated early in the design process to complement free-hand sketches [18]. In line with this tendency, one could think of developing a CAD application that automatically displays the inverted space, run lines and rest places on a digital drawing. After all these techniques are largely based on information that can be read off from a drawing. This would give architects immediately an idea of how their design performs haptically and would trigger them to further refine it. In a digital model, the inverted space and run lines could also be evaluated three-dimensionally, such that problematic points become even clearer. Yet, in developing such application, it is recommended to keep in mind the difference between haptic and visual perception in relation to "form" and "structure" [9]. Visually, we immediately perceive a unit in the different elements. In this way meaning is given to objects and environments. Haptically, however, the different parts and the link between form and meaning are first analyzed but the latter might even be lost. It is the structure that dominates while all elements acquire meaning independently. We may compare it to sketching. While placing the different elements on a white sheet, each element is individually considered and structured. Automatically displaying the inverted space, run lines and rest places may lead to perceiving the information as a form. To encourage architects to analyze a digital plan or model haptically, it is important that the techniques can be applied interactively rather than automatically, so that architects can outline and unfold the structure of the design as well.

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References


