Designing Architecture for More

A Framework of Haptic Design Parameters with the Experience of People Born Blind

Jasmien Herssens

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Prof. dr. ir.-arch. Ann Heylighen | Prof. dr. Bert Willems
“If touch is not a single perception, but many instead, then its purposes are also manifold.”

Aristotle (384-322 BC) De Anima
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An inclusive attitude generates numerous encounters between people. In my aim to make this project as inclusive as possible, I’m very grateful to the many encounters with people and institutes that have contributed to this work. Therefore I want to express my gratitude to a number of people and institutes who helped and supported me during this process.

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In times of test, family is the best...During these years of study I made many sacrifices that had a huge impact on my family. I owe so much to my parents that the following words will not be enough to express my gratitude. During my whole career they have always unconditionally supported me in so many ways. In hard times, they were (and still are) always there for us. Therefore this work is also a tribute to them. Without my parents, this work would never have existed in the first place. I am also very grateful to my parents-in-law and my closest family and relatives: Andy, Dimitri, Els, Hans, Herman, Katrien, Luna, Manon, Martina, Martine, Rudy, Silvie, tante Maria, tante Denise and mamie who all supported me in many different ways.

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Finally, I should like to thank everybody who helped me in different ways to undertake this work but who I forgot to mention by name or whom I could not possibly mention for reasons of anonymity.
Studies in architectural theory and design research have greatly multiplied in recent years. However, relatively little research has been conducted on the multisensory experience of the built environment. Even if it is generally agreed that we experience the built environment with all senses, few architects bear in mind the haptic, olfactory, gustatory and auditory sense while designing. Design research as well as architectural theory refer to a visual bias that is culturally ingrained. As Nigel Cross states, architects and other designers know, think and design in a very visual way. Moreover, vision is often quoted as the spatial sense par excellence and our Western civilization is said to be dominated by vision.

Nevertheless, if architects design with more attention to non-visual senses, they can 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 and are free to rely on the available sensory information. Rather than implementing as many sensory triggers as possible, the intention is to make the built environment accessible and enjoyable for more people, in line with the objective of ‘Inclusive Design’ (U.K.), ‘Design for All’ (E.U.), or ‘Universal Design’ (U.S.). In this research we use the umbrella term ‘Designing for More’ (DfM) for several reasons: first to stress the non-stop iterative nature of an inclusive design process; secondly to avoid confusion amongst and prejudices associated with some terms; thirdly because this research adopts a cultural approach in which people with a disability are involved as experts in the research process. The research design is considered to be a DfM-process in itself and is set up around four tracks:

• a theoretical track
• an empirical track
• a design track
• an evaluation track

The user/experts for this research are people born blind because they have learned to be more attentive to non-visual stimuli. The main objective is the analysis of haptic experiences in the built environment with the help of people born blind. In order to identify haptic experiences in the built environment, we adopted a qualitative research approach, following the principles of Grounded Theory. Qualitative research is considered as an interdisciplinary field in which theory and practice can interact. Within this overall objective, the aim of this research is to develop a framework of haptic design parameters to support architects in implementing haptic experiences during design. In this study haptic design parameters are defined as variable characteristics that can be decided upon by architects during the design process, and the value of which is a determinant of haptic characteristics of the resulting building or space.

Haptic spatial perception involves all the perceptual processes related to the sense of touch. In relation to the built environment, we argue, haptic perception involves active as well as dynamic and passive touch. Whereas active and dynamic touch require movement from the body itself, passive touch arises from movement in the environment.

Theoretical Track

The theoretical track outlines three main parts that discuss three subthemes: the search for experience in architecture, the meaning of experience as a form of expertise for people born blind and the characteristics of haptic experiences.

The theoretical track concludes by giving an overview and linking these three parts together into a theoretical framework that represents our approach towards a haptic experience in the built environment based on the expertise of people born blind. This framework outlines haptic
experience in the built environment as the result of three mental processes. These mental processes take place at three different levels: the level of perception, the level of memory and the level of meaning.

The three levels will offer a foundation for the analysis of the empirical track.

Empirical Track

The empirical track investigates how and why people touch and partly reveals what is touched. In order to obtain richer material we chose to combine multiple methods to collect data on haptic qualities and obstacles in the built environment:

1. Home visits with adults born blind
2. Photo-ethnographic tours by children born blind
3. Focus Group Interviews with caregivers of people born blind.

The findings of these theoretical and empirical studies are threefold. On the one hand haptic qualities and obstacles regarding the built environment are identified. In addition, the results inform us on people’s haptic perception of the environment. Finally, the different research methods turn out to be relevant for sensory research.

Design Track

Triangulating the key results of the empirical studies, and confronting these with the findings of the theoretical track, resulted in an outline of a framework for haptic design parameters.

The theoretical and empirical results show that haptic experience in the built environment relies on an interaction between context, experience and design parameters. This results in a framework that consists out of a main grid representing the context. In context we distinguish the modes of touch (active, dynamic and passive), the perceived affordance of the planes (moving, guiding, resting) and the difference in sensitivity of the body parts. Every possible combination in this main framework consists its own values for the design parameters linked to the experiential values. The latter are placed on an octant that shows the interaction between the different levels of mental processes that involve a haptic experience in the built environment: level of perception, level of memory and level of meaning. The values of the design parameters can change depending on these axes of perception, memory and meaning and of the values of the context. The haptic design parameters are described by material properties and geometrical properties. We consider texture, elasticity, air permeability, specific gravity and temperature as material parameters. Curvature, orientation, configuration and size are geometrical parameters.

Additionally we propose some design techniques that rely on well-known spatial design practices in architecture to assess the haptic experiences of a design project.

Evaluation Track

As the framework of haptic design parameters is considered as a design itself, user/experts are involved to evaluate it in terms of content as well as usability:

1. to assess the wider relevance of the haptic qualities covered by the framework, a focus group interview was conducted with people who are not visually impaired. The group was composed of people with different backgrounds, ages and conditions, including young and older people, a pregnant woman, a wheelchair user, a person with autism, etc. The findings of the focus group interview suggest that the framework of haptic parameters resonates with the experiences of different users;

2. to assess the usability of the framework and techniques for design practice, a workshop was set up with professional architects. Feedback suggests that architects quickly picked up the idea of the framework, and recognized its relevance, but that the framework’s representation challenges us with a sensory paradox: while the parameters question the visual bias in architectural design, they are meant to be used by designers, who are used to think, know and work in a visual way.

We conclude with the highlights on the theoretical, empirical and methodological results. In addition we reflect upon possible directions for future research.
Onderzoek in architectuurtheorie en ontwerpmethodiek is sterk toegenomen in het laatste decennium. Niettemin werd er tot nu toe weinig onderzoek verricht naar multi-sensoriële ervaringen in de gebouwde omgeving. Algemeen wordt aangenomen dat we de gebouwde omgeving beleven met de hulp van alle zintuigen, toch zijn er slechts weinig architecten die rekening houden met de multi-sensoriële ervaringen tijdens het ontwerpproces. Zoals uiteengezet door Nigel Cross kennen, denken en ontwerpen architecten en ontwerpers van de gebouwde omgeving met heel veel aandacht voor het visuele.

Mochten architecten ontwerpen met meer aandacht voor niet-visuele zintuigen, dan zouden ze meer bijdragen tot inclusieve omgevingen. Indien een omgeving alle niet-visuele zintuigen ondersteunt, zijn de gebruikers vrij om terug te vallen op de voor hen meest aangewezen zintuiglijke informatie. De algemene doelstelling van dit onderzoek is om de gebouwde omgeving bruikbaar en aangenaam te maken voor meer mensen volgens de doelstelling van inclusief ontwerpen ook gekend als ‘Ontwerpen voor Iedereen’ (BE), ‘Inclusive Design’ (U.K.), ‘Design for All’ (EU) of ‘Universal Design’ (UD).

Om verschillende redenen brengen wij de gemeenschappelijke doelstellingen onder de noemer ‘Designing for More’ (DfM). Eerst om te beklemtonen dat het ontwerpproces voor inclusieve ontwerpen een non-stop iteratief proces is. Daarnaast willen we verwarring vermijden met de reeds bestaande termen en de misverstanden daaromtrent en de laatste en meest belangrijke reden is het feit dat dit onderzoek een culturele benadering volgt waarbij de diversiteit van mensen net wordt ingezet als een vorm van expertise. Deze culturele benadering gaat hiermee een stap verder dan de sociale benadering waarbinnen ID, DfA en UD zich inschrijven.

Het onderzoek kan zelf beschouwd worden als een DfM-proces en is opgebouwd rond vier grote luiken:

- theoretisch luik
- empirisch luik
- ontwerpluik
- evaluatieluik

De ervaringsdeskundigen in dit DfM-proces zijn mensen die blind zijn omdat zij meer aandacht schenken aan niet-visuele stimuli. Bovendien zijn zij door jarenlange training aandachtiger voor de schakeringen in haptische belevingen. De analyse van de haptische beleving van de gebouwde omgeving aan de hand van de ervaringen van mensen die blind zijn (als vorm van expertise) staat centraal in dit onderzoek. Om tot deze haptische belevingen te kunnen analyseren maken we gebruik van kwalitatief onderzoek, dat de principes van de Grounded Theory volgt. Kwalitatief onderzoek wordt beschouwd als een interdisciplinaire methode waarin onderzoek uit theoretische en empirische resultaten kunnen interageren.

Binnen deze algemene doelstelling ligt de focus van dit onderzoek op het ontwerpen van een kader van haptische ontwerpparameters datarchitecten ondersteunt in de implementatie van haptische kwaliteiten in het ontwerpproces. We beschouwen parameters als variabele karakteristieken waarover de architect kan beslissen tijdens het ontwerpproces en waarvan de waarden bepalend zijn voor de haptische kenmerken en ervaringen van het resulterende gebouw of de ruimte. Haptiek definieën we in de context van dit onderzoek als de studie van de tastzin (in de ruimste zin) in de gebouwde omgeving. In andere woorden, haptische perceptie in de gebouwde omgeving beschrijft zowel het actieve, dynamische als het passieve tasten. Waar actieve en dynamische prikkels voortkomen uit de beweging van het lichaam van de gebruiker zelf is passieve tast het gevolg van beweging in de omgeving zelf.
**Theoretisch Luik**

Het theoretisch luik wordt opgedeeld in verschillende deelvragen: de zoektocht naar de betekenis van ‘beleving’ in architectuur, naar de betekenis van de beleving van blinde mensen als vorm van expertise en naar de kenmerken van haptische beleving. Respectievelijk delen we het theoretische luik op in drie delen die elk een antwoord zoeken op de voorgaande deelvragen.

Op het einde van dit hoofdstuk linken we de verschillende resultaten en bouwen we een denkkader op dat de haptische beleving in architectuur, met de expertise van mensen die blind zijn, beschrijft als een resultaat van mentale processen. Deze mentale processen vinden plaats op drie verschillende niveaus: een niveau van eigenlijke perceptie, een niveau van herinneringen en een niveau van betekenis geven.

Deze drie niveaus zullen ons een aanknopingspunt geven naar de analyse van het empirische luik.

**Empirisch Luik**

Het empirische luik onderzoekt hoe en waarom mensen op een bepaalde wijze tasten en in beperkte mate ook wat ze precies betasten. Voor dit empirisch onderzoek maken we gebruik van kwalitatief onderzoek waarvoor we verschillende studies hebben uitgevoerd om de rijksdom van de resultaten te verzekeren. Bovendien werd ieder deelonderzoek zo opgesteld dat het uiteindelijke totale onderzoekspotzet een gedifferentieerd insicht kan geven. Ook het empirische luik omvat drie grote delen waarvan ieder een apart deelonderzoek vormt:

1. thuisbezoeken bij volwassenen die blind zijn
2. foto-etnografische rondleidingen door kinderen die blind zijn
3. focusgesprekken met zorgverstrekkers van mensen die blind zijn

De resultaten van het theoretische en empirische luik zijn drieledig. De haptische belevingen in de gebouwde omgeving worden in kaart gebracht. Daarnaast geven sommige resultaten meer inzichten in de haptische perceptie van de gebouwde omgeving en bovendien toonden sommige onderzoeksmethodes hun betrouwbaarheid en bruikbaarheid aan in relatie tot zintuiglijk onderzoek.

**Ontwerpluik**

Op basis van de resultaten in het theoretische en empirische luik, werd een triangulatie uitgevoerd op de empirische resultaten en werd een kruisanalyse uitgevoerd door alle resultaten en bevindingen. De theoretische en empirische resultaten tonen aan dat een ontwerpkeuze die rekening houdt met haptische beleving in de gebouwde omgeving steunt op een samenwerking tussen contextuele parameters, belevingsparameters en ontwerpparameters. Dit resulteert in een kader dat opgebouwd is uit een hoofd raster op basis van de contextuele parameters. De contextuele parametersonderscheiden het verschil in tasten (actief, dynamisch en passief), de gepercipieerde gebruikswaarde van de vlakken (bewegingsvlak, geleidingsvlak en rustvlak) en het verschil in sensitiviteit tussen lichaamsdelen. Iedere mogelijke combinatie in dit raster bevat zijn eigen waarden voor de ontwerpparameters gekoppeld aan de belevingswaarden. Deze laatste zijn ondergebracht op een octant dat de interactie voorstelt tussen de verschillende niveaus van mentale processen betrokken bij een haptische beleving: perceptie, geheugen en kennis. De waarden van de ontwerpparameters kunnen variëren afhankelijk van deze assen van perceptie, geheugen en kennis, en van de context. De eigenlijke ontwerpparameters splitsen we op in materiaalparameters en geometrische parameters. Onder materiaalparameters wordt verstaan: textuur, elasticiteit, luchtdoorlatendheid, soortelijk gewicht en temperatuur, terwijl kromming, oriëntatie, configuratie en grootte, geometrische karakteristieken zijn. Bijkomend geven we een eerste aanzet, om met behulp van dit kader aan de hand van schetsen de haptische kwaliteiten van een ontwerp visueel voor te stellen.

Omdat het ontwikkelen van het kader voor haptische ontwerpparameters een ontwerp op zichzelf is, laten we, volgens het model van Designing for More, het kader en de parameters evalueren door eindgebruikers.
Evaluatieluik

Door middel van focusgesprekken met ervaringsdeskundigen werd het kader van ontwerpparameters geëvalueerd, zowel de inhoud als de bruikbaarheid. De gebruikers van het kader zijn enerzijds de ontwerpers van de gebouwde omgeving, maar anderzijds dienen we tevens rekening te houden met de evaluatie door de eindgebruikers van de ontworpen omgeving die resulteert uit het gebruik van het kader. Twee groepen van ervaringsdeskundigen worden geraadpleegd:

1. architecten als ervaringsdeskundigen met betrekking tot het ontwerpen
2. een diverse groep van gebruikers van de gebouwde omgeving die het kader evalueren op de inhoudelijke bruikbaarheid en toepasbaarheid voor alle (ook ziende) gebruikers van de gebouwde omgeving.

We concluderen met een overzicht van de meest belangrijke inzichten met betrekking tot onze theoretische, empirische en methodologische resultaten en reflecteren over mogelijke richtingen voor verder onderzoek.
## Abbreviations

<table>
<thead>
<tr>
<th>abbreviation</th>
<th>in full</th>
<th>English translation</th>
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<tr>
<td>BC</td>
<td>Before Christ</td>
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<td>cf.</td>
<td>confer</td>
<td>compare</td>
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<td>DFM</td>
<td>Designing for More</td>
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<tr>
<td>DFSN</td>
<td>Design For Special Needs</td>
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<td>e.g.</td>
<td>exempli gratia</td>
<td>for example</td>
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<td>EP</td>
<td>Exploratory Procedure</td>
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<td>i.e.</td>
<td>id est</td>
<td>that is</td>
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<tr>
<td>GON</td>
<td>Geïntegreerd Onderwijs</td>
<td>integrated education for people with impairments</td>
</tr>
<tr>
<td>I</td>
<td>intern: verblijf met overnachting</td>
<td>stay overnight</td>
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<tr>
<td>ID</td>
<td>Inclusive Design</td>
<td></td>
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<tr>
<td>SI</td>
<td>semi intern: gaan iedere dag naar huis</td>
<td>go home daily</td>
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<td>LAT</td>
<td>Living Apart Together</td>
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<td>LAVI</td>
<td>Lagere Afdeling Visuele Beperkingen</td>
<td>primary school visual impairments</td>
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<td>LTM</td>
<td>Long Term Memory</td>
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<td>M</td>
<td>moderator</td>
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<tr>
<td>POE</td>
<td>Post Occupancy Evaluation</td>
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<td>SAVI</td>
<td>Secundaire Afdeling Visuele Beperkingen</td>
<td>secondary school visual impairments</td>
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<tr>
<td>STM</td>
<td>Short Term Memory</td>
<td></td>
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<tr>
<td>UD</td>
<td>Universal Design</td>
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Chapter 1: Problem Definition

1. Designing for More Multisensory Experiences
1.1 Questioning the Visual Bias in Architecture

Architectural experiences are the result of perception. People acquire these experiences via their sensory systems. All sensory systems can contribute to an architectural experience. Designers of the built environment aim to create environments that support a holistic experience in which it is possible for the physical, mental, emotional, spiritual, social and virtual experiences to coincide. However, much contemporary architecture struggles with a flattening of the multisensory qualities that contribute to architectural experience. This is because the qualities that might generate olfactory, haptic, gustatory and auditory perceptions are lacking. Sometimes, visual aesthetics simply overrules the other sensory perceptions.

There are many possible physiological, social and cultural reasons for these sensorily limited designs. Firstly, the human condition serves the primacy of the eye as the brain always chooses the quickest way to gather information. Our visual system requires only a limited effort in exchange for a large amount of information. It is argued that 85-90% of the stimuli we rely on are based on visual perception. Sight is the most dominant sense and this is biologically determined as more than 40% of all the impulses entering the brain are triggered by the sense of sight. This physiological fact contributed to the preference of early neurologists to study the visual regions of the cortex. Besides the physiological aspect of the human body, there are also cultural reasons for sensorial shortcomings within the built environment. Architecture, for example, largely revolves around visual language and practice. Moreover, architects’ preference for visual practice is rooted in Western history and is one of the reasons why there is so little knowledge about multisensory design. The cultural history of the West maintained the hegemony of the eye as the result of an ocularcentric mentality. Consequently, architectural practice largely relies on visual representation techniques and sources of inspiration. Whereas human physiology is characterised by slow unidirectional evolution, social and cultural movements change more often and are linked to historical constructs. However, all three have the power to influence a designer’s attitude. In the late 20th century, a social and cultural shift took place within the world of architecture that is still being addressed today.

The postmodern era saw a change within the field of architectural theory as well as design research. Architectural critics and theorists began writing texts that demonstrated the importance of a multisensory approach to architecture. Their discourse was based on, and inspired by, phenomenological writers. The phenomenological movement generated not just theoretical discourse but actually stimulated architects to start creating designs based upon phenomenological philosophy. In the 1970s, Charles Moore played a pioneering role in creating phenomenological architecture, for example. Meanwhile, at the University of Essex, Dalibor Vesely and Joseph Rykwert created an intellectual environment that inspired students such as Alberto Pérez-Gomez to go on to create some of the most interesting phenomenological architecture of the late 20th century.

3 Phenomenology, derived from the Greek phainómenon meaning “that which appears” and it defines a philosophical movement that intends to analyse the structures of consciousness and the related phenomena in the context of perceptions and emotions.
At the same time, design research moved towards a climax in terms of social inclusion. In the U.S. Ron Mace advanced Universal Design as a new paradigm that shifted design research towards a more human-centred future. It is a relatively recent design paradigm and its implementation confronts designers of the built environment with a new challenge: designing environments that are user-friendly and elegant for as many people as possible, regardless of age, ability or circumstance.

However, although research in architecture has greatly increased in recent years, it is a field that is not familiar with explicit sensory practice or sensory discourse. Research into architecture and the non-visual senses, like the sense of touch, is rare. Furthermore, sensory design studies mostly focus on product design. Consequently, research into the implementation of multisensory experiences within the built environment - based on the expertise of users - is rather new. Research shows, for example, that there is a current lack of multisensory orientation systems\(^5\) and if designers are aware of the notion of inclusion, built environments are still designed with guidelines for special needs in mind. Yet inclusive environments can, and should, contribute to the well-being of a diversity of people.

To be more precise: if an environment offers a range of sensory triggers, people with different sensory capacities are able to navigate and enjoy it.

The aim of this doctoral research is to support architects in the implementation of multisensory qualities during the design process. As a result, their designs for built environments might offer a balanced sensory experience for a greater number of people. The methodology is based on insights gained from many different areas of research. The focus of the study is the haptic system and the experiences of user/experts\(^6\) who are blind. This is because blind people are said to be more attentive to non-visual senses.\(^7\)

This Chapter discusses the factors that motivate and influence the research in depth. Neuroscience and architectural theory, as well as design research, play a part; for each of these fields, a brief background is given, as well as a description of the links that can be made with the multisensory experience of the built environment. To conclude, the Chapter focuses on the general objective of the study, which is the formulation of a framework of haptic design parameters, and various sub-objectives.

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\(^6\) Elaine Ostroff calls a user/expert “anyone who has developed natural experience in dealing with challenges of our built environment (…) parents managing with toddlers, older people with changing vision or stamina, people of short stature, limited grasp or who use wheelchairs.” In Ostroff, Elaine “Mining Our Natural Resources: The User as Expert.” *INNOVATION* 16.1 (1997):34


1.2 State of the Art

Multisensory experiences are an indispensable key to the design of multisensory human-centred environments. There is a growing awareness of the importance of this within contemporary architectural circles. However, research in relation to the senses and the built environment is still in its infancy. Although the importance of interaction between non-visual and visual experiences in architecture is clear, it appears that some architects currently fail to address haptic, auditory or olfactory qualities in their work. The key question of this introductory Section is: why has it taken so long for the Western world to recognise the subject of architecture and the non-visual sensory experience as a valid research topic?

1.2.1 Mapping the Architectural Brain: when Neuroscience meets Architecture

Winston Churchill once argued: “We shape our buildings, thereafter they shape us.” The human brain is responsible for turning experience into reality. The area of the brain connected to vision is powerful and important. Richard L. Gregory argues that human evolution has contributed to the fact that regions of the cerebral cortex concerned with thought are younger than the regions of the brain connected to vision, which are older and linked to survival. To be more precise, Gregory proposes that behaviour and action is not the result of what is sensed but what is likely to happen. Throughout history, man has survived through his ability to make predictions and it has been shown that it is the visual regions of the brain that excel at this task. Such predictions might also be based upon other sensory information: for example, it is possible to predict the feeling of a rough texture simply by looking at it. Consequently, our preference for the visual might be an evolutionary fact connected to mind’s ability to process non-visual information and use it to go further than the immediate evidence provided by the senses. Indeed the human brain carries the story of its evolution in its anatomy as the first living organisms in water developed a tube to carry nerves from the distant parts of their body to the central control point.

Neuroscience has a long tradition but everything about our brains has not been revealed yet. The first writings on the cortex dates from the thirtieth Century BC but is better known through a copy named as the Edwin Smith Surgical Papyrus dated 1700 BC (Fig. 1.1). The latter was found in the 19th century. The document’s content gives a description of different medical cases. The sixth case discusses a person with a skull fracture and in these hieroglyphs the word “brain” is used for the first time (Fig. 1.2). Egyptians believed that the heart was the most important organ in the body or the seat of the mind, the center of intellectual activities. The ritual of

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mummification confirms this. While the brain was removed through an iron bar, the heart is handled with care and replaced or kept in the canopic jars.

In the middle of the fifth century BC Alcmaeon was the first writer who considered the brain as the site of sensation and cognition and he conducted the first dissections and theories on the senses, particularly vision.\(^\text{16}\) He described the optic nerves and observations made him conclude that the eye contained light essential for vision.\(^\text{17}\) In antiquity, the Greeks revered the eye as the primary sense. This hierarchy of the senses thus dates back to the Classical world and the adoration of the visual led to the development of optics - the study of light and vision. Plato assumed "(...) that a light flows from our eyes, a subtle fire similar to the light of the sun. When exterior light is fused with the inner light flowing from the eyes, luminosity is strengthened and we can perceive the colours of visible objects."\(^\text{18}\) Aristotle argued the opposite and stated that light formed a medium between viewer and object.\(^\text{19}\) Plato’s Timaeus was influential for the ideology of the Middle Ages that rejected sensation and observation in favour of reason.\(^\text{20}\)

In the middle ages less empirical studies are conducted, in general, and most writings are inspired by the theory of Galen of Pergamon (129-199 BC) who had provided an accurate and detailed description of the anatomy of the brain in ancient times. During the Renaissance Leonardo Da Vinci extensively wrote about, light, vision and optics of the eye (Fig. 1.3). Combined with his talent for anatomic drawings, this made him to be the spearhead of new creative anatomy.\(^\text{21}\) Meanwhile Andreas Vesalius of Padua was a revolutionary anatomist who partly did forget the importance of Galen.\(^\text{22}\)

In the 17th century René Descartes explained that the mind is separate from the material universe. Cartesian Dualism was a very dominating concept that still resonates. In the 18th century and the beginning of the 19th century the central idea lived that the brain produced behaviour, thought and emotion.\(^\text{23}\) Several researchers start with the localization of different psychological functions in different regions of the cerebral cortex. The first correlations between brain and function were set out. This was achieved by literally opening skulls of participants or by observing people with manifest differences in behaviour until they died (at which point surgery was conducted on the brain of the deceased patient). However, it will take till the last quarter of the 19th century before researchers start for a more precise research of sensory centers. Remarkably, most of these studies have put the focus on the localization of visual function in the cortex.

Despite the power of vision that rules in the interests of neuroscience through history, the complete experience

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is a result of all the environmental aspects registered in a multisensory way by our brain as a whole. All sensory sensations contribute to human behaviour. It is therefore important, from a neurological point of view, not to restrict the experience of architecture to that which is visual but to expand the knowledge and study every type of sensory experience.

Architectural neuroscience is a relatively new branch of the sciences. Cognitive reactions in relation to the way people understand the built environment were not studied scientifically until very recently.

When functional brain imaging technology became available in the 1970s, neuroscience as a research domain came into its own. From then on it was possible to actually observe the living brain. In the 1980s, Changeux made the first link between brain-mind activity and environmental design.²⁴ John Zeisel, founder and chairman of the Academy of Neuroscience for Architecture (ANFA),²⁵ realised that Changeux’s discoveries were ripe for development and undertook pioneering research that combined neurology and architecture (Fig. 1.4).

Zeisel proposes a research approach based upon observation and cooperation between architects and people with dementia. He believes that the more you know about how people experience their environment and what they know about it, the better you will understand their behaviour, emotions and cognitive reactions.²⁶ Neuroscientists, architects and designers are thus encouraged to collaborate and consider the relation between body and environment.

In the late 20th century, the knowledge generated by neuroscience spread rapidly, stimulated by the internet and open access to the databases held by neuroscientists around the world. For the first time, physical human behaviour could be connected to different areas of the brain. Today, new discoveries connected to psychological reactions such as empathy, religiosity, sexual attraction and aesthetic judgement are revealed through advances in neuroscience.

In the late 1990s, John Eberhard was one of the first people to link neuroscience to architecture. In his books “Architecture and the Brain” and “Brain Landscape” he tries to explain that every architectural experience is created through networks of sensations.²⁷ These neurological insights are partly based on research conducted by Rita Carter and reported in her book “Mapping the Mind”.²⁸ Eberhard and Carter argue that through the link between architecture and neuroscience it is possible to study human behaviour before the design of the built environment has been completed.²⁹ Around the same time, researchers

²⁵ http://www.anfarch.org/
²⁹ Carter, Rita in Eberhard, John P. Architecture and the Brain. Atlanta: Greenway Communications, LLC, 2007:xIII.

Fig. 1.3 Optical study of “Binocular Vision” by Leonardo Da Vinci
began to understand that our perceptual ability is able to organize a ‘total experience’. This means that our experiences are based not just upon actual sensations and perceptions but also on memories stored in the brain. Our brain contains regions that each respond to certain stimuli. Different experiences recall different memories that are stored in regions of the brain linked to certain topics or knowledge. For example, the percept of a building will be perceived in a different part of the brain than that of a face. Thus, the pattern of brain activity within a particular region of the brain reveals what kind of object a person is looking at.

The lack of attention given to the multisensory experience in most of the present design processes could be addressed by adopting a human-centred approach inspired by neurological insights. The more designers gain insights into the network of stimuli that contribute to certain experiences, the more they can take this into account during the design process.

Neuroscience might thus provide insight into perception and the cognitive reaction to architectural sensations. Eberhard defines it as follows: “It is the combinations of these networks [of neurons across the cortex of our brains] into maps of sensations (combined with associated memories) that enable us to form experiences of architectural settings. These perceptions of architecture are what become ‘percepts’”. The link between perception and an emotional and physical reaction is thus revealed. To be more precise, it is the reason why sensations might stimulate certain networks in our brain to respond to perceptions that cause certain emotions or behaviour. Our sensory systems participate in these processes of sensation and perception. Consequently, designers of the built environment have the ability to affect the user’s brain. The visual system has already been studied at large but the more neuroscientists understand all the sensory processes, the more architects will be able to include multisensory qualities into the design process.

Fig. 1.4 Study of the environment based on the philosophy of ANFA: An object, here a column in a shared interior porch, can help people perceptually divide space. (Congregate House for Older People. Design-research team: Barry Korobkin, John Zeisel and Eric Jahan. Donham & Sweeney, associated architects.)

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1.2.2 Architectural Theory: from Oculocentricity over Scopic Regimes to the Age of Multisensory Networks

Some theorists and critics are convinced that it is our cultural history that has contributed to the Western hegemony of the eye.\textsuperscript{32} It is their belief that the primarily visual nature of Western society and culture has contributed to the absence of multisensory qualities in contemporary architecture.

The history of neuroscience and its results has clearly influenced the Western tradition of philosophical thinking and culture. In ancient Greece, sight was viewed as the most significant and spiritual of all the senses. In their philosophical debates Plato and Aristotle even related sight and hearing to the higher functions of the mind. On the other hand, the proximal senses like smell, touch and taste coincide with the lower functions of the body.\textsuperscript{33} The Greek interest for optics also led to more insights in visual representation techniques. The Romans continued studying optics and, some even argue that the first perspective drawing was a Roman fresco (Fig. 1.5).\textsuperscript{34} Dutch painters already showed their knowledge on depth but Theocentrism partly prevented the creators of focussing on scientific methodologies of representation.

Perspective was discovered and scientifically described during the Renaissance. The discovery of perspective made it possible to represent space as an image. This was a revolution that led to the creation of a new virtual visual world.\textsuperscript{35} Instead of creating in real time, architects were able to use architectural perspective to design on paper.

Besides the importance of perspective within the world of art and architecture it is also worth noting that, for a long time, painting was considered to be the most important form of artistic expression. Moreover, the appearance of museums and zoos further elevated sight to the position of the pre-eminent sense.\textsuperscript{36} This visual dominance continued throughout the 20th century and reached a peak during the era of Modernism.\textsuperscript{37}

In the 1960s, a discourse on the sensory experiences of architecture appeared in reaction to the culture of visual dominance described above. The book “Experiencing Architecture” by Steen Eiler Rasmussen was a pioneering work. Rasmussen was an urban planner but his book was

\textsuperscript{34} Evans, Barrie. “A New View of Perspective.” Architect\textsuperscript{’}s Journal 208.7 (1998): 45.
\textsuperscript{36} Bowring, Jacky. Sensory Deprivation: Globalisation & the Phenomenology of Landscape Architecture, Sint-Petersburg: St. Petersburg State Polytechnic University Publishing House, 2007.81.
not limited to the urban environment. On the contrary, he included all elements of the built environment. He argues, for example, that details do not reveal anything essential about architecture since good architecture is created through ‘integrated wholes’. The book explores different architectural examples and, as outlined in the introduction, language is used to stimulate the imagination of the readers in relation to sensory experiences. The importance of images is not denied, yet the author describes the other non-visual experiences that contribute to the whole architectural experience. Reality is different from images. As stated by Rasmussen: “Anyone who has first seen a place in a picture and then visited it knows how different reality is. You sense the atmosphere all around you and are no longer dependent on the angle from which the picture was made. You breathe the air of the place, hear its sounds, and notice how they are re-echoed by the unseen houses behind you.”

Throughout the second half of the 20th century, there was a growing interest in the integration of sensory experiences into architecture. Architectural theory was increasingly influenced by phenomenological writers such as Martin Heidegger, Maurice Merleau Ponty and Gaston Bachelard. Phenomenology originated as a philosophical movement based on the principles of Edmund Husserl who aimed at structuring consciousness from the perspective of experience. Many important architectural thinkers were inspired by the movement such as Christian Norberg-Schulz, Thomas Thiss-Evensen, Martin Jay, Kenneth Frampton, Juhani Pallasmaa, Alberto Pérez-Gomez and Deborah Hauptman. Frank Lloyd Wright, Louis Kahn, Jørn Utzon (Fig.

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1.6) and Alvar Aalto were all visionary architects in sensory architecture. Today, architects like Steven Holl, Caruso St. John and Peter Zumthor (Fig. 1.7) endorse the phenomenological philosophy.

Most of their theoretical writings are explicitly or implicitly based on the belief in ocularcentrism in the West. However, depending on their personal interests, writers stress different aspects, or discuss the theme of multisensory design from a different perspective, for example the experience of the body, the architectural representation or the importance of the meaning of place.

In terms of architectural representation, Martin Jay’s well known essay “Scopic Regimes of Modernity” inspired many different critics, theorists and architects. Jay refers to three visual core regimes prevalent in Western culture. Christian Metz, the French film theorist, first proposed the use of the term ‘scopic regimes’ in his book “The Imaginary Signifier”. Metz referred to the difference between cinema and theatre as “what defines the specifically cinematic scopic regime is not so much the distance kept ... as the absence of the object seen”. The concept of scopic regimes implies that there are specific ways of seeing and that they are representative of our culture. Jay developed the idea of scopic regimes further and defined three main categories: Cartesian perspectivalism, the art of describing and baroque vision. The first regime, Cartesian perspectivalism, is founded upon the unique viewpoint of the observer, one of the main principles of Renaissance perspective. The second regime is defined as the art of describing. The difference between this regime and Cartesian perspectivalism lies in the fact that it focuses upon the description of the visual surface in place of narratives. Painting is paramount, as are techniques and attention to detail. This regime is associated with the attention Dutch painters paid to the tactile nature of the world around them, as evidenced in the way they represented textures in their work (which can be said to contain as much a haptic as a visual experience). The third regime is baroque vision, or the rejection of monocular geometralization and rectilinear perspectivalism. In this regime it is not reason that is of interest but the senses.

While Jay is defining his scopic regimes by means of representation, Kenneth Frampton emphasizes the importance of experiential qualities in relation to places. Although Frampton is often described as a postmodern architectural critic, he himself rather prefers to be positioned as a critical regionalist. Critical regionalism - as defined by Alexander Tzonis and Liane Lefaivre in the 1980s - was a reaction against the global uniformity of modernism. They argued instead for the integration of elements taken from the local environment. In his discourse on critical regionalism Frampton explains “The tactile resilience of the place-form and the capacity of the body to read the environment in terms other than those of sight alone suggest a potential strategy for resisting the domination of universal technology.” Taking Frampton’s critical regionalism as a starting point, it is possible to view the body as an environment that requires localized geographic knowledge. Máire Eithne O’Neill argues that if we accept the notion of critical regionalism we must also give serious consideration to non-visual aspects of spatial experience.

Postmodernism supported the phenomenological platform by stimulating architects and theorists to search for inspiration in cultural, historical, urban and social contexts and to reflect upon the foundations of architectural theory. However, deconstructionism and post-structuralism stood partly in the way of phenomenology’s total breakthrough. Digitalisation developed hand in hand with structuralism. Alberto Pérez-Gómez argues, however, that digitalisation did not succeed in dethroning the hegemony of the eye: “Even for architects who believe in the significance of fragmentation and complex geometries, computers have contributed next to nothing toward destructuring the hegemony of panoptic space and proposing a more meaningful and participatory urban space.” Besides the digital techniques the publication of architectural projects contributes to the visual attention. Pictures and images dominate the architectural journals and books and contribute to

Fig. 1.7 Atelier of Peter Zumthor, Haldenstein, Switzerland 1985-1986, The timber construction refers to the local buildings and agriculture but the shape is designed as an object. It is like a piece of furniture that triggers the sensory experience of visitors and inhabitants.
the visual culture. For example Janny Rodermond refers to the career and architectural reputation of Jean Nouvel that is founded on the medium of visual publications.46

At the start of the new millennium, there is a renewed interest in sensory experiences of the built environment and the way in which meaning can be given through experiences. The writings of Juhani Pallasmaa have certainly contributed to this revival. In his essay The Eyes of the Skin, Pallasmaa links the visual realm to contemporary technological and consumer culture. His recently published book Encounters builds further upon this idea and links it to the creation of meaningful environments. Encounters is a collection of essays in which the focus is put on the preservation of human experience by means of architecture.47

Besides Pallasmaa, other theorists in the field of visual studies and architectural theorists like William J.T. Mitchell, Chris Jenks, Peter Eisenman have referred to Jay’s terminologies and definitions to explain the dominance of the visual in the West.48 Instead of considering the scopic regimes as hierarchical dogmas, this doctoral research is more aligned with views of Gavin Perin who argues that it is better to approach them as aspirations of cultural innovations. Perin thus proposes that contemporary culture may feed the scopic regime that currently exists: the scopic regime of the digital age.49 Because this regime is not limited to the visual system but goes far beyond it, digitalisation has created a new type of gaze and a new and broader scope. Both Angela Krewani and Christian W. Thomsen state that the abstract nature of computer space will disappear. Instead, a new multisensory, multi-media sensibility is on the agenda.50 The reality of cyberspace is not a new phenomenon to us. Decades ago, Jean Baudrillard warned against the suspected, or real, dangers of cyberspace in which he saw “a devastation of the body by bodily prostheses”.51 Deborah Hauptmann, however, does not fear the prosthetic body. She agrees with Gilles Deleuze who stated that there are many bodies: individual, collective, mystical, corporate, institutional, animal and even the prosthetic body and ethological body.52 Hauptmann thinks we should move away from the notion of the body as a static concept and an integrated whole that results from our perspective driven culture. She refers to Donna Haraway, who considers the body to be a developing hybrid creature.53 For example, the consideration of the body as an evolutionary organism requires designers to integrate the factor of time into the design process. This can be achieved by means of creating ‘spaces of affect’ instead of ‘effecting spaces’, states Hauptman.54 A space of affect is considered as a stimulating environment in which the senses are triggered and stimulated but in an unconstrained manner.

Today, the design and construction process of the built environment is supported by technology and tools in ways that were previously unimaginable. As a result, it is now much easier to create a differentiation of experiences in architecture. However, Rudolf Arnheim argues that our experiences and ideas tend to be “common but not deep, or deep but not common.”55 He explains this by way of the fact that we have forgotten to comprehend through our senses, “Concept is divorced from percept, and thought moves among abstractions. Our eyes have been reduced to instruments with which to identify and to measure; hence we suffer a paucity of ideas that can be expressed in images and incapacity to discover meaning in what we see. Naturally we feel lost in the presence of objects that make sense only to undiluted vision and we seek refuge in the more familiar medium of words.”56

Despite the strong phenomenological movement in architectural theory, research on the phenomenological non-visual experience of architectural elements is still pioneering work. According to Rudolf Arnheim the distance between concept and percept may have contributed to this phenomenon. Gerald Walker defines this as the gap between architecture’s consciousness of itself as rigorous discipline and the everyday way in which it affects people.57

Similarly, Pérez-Gomez explains that the relation between architecture and perception is still questioned today: “By revealing the limitations of mathematical reason, phenomenology has indicated that technological theory alone cannot come to terms with the fundamental problems of architecture. Contemporary architecture, disillusioned with rational utopias, now strives to go beyond positivistic prejudices to find a new metaphysical justification in the human world; its point of departure is once again the sphere of perception, the ultimate origin of existential meaning.”

What we are missing today are perceptual insights into design. However, current architectural theory is beginning to pay more attention to the subject of creating sensory qualities through design. Joy Monice Malnar and Frank Vodvarka recently published Sensory Design, a book that takes the first steps towards better insight into perceptual responses in relation to the built environment. It is a reaction against the Cartesian dualism that exists between subject and object and between body and space that still dominates architecture today. Instead, it raises a plea for a new sensory typology to overcome the gap between concept and percept.

1.2.3 Mind the Gap in Design Research: the Difference between Real-Time Creation and Imagination

Although the gap between concept and percept comes partly down to cultural history of architecture, it can also be viewed as linked to the fact that architects - like other designers - tend to think, learn and work in a visual way. In design research, such knowledge and working methodology is highly valued as paramount to design expertise. In the case of architecture, however, it is not only a particular strength, but may just as well be regarded as a serious weakness. The absence of non-visual features in traditional architectural spatial representations indicates that these are disregarded - instead of being viewed as important elements during the creation of a space. This bias towards vision, and the suppression of other senses - in the way architecture is conceived, taught and critiqued - results in a disappearance of sensorial qualities.

The architect and theorist Bernard Tschumi noticed that there is a gap between the mental world in which architects design and the physical world in which they build. The origin of this gap can be traced back to the Renaissance which saw not only the revival of interest in antiquity, but also the rebirth of the master builder into an architect. The scientific invention of perspective contributed to the fact that, ever since the Renaissance, architects

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have distinguished themselves from master builders. From that point onwards, the discipline of architecture was primarily performed visually - by means of drawings and other visual techniques that focus upon design aesthetics. Prior to the Renaissance, large architectural projects were led by a master builder responsible for the supervision of a team of workers. The master builder set the building’s margins in a very physical way by walking with his head of construction on the site of building - in this way, the place of construction was consciously, as well as literally, marked out. It was a physical and haptic way of designing. Gradually, with the invention of perspective, a visual design tradition grew exponentially until almost all design processes took place within an architect’s office. Even today, architects prefer visual language to communicate and create. According to Eberhard it is even the key factor for evaluation in education: “Architects will likely consider the sensory system that makes vision possible as the most important for their purposes. Students in architectural schools are judged by the visual perception of their teachers.”

Frances Anderton argues that this visual bias even becomes part of the designer’s attitude. Colour is often limited to the absolute minimum and, in general, the whole representation and even the construction of the built environment is rendered white. Anderton explains that this is the result of the architect’s visual preferences. For example, even the black clothing of architects contributes to this attitude: “The designers (invariably dressing in black to contrast – like the penguins - with their white walls and fashionably pallid skins) of these squeaky clean, virginal environments claim them to be imbued with Classical, or Zen, qualities.”

Visual language is very limited when it comes to representing multisensory experiences. Consequently, it can be argued that it may not be able to catch holistic multisensory experiences. However, if the distance between concept and percept grows, buildings might become very difficult, tiring or annoying, to use. As Selwyn Goldsmith states we are, as a result, “architecturally disabled.” If environments lack user-friendliness, multisensory qualities and functionality they end up as places that lack physical or mental accessibility: “distorted spaces.” Architects often design public buildings, such as hospitals and schools, without having had much contact with their future users. As a result, such buildings do not always comply with human needs and therefore fail to meet the needs of all users. A photogenic building may look very beautiful but be an acoustic disaster for somebody with a hearing impairment. Designers, producers and constructors ought to be responsible for “handicap elimination” in the built environment.

We do not have to adapt ourselves to the environment; it is the environment that has to be adapted to us. In order to create a more inclusive environment, architects need to start listening to the needs and experiences of user/experts. Their experiences provide insights into human factors essential for a more human centred inclusive design.

In an attempt to make design more responsive to its users, a whole movement of design research arose around mid 20th century: man-environment relations, environment-behaviour studies, environmental psychology,... Remarkably a lot of design research has been conducted outside the domain of design by researchers in psychology, sociology and anthropology. Currently, designers more and more recognise the importance of socio-cultural values in the design process and the interest for several social movements affirms this growing interest among designers.

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1.3 Towards ‘Designing for More’

This research does not further elaborate on the possible causes for the visual bias in architecture but it does recognize the visual preference in the architectural design process. Consequently, we start from the outlook that ‘architectural disability’ can be overcome if designers adopt a more inclusive design approach. Architects are people, creating for people, with people. Therefore a more human centered approach would be appropriate, resulting in a design process that is not limited to visual information, creation and representation but with attention for all human experiences. Universal Design (UD)\(^{73}\), Inclusive Design (ID)\(^{74}\) and Design for All (DfA)\(^{75}\), used in the USA, UK and mainland Europe respectively, are three synonyms for a recent design paradigm that aims at handicap elimination in the physical environment. Despite the fact that each term is region specific, all have the same purpose: the creation of a more inclusive environment for everybody. The concept aims at usability and comfort for as many people as possible regardless of age, ability or circumstance. However, the majority of designers do not yet recognize the possibilities and opportunities presented by UD, ID or DfA. Most of them connect these terms with Design for Special Needs (DFSN) or ‘accessibility’ and consider the concept behind them as an obligation - instead of a challenge and an opportunity. As architects within the field of UD, ID and DfA are rare, the philosophy of ‘normalization’ frequently underlies current practices.

1.3.1 A Brief Historic Overview

For a long time, people were convinced that impairments could be overcome through the adaptation of the body itself. In general, restrictions were viewed as the result of impairments of the body that had to be restored or removed. From the Greeks to the Enlightenment, most impairments were considered as religious signs and were treated respectively. For example the Greeks believed that the birth of a blind child was a punishment of the Gods. Without compunction, food and basic care were denied.\(^{76}\) Sickness was a form of weakness too. Hospitality and care for the weak is one of the prime achievements of civilisation and a contribution to charity is a religious value.

However, the scientific innovations of the Enlightenment changed the dogmatic belief in authority and created a medical framework as for the solution of problems. According to Oliver Heiss et al. disabilities are medically diagnosed using the following categories: motor, mental and sensory impairments.\(^{77}\) But it wasn’t until the 20th century that the possibilities of environmental adaptations aimed at encouraging individual independence were acknowledged.

At the end of the 19th century, industrialisation brought economic prosperity. The technical revolution in for example steel and concrete, caused a change in attitude of the designers. From that point on architects

were no longer restricted to classical rules and constraints. Consequently, they gained more freedom to give attention to the actual experience of the built environment. One of the first architects in the role of creator for experiencing architecture was Frank Lloyd Wright. His most famous design “Fallingwater” is a creation that supports all sensory experiences (Fig. 1.8 + 1.9).

The reverse of the coin of industrialisation was that new machinery caused serious injuries and accidents. Industrial accidents often led to unemployment amongst workers. In the textile industry, for example, people were more likely to lose their hands and arms when they were distracted by having to change the threads of the loom. Safety instructions and security were minimal. As a result, accidents were frequent and popular street imagery bears witness to the rise in physical impairment around this time.

Industrialization was one factor but the two world wars also contributed significantly to the rise in the number of people with an impairment.

Consequently, the image of people with impairments changed in the 1950s and this brought with it a new social discourse. Meanwhile the interest for a more human and social approach was also influenced by the upcoming
modern social sciences in the 20th century. Psychology, anthropology and sociology emerged and along came the social scientists who observed buildings and inspired architects.

Society was encouraged to perceive and think about disabilities in a different way. Specific changes in the built environment that could support people became a social objective. Initially, this discourse was defined as Design for Special Needs (DFSN) or Barrier-Free Design, a design approach in which the focus lies on a specific group of people with impairments, for example wheelchair users. Hubert Froyen defines this as a micro approach that supports solutions with specific adaptations.

In the 1970s, several international governments integrated the social and academic movements into resolutions, legislation and recommendations. In the domain of social research “environmental psychology” was described for the first time and Environmental-Behaviour studies (E-B-studies) were conducted. General concepts discussed in E-B-studies are for example: privacy, wayfinding, environmental perception, territoriality and personalization. The best known research methodologies who result out of the E-B-studies are user-needs programming and post occupancy evaluation (POE). Evidence-Based design was the design methodology linked to these E-B-studies.

This change in legislation and social research resulted in the fact that impairments were no longer considered as an exclusive individual problem but related to society as a whole. According to Heiss et al. the barriers to mobility and lifestyles in the 1970s were related to the construction and technical aspects of the built environment. Discourse about impairments was no longer restricted to the body, for example physical, mental or intellectual disabilities, but extended to environment in general. This had an impact on design reference books and publications on anthropometrics and measures appeared, such as “Architectural Graphic Standards”. These books began to include dimensions for women and children. However, dimensions for persons with impairments, such as a person seated in a wheelchair, did not appear until the 1990s.

During the 1970s and the 1980s, Barrier-Free Design was commonly used as an umbrella term to define initiatives that focused on the surroundings of the individual to support people. The term Accessible Design, used in the US, had a similar meaning and came to be viewed more positively than Barrier-Free Design, but it was much more linked to requirements that were supported by legislation.

In the 1990s, principles for equal opportunities increasingly become international policies. This postmodern discourse created a new human centred design approach as advanced and defined by Ron Mace: Universal Design (UD). Throughout the world, many different initiatives were taken. In the United States, the Center for Universal Design (CUD) in North Carolina became the pilot centre for Universal Design. In 1993, the European Institute for Design and Disability (EIDD) was established in Dublin. The common belief was that people must not be forced to adapt to the environment, but the built environment should be adapted to its inhabitants. This movement advanced a macro approach that was aimed at finding solutions for as many people as possible. Cheryl Davies and Raymond Lifchez called for UD to be viewed not as a restriction but as a “major perceptual orientation to humanity”. In the context of architecture, UD aims to find solutions within the environment through the socio-material interaction with the environment. This consideration corresponds with the social model approach of disability.
In disability studies, model thinking is used as a way to reflect upon reality. Patrick Devlieger et al. defined a ‘model for disability’. In this model, four approaches are categorized: religious, medical, social and cultural. (Fig. 1.10)

Impairments as punishments or gifts fit the religious model, whereas impairments explained in the light of natural sciences fit the medical model. In the early 1960s, the medical model was questioned by different theorists such as Thomas Szasz, Howard Becker, Erving Goffman, Dorothea and Benjamin Braginsky, Jane Mercer, Frank Bowe and the man who suggested the replacement by the social model: Mike Oliver. The social model derived from the society’s perception of the body and the interaction between the body and the socio-material environment. It can be argued that a disability arises from the interaction between individuals and the environment. To be more precise: society disables people. The social model differs from the moral and medical models because it does not consider the body as something isolated from the world. On the contrary, disability is the result of an interaction with the socio-material world. It is through social interaction that people are compelled to consider disabilities and it is the socio-material environment that creates a handicap situation. The cultural model, on the other hand, starts by considering the way people differ. In this context, disabilities are no longer restrictions but provide an opportunity to improve the environment, or challenge it. Although Devlieger et al. confirm that the dominance of one model over another may change with time and depend upon certain populations, the juxtaposition in contemporary society in which the cultural model has established itself is increasingly recognised. It would appear that the time is ripe for a cultural shift. Heiss et al. state that society is facing its greatest challenge yet: sustainability. Besides the obvious aspects of ecology and economy, sustainability also involves equal opportunities for all members of our society on a socio-cultural level. UD is part of this socio-cultural movement as the differences of people are integrated and recognized within society and viewed as valuable improvements to it.

Most researchers in UD, ID and DfA, share the same main objective: to consider design for, and with, diversity as paramount. However, a debate exists as to the appropriate term for this design movement. Is this discord the result of ambiguity in the terminology and definitions? The next Section outlines the differences and similarities in the existing definitions.

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91 Devlieger, Patrick, Rusch Frank; Pfeiffer, and David Pfeiffer. *Rethinking Disability*: Garant, 2001 (1 2003).


1.3.2 Universal Design, Inclusive Design or Design for All: the Question of Similarity or Difference

1.3.2.1 Universal Design (UD)

Ron Mace coined the term Universal Design and defined it as follows: "an approach to design that incorporates products as well as building features which, to the greatest extent possible, can be used by everyone."94 A similar definition is coined by the Center for Universal Design at North Carolina State University.95 In The Universal Design Handbook, Eileen Ostroff elaborates on the fact that this approach implies that equity and social justice are embodied within the design process and that designs that work for as many people as possible are the end result.96 Similarly, Oliver Herwig states that UD means Design for Everyone.97 However, in the Dictionary of Architecture and Landscape Architecture, UD is defined as equal to Barrier-Free Design: “Barrier-free or Universal Design: Design for Handicapped accessibility, considering the needs of those with visual, hearing and mental disabilities as well as those with physical mobility problems, e.g. buildings with alternatives to stepped entrances and internal steps and staircases. It became compulsory by federal law in the USA after 1990.”98 Although UD aims at environments that support people with or without impairments, this definition appears to focus on the integration of special needs only. This definition thus reflects DFSN rather than UD. Consequently, many people associate it with accessibility standards. Ostroff explains that the term has inappropriately been adopted by some people as a trendy synonym for compliance with the Standards for Accessible Design that is supported by the Americans with Disabilities Act.99 Besides the ambiguity in the use of the term ‘universal’, most people who hear the term UD for the first time are confused and associate it with the Neoclassical architecture of the great utopian architects like Etienne-Louis Boullée, who created designs that were never meant to be realized but which were displayed in an imaginary museum for architecture (Fig. 1.11).100

100 Lemagny, Jean-Claude. Visionary Architects. Santa Monica: Hennessey+Ingalls, 2002.
The principles of Universal Design

Equitable Use
The design is useful and marketable to people with diverse abilities.
1a. Provide the same means of use for all users; identical whenever possible; equivalent when not.
1b. Avoid segregating or stigmatizing any users.
1c. Provisions for privacy, security, and safety should be equally available to all users.
1d. Make the design appealing to all users.

Flexibility in Use
The design accommodates a wide range of individual preferences and abilities.
2a. Provide choice in methods of use.
2b. Accommodate right- or left-handed access and use.
2c. Facilitate the user’s accuracy and precision.
2d. Provide adaptability to the user’s pace.

Tolerance for Error
The design minimizes hazards and the adverse consequences of accidental or unintended actions.
3a. Provide safety for the user’s body position.
3b. Provide safety for the user’s body motion.
3c. Provide safety in all directions of motion.
3d. Minimize unintended actions.
3e. Minimize injuries from hazardous materials.
3f. Encourage use of restraints to prevent misuse.
3g. Minimize adverse consequences of hazardous materials.
3h. Minimize inadvertent or accidental actions.
3i. Minimize adverse consequences of hazardous materials.
3j. Minimize adverse consequences of hazardous materials.
3k. Minimize adverse consequences of hazardous materials.
3l. Minimize adverse consequences of hazardous materials.
3m. Minimize adverse consequences of hazardous materials.
3n. Minimize adverse consequences of hazardous materials.
3o. Minimize adverse consequences of hazardous materials.
3p. Minimize adverse consequences of hazardous materials.
3q. Minimize adverse consequences of hazardous materials.
3r. Minimize adverse consequences of hazardous materials.
3s. Minimize adverse consequences of hazardous materials.
3t. Minimize adverse consequences of hazardous materials.
3u. Minimize adverse consequences of hazardous materials.
3v. Minimize adverse consequences of hazardous materials.
3w. Minimize adverse consequences of hazardous materials.
3x. Minimize adverse consequences of hazardous materials.
3y. Minimize adverse consequences of hazardous materials.
3z. Minimize adverse consequences of hazardous materials.
4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
4b. Prove adequate contrast between essential information and its surroundings.
4c. Maximize “legibility” of essential information.
4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Perceptible Information
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities.
5a. Use text to communicate essentially necessary information.
5b. Use redundancy to communicate essential information.
5c. Provide adequate and effective perceptible information for the category of user for whom it is most needed.
5d. Use visual perception when information is essential to use or safety.
5e. Use graphics to highlight important information.
5f. Use color in the design to identify important elements.
5g. Use color effectively to communicate information.
5h. Use color to alert the user to hazards.
5i. Use color to inform the user about important actions.
5j. Use color to provide feedback to the user.
5k. Use color to indicate the presence of important information.
5l. Use color to indicate the importance of information.
5m. Use color to indicate the importance of information.
5n. Use color to indicate the importance of information.
5o. Use color to indicate the importance of information.
5p. Use color to indicate the importance of information.
5q. Use color to indicate the importance of information.
5r. Use color to indicate the importance of information.
5s. Use color to indicate the importance of information.
5t. Use color to indicate the importance of information.
5u. Use color to indicate the importance of information.
5v. Use color to indicate the important information.
5w. Use color to indicate the important information.
5x. Use color to indicate the important information.
5y. Use color to indicate the important information.
5z. Use color to indicate the important information.
6a. Minimize physical effort.
6b. Minimize repetitive motion.
6c. Minimize sustained physical effort.
6d. Minimize repetitive motions.
6e. Minimize fatigue.

Low Physical Effort
The design can be used efficiently and comfortably with a minimum of fatigue.
7a. Allow user to maintain a neutral body position.
7b. Make reach to all components comfortable for any seated or standing user.
7c. Accommodate variations in hand and grip size.
7d. Provide adequate space for the use of assistive devices or personal assistance.

Size and Space for Approach and Use
Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user’s body size, posture, or mobility.
8a. Provide a clear line of sight to important elements for any seated or standing user.
8b. Make reach to all components comfortable for any seated or standing user.
8c. Accommodate variations in hand and grip size.
8d. Provide adequate space for the use of assistive devices or personal assistance.

Fig. 1.12 The 7 Principles of Universal Design

The Modernists, on the other hand, believed in a universal and unitary design that would rationalise the usability of the built environment. Modern architecture was meant to be a universal style for the elevation of universal man. According to Oud, who was a member of the modernist movement de Stijl, the definition of universal focused on the result of mechanical production. Moreover Modernists aimed a homogeneous universal space.

However, UD is actually about creating a realistic and supportive architecture, as opposed to Neoclassical drawings intended to please the imagination and different from design resulting from mechanical production or aiming at homogeneous spaces. Based on insights of professionals in UD, the Center for Universal Design in North Carolina developed what they defined as “The principles of Universal Design”, seven key terms containing the main objectives of UD: Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use (Fig. 1.12). The aim is to include as many people as possible. Thus Donald Norman states that Universal Design is about designing for everyone; it is a challenge but he agrees that this is no excuse for not designing usable products that everyone can use.

1.3.2.2 Inclusive Design (ID)

Whereas UD is a term that originated in the USA, ID originated in the UK (which is where it is used most frequently). For a definition, John Clarkson et al. refer to the British Standard Institute: “The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible...without the need for special adaptation or specialised design.”

Clarkson et al. go further: “By meeting the needs of those who are excluded from product use, inclusive design improves product experience across a broad range of users. Put simply, inclusive design is better design.” This definition makes the core message clear. Clarkson et al. also clarify the linguistic confusion that exists when talking about UD by explaining what ID is not. They state that ID does not naively imply that it is always possible or appropriate to design one product to address the needs of the entire population. Neither is it only DFSN, nor a stage that simply can be added into the design process. Instead, they refer to a waterfall model. However, the main definition focuses on products and services whereas the design world as a whole ought to improve and encourage ID. Remarkably, John Clarkson himself questioned the term during a discussion at the Include 011 conference in London. Clarkson explicitly stated that he does not like the term. Clarkson et al. go further: “By meeting the needs of those who are excluded from product use, inclusive design improves product experience across a broad range of users. Put simply, inclusive design is better design.” This definition makes the core message clear. Clarkson et al. also clarify the linguistic confusion that exists when talking about UD by explaining what ID is not. They state that ID does not naively imply that it is always possible or appropriate to design one product to address the needs of the entire population. Neither is it only DFSN, nor a stage that simply can be added into the design process. Instead, they refer to a waterfall model. However, the main definition focuses on products and services whereas the design world as a whole ought to improve and encourage ID. Remarkably, John Clarkson himself questioned the term during a discussion at the Include 011 conference in London. Clarkson explicitly stated that he does not like the term Inclusive Design because it intrinsically suggests separation but to get the message across this terminology and its definitions should finally disappear.

Indeed, the use of the term might stress the differences in users and their specific difficulties, whereas the main objective is that these ideas will be taken over in the larger scope of the design process. In line with the latter objective, the term might exclude itself and therefore cause confusion. Perhaps ID is less appropriate in the context of future architectural designs as the more designers are familiar with the term and its design process, the more it will become part of the larger design process.

1.3.2.3 Design for All (DfA)

DfA is one of the common themes of the Universal Design Handbook and is a synonym for UD that has been increasingly used in Europe since 1967. One of the co-authors of the UD handbook is Louis-Pierre Grosbois, a French architect who defines DfA as a concept that is identical to UD. Grosbois cites Vitruvius, the Roman architect, who stated that architecture is based on three main principles: firmitas (solidity of construction), venustas (aesthetic experience) and utilitas (adaptation to use). For Grosbois, DfA is an extension of utilitas. However, he states that it is only through a dialogue between solidity, usefulness and beauty that DfA can come into being.

The European Institute for Design and Disability (EIDD) adopted this vision and use DfA as the common concept behind the platform of European Design and Disability. In the EIDD Stockholm Declaration, DfA is defined as: “design for human diversity, social inclusion and equality. This holistic and innovative approach constitutes a creative and ethical challenge for all planners, designers, entrepreneurs, administrators and political leaders.” This definition comes closest to the objectives of both UD and ID. Moreover, the term is less restrictive and embraces the design world as a whole.

According to Oliver Herwig, the fact that disabled people are perceived as equal has caused the definitions within the terminology to change. UD, ID, DfA and Accessibility for All are increasingly replacing the term Barrier-Free design. Heiss et al. add that these changes to the definitions are an expression of a real change within society. To be precise: diversity is seen as normal. As a result, UD, ID and DfA involve a social model approach.

It is possible that the top of the model framework is not reached yet and this semantic evolution might continue well into the future. The cultural model implies that the terminology might improve in line with cultural
knowledge. More precisely, the diversity of people and environments is recognised as a fundamental part of the design process.

Today, however, it is clear that the definitions are not uniform enough in terms of content. Moreover, the fact that a single concept can be called different things is confusing and generates much discussion, as witnessed on more than one occasion at conferences and during informal discussions. Indeed, some terminology invites contradiction. UD might sound too utopian and DfA similarly has very ambitious connotations. Although utopian concepts might challenge designers, these ambitious terminologies actually seem to discourage them. It creates an unachievable destiny and most designers still link it immediately to DFSN, with the concept elevated the level of all users of the built environment. Although this is not the premise of UD or DfA, the linguistic ambiguity creates confusion. Universal, in the context of design, is unrealistic. To put it in the words of Jonathan Chapman and Nick Gant: “As a designer, it is unrealistic to think that you will single-handedly save the world, and to pursue this destiny is hazardous, as it sets up an unachievable (utopian) destiny that guarantees failure.” ID, on the other hand, is primarily defined in relation to product design that makes it confusing for architects and other designers. It also encourages an explicit separation, as previously explained by Clarkson.

The confusion in the language might perhaps demonstrate that the concepts are not inspiring enough for designers. Instead of encouraging designers, it puts them off and leaves them in the dark since most UD, ID or DfA examples deal with negative bias. However, it is true to say that the concepts of UD, ID and DfA go far beyond DFSN (or Accessibility) and do not limit creativity.

This thesis takes the point of view that the more designers approach diversity as valuable and normal, the more it will become part of design methodologies and general design attitudes. In this way, designing for diversity might become an inherent part of design thinking and support a sustainable environment. Therefore, within this thesis a terminology that puts more stress on the actual design process and the challenge behind the general concepts of UD, ID, DfA is preferred. Besides, it is hoped that the concept will become such an integral part of the larger design process that it won’t even need to be referred to.

1.3.3 Designing for More: A Design Attitude for a Sustainable Future

The aim of this research is supporting a design attitude that extends the barriers of knowledge and includes as many people as possible, without any degree of separation. We thus encourage an attitude that involves sustainability in the broadest possible sense. Within this discourse, the term Designing for More (DfM) is proposed and used throughout for different reasons: to stress the non-stop iterative nature of an inclusive design process, to avoid confusion amongst and prejudices associated with some terms, and because DfM is a challenge and adopts a cultural approach in which people with a disability are involved as experts in the research process. We already extensively elaborated on the possible confusions of the existing terms. Therefore the following Paragraphs zoom in on the process of DfM and its challenges.

1.3.3.1 The Process of Designing for More

Design is a word that has a meaning as a verb, as well as a noun. It does not therefore stress the particular importance of the design process. However, the design process also determines the degree of inclusion and actually generates the general aims of UD, ID and DfA.

Underpinning our research is the conviction that this approach will encourage an unending iterative
process. In line with John Salmen, our research also approaches inclusivity as a horizon that recedes into the distance towards which good design will forever advance.\textsuperscript{114} Instead of relating design to a static approach and utopian dream, emphasis is placed upon the design process and its intentions. Edward Steinfeld and Beth Tauke coined the term Universal Designing in 1997 and defined it as a constant, never ending process and Salmen, argues the relevance of ‘designing’ by explaining the constant changes, improvements and evolutions that are gone through during the design process in line with UD, ID or DfA.\textsuperscript{115} Within this research and in line with Alastair Fuad-Luke, design is viewed more as a process that can generate well-being (Fig. 1.13).\textsuperscript{116}

In the context of our research, it is therefore clearer and more appropriate to speak of ‘designing’ instead of design.

1.3.3.2 The Challenge of Designing for More (DfM)

Most designers may find this process challenging. It requires constant innovation, the inclusion of user/experts, evaluations during and after the design process and, above all, demands a design attitude that meets the objectives of ID. The conditions of DfM might, however, stimulate their creativity. “Design must treat society and the environment as clients too”, argues Fuad-Luke.\textsuperscript{117}

With society as a whole and the environment as clients designers are challenged to confront their ideas with innovations drawn from many different research domains. Despite the fact that physical, social and cultural factors have already been studied and addressed by many architecture programmes, the cognitive aspects require further interdisciplinary research if designers also want to meet human needs. Researchers are still making new discoveries in the fields of perception, behaviour and cognition - all of which might challenge designers to create innovative inclusive environments. Multisensory design requires people who are able to express their needs and preferences and sensitive designers who are able to empathically understand them. According to Marieke Sonneveld, the tools required to support these processes differ in their character, as does the support designers require if they are to understand that sensory needs can differ from the sensory expression of users.\textsuperscript{118} Moreover, all living organisms contribute to the well-being of the planet and its inhabitants. Indeed, to overcome all barriers we must take all life into account and, most importantly of all, its social impact. Charles Jencks once argued that social life inspires innovation in architecture: “\textit{There is a natural discipline that comes from life. And once you accept that, you realise that architecture today must be re-invented. The revolution in science has to be interpreted in terms of social life.}”\textsuperscript{119}

In the term, Designing for More, the word ‘more’ suggests a never-ending process and might also refer to the extension of the design world through the inclusion of all living organisms. Taking their expertise into account fits in a cultural model approach that opens up new opportunities. Besides, we could even state that it is a plea for an increase in aesthetics. Nowadays, beautiful design that is usable is still rare. The aim of DfM is to fuse aesthetics and usability. Aesthetics also contribute to the usability of the environment. Bryan Lawson explains this by referencing Philip Johnson, the American architect, who observed that some people find chairs beautiful to look at because they are comfortable to sit in, while others find chairs comfortable to sit in because they are beautiful to look at.\textsuperscript{120}


Designing for More (DfM) is thus a design approach that aims at designing for a more sustainable environment in which aesthetical, ecological, economical, sociological, psychological, physical, cognitive and cultural aspects go hand in hand. It is a non-stop iterative process that values the importance of diversity by means of user involvement. This holistic approach requires a design attitude and thinking for planners, designers, entrepreneurs, administrators, contractors, political leaders and anyone who contributes to creations in a sustainable environment. In this way DfM aims at creating design solutions for more people, more senses, more actions, more experiences, more user interactions, more design narratives, more possibilities, more sustainability...
Fig. 1.13 Continuous user feedback during the whole design process.
1.4 Aim

The general aim of this research fits the DfM objectives. This research aims to support architects in the creation of better multisensory designs so that more users may enjoy the environment. It also aims to enable more users to participate in the design process so that sustainability is achieved. Research shows that people who are born blind are more attentive to nonvisual experiences and consequently their expertise is highly valuable when trying to improve multisensory qualities. The focus of this research is on the role of haptics within the built environment. To be precise, the main aim is the development of a framework of haptic design parameters that are able to inspire and enable architects to implement haptic qualities in the design process. Indeed, a balanced multisensory environment will naturally include more people.

On the one hand, the framework is intended to support designers with insights drawn from different haptic experiences. These insights are meant to offer inspiration for the implementation of haptic qualities during the design process. For the users, on the other hand, the framework may offer a language through which to express their haptic experiences and thus provide insights into the haptic perceptual process itself. Our daily language lacks multisensory expressions and vocabulary. If architects want to rely on the expertise of users during the design process, it might be helpful for users as well to have insight in the framework.

1.4.1 Aim 1: Designing a Sensory Research Methodology

This type of research is without precedent. Therefore, the first priority was to design the research methodology for an inquiry into the sensory qualities of the built environment and the implementation of these qualities into the design process.

It is necessary to develop a research methodology that investigates the haptic qualities in the built environment as well as the haptic perceptual process. The process is one of trial and error and starts with pilot studies in the field. The structure of this thesis, the methodology and the research questions are explained via the road map in Chapter 2.

The main aim is the design of a framework of haptic design parameters. Therefore the whole research set-up is a DfM process in itself and consequently involves the expertise of people born blind.

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1.4.2  Aim 2: Involving User/Experts: the Experience, Expertise and Knowledge of Blind People regarding the Built Environment

In establishing the strengths and weaknesses in design expertise, it could be argued that the visual knowledge held by designers might just as well be regarded as a form of ‘not knowing’. This becomes especially clear when the knowledge of architects is confronted with the spatial experiences of persons who are blind. From their perspective, architects are actually designing in the dark - in the sense that they increasingly emphasise the visual, and are insufficiently familiar with the multisensory richness of beneficent built environments. The discrepancy between these two ways of understanding space illustrates what Ray McDermott and Hervé Varenne call, “the power of society to disable”. However, it can also be considered an invitation to designers to question the frames of reference that underly the way they tend to conceive space. In terms of how blind people are perceived, there are many contradictions and misunderstandings. It is therefore useful to accurately define blindness when it comes to an exploration of the expertise, experience and knowledge of people born blind. Although the confrontation focuses on design in architecture, the underlying rationale may be relevant for other design domains as well.

This thesis fits the cultural model approach of disability in which the focus is put on the talents of people born blind. For this reason, people first language is used throughout the text, and in particular the term 'people born blind', both as a concept and as a descriptive term. However, the thesis also aims to be inclusive of all readers. It seems appropriate to sometimes use the term 'blind people'. In so doing, complex grammatical constructions and sentences are avoided.

1.4.4 Aim 4: Designing a Framework of Haptic Design Parameters

1.4.4.1 DfM Haptic Qualities and More Balanced Multisensory Experiences

Researchers argue that architects and designers need to understand the message behind multisensory design. However, even today, very few practitioners are aware of what multisensory qualities actually are and what their constraints and implications might be. The general objective of this thesis is to explore the possibility of stimulating the design of environments with multisensory qualities and the focus is placed upon the haptic sense. The architectural and sensory reasons are explained in Chapter 2.

Haptic refers to the sense of touch but this sense has the most diverse terminology of all the senses. Whilst the variety of nouns and adjectives might help to differentiate feelings and experiences, it can also cause confusion. Nevertheless, in the context of architecture, it is appropriate to refer to the haptic sense. A definition of the haptic sense is thus also important (and is included within this research), as is a thorough investigation into the haptic qualities and constraints within the built environment. As part of an inquiry into the relationship of the haptic sense to others it is also important to differentiate between haptic and optic.

1.4.4.2 DfM: Users

As the development of the framework for the haptic parameters is a design process within itself, it is necessary to include user/experts within it. Consequently user/experts are situated on two levels: as part of the design process and in the assessment of the actual usability of the resulting built environment. Therefore the user/experts of the actual framework are the architects, whereas the results of the architects that used the framework, the built environment, houses and designs, will be used by a diversity of users in the built environment. It can thus be said that the designers evaluate the usability of the framework and a wide and diverse range of users check the content. Rather than implementing as many sensory triggers as possible, or limit them to extreme situations, the purpose is to make buildings and spaces accessible, inclusive and enjoyable for more people: a macro approach. At present, the implementation of haptic knowledge within the built environment is limited to a micro approach, such as tactile pavements and signals (DFSN). These adaptations are adequate. However, they do not contribute to the overall quality of a space. Often these adaptations are changed or added to after construction. They can provide safety for people who are blind but they do not contribute to the comfort or experience of sighted people. Moreover, sighted people often do not know what the difference between ribs and knobs on tiles mean. Paradoxically, these supporting haptic adaptations are excluding other users. In extreme conditions, when the tactile pavements are not well constructed, they might even be dangerous. A tram and bus stop, for example, might be indicated by the use of rubber tiles on the floor. The tiles are fixed with glue and due to temperature changes air bubbles form underneath the tiles (Fig. 1.14). This creates a serious danger instead of a safe warning signal for all users. If the meaning of the tiles had been discussed and evaluated during the design process, the end result might have been different. Perhaps tiles would not needed to have been added or a different texture could have been used that functions just as well in terms of orientation.

1.4.4.3 DfM: Participation

The framework is the result of a DfM process itself, as previously mentioned. Advancing blindness as a form of...
expertise is a refreshing twist on the notion of disability. Instead of viewing disability as a physical or mental characteristic of the individual, or as a result of the interaction between an individual and an un-adapted social or physical environment, this research emphasises the potential and transformative power of disability. This study adopts a model of expertise that has, so far, received little attention in design research - namely the notion of expertise as differentiation. This notion offers an excellent vehicle for the development of a trans-disciplinary comparison between the way space is understood by those engaged in professional design practice, and the way it is understood by individuals who live with a disability. As such, it quite literally embodies the cultural model of disability, which acknowledges that disability questions the way the physical world is organized but, at the same time, represents a resource that can contribute to that world. While architects tend to associate disabled persons with accessibility norms that hamper creativity and design freedom, this research behind this thesis turns this notion upside down and gives such people the role of experts within the search for multisensory qualities in architecture. The content of the framework will therefore be organised according to the experience and expertise of people born blind.

1.4.4.4 DfM: Sustainable Design (Process)

Architects may rely on the framework during the entire design process but the information is not compulsory which means that the framework itself intends a descriptive way of informing designers on a DfM approach. The framework aims to be inspiring for architects without limiting their creativity. Furthermore it aims to include haptic qualities in their designs, which can occur at any stage during the design process. Haptic perception involves complicated processes and the framework offers an overview of perception and the haptic sense in relation to the built environment in an abstract, but clear, way. It is therefore important that designers learn how the framework actually works so that it is clear which experience, action or behaviour results from a certain architectural characteristic. Every step is based on the insights gained into the haptic sense.

This thesis is not ordered chronologically in terms of the different objectives described above. Some research questions and aims follow different research tracks. Instead, the text follows the tracks that were set out when designing the research methodology. This research methodology grew out of pilot studies and a basic literature review, as explained in the following Chapter.

Chapter 2: Research Design

2. Towards a Framework of Haptic Design Parameters
2.1 Introduction

The main objective of our research is to gain insight in how designers of the built environment can incorporate haptic experiences in their design. We focus on the development of a framework of haptic design parameters that can support designers of the built environment by offering information, inspiration and feedback for their design in relation to haptic experiences.

Developing a framework of haptic design parameters is strictly speaking a form of design in itself. Therefore, in the context of Designing for More (DfM), it is logical to set up a DfM-process in order to create this framework. As explained in Chapter 1, DfM builds on the principles of UD, ID and DfA and is not a restriction but an attitude. What characterizes a DfM-process is the fact that it is a non-stop iterative process, it acknowledges diversity by means of user involvement and it requires approaching the design from a user point of view in the first place. These three general conditions for DfM form the foundation in Chapter 2 to discuss and motivate our research questions and the research design to address these questions.

Our main research questions are described as follows:

- What constitutes haptic experience in the built environment?
- What is the expertise by experience of people born blind regarding non-visual sensory experiences in the built environment?
- What does ‘blindness’ and ‘haptic’ mean in the context of the built environment?
- How can we design a framework of haptic design parameters?
- How do users of the framework of haptic design parameters assess its idea and content?
2.2 Outlining the Research Tracks through DfM

2.2.1 A Non-Stop Iterative Design Process

Designing for More requires a non-stop iterative design process. This way the process can enrich the results over and over again. Accordingly, the main research setup was built upon this condition and supports a cyclical design process. The DfM-process identifies five different steps (Fig. 2.2): analysis, concept, design, construction and the experience together with the evaluation. For the analysis and conceptualisation of the framework of haptic design parameters we rely on the research conducted in the theoretical and empirical track. The design and construction of the framework and its parameters are addressed in the design track, and the assessment of the parameters and their framework takes place in the evaluation track.

Consequently we differentiate between four main research tracks, each discussed in a different Chapter:

1. **theoretical track** | Chapter 3: discusses the theoretical background regarding the meaning of experience in the built environment and blindness and the haptic sense in particular.

2. **empirical track** | Chapter 4: explores haptic qualities and constraints in the built environment based on the expertise of people born blind.

3. **design track** | Chapter 5: outlines the framework and formulates the haptic design parameters, using the results of the theoretical and empirical track as a starting point.

4. **evaluation track** | Chapter 6: reports on an evaluation of the parameters by architects/designers and sighted users of the built environment.
Fig. 2.2 Research design is a non-stop iterative process based on the idea of DfM.
These four tracks form part of a cyclical design process that increasingly enriches itself. The evaluation track also indicates directions for future research (Fig. 2.1).

Chapter 3 covers the theoretical track. Through literature study on architectural experiences, studies with people born blind and haptics, this Chapter defines the meaning of haptic experience in the built environment based on the expertise of people born blind. The theoretical track concludes with a theoretical framework that outlines the levels of mental processes involved in haptic experience in the built environment. However, in general studies on how people born blind experience the built environment are rare, in particular studies on haptic experiences. Therefore additional research is necessary. Chapter 4 covers the empirical track in which the same research questions are addressed empirically. The results from Chapter 3 and 4 form the basic analysis and concepts behind the design of the framework of haptic design parameters discussed in Chapter 5. To stimulate the non-stop iterative process of DfM, Chapter 6 reports on an evaluation track in which the framework of haptic design parameters is assessed by users of the parameters as well as users of the built environment.

2.2.2 Diversity Through User Involvement: the Expertise of People Born Blind

The design of the framework of haptic design parameters builds on the experience of people who are blind. Because blind people are said to be the user/experts\(^1\) in multisensory experiences in the built environment,\(^2\) they are our key participants. Their expertise for this research is grounded on the fact that people born blind are better trained in non-visual perception and consequently they are more attentive to haptic experiences as well. Therefore, they will be able to detect a wider range of haptic experiences and in a more detailed and profound manner.

As explained in Chapter 1, visual stimuli take a large share in the whole process of sensory perception and often largely influence other sensory experiences. Therefore, non-visual qualities and experiences in the built environment are ideally examined when vision is absent. Indeed, as David H. Warren states, vision provides a framework into which every spatial sensation is integrated and one that makes a person interpret the spatial aspects of non-visual sensations.\(^3\) Since vision has too much of an organizing role in spatial perception, working with blind people has much to recommend it. Robert Kitchin explains that, “an understanding of how persons with visual impairments or blindness understand space could lead to the planning of environments that are easy to remember and that facilitate greater and more pleasurable use. This understanding could also provide knowledge about the content, form and location of spatial information that should be made available to blind or visually impaired pedestrians. In addition, it could provide clues about how to enhance this group’s way-finding and orientation skills by supplying feedback on current knowledge and strategies of thought. Such feedback could provide mobility specialists with information on how to teach more effective strategies of spatial thought and could provide navigation aid designers with benchmarks for measuring the impact and effectiveness of various training strategies and mobility aids.”\(^4\) We cannot learn about purely haptic spatial perception by studying people who both see and touch the stimulus object because, even if a sighted person closes his or her eyes, visual information

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\(^{1}\) Ostroff, Elaine. “Mining our Natural Resources.” INNOVATION, the Quarterly Journal of the Industrial Designers Society of America 16.1 (1997): 33-35. We refer to Eileen Ostroff an international leader and design advocate who has had a significant impact on both design practice as well as design education for over 30 years. Highly regarded for her expertise on issues of accessible and universal design, for involving user-experts in the design process and for her collaborative style, Ostroff remains one of the world’s leading advocates and authorities on innovative design solutions that enhance the experiences of people of all ages and abilities. As she developed in 1989, the Universal Design in Education Project (UDEP) with support from the National Endowment for the Arts which inspired similar programs in Norway, Sweden, Belgium and Japan, and has a Global Universal Design Educator’s Online Network with more than 400 participating educators, we decided to use in this context the term “Universal Design” instead of Design for all. Biography Ostroff on http://www.vic2010.com/files/ElaineOstroff.pdf (August 9th 2010)


is not totally excluded. This is different for people born blind as they have no residual vision and lack a visual reference system. Similarly, Hollins states that, “Only when the subjects of an experiment are congenitally blind, can it be stated with certainty that visual experience plays no role in their touch perceptions.” Consequently, our research focuses on the expertise of people who have no residual vision or have never been able to see, or people who became blind before the age of three to five years. This is because people who have more than five years of visual experience may have built up a visual reference system. Theodore Schlaegel found that reports of visual images predominated in the case of most individuals who had become blind after the age of six, but in none of the participants blinded prior to that age. Besides the influence and existence of a visual reference system, research shows also that blind people, who have no visual history, totally depend upon their other senses. Gordon Dutton, an ophthalmologist, confirms that the first seven years are critical for the development of vision, hearing, intellect and social development. Hollins argues that when attempting to define the nature of haptic perception the ideal solution is to work with people born blind: “A better strategy for learning about pure haptic perception, uncontaminated by visual influences, is to study congenitally blind people who have not acquired sight, as they explore and learn about objects in their environment using the sense of touch.” Susanna Millar adds that in the absence of sight the proprioceptive and kinaesthetic information given by people born blind is both crucial and more reliable. Moreover, blocking vision can increase the perceived intensity of other senses. Interestingly, people born blind do not ‘miss’ sight: “they know that the faculty exists, that life in a world where most people can see would be more convenient if they could too, but they do not long to see the sunset”, states Hollins. This supports the fact that they rely on their non-visual senses in the first place, which is appropriate given the aim of our research.

The expertise of people born blind in experiencing non-visual aspects is widely recognized, as they are more sensitive and attuned to this ability. Due to the absence of visual stimuli, people born blind daily rely on the input of non-visual stimuli for the exploration and experience of the built environment. Consequently, they are very well trained in the process of non-visual perception. Susanna Millar points out that the people born blind rely in large measure on haptic information for their spatial awareness: “In blind conditions the crucial information is haptic. It depends on active movement rather than vision. Information from movement output thus plays an important, and probably crucial, role in tactual recognition.” Similarly, the philosopher George Berkeley points out that congenitally blind people have a reasonably good understanding of space and perceive the spatial arrangement of objects in the environment accurately, when examining them by touch. Hollins thus follows Berkeley’s statement that refers to the ability of blind people to rely upon the sense of touch.
Besides presence (or absence) of residual vision, the cause of blindness, the kind of visual impairment, the age of onset, the duration of being blind are all factors that may contribute to the spatial knowledge and perception of blind people. People born blind will thus be the user/experts in this research and provide information about non-visual qualities and haptic perception in the built environment, because they are more attentive to non-visual stimuli\(^2\) and consequently to the haptic sense. The findings primarily focus on haptic experiences and will not unnecessarily be influenced by visual stimuli.

2.2.3 A Human Centred Design Attitude

Whereas architects are used to creating from a design-centred perspective in which vision dominates, our research requires a position that is human-centred\(^3\) because it focuses on the users’ point of view and tries to find haptic qualities and constraints in architecture based on the experience of user/experts and their perception of the built environment. In line with the general human-centred approach\(^4\) of this doctoral research, a phenomenological approach towards data collection and data analysis is recommended because this approach does not start from a visual object but instead focuses on the acts enacted between the user and the environment. Taking a phenomenological point of view, and in order to identify haptic experiences in the built environment we adopt a qualitative research methodology, following the principles of Grounded Theory, in which meaning is found in the experience itself.\(^5\)

Grounded Theory is a research methodology that grew out of the necessity to approach reality without proven theses in mind: “A true Grounded Theory is abstract of time and place. It generates conceptual hypotheses that get applied to any relevant time, place and people, and people with emergent fit and then is modified by constant comparison with new data as it explains what behaviour obtains in a substantive area.”\(^6\) Kenneth Carruthers states that architectural space eludes reproduction and must be experienced in order to be understood.\(^7\) A qualitative research methodology is therefore more appropriate. Although qualitative research was long perceived as subjective, non-scientific or unverifiable, scientists increasingly acknowledge the diversity and richness of this type of research. In the domain of social sciences, as well as disability studies, qualitative research is becoming a common methodology.\(^8\) Qualitative research is exploratory and particularly useful when the researcher does not know which important variables require examination. Very few researchers interested in architecture have conducted research into sensory-inclusive design in real settings with the help of blind people.\(^9\) Similarly, research into the haptic experience in relation to architecture is

\(^4\) Professors Patrick Whitney explains that designers have to change their attitudes and move from a “design centred approach” towards a “human centred approach”. He stresses that designers create in the first place for people and that therefore the human factor is prior to the design related factors, for example aesthetics. X. “Design in a Global World: Interview with Professor Patrick Whitney.” FAAE News Sheets 66.June (2003): 19-21.
\(^8\) Desnorck, Geertje. Mensen met een handicap. Gent: Academia Press, 2007:15
Whilst there has been an increasing interest in the senses in recent years, few studies have paid attention to the senses in relation to architecture or urban studies. The topic is new and, to our knowledge, has never been investigated through the expertise of people born blind. Existing theories do not apply to the particular group under study. For example, many of the studies with people born blind rely on knowledge of visual perception and can only be validated by the participants using visual perception. According to Janice Morse if little research has been conducted on a concept or phenomenon it asks for a qualitative approach.

The questions addressed in this research require an interdisciplinary approach that is based on scientific research conducted in psychology, sociology, anthropology, neurology, product design and architecture. Qualitative research can capture and reconcile data from different research areas. It opens up the way for an analysis of material using interpretation. In other words, our research fits within an interpretative framework supporting a phenomenological approach. It considers the built environment and its users as an interactive whole. Human behaviour is viewed as an intentional action that is focused upon something. Meaning comes from interaction. Three types of study are recognized within qualitative research and its interpretation: ethnographical, case and theoretical studies. The more research methods that are used, it is argued, the richer and more valuable the resulting material. Our research combines multiple data collection methods in relation to haptic experiences in the built environment: in-depth interviews, guided tours, observations, photo-ethnography and focus group interviews.

The remainder of this Chapter explains the main decisions taken for the research methodology and the reasoning behind the research design, as well as the different research methods applied. As each Chapter describes a different research track, we follow the sequence of Chapters in describing the different research methodologies applied, the road map towards a framework of haptic design parameters (Fig. 2.3).

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42 Boeije, Hennie. Analysere i kvalitativt underzoek. Amsterdam: Boom Onderwijs, 2005. 20
Fig. 2.3 Road map of research design
2.3 Theoretical Track

The framework of haptic design parameters aims to support designers of the built environment by offering information, inspiration and feedback related to haptic aspects of their designs. Before we are able to outline the main parameters involved in haptic experience in architecture, we first have to identify what haptic experience in the built environment exactly is. To answer this question we divide it into different sub-questions: What does experience mean in relation to architecture? What is experience in the built environment for people born blind? and What is haptic experience? The search for the answers to these questions structures the theoretical track in Chapter 3 that characterises three main Sections:

1. Defining Experience of Architecture
2. Blindness as a Form of Expertise of People Born Blind
3. Haptic Experiences in the Built Environment

The theoretical track will be of help when outlining the empirical track since a constructionist approach is taken: theoretical insights are used to evaluate the empirical results by means of cross analysis.

2.3.1 Defining Architectural Experience

The first Section of Chapter 3 investigates the meaning of experience in architecture. We make use of insights in perception to describe experience in architecture. Perception can be linked to spatial experience. Gernot Böhme outlines the importance of studying perception first, instead of the stimuli, and states that designers already do this intuitively: “One could learn more about synaesthesia from these aesthetic workers than from sensory physiology, psychology or aesthetic theory. The theory generally takes as its point of departure the prejudice that there are five senses with specific sensual energies and specific sensual qualities, and only searchers for so-called intermodal qualities or emotional effects of the sensual qualities when proceeding from this precondition. The reasons for this theoretical situation seem to me to lie in the fact that the phenomena of human sensuality are not generally analysed from the point of view of perception, but from that of their cause, the so-called stimuli. It may well be time to invert this relationship”.42

What Böhme tries to clarify is that designers need to understand the very essence of an experience before they can actually design for that experience. If designers have a better insight into the way people perceive, they can design appropriate environments. Similarly, O’Neill states that it is helpful for the designer to understand the modes of perception and learning that give people the information they care about in a particular setting.43 It is clear that if designers want to know how people experience the environment haptically, then understanding the link between perception and material creation in the environment is crucial.

2.3.2 Experience as Form of Expertise of People born Blind

The second Section of Chapter 3 zooms in on blind people as they are the users/experts in this research. Literature shows that before one can design with, and for, people with visual impairments a thorough background study is required. This Section starts with a historical overview on blindness. Molyneux’s question marks a turning point in the history of blind people. From then on, people without vision were increasingly examined in terms of their perceptual knowledge and capabilities. The question deals with the interconnectivity of the senses and the spatial knowledge of people who are blind. Additionally we define the meaning of blindness as it is an umbrella term that requires further clarification. Furthermore, this Section zooms in on how blind people deal with spatial knowledge. A considerable number of studies have been conducted together with people born blind. Révész categorised five different domains in research on blindness: medicine, philosophy, psychology, pedagogy and sociology. Today we can expand this list with several domains: computer sciences, neurology, engineering sciences, design... Most studies describe attempts at solving immediate problems with specific solutions, like adaptable pavements for people with visual impairments. Some of these studies even insert or rely upon visual cues for studying spatial exploration of people born blind. Moreover, the research methods used in several research domains are highly heterogeneous, and many inquiries are debatable. Roberto Passini and Guylène Proulx state that this is due to two aspects: first the different variables in visual impairments and second the heterogeneity in experiments.

First blindness is characterised by a huge variety. Studies often neglect specific characteristics on blindness or blind participants. Blindness can appear in different degrees and in different forms because people can become blind for different reasons and at different ages. Consequently, people’s spatial knowledge may considerably differ depending on the age of onset blindness and the eye condition itself. Both influence how a person perceives and represents space. However, studies show that few researchers pay attention to this diversity. This results in a misinterpretation of cognitive abilities. As a result researchers still disagree about the ability of blind people to understand spatial relationships or build an accurate cognitive map.

Nevertheless, in the context of our research the important question is not so much, whether or not blind people understand space the way sighted people do, but rather how they experience space and what their marked and attentive perception of non-visual qualities reveals.

Secondly the disagreement on spatial abilities may be due to the fact that studies are very varied in terms of research set-up, goals and research domains. For example, many researchers conduct studies in small-scale demonstration settings, while it is more appropriate to work in complex environments resembling real-world environments. On the other hand, much research relies on characteristics requiring visual knowledge. It is clear that researchers need to consider these complexities when formulating and testing their research questions.
hypotheses. Otherwise the research set-up itself already may lead to different opinions and approaches towards the spatial abilities of blind people.

However, despite the large number of research domains conducting studies on blindness, and their huge heterogeneity, architectural research using the expertise of people born blind is rare.

Whereas several laboratory and environmental studies take place in the domain of psychology and geography, research in the domain of architecture is rather uncultivated. Roberto Passini and Guylène Proulx already indicated this lack of attention for blind people in the built environment in the 1980s. Geographers and environmental psychologists responded to this lack and at the end of the 20th century, interest arises in research on wayfinding with blind people. Researchers like Robert Kitchin, Daniel Jacobson and Mark Blades, already included people born blind. Yet, in general, orientation is their focus and experiments take place in laboratory settings or based on models. Consequently, the experience studied is rather artificial compared to experiencing architecture in real time. In psychology, different researchers also showed interest in the spatial experience of people born blind. For example, Révész and Karlsson conducted studies with blind people and focus on experiences of spatiality to learn more about non-visual perceptual experiences.

Nevertheless, to our knowledge, until recently only two researchers in architecture conducted research with the help of people with visual impairments focussing on the multisensory experiences. Camilla Ryhl did research in home environments with visually impaired people and Marta Dishinger focussed her research on the urban environment. Design practice pays also little attention to the expertise of blind people, unless they own the building. Occasionally a design is adapted to a blind user, yet rarely is it conceived with the expertise of someone who is blind.

2.3.3 Focus on Haptic Experiences in the Built Environment

The third part of the theoretical track, introduces the reader to the world of haptic perception and experience. This Section explains the nature of touch and focuses on why, what and how we touch within the built environment. Depending on the research domain it is used in, ‘haptic’ is a term with different connotations. Therefore this Section starts by clearly defining the meaning of the term haptic in relation to architecture. Subsequently, an overview of the historical, cultural and social context surrounding the sense of touch is given. Despite the rich sensory information given by the sense of touch, it has long been viewed with contempt. Today, the importance of the haptic sense is recognized and its relationship to the other senses is investigated. Recent scientific studies have brought a new level of insight to the interconnectivity of the senses and the position of the haptic sense in relation to them. Besides providing new perspectives on the meaning of haptics, it is interesting for designers to know how, and why, people touch.

But why did we focus on the science of touch in the built environment or haptics? There are many different reasons, on many different levels, for focusing on haptics. Firstly, the characteristics of the haptic system play a key role in the experience of the built environment. Secondly, cultural, philosophical, neurological and sensory points of view are a motivating force. Consequently the desire to study the haptic system stems from an interest in both architecture and the sense of touch.

2.3.3.1 An Architectural Approach

From an architectural perspective, the haptic sense is important. Kent Bloomer and Charles Moore, architects and architectural critics, contend that as far as the built environment is concerned we know and feel the most thanks to our haptic and basic orientation system. 57 This is substantiated by Juhani Pallasmaa’s statement that, “all the senses, including vision, can be regarded as extensions of the sense of touch – as specialisations of the skin. They define the interface between the skin and the environment – between the opaque interiority of the body and the exteriority of the world.” 58 We use most of our senses in a very subtle and almost unnoticeable way when exploring the built environment. Ultimately, the haptic sense is one of the most explicitly apparent senses because it requires the body to move or something to be felt through the body. The haptic sense differs from other senses because it enables us to modify and manipulate the world around us. 59 We cannot change our environment through sound, sight, smell or taste - but we can through haptic body movements. The reverse is also true: the sense of touch can leave its own mark on the body; for example, the skin can be dried by the sun and roughened by the wind. 60 Such a strong level of interaction reveals the importance of touch when experiencing the built environment. Even in the exploration of the environment, states Gregory Burton, the importance of haptic perception is vital. He considers it to be universal amongst animals. 61

2.3.3.2 A Sensory Approach

The sense of touch is quite remarkable: it was long viewed with contempt, whilst its capacity was never denied. 62 Throughout history this contradiction did not go unnoticed by philosophers and anthropologists who explicitly choose to either elevate, or denigrate, the sense of touch. Consequently, vision and touch are frequently considered to be opposites. Although vision is often called our primary sense, some recognize the capacity and importance of haptics. Denis Diderot, the French philosopher, considered that of all the senses, “touch was the most profound and philosophical of all the senses and that sight was the most superficial.” 63 The anthropologist Ashley Montagu also shows his preference for the sense of touch and names it the parent of all the senses: “The skin is the oldest and the most sensitive of our organs, our first medium of communication, and our most efficient protector... Even the transparent cornea of the eye is overlain by a layer of modified skin... Touch is the parent of our eyes, ears, nose and mouth. It is the sense which became differentiated into the others, a fact that seems to be recognised in the aged-old evaluation of touch as ‘the mother of the senses’.” 64

The first senses that a foetus develops are haptic. These also happen to be the senses that first respond to stimulation. 65 According to John Paul Eberhard, “the sensory systems of the human foetus develop in a predetermined sequence. Four of them - touch, pain, position, and temperature sensitivity - are the first to appear”. 66 Human beings cannot exist without touch. The importance of haptic perception is underlined by different and specific aspects that show it cannot be replaced by other senses. Marieke Sonneveld puts them into categories: first, the awareness of oneself as people constantly physically interact with the built environment using the whole body; second, the knowledge of the material world as the experience of touching the environment embodies the very essence of what haptic perception is all about (people need to touch the world in order to know and understand it); third, the development of feelings and emotions, because

touch is the basis for the sensation of contact and, last but not least, touch as a specific communication channel. Whereas vision and hearing are remote senses, haptic perception implies contact and thus bodily involvement. According to Harlow’s study: “Touch deprivation early in life stunts growth, both physical and social.”68 Touch is a sense that carries many socio-cultural connotations. It has also shown to be therapeutically effective and it is a widely recognised, universal means of social communication: the act of shaking hands, for example.69 From a sensory perspective, haptic perception is thus shown to be equally important to other sense.

Chapter 3 defines haptic experience in the built environment based on the expertise of people born blind. The findings result in a theoretical framework that summarizes the levels of mental processes involved in a haptic experience in architecture. The literature study in Chapter 3 also reveals that little research on haptic experiences in the built environment has been conducted. The available results are insufficient to set up the framework of haptic design parameters. From the start empirical studies were involved in the research design, but after the literature study they appeared essential to identify the haptic design parameters in the built environment as well as their values. Empirical research is therefore conducted with people who are blind and it is the topic of the Empirical Track as described in Chapter 4.

2.4 Empirical Track

Chapter 4 reports on the findings of the empirical studies. Few precedents on empirical methodologies in sensory research are available. We follow the principles of the Grounded Theory and therefore we make use of multiple research methods. The more research methods, the richer and more valuable the material. Based on findings in pilot studies as well as theoretical and methodological background, we developed three main methods:

- Home visits to adults born blind in which in-depth interviews are combined with guided tours through the home
- Photo-ethnography with children born blind
- Focus group interviews with professional caregivers

The main aim for each study is to understand the participant’s haptic experiences as profoundly as possible. In research, this focus on experiences of participants is better known as an emic point of view. Applying a cultural model of disability that considers disability as an expertise, we use the expertise and insights of people born blind as the basis of the research set-up. The following Sections report on our approach for the research design of the empirical track and the motivation behind each study.

2.4.1 Pilot Studies for Empirical Track

In designing the empirical track we conducted pilot studies in order to become familiar with the world of people born blind and to look for leads that would help with setting up the structure of the empirical research. They form a background for the creation of the empirical track. The aim was to identify the most appropriate research methodology based on feedback and insights gained from immersion in the world of people born blind.

2.4.1.1 MuZIEum Nijmegen

The pilot studies started with a visit to the muZIEum in Nijmegen (NL) (Fig. 2.4). We accepted an invitation to guide four blind people to the museum. The staff of the museum ensured that the visit was very personal and participants could feel sculptures placed on a crescent shaped pedestal. The art works triggered the almost constant exchange of haptic experiences between the participants. This exploration revealed that besides through materials, haptic

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Fig. 2.4 MuZIEum, Nijmegen (NL)

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Pilot study conducted on March 5th 2006. On May 31st 2010 the muZIEum in Nijmegen closed its doors. After 6 years of interesting exhibitions it no longer exists due to reform. [http://www.muzieum.nl/](http://www.muzieum.nl/)
aesthetics were also supported through details. Questions were asked about the museum space but, as the focus was on the sculptures, none of the participants were interested in being interviewed about the built environment during the visit. On the way back home, the participants reflected upon their experiences and commented that the shape of the pedestal had functioned extremely well as an orientation tool. Surprisingly, the conversation and guidance of the participants on the way to, and from, Nijmegen was of more interest to the research than the visit itself. When passing fences, for example, all participants suddenly started to slide their canes along the rails. This gesture resulted in a form of music. One of the discussions on the train was about the smell of a train compartment. Both events illustrate the fact that blind people are more attentive to the non-visual senses and that when investigating the experiences stimulated by the haptic sense, personal interviews with blind people are more appropriate than group interviews. Haptic perception is an intimate sense and it is therefore important to create a feeling of trust between participant and researcher. Moreover, well known environments can be expected to stimulate confidence and trust.

2.4.1.2 Louvre, Paris

On May 16th 2006, we were invited for a private guided tour through the Louvre. In an empty 60,000 m² museum two people born blind and two sighted people walked from one art experience to the other (Fig. 2.5). The guide invited the two people born blind to touch sculptures, ranging from a sphinx to a work by Rodin. Once again, two important things came to the fore: the importance of materials and the fact that, when visiting a museum, the participants’ attention is devoted to the experience of touching the art works. It is therefore not the place for spontaneous conversations about personal experiences of the built environment. According to Karin De Coster, it is still evident that museums have principally been constituted as ‘spaces of seeing’. For this reason as well, Kevin Hetherington points out that to be in a museum without vision is a problem: “to be without sight in such a space is to present a problem.” Therefore, for the research we wish to undertake, museums are not ideal locations. Moreover, in new environments blind people focus mainly on orientation, whereas our research aims to look also at aspects of experience.

2.4.1.3 Private Home of a Person with a Visual Impairment

In January 2007, a visit was made to the residence of a man born with a visual impairment. He owns a software company, located in his home, and personally

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72 The Louvre in Paris, is a museum that is closed on Tuesdays except on special invitations for people with a disability. We were invited to attend this exceptional guidance in a museum without visitors, but ourselves. The Louvre is committed to make its collections and services accessible to the widest public possible. This commitment to accessibility was recognized in 2002 when the museum was awarded a “Tourisme et Handicap” label. http://www.louvre.fr/fr/pratique/alaune_handicape.jsp?bmLocale=en


followed up the entire design and building process of the house. The visit reveals that a guided tour opens up many new insights and, as the inhabitant moves through the house, encourages discussion about different aspects of the environment. Moreover, the man explains how he had been involved in the design process and how this interaction led to different results. For example, one of the reasons why he decided to install an industrial refrigerator instead of a domestic one was in order to create a clear layout and structure in the fridge instead of having to move food to find other nutrients (Fig. 2.6). Besides searching for different machines that might be of use to him, he even started to design himself. To find the ideal size of a room he used tape to mark out the area. This latter observation is both important and interesting because it reveals not just the expertise of people born blind, but also suggests their meaningful contributions in the design process (cf. participatory design).

Orientation strategies as well as experiences were discussed during the home visit. This generated useful information. The person with a visual impairment seemed to feel comfortable at home and this makes conversation more spontaneous and personal. Moreover, it is presumed that the participant may talk longer and that as a result the interview may be potentially more interesting.

2.4.1.4 Tandem Tour to the Sea Coast and visit to an Amusement Park

In the summer of 2007, a bicycle tour to the coast and a day trip to an amusement park provide us the opportunity to work with children born blind and their caregivers (Fig. 2.7). Both activities reveal that children are very honest and spontaneous, but that they are very sensitive to reactions from the group. Moreover, there is a strong pressure from the group as well and it is very difficult to talk in group about private subjects or feelings. For example, their preferences or dislikes for haptic aspects in their environment are not discussed in the presence of others. However, when one of the caregivers picks out a boy and asks him to talk about his experiences in the built environment, this child gives a very open and interesting account about his experiences. Their actions and performances during activities also reveal their expertise and experiences on the sense of touch. For example, we personally experience the children’s awareness for balance during the tandem tour and in the attraction park we notice that the children orient themselves upon bollards that delineate the queues of the different attractions.

During both activities, it also became clear that the caregivers have huge experience with children with visual impairments and that their education and approach has a huge impact on the children.

http://www.demarkgrave.be/
2.4.1.5 De Markgrave, Antwerp

Between December 2006 and July 2007 several observation visits are made to De Markgrave in Antwerp, an institution that offers professional services regarding training, rehabilitation, activities and housing for adults with visual impairments (whether combined with other impairments, or not). Participatory activities take place with the visually impaired adults. As most participants have additional problems, such as mental and/or hearing impairments, the interviews have to be carefully customized to each participant. Some participants have difficulty speaking, whilst others have difficulty understanding the questions. If questions are not understood, they need to be rephrased. Some questions end up being too general which makes it very difficult to compare the interviews afterwards.

In the housing facilities next to De Markgrave, most participants live in a very small room that they have furnished and decorated with the help of caregivers. Consequently, their personal preferences are not fully represented in the interior decoration and, in addition, their involvement in decorating the room is limited (Fig. 2.8). This is because most caregivers regularly buy furniture for the inhabitants in their favourite shops and also give instructions on how the room should look. Similarly common rooms have no personal touch but focus on orientation in the first place (Fig. 2.9). The environment of the inhabitants therefore does not necessarily mirror their own likes.

The main conclusion reached by the pilot study in De Markgrave is that it is important to work with participants who have the ability to make their own decisions as to what they prefer in terms of housing. The location is ideal when looking for objectively comparable home units for different adult participants. However, the residents are not completely involved in the design of their home environment and, due to the variety of disabilities, it is very hard to have a personal conversation and consequently to interview participants.
2.4.1.6 De Vlier, Klavervier and ‘t Wit

Caregivers at Spermalie advised us to make three visits to other community houses that form part of the organisation of the Spermalie boarding school. De Vlier, Klavervier and ‘t Wit are care centres that provide housing and support for visually impaired people via day care activities and recreation. Many residents have severe additional impairments (mental as well as physical). This would make it very difficult to interview the residents themselves. All of the caregivers and managers are aware of the impact of the built environment upon human behaviour and experience, but lack of resources, time and architectural knowledge has resulted in buildings that, apart from good colour contrasts and handrails, lack any special spatial characteristics that would support a non-visual experience. The opportunity to provide a structure or pleasant atmosphere for blind people is lost. It is explained that when some people do not feel well and want to have some time to themselves, or they are unruly, a small dark two metre square room is foreseen for isolating them (Fig. 2.10). However, the environment should be designed so that people feel comfortable all the time and do not need to abreact on the interior or infrastructure. The visits reveal that disability is still very much approached according to the medical model in building community homes for people with different impairments. Caregivers make great efforts to imply the Design for Special Needs concept, but architects also need to be more aware of the possibilities. For example, one of the staircases ends with a half step and many residents fall at that point. Caregivers already marked the stairs, however this is a structural design problem as you do not expect that the last step is chamfered (Fig. 2.11). A positive example is the making of a small interior wall in one of the residents’ room. It was an idea of the parents of the person born blind and supported by the staff of the care centre. By placing a low wall between his desk and his lavatory, in the middle of his room, this resident received a guiding wall that avoids him to bump into furniture or other architectural elements (Fig. 2.12).

2.4.1.7 Discussion Pilot Studies

The visit to the MuZIEum as well as the Louvre made clear that not the museum visit itself is interesting but instead the travelling hours where we guide people to our destination reveal much more experiences on the built environment. The success of guided tours is also clear during the private home visit of a person with a visual impairment. While he walks through the home he continuously speaks and consequently this interview results in a huge amount of interesting information.

Throughout all pilot studies the difference between people with residual vision and people born blind was noticed. Whereas people with residual vision focus on visual information, people born blind rely on their non-visual experiences in the first place. The pilot studies also made clear that group interviews with people born blind are very difficult. Personal conversations are far

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76 The different models of disability will be further explained in Chapter 3
more interesting. Except for the interviews with people who have a visual and mental impairment. At these care centres it was very difficult to build a regular conversation with the residents. Children, on the other hand, are also a difficult group but for different reasons. They fear group conversations about personal subjects and mutual trust is required before they speak on personal experiences. Nevertheless, the children’s spontaneity and honesty is largely appreciated as well as the knowledge and expertise of their caregivers.

The pilot studies at the care centres reveal that the personal home environment in a community home is ideal for the comparison of differences in interior design, but that there is a lack of personal contribution in the furnishing and design of the environment. On top of the difficulties in communication as explained before, this makes participants with no additional impairments better suited. It is therefore concluded that the homes of adults without additional impairments offer the most interesting settings in which to study the haptic qualities and constraints of the built environment.

2.4.2 Participants of the Empirical Track

Based on the findings of the pilot studies and the theoretical background on the expertise of people born blind, we decide that people born blind without additional impairments are our user/experts. As both adults and children showed an interesting expertise, we decided to work with both groups. In addition, caregivers are extremely experienced. The three studies in the empirical track thus involve three different groups of participants: adults born blind, children born blind and caregivers of people born blind.

2.4.2.1 Adults Born Blind

Blind adults without additional impairments tend to perceive themselves as more independent and thus, for the home visits, it is decided to focus on this group. These participants also score higher on quality of life measures than adults who are blind by accident and have additional impairments. Quality of life has become an important outcome measure in the field of disability studies.


Rimmerman and Hanna Morgenstern conducted research with people who are visually impaired in order to measure their quality of life. A higher quality of life was associated with congenital visual impairments and acceptance of visual impairment.\textsuperscript{80} As people born blind do not miss their sight,\textsuperscript{81} they consequently score higher in terms of life quality on the measuring-scale used. Moreover, Steven Hagemoser, Ramiro Martinez and Kenneth Sewell found that people who accepted their blindness perceived themselves as being more independent in their daily activities than did those who had difficulty considering themselves as blind.\textsuperscript{82} If people born blind score better on quality of life measures it suggests that they perceive themselves as more independent as well. In this respect, there is a consensus that the subjective perception of disability is a better predictor of quality of life than is the objective assessment of blindness or low vision.\textsuperscript{83} Some researchers link quality of life directly with the subjective experience of life,\textsuperscript{84}\textsuperscript{8} we presume that autonomy is essential for quality in life (since participants who are more autonomous probably participate in the choice and furnishing of their house). Participants who are aware of their independence are likely to decide themselves, or in agreement with their partners or family, on the purchase or rental of a home and its interior design.

2.4.2.2 Children Born Blind

Children in general are a unique group to research as their perception is very primary. In this respect, they are truly honest and pure. For example, children first used the Crown Fountain by Jaume Plensa in Chicago’s Millenium Park - they knew immediately it is meant to walk barefooted upon the fountain’s thin surface of cooling water (Fig. 2.13).\textsuperscript{85} Bjarne Fjeldsenden states that children who are congenitally blind are very sensitive to poor environmental stimuli and concludes that such children are very grateful when asked to participate in research dealing with the less striking factors of the environment.\textsuperscript{86} Very few studies have attempted to examine the relationship of various aspects of the environment to the overall development of blind children.\textsuperscript{87} Childhood experiences in the landscape represent an important phase of tactile and kinaesthetic learning.\textsuperscript{88} Haptic feedback is very much influenced by a person’s experience so the more one has already touched, the more one will have his/her own way of explaining touch.\textsuperscript{89}

In addition to their honesty and sensitivity, children are the ideal participants for a study on haptic experiences. Anna Halprin praises the spontaneity of the child: “I am level-making a big jump, because what I am saying is that somehow or other we’ve lost the ability to experience as children experience and I use the child because the child has such an instinct to ritualize and create spaces; the child hasn’t yet been deadened.”\textsuperscript{90} John Rieser suggests that children change position more in terms of their body movements than in relation to the layout of external spaces.\textsuperscript{91} In children born blind this phenomenon is even more prominent. Roelof Schellingerhout states that these children rely on an egocentric way of perceiving space, meaning that on...
the one hand they perceive their position in relation to their own body (and not in relation to the environment) and on the other hand that they perceive spaces in terms of the movements that have to be made. These movements of the whole body are fundamental for haptic experiences.

2.4.2.3 Caregivers of People Born Blind

The people who care for people with visual impairments can provide invaluable insights and information about certain daily experiences. According to several researchers, the influence of education in an institute for the blind is a very important aspect in the experience of blindness. Hollins states that if parents and educators work together to strengthen the child’s haptic skills, it can confidently be predicted that an increased mastery of the physical environment will result. Besides particular individual differences among children it is pointed out that the amount of early training, for example for mobility, will be decisive. Along the same line Dewey states that true personal growth can only be achieved through experiences. The caregivers stimulate, support and witness these experiences on a daily basis. Their background knowledge can verify and clarify other findings and impressions.

2.4.3 Home Visits

The implementation of the empirical track starts with the home visits to adults born blind. The idea was partly based on the interesting findings of the pilot study in the private home of a person born blind. Furthermore there were several theoretical, methodological as well as pragmatic reasons to conduct studies at home. We zoom in on the most important aspects that motivated this choice.

First considering the use and meaning of different building typologies, the different connotations of ‘home’ are recognized as a supporting element of our research into haptic experiences. Several researchers have elaborated on the meaning of ‘home’ and consider it as a multidimensional concept. Home is symbolic of who we are, our taste, our family structure, our hobbies, our life-style. To refer to Martin Heidegger, dwelling is “the essence of Being-in-the-World”. Most physical housing units also represent this by means of the social aspect or household. Different meanings come to mind when talking about home, ranging from a purely physical object to the home as an extension of our sensorium. The latter is motivated by Michel Serres who elaborated on the home as a second skin that enlarges our sensorium. The impact of home on our sensory being is also explored by Avtar Brah who explains that “being at home” involves the “immersion of a self in a locality”. The locality influences us via the senses and defines the multisensory experiences. Equally,
individuals also influence the locality. Shelley Mallet supports this theory and concludes that the boundaries between home and self are permeable.\footnote{101} Donald Norman regards homes as the biggest sites of customization. He refers to newly constructed, identical-looking houses that soon transform themselves into individual homes as their occupants change furnishings, paint, window decorations, lawn and, over years, modify the house’s structure, add rooms, change garages and so on.\footnote{102} The home is certainly a sensory domain, according to Sarah Pink.\footnote{103} She explains that the term refers to the modern Western home, as a domain that is a multisensory, ‘mere experience’ (understood to be composed of the cultural categories of smell, touch, taste, vision and sound) and created by human agents through manipulation of these sensory elements.\footnote{104} Whereas most anthropological and disability studies of the home have focused on material aspects, our research aims to focus on the haptic experiences in the built environment by means of the expertise of people born blind. Understanding the way blind people live is an advantage in this context. “Our residence is where we live, but our home is how we live”, states Robert Ginsberg.\footnote{106} As a designer it is interesting to know how people live but also why they live that way. The process of design requires knowledge about how we live and, as Akiko Busch points out: “the process of design has very much to do with how things fit—how things fit the hand, how furniture fits the body, how people fit in buildings, and how buildings fit the landscape”.\footnote{108} Therefore it is important to identify different ways of making things ‘fit’. In analysing how congenitally blind people move through their home, we want to gain a clearer insight into our haptic perception system and how haptic characteristics can help make the built environment ‘fit’. Christopher Alexander described a “degree of fit” as the relation of mutual acceptability between form and context.\footnote{107}

From a methodological point of view, it was also interesting to conduct research at home. According to Norman Denzin and Yvonna Lincoln, the best habitat for qualitative researchers is a familiar setting: “qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meaning people bring to them”.\footnote{108} This approach fits in with the aim of Designing for More in which the experiences and perspectives of user/experts are applied to an investigation of the environment.\footnote{109} In addition, research methods regarding inclusive design, as well as haptics, are often very heterogeneous. Moreover, many architectural studies extrapolate findings on an urban scale, while the studies are based on laboratory set-ups on a micro scale. Instead, the recommendation is to undertake research in settings that actually exist. Although it is more complex, it is also more truthful.\footnote{109} Unfortunately, these studies are too small in number.

Furthermore, our decision to work within people’s homes is motivated by the absence of architectural research into housing related to inclusive design. Researchers confirm that there is a need for research into inclusive design within the home environment. Robert Imrie explains that explorations of the meaning of the home, and housing studies more generally, rarely consider the body and impairment and its interactions with domestic space.\footnote{111} This is curious because impairment is a significant and intrinsic part of the human condition and can affect anyone at any time. Finally, there was an additional advantage to work at home with people born blind as they always have to overcome the fear of physical obstacles that comes when moving to, or through, an unknown place. We assumed that choosing an unfamiliar location for the empirical study would result in a list of physical barriers and hamper any discussion of the spatial experience. Interviewing people at home has an additional practical advantage:

\begin{itemize}
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the participants are not asked to make a journey to a new place, which lowers the threshold to participate.

2.4.3.1 In-Depth Interviews

The home visits began with semi-structured in-depth interviews with the participants. The advantage of such an approach is that there is a guiding principle that allows greater comparability across different interviews, but the questions can follow a different order depending on how the interview unfolds. As a result, the interview appears to be an ordinary conversation born out of mutual trust, whereas the structure of the questions means that the main topic is not deviated from. Because we are to meet participants for the first time, we anticipate that many interviewees will feel uncomfortable. A reassuring conversation can generate a great deal of information. It is not important how many people have the same haptic experience of an object. Instead, it is vital to find out how and why people rely on haptic perception. The in-depth interviews mainly ask people ‘how?’ and ‘why?’ instead of taking a quantitative approach by asking ‘how much?’ Frequency is less important than the meaning of the experience.

2.4.3.2 Guided Tours

The idea of complementing the interviews with guided tours through the home is inspired by a phenomenological approach that focuses on the practice and the ways people ‘do’ and ‘feel’ home, rather than the ways in which they ‘think’ about haptic experiences at home which is the focus of the in-depth interviews.

As O’Neill states: “Planners, environmental designers and design students can acquire a better understanding of what is important to people who feel a connection to their surroundings, and how they develop their topistic sentiment by examining the perceptual and place-learning patterns of various individuals and populations.” The fact that guided tours take place in, and discuss, the personal environment encourages long personal conversations. John Paul Eberhard states that our experiences of an environment are saved in our long-term memory and consequently will connect to personal feelings. He explains: “Here is an important point for architects. Nothing is stored in long-term memory that you have not personally experienced - another person cannot cause your brain to remember the things he or she remembers.” Consequently, if participants would guide us through the built environment we assumed that certain personal experiences could call up memories on haptic experiences in the built environment and could perhaps provoke haptic actions.

These guided tours’ phenomenological approach asks for a corresponding methodology. As explained by Bermudez, architecture lacks methodologies to conduct phenomenological studies: “As our discipline lacks enough knowledge on a phenomenological approach, importing models from other fields appears to be an appropriate starting point. In this sense, the narrative arts (especially those involved with the temporal representation of audio-visual narratives) offer us the best insights. For example, principles of cinema and storytelling give us an excellent guidance for designing architectural experiences that have a structuring theme (parti), a plot (order), unfolding episodes (rhythm), and special events (details).”

Inspired by sociological and anthropological studies we decided to analyse these guided tours by means of video ethnography. In disability studies it is used only recently, but in sensory research it is a common methodology. Sarah Pink points out that ‘walking with video’ identifies a phenomenological approach as it attends to sensory elements of human experience and place making. According to Pink, walking with another person allows researchers to learn about the participant’s experiences empathically. Her basic assumption is based upon

Steven Feld’s phrase: “as place is sensed, senses are placed; as places make sense, senses make place”.\textsuperscript{120} Starting from this idea of embodied experience, in which the sensory body organises an environment through experience, we decided to record these guided tours on video.

However, video also has limits. It cannot record haptic experiences that do not require movements of the body, or sensations such as smell or heat. Human beings have their full sensory capacities (colour, full resolution, peripheral vision, etc.) available, whereas standard video is not even capable of capturing the amount of detail visible on a medium-resolution workstation screen.\textsuperscript{121} Furthermore, from a methodological perspective, it might seem awkward to use a visual technique for analysing haptic perception of blind people as they are not familiar with the medium. Nevertheless, these aspects do not undermine the many advantages that video offers to our research.

Whereas in some research projects people are influenced by the presence of a camera,\textsuperscript{122} blind people are less aware of it. Consequently they behave in a much more spontaneous way. Moreover, the guided tours could provide a shared resource that identifies gaps between what people say they do (in the in-depth interviews) and what they actually do.\textsuperscript{123} Researchers have shown that synchronizing movements with another person is a way for one person to indicate to another that they wish to establish ‘an action exchange system’\textsuperscript{124} without making an explicit request. By simply picking up on the rhythm of another’s movements or speech, people establish a connection that, at the same time, does not commit them to an explicit initiation.\textsuperscript{125} In this way, recording a walk on video can connect the researcher and participant in an unconstrained way.

Another interesting aspect is that there is a thin line between the visual and haptic experience in terms of communication and perception in the built environment (as will be discussed in Chapter 3). According to MacDougall, the visual offers a second route to sensory experience.\textsuperscript{126} In 1898, Alfred Cort Haddon was one of the first academics to use film as part of his expedition to the Torres Straits Islands, a large multidisciplinary expedition to scientifically study the Island’s inhabitants. According to Alison Griffiths, Haddon’s filmmaking was a form of ‘haptic cinema’ as the film invites people to ‘feel’ or ‘touch’ the image.\textsuperscript{127} This sensory approach would have been a rather new and innovative way of filming as it created a ‘sensory rich’ experience.

Video is also an ideal way to record movements. Movement, as part of haptic experiences, is an important, yet underestimated, aspect in the experience of the built environment. Paul Zucker states that space can be experienced through visual and kinaesthetic perception.\textsuperscript{128} This explains why people move through space in order to explore it and acquire topographical knowledge.\textsuperscript{129} A phenomenological perspective can bring an important dimension to disability studies just as the living body maps out the temporal-spatial world through movements and actions.\textsuperscript{130} To cite Isadora Duncan: “All gestures have a moral resonance, and thus can directly express every possible moral state.”\textsuperscript{131} By means of proprioception and tactile acts, place is made in space and meaning is given to our environment. Walter Benjamin’s notion that our everyday perception of the built environment

\textsuperscript{120} Feld, Steven, and Keith H. (eds.) Basso. Senses of Place. Santa Fe: School of American Research, 1996-91.
derives from use indirectly fits in with how we approach the haptic sense in our research.  

Although we focus on movement, language may give meaning to the experiences. During the guided tours people speak aloud. This can be considered an ‘inner conversation’ as described by George Herbert Mead: “The self which consciously stands over against other selves thus becomes an object, and other to himself, through the very fact that he hears himself talk, and replies. The mechanism of introspection is therefore given in the social attitude which man necessarily assumes toward himself, and the mechanism of thought, in so far as thought uses symbols which are used in social intercourse, is but an inner conversation.” In this way, the guided tour is an act of giving meaning to the environment through walking and conversations. The researcher also takes part in this process. As mentioned before, we all rely upon our haptic system. But according to Rachel Sullivan, touch differs from the other senses in that it always requires the presence, together and separately, of the body or object we touch and the body part we touch with. Eisenbach states that as a result, the effect of space on movement and, reciprocally, the effect of movement on space are intertwined and inseparable. Consequently, haptic perception usually requires movement of the body or the movement of the surrounding environment. For example, we can experience floor textures by shuffling barefooted through the house. Movements evoke haptic experiences. These haptic experiences are revealed through the guided tours.

2.4.4 Photo Tour

The second Section of Chapter 4 describes a photo ethnographic study together with children born blind. The pilot studies showed the children’s honesty and spontaneity. Moreover, due to their young age, they are less cultivated and consequently their haptic experiences are in a sense more pure. Based on these benefits, we addressed in December 2006 a call to boarding schools for blind children in Flanders to ask whether we could conduct temporary observations.

Representatives of all these schools attend a monthly meeting, in which upcoming research projects and calls are discussed. We were invited to present our topic and research set up during one of these meetings. Based on the findings of the pilot studies it was important to observe children with few, or no, additional impairments. The members of the group agreed that Spermalie in Brugge would be the best location for the research as most of the children there have few additional impairments, if any at all; other institutes provide care and education for a higher number of children with profound mental disabilities.

Spermalie is the oldest institute for the education of children with autism, visual or hearing impairments in Belgium. It currently takes care of 81 children with visual impairments. From November 2007 till March 2008, we conducted observations on a weekly basis. The observations took place at the LAVI-department, with a group of children between the ages of 3 and 13 years old, attending kindergarten and primary school classes at the boarding school. For the first two months no other activities were planned other than those organised by the educational staff. After two months, mutual trust had grown between the researcher, children and teachers. With the approval

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136 As the researcher’s mother tongue is Dutch, interviews were conducted in Dutch, because in this way trust is created in a more easy and natural way and language is used in a proper way. Marike Sonneveld PhD, used English as research language whereas the participants were Dutch speaking, consequently this led to poor language use and many mistakes. In Sonneveld, Marike. Aesthetics of Tactual Experience. Delft: T.U.Delft, 2007:201.
137 Up till 2009 the education for children with special needs has been categorized in groups of disorders. In practice this means that children are first diagnosed based on a language, speech or learning disorder before the child is allowed to go to special education. A working paper of the Flemish minister of education in 2005, Frank Vandebroucke brought the topic back on the table and questioned this 30 year old categorization. Meantime the Flemish government agreed upon a reformation and started from September 2009 with a new approach. The main change is that the focus lies on the child’s education and needs instead of its dis- or abilities.
139 LAVI is an abbreviation for ‘lagere visuele’ [primary school visual impaired] referring to the primary school for visual impaired children.
of the educational staff, the care supervisor allowed us to plan specific activities in the context of our study. The final study was a photo tour. The specific details for the motivation of a photo ethnographic study at Spermalie are described in Chapter 3.

Photography as research methodology is not new. Not only architecture but also other cultural phenomena triggered photographers to use the camera as the key for documentation. In the 19th century, colonialism stimulated researchers to visualise new cultures. Starting as a documentary act this colonial photography soon resulted into the starting point of what has become visual anthropology. Although these documenting pictures brought interesting information to the Western world, photography was used in its best-known way: the researcher taking photographs of the subject under study. John Collier Jr. is best known as one of the first developers creating this connection. Together with Malcolm Collier he wrote *Visual Anthropology: Photography as a Research Method*, a manual for a systematic approach to visual research.

However, using photography for conducting research with blind children on the haptic sense in the built environment might seem as paradoxical as the video tour during the home visits. Different from photographers who adopt a visual approach, the photographers in our study experience the built environment in a non-visual manner. While photography is intended to create a visual outcome, our study puts visual triggers out of order due to the children’s capacities. As a result, their photos arise from other non-visual sensory experiences and stimuli. All these sensory stimuli can be triggers for taking a picture.

Using photography as a tool for communication with people with impairments is not new. In the 1970s researchers like Robert C. Ziller and Dale E. Smith start implementing photography as a research method for observing the self of people without influencing the subjects. By the end of the 20th century, the camera connects the objective with the subjective world as people set in the camera for research objectives of the self. Before Universal Design, Inclusive Design or Design for All was even considered as a design approach, Ziller and Smith observed people with an impairment using the camera as a tool to overcome the constraints of language. They demonstrated that photography is a unique medium for observing people with difficulties in communication, for example, children, older people or people with an impairment. The camera elicits behaviours and attitudes that form the basis of the research analysis, in other words it allows for a phenomenological approach in which pictures are taken ‘by’ and not ‘of’ the perceiver. The spatial experience of people in wheelchairs consists of a 180 degrees flat world in which acute angles between floor and passing planes are scarce. Consequently, people in a wheelchair rarely look up or down. Most of the time windows are too high to look through as well. The world seen from a wheelchair user’s viewpoint is different than from a walking or standing viewpoint and the use of a photo camera can introduce us into these different perceptual, physical and social viewpoints.

Besides the impact of photography to serve communication for people with impairments, this methodology shows to be useful for sensory research as well. Participants in research are not taught to articulate their sensory experiences. Participants may even have fear to express their own opinions. To overcome these shortcomings researchers use photography or visual imagery as a means of communication. Anthropologists discovered that photo ethnography offers a relevant research method in situations of language deprivation. Photo ethnography is also referred to as ‘native image making’ due to the intimate, almost voyeuristic, nature of the method. According to Samantha Warren visual research provides data at different levels:

1. data including visual signs and symbols;
2. records that document social, cultural and physical processes;
3. stimuli to elicit information from research participants;
4. method to help participants to express their thoughts, behaviours, reactions and experiences.

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Besides the advantages for communication, “Photographs, more than almost anything else, have a special emotional appeal: they are personal, they tell stories. Personal photographs are mementos, reminders, and social instruments, allowing memories to be shared across time, place and people.” 146 Researchers discovered that photo ethnography offers a useful research method for situations in which there is language deprivation.147

Within photo ethnographic studies the camera is often viewed as a tool that reveals a ‘dark space’. As Roland Barthes wrote, it helps to close your eyes when contemplating a photograph: “Since absolute subjectivity can only be achieved in a state of stillness, in striving for stillness, and to close your eyes signifies bringing the image to speech in the stillness.”148 Our knowledge in relation to sight and blindness evokes elaborations and philosophical discussions on the meaning of sight and vision and visual perception. However, discussions about spatial perception generate insights into the world of the participants whilst they engage in taking a picture.

2.4.5 Focus Group Interviews

While the two approaches mentioned above both rely upon the personal experience and perspective of people born blind, the third and last empirical study focuses upon what can be learnt from the experiences of people who have worked for years with congenitally blind people. Focus group interviews were conducted with two groups of about 11 people trained as remedial educationalists, physiotherapists, occupational therapists, socio-cultural workers or teachers. Robert K. Merton, the so-called ‘father of focus group interviews’, describes a focus group as a group of participants who share common experiences relevant to the main topic of the interview.152 Our participants were interviewed in a familiar environment, at their workplace and the focus group interviews had a semi-structured format.

The participants are caregivers who work at Spermalie in Brugge. Because we were already familiar with the environment and the operation of the school as a result of the observational work we had conducted there, it was particularly interesting that Spermalie was also the location for the interviews with the caregivers.

The interaction between participants, is one of the main reasons for conducting a focus group interview. Such interviews can be highly stimulating and very valuable. The efficiency of group dynamics allows a moderator help people who share an opinion convince others, with a different or opposite opinion, to agree with them.153 In this way, this qualitative research technique results in an overview of different, or similar, opinions within a reasonable time frame. Carers share a large pool of common knowledge relating to haptic experiences, but are not the direct focus of our research. Therefore, the most efficient methodology for comparing what different caregivers mean was to conduct focus group interviews.

149 Bavcar, Evgen, born in Slovenia in 1946, lost his eyesight at the age of twelve. Took up photography in the sixties. He lives in Paris since 1972. Bavcar studied philosophy and made his PhD on Adorno and Bloch.
2.5 Design Track

Chapter 5, the design track, reports on the design of the framework of haptic design parameters. The Chapter starts with the main concepts for the framework and subsequently zooms in on the different parameters separately. These parameters are based on the results of the theoretical and the empirical track. For the analysis of the empirical results we made use of triangulation. Triangulation is a mixed-method strategy used in social sciences, whereby data from different studies are cross-examined to answer the same question. In this case: what are haptic qualities and constraints in the built environment?

The triangulation of the findings from the home visits, photo ethnography and focus group interviews enables to identify rich and poor haptic experiences in the built environment. According to Uwe Flick, the combination of multiple methodological practices, empirical materials, perspectives, and observers in a single study is best understood as a strategy that adds rigour, breadth, complexity, richness, and depth to an inquiry.\(^{154}\) Consequently, triangulation is not a tool or a strategy of validation, but an alternative to validation. Cohen, Manion and Morisson explain it as “an attempt to map out, or explain more fully the richness and complexity of human behaviour by studying it from more than one standpoint.”\(^{155}\) It is the richness of being able to look at things from different points of view that makes triangulation an interesting research methodology. Besides the actual results, it provides an interesting background to the research as pointed out by Norman Denzin and Harry Wolcott: “Triangulation is a term frequently heard in association with ethnography, not to be taken as literally as it implies, but a reminder of the need to corroborate findings. Similarly the idea of incorporating ethnographic reconnaissance as a standard practice in all field-based research is intended to encourage more researchers to give more consideration to the benefits of having more of a look around, and thus to take more cognizance of context in studies of even the shortest duration.”\(^{156}\)

The actual design of the framework is based on diagrams, schemes, intuition and imagination but is very difficult to describe as explained by Cross: “An aspect of concern in design methodology and related areas of design research has been the many attempts at proposing systematic models of the design process, and suggestions for methodologies or structured approaches that should lead designers efficiently towards a good solution. However, most design in practice still appears to proceed in a rather ad-hoc (in italic) and unsystematic way. Many designers remain wary of systematic procedures that, in general, still have to prove their value in design practice.”\(^{157}\) Besides the definition of each parameter and a motivation based on the triangulation, one or more examples are used to illustrate the meaning of the parameters.

The design track concludes by providing ways to implement the framework of haptic design parameters into the design process as well as an evaluation tool to screen existing design drawings in terms of haptic experiences.


“Testing is essential to design as inquiry.” states Zeisel, and we agree. In the last research track, outlined in Chapter 6, it is important that the design itself, the framework of haptic design parameters is assessed. The evaluation consists of two focus group interviews: one focus group with end users of the framework, the designers of the built environment or architects, and the other focus group is conducted with end users of the built environment. In this way, the key goals are verified: the usability of the design parameters for designers and the degree to which their content fits the haptic experience of more, including sighted people. Originally, we intended to conduct a Post Occupancy Evaluation (POE) study with end-users of the built environment. Initially, we decided to conduct research into the Universal Design Lab in Hasselt, due to be completed in early 2010. The lab shares similar conceptual premises as it wants to support architects in implementing inclusive design. However, as a result of decisions taken internally this part of the project was put on hold. The other option, therefore, was to conduct a POE of existing buildings. Visio, in Huizen (The Netherlands), was selected as the subject of the investigation. This site comprises a campus, offices and dwellings for people who are visually impaired. Three recently constructed buildings are analyzed. Interviews with clients and architects are conducted and transcribed. Architectural plans and information are copied. However, the analysis of the plans and interviews led us too far from the main research question: to assess the application of the framework of haptic design parameters and their values in the built environment. Further research is required in order to be able to verify which values were, in fact, consciously intended by the architect (or client), and which were a coincidence. Focus group interviews with both groups of end users would therefore be the most appropriate methodology.

2.6.1 Focus Group Interviews with Architects/Designers

In line with the overall objective of our research, the parameters are developed to conform to the principles of Universal Design. To be more precise: they must contribute to design work that is equitable, flexible, simple and intuitive. Moreover, the framework of haptic design parameters has to possess a tolerance for error and not require any undue physical effort. It must also be appropriate in terms of usability. Ease of use is of great importance to the public - so much so that it is now equal to the notion of quality, state John Clarkson et al in the book *Inclusive Design Toolkit*. To check whether the parameters are usable, a focus group interview (in the form of a workshop) and a structured open interview was organized with target users, i.e. architects and other designers of the built environment. Besides the assessment of the usability of the parameters, architects and designers were also asked to give feedback on their content. Previous research has shown that designers can provide the scope for better user interaction in their work by paying more attention to mental models of users, prior tacit knowledge, interface metaphors and affordances. By asking...
architects to work with the parameters while engaged in an actual design project it is possible to analyse such personal mental interactions.

The evaluation and results of this focus group interview are discussed in the first section of Chapter 6. The second section outlines the feedback of the end users of the built environment.

2.6.2 Focus Group Interviews with Sighted Users of the Built Environment

Finally, a focus group interview was conducted with a diversity of sighted users of the built environment. As the outcome of using haptic design parameters needs to be good for all users, the focus group interview asked questions which addressed the outcome values. Hollins argues that: “The nature of their (congenitally blind people) sensory experience can best be understood by contrasting it with the perceptual world of sighted people in two ways. First, the haptic experiences of congenitally blind people can be compared with the visual experiences of the sighted. This type of comparison allows us to learn how blind and sighted people differ when both are using their primary spatial sense. Second, the haptic experiences of the congenitally blind can be compared with the haptic experiences of the sighted, which frequently involve visual imagery.”

Besides the comparison of the experiences of blind and sighted people, this approach can open up insights into the language of design as most designers work and think in a visual way. Moreover, Ledermann, Thorne and Jones point out that the answers of sighted people will give a good impression of their haptic feelings because asking about the haptic sense makes them think about it more. Therefore, the visual information is already unbalanced.

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2.7 Conclusion

The last Chapter highlights the major results found in all the several Chapters and elaborates upon the directions for future research.
2.8 Summary

The foregoing Chapter summarized the research design and the different questions that will be discussed in each Chapter as well as the motivation behind the research design. The whole research can be considered as a DfM process in itself and consists out of four main tracks: the theoretical track, the empirical track, the design track and the evaluation track. Chapter 3 discusses the theoretical track that focuses on the identification of a haptic experience in the built environment and also describes the values of the experiences of people born blind as a form of expertise to study these experiences. The Chapter concludes with a theoretical framework that outlines the three main levels of mental processes that are involved in a haptic experience of the built environment and that corresponds with the levels of mental processes conducted by people born blind to build up an experience in the built environment. Chapter 4 investigates in real time with the help of participants born blind as well as caregivers why, how, where, when and what exactly is haptically experienced in the built environment. Based on the triangulation of these findings as well as on the cross analysis throughout the results of Chapter 3 and 4, the main concepts are created for the framework of haptic design parameters in Chapter 5. Each parameter will be described and motivated in detail. One or more examples clarify the exact meaning of each parameter. Subsequently, the application of the parameters in the design process is explained as well as a methodology to evaluate an existing design in terms of haptic experiences. Chapter 6 reports on the evaluation of the parameters by end users of the framework, architects, as well as end users of the built environment. The thesis concludes with the main highlights on methodological as well as design oriented findings and the directions for further research. In line with the non-stop iterative DfM process, the last Chapter links back again to the first Chapter.
Chapter 1: Problem Definition
Chapter 2: Road Map PHD
Chapter 3: Theoretical Track
Chapter 4: Empirical Track
Chapter 5: Design Parameters
Chapter 6: Evaluation
Chapter 7: Conclusion

State of the Art | Research Track | Design Track | Evaluation Track
Chapter 3: Theoretical Track

3. Experience as a Bridge towards Designing for More
3.1 Introduction

As explained in Chapter 2, very few studies into people born blind have been conducted in the research domain of architecture, and even less on the theme of haptic perception. Therefore, a research methodology has been built up that consists of a theoretical and an empirical track.

Linking the theoretical and empirical track is the quest for haptic experience that support multisensory architecture as identified through the experience of people born blind – an experience that can be regarded as a form of expertise.

This Chapter starts by discussing the meaning of an architectural experience in the context of this research. After the search for a definition, the focus shifts and we look at how architectural experiences take place. We explain the evolution of architectural experience, plus its characteristics, and conclude by placing these insights within the context of DfM.

Having gained an insight into the conditions in which architecture is experienced, the next Section discusses the experience of people born blind as a form of expertise. This theoretical approach is consistent with the cultural model of disability, which considers disability as a form of expertise and regards the differences between people as opportunities for improvement. This research therefore considers blindness as an expertise that is essential to the study of the haptic sense.

The third Section starts with a detailed explanation of the meaning of haptics and, more precisely, the relationship of haptics to architecture. Consequently, we focus on the haptic sense throughout history. Once the meaning of haptic experience in the context of architecture is clear, we examine haptic properties within the built environment. To be more precise, we look at how these might contribute to the experience of architecture. Subsequently, the Section elaborates on architecture that possesses haptic qualities and how this is experienced.

The Chapter concludes with the presentation of a theoretical framework that shows the links between the levels of mental processes that are involved in an architectural experience, the levels of comprehension that people born blind need for an environmental experience, and the conceptual levels that haptic experiences rely upon. These different levels show similarities and they form the basis for our framework of haptic design parameters.
3.2 Defining Architectural Experience

Whereas the term ‘experience’ is commonly used in design and research, it is seldom properly defined. Experience derives from the Latin ‘experienda’ which means ‘the act of trying’. It is further defined as “direct observation of or participation, mostly personal, in events as a basis of knowledge or as the fact or state of having been affected by or gained knowledge through direct observation or participation.” One scientist who has extensively explored the meaning of experience is the geographer Yi-Fu Tuan. In his book, Space and Place, the Perspective of Experience, he looks at experience from the perspective of different disciplines, ranging from geography, anthropology, literature, theatre and psychology to theology. According to Tuan “Experience is a cover-all term for the various modes through which a person knows and constructs a reality.” Earlier, Christian Norberg-Schulz had already associated the meaning of knowing and constructing environmental reality with the ‘use’ of architecture and pointed out that: “An account of the experience of architecture, however, treats the question of how architecture in the widest sense of the word is ‘used’”. Experiencing architecture is thus a form of using architecture. However, it is not just limited to the perception of aesthetic characteristics, or geometric forms in terms of function and use. An architectural experience covers much more.

Architectural experiences are part of our life experience. Life covers different kinds of experiences and challenges us towards new knowledge and skills, trains us in habits, invites us to participate or observe daily events, and to perceive the world with former experiences in mind.

The built environment fulfils and supports one of the primary needs of all human life. Designers participate in creating the whole experience. Vision sometimes makes us forget the importance of other sensory qualities and pushes us away from the non-visual senses and their interactions. However, architecture is not only viewed, but experienced by all senses. Therefore, non-visual perception is an important aspect when studying architectural experience.

The experience of architecture is a perceptual process, in which the quality of space, matter and scale is assessed through the combination of multiple senses. Experiencing architecture is therefore intrinsically multi-sensory in nature. In his book, Experiencing Architecture, Steen Eiler Rasmussen discusses this topic extensively. Rasmussen, one of the pioneers in architectural phenomenology, explains that: “Architecture is not produced simply by adding plans and sections to elevations. It is something else and something more. It is impossible to explain precisely what it is – its limits are by no means well defined.”

On the whole, art should not be explained; it must be experienced.” Architect and theorist Juhani Pallasmaa currently maintains this phenomenological approach. In his essays, he clarifies the importance of multisensory experiences in architecture and calls for more attention to be paid to the non-visual senses within the design process. Experiencing architecture is multisensory in nature, as is its perceptual appearance. The latter is not just restricted to a visual bias but involves all the senses. As David Howes points out, this is where the notion of sense-scapes comes in. A designer needs to be aware of the landscape and the haptic, auditory, olfactory and gustatory scapes of the environment.

The importance of multisensory qualities can be experienced in everyday life. I remember visiting the Pantheon in Rome and closing my eyes for five minutes in order to register all the sensory experiences around me. Sitting on one of the benches, I felt the warmth of the sunshine on my skin, the silence of the building - despite the noise of tourists - and the smell of the air in the Italian city. The atmosphere of this building is enormous and forces people to think and focus. It was a multisensory experience of architecture.

Instead of merely focussing on the formal aspects of architecture in order to create space, this research follows a phenomenological approach and considers architectural experience to be an interaction between the body and the environment. This approach starts from a symbiosis between the body and architecture as explained by Pallasmaa: “Place and event, space and mind, mutually define each other and fuse inevitably into a singular experience. The mind perceives the world and the world exists through experience. Experiencing a space or a house is a dialogue, a kind of exchange: I place myself in the space and the space settles in me”.

The phenomenological approach results in the consideration of architectural experience as an embodied experience that is generated through sensory perception, a process that is the result of a dialogue between the whole body and its environment. This embodiment questions Cartesian dualism and calls for an acknowledgment of the body in contemporary thinking.

Fig. 3.1 Spanish Steps, Rome (IT)

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entering, not the door; the act of looking out of the window, not the window itself; or the act of gathering around the hearth or the table more than these objects themselves - all these verb expressions seem to trigger our emotions.\textsuperscript{14} All these acts intrinsically require movement and it is clear therefore that perception requires movement. In turn, perception is essential for experience.

### 3.2.1 Movement as Catalyst for Architectural Experience

Several theorists like Yi-Fu Tuan\textsuperscript{15} and Francis Ching have stated that movement is an essential condition for architectural sensation: “Architecture is experienced through movement in space-time, approach and entry, path configuration and access, sequence of spaces, light, view, touch, hearing and smell.”\textsuperscript{16} By means of movement, our bodies are in a constant dialogue with our buildings.\textsuperscript{17} John Gray makes us aware of the fact that “walking is a form of place making”.\textsuperscript{18} Thus, by means of movement, senses are placed and places are sensed. Steven Feld explains it as follows: “as place is sensed, senses are placed; as places make sense, senses make place.”\textsuperscript{19} Besides the ‘ready-made space’ of the eye, architectural design can define or challenge identity through bodies that make mutual movements with one another.\textsuperscript{20}

It is clear that although architecture might be a facilitator for these movements it is, in itself, immovable. Besides the ageing of the building, the physical output of an architectural design is rather static. Its users, on the other hand, are in constant movement. Rasmussen rightly points out that: “architecture itself has no time dimension, no movement, and therefore cannot be rhythmic in the same way as music and dancing are. But to experience architecture demands time; it also demands work – though mental, not physical, work. The person who hears music or watches dancing does none of the physical works himself but in perceiving the performance he experiences the rhythm of it as though it were in his own body. In much the same way you can experience architecture rhythmically.”\textsuperscript{21} Rasmussen explains the creation of time by referring to the Spanish Steps in Rome (Fig. 3.1) which he considers to be a petrified dance rhythm. The steps are used not only to overcome a certain height difference between two parts of the city, but also form seats, a playground for children or a beautiful view over the city. Here, time receives its meaning through the acts of people. The rhythm of the users creates both time and movement.

### 3.2.2 The Characteristics and Process of Architectural Experience

Although we recognize that each experience is unique (because we never experience exactly the same thing twice),\textsuperscript{22} and because experiences might differ amongst different cultures,\textsuperscript{23} it is essential to have an insight into the characteristics that are common to architectural experience. Understanding the meaning of architectural experience may reveal experiential qualities and constraints within the built environment. How do we experience architecture and what contributes to this experience?

In search for an answer to these questions, Anne Stenros defines three levels of perception that contribute


\textsuperscript{19} Feld, Steven, and Keith H. (eds.) Basso. Senses of Place. Santa Fe: School of American Research, 1996.


\textsuperscript{23} While we are aware of the fact that different cultures describe experience using different mixes of sensory metaphors which are not limited to visual experience only, it would take us too far to discuss all these differences in detail.
to architectural experience: the perceptual level (orientation), the memory level (identification) and the abstract level (representation). Although we largely agree with and rely upon Stenros’ definitions, we sometimes use different terms. This is because we want to avoid confusion with other terms, or because we question the way that certain concepts are explored. To avoid confusion with the name of the first level ‘Level of Perception’, and the general for all the ‘levels of perception’, we chose to identify these three levels of mental processes. Besides, the word ‘representation’ has other connotations. This research study therefore replaces this term with ‘meaning’.

Although all these levels work together simultaneously, it is interesting to investigate them separately because each level covers a different sense of perception. Together, the different levels contribute to an architectural experience in its broadest sense (Fig. 3.2).

By means of these levels, a person, or ‘perceiver’, is in continuous interaction with the environment (Fig. 3.3). The following paragraphs describe the three levels of mental processes that we adopt in our research.

### 3.2.2.1 The Level of Perception

The perceptual level refers to the actual perception of the environment. It involves all perceptual processes and is triggered by a direct physical stimulus. Stenros also understands this to be the level of orientation. The perceptual level explains the way we perceive and analyse the environment by means of environmental elements. These elements are man-made or natural. Movement supports the perception of these perceptual stimuli. This level of perception contributes to a bodily way of perceiving. In a way, you could state that this perceptual level stands for the perception of direct stimuli from the environment by the body. For example, the feelings of grass beneath your feet while walking through a park, or a rough texture felt whilst leaning against a wall. These are two examples of perception at the perceptual level.

### 3.2.2.2 The Level of Memory

The memory level consists of connecting mental images to activities and places. The memory level considers the images and feelings triggered by the environment as a result of personal history. It takes place when an immaterial stimulus triggers our perception. This level is also understood as the identification level and is essential in relation to memories. It turns space into a place, and triggers our special consciousness towards an important environmental point. Pallasmaa, who explains that empathy and compassion are the result of identification and embodiment, also stresses the importance of identification in an architectural experience.

At the memory level, space is demarcated — this is something that is essential for the creation of a place, as will be explained later in this Section. A boundary is not simply the place where something stops, as discussed by Heidegger, but the point at which things begin to gain presence. For example, when you are walking

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Fig. 3.3 The Interaction between the Levels of Mental Processes
through a park and see the boundary between a stone path and a grassy field, the process of identification is taking place. At that point, identification gives meaning to the location by demarcating the footpath.

This level also generates habits, which take the form of bodily knowledge through appropriation. It is bodily knowledge that defines architecture, according to Walter Benjamin.28 Several researchers reference *The Work of Art in the Age of Mechanical Reproduction* in which Benjamin points out that our everyday perception can only be understood through tactile appropriation.29 Through use, we give meaning to our environments, and also create it. Proprioception and tactile experiences contribute to this meaningful act and the founding of ‘habits’.30 Habit is derived from the Latin *in + habitate*, meaning ‘to dwell in’. Consequently, the word inhabit is also concealed within the word habit, as pointed out by Leslie Kavanaugh.31

### 3.2.2.3 The Level of Meaning

Stenros identifies the third level as the abstract level, but we prefer to speak about the level of meaning. This level organizes and directs the whole process of perception.32 For this level of perception, no direct environmental stimuli are required. People are able to imagine the environment. According to Michael Schwarz, it is because of such experiential abilities that artists such as James Turell (Fig. 3.4) design environments that aim to make viewers conscious of their own experience.33 Indeed, people are able to change their environmental images at this level, or even add additional information to the whole experience.

Stenros also defines this as the level of representation, by which she means the figuring of the environment.34 However, this term also has many other connotations, such as the mental representation of perceptions, or the visual representation of an architectural concept or design, for example. Therefore, we decided to identify this as the level of meaning instead. By adding knowledge or skills to the perceptual process, users give meaning to their environment.

At the level of meaning, movement comes in the form of affection. In art, this is recognised as mimesis. For this term, we are indebted to Theodor Adorno. Adorno refers to mimesis as a kind of affinity between things and persons that is based not on rational knowledge and which goes beyond the mere antithesis between subject and object.35 It is a point at which rational thinking makes place for something more: a kind of affinity that is required for the creation of embodied experience.

#### 3.2.3 What it Means to Experience Architecture and the Creation of Place in Space: Atmosphere

Architectural experience is thus an embodied experience that results from an interaction between the three levels of mental processes. Pallasmaa explains that the reason it is, indeed, an interactive process: "We do not live in dissociated material and spiritual worlds as these worlds interpenetrate fully."36

If all three levels are activated, or people are conscious of all three, the feeling of place comes into being (Fig. 3.5). From the moment people began living in dwellings, the meaning of ‘space’ and ‘place’ has been one of

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Fig. 3.4 Osher Sculpture Garden, De Young Museum, by James Turell, Sculptor of light, San Francisco (U.S.)
the primary questions in life. Tuan explores the meaning of ‘space’ and ‘place’ in great detail. ‘Space’ is more abstract than ‘place’, but: “space can become place if we get to know it better". In other words, if meaning is given to it or habits created.

According to Tuan, when it comes to explanation, ideas and words require each other. He points out that if we think of space as movement, then place is ‘pause’. In this way each pause in movement will allow a ‘space’ to become a ‘place’. The making of places in space has to happen before the creation of atmosphere can come into being.

Atmosphere results from the dialogue between the built environment and the world, and starts where construction stops.

The importance of atmosphere in the experience of architecture is something that is also clear to Mark Wigley. He even demonstrates the crucial meaning of atmosphere in his essay The Architecture of Atmosphere: “It is the climate of ephemeral effects that envelops the inhabitant, not the building itself. To enter a project is to enter an atmosphere.” Architectural design is not limited to the creation of the physical environment. It also has to meet the needs of its users in all aspects of perception. Pallasmaa illustrates this by means of a metaphor: “Architecture is to recreate ‘the womb’ and ‘the mountain’ in the mind, the former a closed, sheltering interior and the latter an exterior landmark, a place visible from afar and with a wide view.” In line with Tuan, we agree

that an experience can be direct and intimate or it can be indirect and conceptual and mediated by symbols. Proximal senses like touch, taste and smell provide faster, more direct and intimate experiences, whereas distal senses more often rely upon symbols and a conceptual understanding of the environment.

An architect who identified himself with the creation of ‘atmosphere’ is Frank Lloyd Wright. He is one of the architects who succeeded in creating environments that improve after being constructed. For example, Wright was excellent in designing buildings that worked in symbiosis with their surrounding environments. In Fallingwater, as soon as the construction was finished, he left the rest of his work to nature. (Fig. 3.6) Trees and shrubs grew in, on and next to the house. The more nature becomes one with the built environment, the more the design corresponds with the intended architectural sphere. The greenery and the waterfall insert the notion of time into the design. Here, nature and space become one integrated whole. Physical perceptions, as well as memories and concepts, are in balance and a place is created. Wright was aware of the importance of creating places in space. For example, he designed smooth transitions between the inside and outside of the building. The heart of a building was, consequently, a true example of ‘place’.

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3.2.4 Discussion: Architectural Experiences for ‘More’

The previous Section made clear that architectural experience involves ‘more’ than the perception of a physical environment. An architectural experience is a process that results from the three levels of mental processes. It is an embodied experience that relies upon the interaction of the level of perception, the level of memory and the level of meaning. In other words, it relies upon the interaction between orientation, identification and affection. Atmosphere appears when the three levels are addressed. Moreover, when all three levels are in balance, the notion of place comes into being and an ideal atmospheric experience is achieved.

Each level of mental process connects to different design characteristics (Fig. 3.7). The level of perception (or orientation) is concerned with the physical environment and consequently its physical characteristics. The level of memory, on the other hand, concerns memories based on environmental identification. The level of meaning, however, combines the information related to orientation and identification with general information (based on knowledge and design skills) to create a balanced atmosphere. The processes within these three levels take place simultaneously, but some might be more emphatic than others. Depending upon the accentuation of the levels of mental processes, the architectural experience can differ and, as a consequence, so can the atmosphere. For example, if more stress is placed upon the perception of the physical environment, and less attention is paid to the spatial concepts (for identification), and meaning is lacking, a building might be experienced in very functional terms, instead of it having a larger impact. However, in the creation of balanced architectural experiences, all three levels of mental processes need revision.

All these levels work together simultaneously and are inextricably linked. However, the perception of physical sensory stimuli is a condition for identification and affection. Identification and orientation are required, in turn, for the achievement of the level of meaning. Therefore, the levels of mental processes represent a kind of hierarchy (Fig. 3.8).

Movement triggers the interaction between the levels of mental processes and, as experience results from a perceptual process, we argue that movement is a requirement of experience.
3.3 Blindness as a Form of Expertise

People born blind are the ideal user/experts for an investigation into haptic experiences. Chapter 2 explained in detail why we chose to work with user/experts born blind for this research. To summarise, they are more alert to non-visual sensory experiences. Instead of focussing on the inabilities of people with a disability, this research turns the notion upside down and takes the position that it is not the body that is impaired, but society. Blindness is viewed as a form of expertise that can be used to study the multisensoriality of the built environment. The models of disability explain how disability is viewed within society. A particular model can often dominate a society. Nevertheless, different models can also be present simultaneously. This approach fits the cultural model of disability in that it views disability as an opportunity.

Before we explore the expertise of people born blind and the built environment in more detail, it is necessary to position blindness within a historical context that is linked to the models of disability. Each model defines blindness in a different way. Historical insights have contributed to innovation in the approaches taken to disability. In addition, we attempt to clarify the differences between blindness and other visual impairments.

The second part of this Section examines the experience of people born blind in the built environment.

Experience is considered to be an expertise that has been gained as the result of perceptual learning. This expertise has two main elements:

1. the expertise as it relates to environmental exploration
2. the expertise as it relates to environmental interpretation

Although researchers might disagree as to how people born blind process sensory stimuli, and whether their abilities are equal to those of sighted people, research into the environmental experience of people born blind shows that they rely on the same levels of mental processes as those of sighted people. Moreover, we recognise that the three way division in the levels of mental processes that are involved in an architectural experience have identical characteristics as the levels of comprehension of people born blind, as described by the psychologist Gunnar Karlsson.

The Section concludes with a discussion of these similarities and the links between the framework of architectural experience and that of the architectural experience by people born blind.
3.3.1 Models of Blindness in Western Society throughout History

Disability studies recognise four models of disability: moral, medical, social and cultural. These models attempt to explain the differences between the existing approaches taken towards disabilities and the corresponding experiences.

3.3.1.1 Blindness in the Context of the Moral Model

For centuries, Western society followed the moral model, believing that, (the) God(s) had power over blindness. The most ancient knowledge that we have concerning blindness dates back to antiquity. The Greeks and Romans considered a blind child to be either a punishment, or a gift from the Gods. If people considered the child evil, they felt no guilt at dismissing it or refusing to look after or feed it. Christianity gave children with impairments the right to exist. Nevertheless, most parents or guardians abandoned them. Blindness was more accepted than other impairments; blind, highly intelligent citizens often mediated between the visual human world and the non-visual world of the Gods. However, blindness was also viewed as a punishment for sexual impurity.

Until the Middle Ages, incest, paedophilia and rape was punished by the removal of what was perceived to be the body part linked to the crime: the eyes. This tendency survived into the 18th century. Many of those punished became beggars. Although disabled people were the ‘special’ citizens or ‘fools’ of a village, and the target of aggression and frustration, Christian thinking began to stimulate medieval men and women into helping these people. In the 15th century, poverty and disability were equal to sin and criminality. The Uomo Universalis was the Renaissance ideal and impairments were likened to the devil’s work.

As the slave trade flourished, Christian charity weakened. Begging was forbidden and everybody was obliged to work - blind people could plait reed baskets or work with wool. During the 17th and 18th century, Christianity and the concept of charity experienced a revival. France and Germany built many schools for the blind. Valentin Haüy (1784) founded the first school for visually impaired students, where Louis Braille would become a student.

The Enlightenment was the era of empirical research and William Molyneux (1656-1698) wrote a letter to John Locke (1632-1704) which opened up a discussion on spatial imagery and people born blind. In this letter, Molyneux asks Locke whether it would be possible for a man, born blind but having later gained vision, to recognize by sight alone the shapes he had previously known only through touch. This is the first recorded link between haptics and vision, and it marks the beginning of a great scientific quest.

Moreover, different researchers have correctly noticed several layers to the question:

1. the parallel between haptic and visual perception and information
2. the haptic and visual information exchanges
3. the interest in a substitute for the senses

The parallel between tactile and visual perception defines the interest in similarities and differences between the two sensory sources of perceptual information. Several studies would be devoted to identifying these. Secondly, the possibility of exchange between both senses is at the heart of the historical and philosophical debate on congenital knowledge versus sensory experience. In addition, Molyneux’s question opened up a scientific discourse on the exchange of sensory information, a topic that is still the subject of contemporary research. Géza Révész defined this as the ‘vicariate of the senses’, or the quest for a substitute for the senses.

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Prior to the Enlightenment, the discourse on the experiences of blind people was limited to philosophical or moral questions. Indeed the question of Molyneux might be regarded as a turning point in the history of research into sensory perception in general. His question raised new research questions in different research domains.

### 3.3.1.2 Blindness in the Context of the Medical Model

During the Enlightenment, the interest in new knowledge (science) and new forms of society accelerated. This also had an impact upon research into blindness. For example, by the mid 18th century, there was an enormous expansion of interest amongst researchers as to the ability of blind people to perceive objects from a distance without physical contact. Furthermore, huge progress was made in the sphere of medical research and the insights gained into impairments created the first basis for an approach to disability (in general) and blindness (in particular) that was medically orientated. Previously, exact descriptions of the difference between low vision and blindness were unclear. Gradually, medical research revealed an increasing number of details about the variations within visual impairments. Based on these medical results, the first scientific definitions of visual impairments appeared, as did classifications of different types of visual impairment. The medical model treats disability as a physical defect that needs to be cured through surgery, or via adaptations of the body. Visual impairments are characterised by huge variations in cause, development and type.

Some visually impaired people have residual vision while others have no vision at all, or at the very most can perceive light. If they have residual vision, people try to obtain as much information as possible from their remaining visual perception. However, if there is no sight then people pay more attention to other sensory information.

Visual impairments can be static or progressive. Some are acquired and others are congenital.

A person who was born without sight, or who has no visual remnants (obtained before gaining visual memory), is identified as congenitally blind, while someone who lost his or her sight at some later point in time is said to be adventitiously blinded. Congenitally blind people do not have visual memories of objects or activities.

Some diseases are cerebral, while others are physical (in terms of the eye). For example, our brains are able to mislead. In the case of brain injuries, the sensation of stimuli might be unaffected before it reaches the brain but the brain can make mistakes when processing the information. Therefore, people might not notice that their visual perception is incorrect. The drawings of Escher illustrate this phenomenon (Fig. 3.9). Our eyes receive the stimuli but our brains conduct the processing and interpretation.

![Fig. 3.9 Lithograph Relativity, M.C. Escher, 1953](image-url)

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order to process this, the brain relies upon memories and knowledge of former drawings of stairs. Only when paying close attention do people notice that something is not right.

The most frequent causes of blindness are glaucoma, macular degeneration, cataracts, diabetic retinopathy, neuroretinitis and retinitis pigmentosa. Some causes of blindness can be cured through medical intervention but it is much more difficult to recover from those that are related to the brain.

Most countries still rely on these medical categories and causes when drawing up legislation. The medical model offers a way of categorizing the difference between visual impairments, upon which governments can base legislation relating to repayments, taxes or grants. However, this interpretation is the result of a medical analysis of the body that does not take the experience of the body as a whole, or its interaction with the environment, into account during the evaluation process.

The best-known medical regulations, upon which much legislation still relies, is the international standard of a visual impairment developed by the World Health Organisation (WHO) in 1977. The WHO distinguishes between persons who have poor vision and those who are completely blind. Based upon medical knowledge, and the possibility of people being able to correct their vision with the best possible refractive correction, blindness is defined as the visual field being 10° or less (the norm being 180°), or a visual acuity amounting to 1/20 or less (i.e., a person would have to stand 1 meter from an object to be able to see it with the same degree of clarity as a ‘normally’ sighted person would from a distance of 20 meters). Another formulation is that any person whose visual acuity is worse than 20/400 in the better eye with best correction, or with a visual field of 10° or less, is considered legally blind. Low vision, on the other hand, is defined as being the best-corrected acuity from 20/70 to 20/400 in the better eye, with corresponding visual field loss, to less than 20° in the better eye with best possible correction (Fig. 3.10 & 3.11). For example, a person with tunnel vision can have a visual field of 18°, which means s/he still sees parts of the visual field very sharply whilst being considered legally blind. In addition to the degree of impairment, there is a range of visual impairments that further adds to the diversity in visual perception among visually impaired persons. Although many countries follow the regulations of the WHO, others enact their own legislation on visual impairments. Since there are no strict common

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55 In 2002 the World Health Organisation (WHO) reports 37 million blind people worldwide. In Belgium blindness takes an average of 1.2/1000 people of which 10% are younger than 18 years, 23% are between 18 and 60 years and 65% are over 60 years. Only one in ten is totally blind and has no residual vision. It is generally assumed that 50% of people with a visual impairment also have one or more other disabilities. On www.kimbols.be and Beel, V. Blind zijn is moeilijker in de visuele maatschappij., De Standaard, April 8th 2006.
denominators, it is difficult to estimate the exact number of people in the world who are blind. In 2002, the WHO reported 37 million blind people worldwide. The number of people in Belgium who are legally blind is also very difficult to determine, for there is no national registry of people who are blind, or have low vision. Statistics fit the medical model approach and are important, but such results do not encompass the whole experience of people with visual impairments. Numbers do not explain the actual disability experiences of people born blind.

After WW II, disability gradually came to be viewed as a social construct.

3.3.1.3 Blindness in the Context of the Social Model

In the social model, disability is understood to result out of the interaction between body and social and material environment. This model acknowledges that people, labelled as legally blind (according to the medical regulations social and material) might not feel themselves to be impaired in relation to the environment. From this point of view, a person becomes disabled when the socio-material environment disables the body. For example, people who have the status of legally blind may still see well enough in order to integrate perfectly into an environment, whilst others with low vision are hampered in certain activities and need more support. In other words, a blind person may be able to walk from home to the shop perfectly, while s/he might feel impaired when not being able to read the pricing in the shop. According to the social model, disability is the result of interactions within the socio-material context.

Helen Keller stated that blindness is not a problem: “but the attitude of the seeing to the blind is the hardest burden to bear.” In this context, the most common mistake is to view blindness as the denominator for people who are born blind and who have no visual experience or knowledge of visual concepts. In much the same way, Martin Milligan, a blind philosopher, thought that people would disqualify him as a spokesperson for the blind, since he may have retained some vestige of a visual memory from his early childhood. Philosopher Brian Magee, his sighted friend and co-author of the book *Sight Unseen* refuted this argument. Magee consulted a neurologist who assured him that the loss of sight at such an early age would make Milligan’s brain indistinguishable from that of a person born blind.

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56 On February 20th 2007 the institute for the statistics in Belgium: Nationaal Instituut voor Statistiek in Coupure Rechts 620, Gent, Belgium was visited. Unfortunately it turned out that the institute does not keep track of statistic numbers on visual impairments nor on blindness in Belgium. The head of the institute, surprised himself, even contacted several other departments to verify the catalogue. This evoked a chain reaction and surprisingly Harry Geyskens, coordinator of the Belgian Confederation of Blind and Visually Impaired People, contacted us that same day to confirm that there are no exact data on people who are blind or visually impaired and that all numbers are based on estimation and statistics of neighbouring countries.


The idea that all blind people have never seen before and have no residual vision was the first assumption of Helen Hollis, project architect at the Alec French Partnership. She worked on the design of the Vision Care Centre in Bristol: “We found that a large percentage of those registered blind have varying qualities of residual vision (only a few are totally blind) – they are partially sighted and can appreciate a whole range of visual things. We were also hastily reminded that ‘blind’ means ‘without sight’ and certainly not ‘undiscerning’ or ‘unobservant’.”

The design process itself made her aware of the diversity of blindness and freed her from a negative bias. Georgina Kleege defines this negative assumption as a common misconception, which she calls ‘the hypothetical’ - the person who is blind and does not know any visual concept. Although people can be blind in medical terms, sometimes they do not feel blind at all and vice versa. Most people born blind do not feel disabled but the socio-material environment makes them feel that they are. Consequently, the etiquette of ‘social blindness’ might have a much greater influence on a person’s experience. A medical declaration does not necessarily reflect people’s experience. The social model does, however, acknowledge that society contributes to disability experiences.

After WWII, more and more people began to accept disability as a condition partially created by medical conditions and largely influenced by social attitudes and constructs. As explained previously, disability may be the result of the social environment that stigmatises, or the socio-material environment that disables its users. In other words, disability experience finds itself on two different levels: 1) the level of spatial communication and knowledge and 2) the level of the material environment that disables. Both levels might disable people when they participate in society. At the first level, people are required to adapt socially to the environment. At the second level, it is the material environment that is required to adapt. If environmental designs focus on visual experiences, and other sensory characteristics are absent, handicap situations can be created by architecture. For example, it is very difficult for people with a visual impairment to find a hotel entrance if it is similar to the window openings on the ground floor. As explained in Chapter 1, perceptual processes rely on different sensory sources. If the input is restricted to visual information, it affects the whole experience. Regarding the hotel entrance, the door could be larger so that users feel the difference in size.

### 3.3.1.4 Blindness in the Context of the Cultural Model

In the cultural model of disability on the other hand, people’s differences are viewed as opportunities. At the beginning of the 21st century, anthropologists advance the cultural model of disability as a way of thinking about disability in new ways and from different points of view. This evolution is a consequence of the postmodern world in which there is a strong emphasis on culture. The cultural model is not a stand-alone theory but builds upon the medical and the social models. Instead of understanding disability on a medical or socio-material level, the cultural model starts from the idea that people with impairments are the same, but different, and that it is this difference that makes people with disabilities experts in certain contexts. Different visual impairments induce very different experiences depending upon the interaction and the context, the remaining vision, the type of impairment and the personality of the visually impaired person. Julia Thomas compares seeing with reading, because reading also requires the brain to constantly interpret things.

Consequently, different visual impairments will result in different experiences and different kinds of expertise.

The aim of this research is to reveal insights into the non-visual characteristics of the built environment. Applied to our research, the most appropriate expertise in relation to haptic perception comes from people born blind.
Researchers show that they are more attentive, or physically attuned, to the haptic sense.  

However, it might seem paradoxical at first sight that the experts in our study are limited to people born blind (with no residual vision), whereas the aim is to support designs that include as many people as possible. Only 10 to 20 per cent of the people designated as legally blind, in countries where such designation exists, have no visual perception. Therefore, in terms of the research into DfM, this limitation in user/experts might seem awkward. After all, defining or categorizing is not a neutral process.

Nevertheless, our research is not limited to people who are blind. On the contrary, we call upon their expertise to benefit as many people as possible. Several researchers have already shown that it is this awareness (or attentiveness) within people born blind that makes them unique user/experts regarding multisensory design. Moreover, Kleeege points out that you could start from the premise that the average blind person knows more about what it means to be sighted than the average sighted person knows about what it means to be blind.

People born blind possess the knowledge and experience of both the visual and non-visual worlds. In his book, *Blindness* the novelist José Saramago translates this insight into a story in which an entire town suddenly becomes blind. Saramago ends his book with the following consideration: “I don’t think we did go blind, I think we are blind, blind but seeing, blind people who can see, but do not see.” People who are blind are more experienced than sighted people when it comes to non-visual experiences and they are thus the ideal guides to lead us in this research through the haptic non-visual world.

Our research considers disability as an expertise that has the power to reveal differences within an environment. Differences construct our bodily experience, both material and immaterial. Henri-Jacques Stiker calls upon us to appreciate these differences because innovation lies within them. ‘Otherness’ is our challenge, as are the questions relating to how these differences are thought of, organized and integrated into a modern democratic society. The cultural model of disability embraces these ideologies, adopts a phenomenological perspective and considers the body to be a ‘lived body’.

The cultural model of disability provides an opportunity to look at information on disability as an experience. It is this that we are looking for in DfM: disability can be a source of expertise that allows us to look at the design process from a different perspective.

### 3.3.2 Blind People’s Experience of the Built Environment as a Form of Expertise

The noun experience is linked etymologically with expertise. Tuan correctly remarks that experience shares a common root (PER) with exPERt and he explains that in order to become an expert, one must dare to confront the perils of the new. It is clear that we are looking at the experiences of people born blind as form of an expertise. Their expertise in relation to non-visual qualities is an opportunity. Indeed, a disabled person is a person with a lived body, in a world that is different from the world of an able-bodied person.

In a traditional, general-process view of expertise, expertise is the result of a superiority in information processing: experts use different processes to novices, or they use same processes but more rapidly. The more recent quantity-of-knowledge view attributes experts’ performance less to mental processing than to the fact that experts tend to know more. By contrast, in the context of

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this research expertise derives from the notion of differentiation or connoisseurship,77 as advocated by ecological psychologists.78 In their view, expertise develops through perceptual learning i.e. through the discovery of distinctive features and invariant properties within things and events. James J. Gibson and Eleanor J. Gibson explain: “In this theory perception gets richer in differential responses and not in images. Instead of becoming more imaginary, it becomes more discriminating. Perceptual learning, then, consists of responding to variables of physical stimulation not previously responded to. The notable point about this theory is that learning is always supposed to be a matter of improvement - of getting in closer touch with the environment.” It is because of this perceptual learning that experts are able to differentiate, in their body or surrounding world, variables that are meaningless to novices.79

More familiar is the development of connoisseurship through the triggers induced by professional activities. A tailor will be able to distinguish every fabric with the slightest touch. Designers, for their part, seem to be especially fluent in visual knowledge and thought.80

As far as people born blind are concerned, their heightened awareness of haptic qualities and sound in the environment enables them to distinguish a variety of haptic, and adapted techniques and strategies, that enable them to analyse the environment in a way that architects are not always aware of.

Since we consider expertise as a form of perceptual learning, we begin by investigating the perceptual expertise of people born blind in relation to the built environment. Two categories can be distinguished: expertise in environmental exploration and expertise in environmental interpretation. In the paragraph on environmental exploration, the focus is placed upon the nature of stimuli, sensation and the way stimuli are sensed. The paragraph on environmental interpretation examines how these stimuli and explorations are processed.

### 3.3.2.1 Blind People’s Expertise in Environmental Exploration

In the context of environmental exploration the expertise of people born blind involves all the sensory systems and the related information that enables them to experience space. Perception is not limited to one sense, but is a process in which multiple senses play a role. These reasons of cross-modality made Gibson prefer to speak about ‘sensory systems’ instead of ‘senses’.81 A system connects to other systems and involves more than one sort of stimulus.

According to Hollins, the two most important qualities that people born blind possess, in terms of environmental exploration, are their sensory attentiveness and, secondly, the expertise on the haptic sense.82 In the following Section we zoom in on this expertise. Whereas the Section on sensory attentiveness discusses the importance of non-visual senses to people born blind in general terms, the Section on the haptic and auditory sense, obstacle perception and exploration addresses the particular abilities more specifically.

**Sensory Attention or Awareness**

According to Mark Hollins, the most frequent question asked about blind people is whether their other senses have developed a greater degree of sensitivity – especially hearing and touch - because of their loss of sight.83 Different studies have already shown that blind people do

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not have better ears, skin, muscles or joints. However, a great deal of practice enables them to pay more effective attention to the non-visual aspects of their environment than sighted people. As they have to rely entirely on their other senses, they are more attentive to these than to sight. John Hull, a blind professor, affirms: “While it is true that blind people cannot do anything that sighted people cannot do, it may be the case that blindness enables tactile and acoustic experiences to be absorbed with greater concentration and intensity. At any rate, we certainly cannot compare the experiences of sighted and blind people point by point in this way, especially if we are coming from a philosophy of normality which assumes a deficiency model of disability.” Jacques Lusseyran, a blind biographer, formulates it in a less nuanced way and explains that: “A blind person hears better, and that is as it should be, because he hears what he does not see. A blind person has a better sense of feeling, of taste of touch. He should be told how much his senses keep in reserve for him. But first of all, it seems to me, it is necessary to point out to him the condition that leads to such a widening of the senses.”

Besides the fact that there is physical reason for people born blind to focus upon non-visual stimuli, it may also be that their personality also contributes towards a preference for a particular sensory system. It is comparable to professional training. A well-trained brain on one specific perceptual source is better at adapting itself to information gathering based on that particular source. Regarding spatial experience, touch and hearing turn out to be at their most effective when vision is absent. As observed by David Warren, the spatial experience of blind people is primarily the result of haptic and auditory stimuli. Consequently, their appreciation of space relies upon haptic and auditory information. Thus people born blind are experts in defining the variety of haptic and auditory stimuli.

The Haptic Sense

When vision is absent, many people claim that the haptic sense is the most important source of information regarding the environment. Several researchers point out that people born blind rely in large measure on haptic information for their spatial awareness. “In blind conditions the crucial information is haptic. It depends on active movement rather than vision. Information from movement output thus plays an important, and probably crucial, role in tactual recognition.” Moreover, blind conditions are pure haptic conditions in which movements are more reliable than any external layouts.

Similarly, the philosopher George Berkeley and the psychologist Mark Hollins point out that, if people born blind rely on the haptic sense, they have a reasonably good understanding of space and perceive the spatial arrangement of objects in the environment accurately.

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For Lusseyran, touch is also the most important sensory source. Moreover, he even questions whether touch is a sort of awareness, or attention, in itself, or more of a quality that is based on feeling and intellect. Denis Diderot believed that the sense of touch enabled people born blind to think on an abstract level because they constantly stored impressions of the felt objects in their memory as a sequence of tactile points. Some researchers claim that blind people’s knowledge and experience of the world are based on haptic experiences and representations. For Karlsson, the haptic sense is a necessary condition, and the most important sense that provides blind people with information. Rachel Sullivan lists the advantages that people born blind have as a result of their daily haptic explorations:

- an improvement in finger sensitivity and hand dexterity;
- a heightened ability to concentrate and focus;
- better control of the hands when acquiring new skills;
- the establishment of an independent spirit through discovery, discernment and decision making;
- the ability to build concepts and make cross references;
- an enlarged experience;
- a special degree of literacy;
- a better understanding of the language of art and the arts in general;
- the ability to receive clues as to the structure of the universe: how the harmony between natural forms and mathematics can relate to nature and man-made objects, landscape and citiescape;
- skill in making connections in the arts and in life situations;
- the ability to experience pleasure.

The Auditory Sense

Studies have shown that compared to sighted people, blind people are better at discriminating simple auditory patterns in a complex auditory stimulus. Moreover, blind people exposed to a diversity of sounds are better at discriminating variations in intensity. The latter suggests that their visual history is not the only reason for their expertise in detecting auditory information. Some researchers show that it is their range of experience that contributes to the heightened awareness and that bodily movements support the higher level of attention paid to auditory information. Some researchers consider obstacle perception, or ‘facial vision’, to be a way of gathering auditory information.

Obstacle Perception or Facial Vision

In the context of environmental perception, one of the most remarkable abilities that blind people possess is called ‘obstacle sense’, a reference to their ability to detect objects at a distance of several meters. For example, spatial volumes are noticed and openings in, or between, walls are detected. Moreover, blind people can ‘read’ different ceiling heights. Several researchers frequently discuss this topic. As early as the 17th century, Denis Diderot called this ability ‘facial vision’. This was because he believed that air currents created by the obstacle subsequently brushed against the blind person’s face, thereby providing them with information. Diderot relied upon the testimonies of blind people in order to reach this conclusion. In the mid-20th century experimental psychologists also investigated the reasons behind this phenomenon.
Supa, Milton Cotzin and Karl M. Dallenbach revealed that obstacle perception is not unique to blind people and that sighted people can also learn it. Additional research revealed that obstacle perception also depends upon auditory information. Supa et al. explained that the pressure theories were untenable. From that point onwards, researchers discussed the nature of the stimuli that is required for obstacle perception and whether such information needs to be auditory or haptic. There is little agreement as to what and how blind people perceive through facial vision. Hypersensitivity to air currents and temperature, perception of light, electromagnetic waves through specialized nerves in the face, recognition of ether waves and other occult forces and auditory stimuli - all of these explanations have been put forward as factors potentially linked to obstacle perception.

Today, researchers still disagree as to whether obstacle perception is the result of auditory or haptic systems, or an interaction between both. When asking people born blind to explain this experience, they have difficulty pinpointing the sensory system they rely upon. Lusseyran elaborates further on this type of perception: “Does a blind person really know what he perceives when, walking along on the sidewalk, he suddenly indicates that he has recognized a gap in the wall or building? Or when he stops a few inches before reaching an obstacle, without even having brushed against it? Can he put into words what he experienced? I think not. He will say, when asked, that he heard something: less resonance, a movement of the air, like the very slow approach of an object.”

Révész explained that people born blind are able to recognise obstacles that lie up to 3 meters away from their bodies. In addition, people born blind have a heightened awareness of temperature. Révész showed that they are able to perceive the warmth of a cylinder with a temperature of 40-50° from a distance of 7-13 cm whilst sighted people can only sense it from a distance of 1-3 cm.

In relation to auditory information, people also equate obstacle perception with echolocation. Eric Schwitzgebel and Michael Gordon define echolocation as the ability to detect the reflective and reverberant characteristics of an object or an environment using locally generated sound. People may analyse the soundscape to orientate themselves or to interpret the environment. Interestingly, attentive observers may consciously or unconsciously influence their soundscape through the sounds they make themselves, by using a cane for example. Training in sound reverberation (and its analysis) exists and well-trained people can even use the clicking sound of their tongue to gain information about the environment. Rice and Juurmaa observed that people who are congenitally blind perform better at echolocation and echo detection. Daniel Kish is one of the pioneers of this skill, both in terms of observation and practise. Sound reflection (an echo) can provide a great deal of information and, as a perceptual process it is comparable to the technique used by bats. In the Life Learning Center for the Blind in Boston, the communal rooms have different ceiling heights so that the acoustics differ and visitors can distinguish the different rooms.

Barry Blesser and Linda-Ruth Salter contend that facial vision is not strictly auditory or haptic, but relies on cues that involve both. In all probability, people without vision rely on every available information cue. Auditory and haptic stimuli work together, but some people born blind prefer auditory information whilst others focus upon haptic stimuli. However, the unique expertise of

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106 Kish, Daniel. Echolocation, 3 december 2007: California State University, 2002-2.
people born blind in the context of a haptic architectural experience, and their impact on environmental experience, is striking.

**Non-Visual Environmental Exploration**

Although stimuli may be passively felt such as the temperature of a room, for example, a huge amount of stimuli depends upon an active and dynamic exploration of the environment. This requires the body to move through it. Such an exploratory process may influence the nature of the stimuli or, vice versa, the stimuli may influence the process of exploration. The source of the stimulus, the location, function of the stimulus, the context of the environment and the memories, knowledge and skills of people born blind all contribute to the type of exploration.

Some environments invite exploration, while others arouse resentment. People are generally eager to walk around or spend time in a shop or museum, for example, but avoid less hygienic environments. However, the type of exploration method used is also rooted in personality.116

Environmental exploration is characterised by different techniques, strategies and patterns. The techniques involve the manner in which basic physical movements take place, whilst strategies cover the whole methodology of exploration. Patterns, on the other hand, are the result of the strategies and represent the whole configuration of the movements conducted.

Everett Hill conducted studies with visually impaired people in order to observe their exploration strategies. Through a literature review of previous research, and his own findings, he distinguished three main strategies:

1. the hands and arms can be moved in various patterns to explore the immediate surroundings (hands and arms)
2. a cane or other object can be moved to extend one’s reach (tools)
3. an individual can systematically and independently walk the space of exploration (walking)117

We follow Hill’s classification and focus on the most important strategies people born blind use when exploring the environmental: hand-arms exploration, exploration through tools extending the body and exploration through movements. Each strategy is characterised by sets of different techniques.

**Hands and Arms**

In general, patterns of exploration by means of hands and arms are common in situations where vision is absent.

According to Stanley Suterko, people who are visually impaired prefer to obtain information that orientates them through the hands and feet.118

People who are blind use techniques that are similar to other people when they explore an environment but may, in addition, develop specific exploratory techniques that help them to explore more efficiently.

If a blind person keeps one arm bent at chest height, they expect to meet doors or cupboards, for example. If they let their arms hang down in front of their pelvis with the backs of the hands pointing up, they are typically searching for tables and chairs.

In new situations, visually impaired people might start ‘trailing’, a technique in which the back of the hands slips slightly over straight surfaces. This helps them detect objects, to move in a certain parallel direction or to find their own position in space. This technique is typically used when people move along a route or path. Other techniques related to proximal perception include the exploratory procedures described by Lederman and Klatzky that will be explained in the Section on haptic experience of the built environment (Section 3.4.1).

**Tools Extending the Body**

Tools are the aids by which people are able to extend their body for the purposes of environmental exploration. Some researchers even define the hand itself as a tool.119

This section, however, is limited to a discussion of non-human tools. For example, canes have been

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supporting tools for walkers and visually impaired people throughout history. However, the first white cane was not introduced until World War I. Besides acting as a symbol, it also enables blind people to orientate themselves. They may use a white cane for physical stability (support cane), for orientation (long cane), for greater visibility or for support whilst moving (identification cane). Different kinds of canes exist, in different colours (white, yellow), with different cane tips (rubber, plastic, and sphere) and different materials (wood, acrylic, aluminium). Most are made of lightweight fibreglass or carbon fibre. Some are telescopic or foldable. The most famous are the white canes that resemble white sticks with red fluorescent marks on them. They are known as the Hoover, after Dr. Richard Hoover, the father of the lightweight long cane technique. The length of a cane differs according to the height of the user. Different exploratory techniques can be used with a cane: scrolling, sweeping, scraping, tapping or just holding the cane in front of the body to avoid obstacles. Purvis Ponder described a way of using the cane to locate the desired sidewalk during recovery situations by, for example, sweeping the cane in a 180°arc.

Besides canes, some blind people choose a dog for support. They therefore rely on the capacity of the dog. Besides the bumps that the dog gives, the owner might feel his/her movements and actions through the leash. In a way, they might feel that their dog is a sort of ‘third hand’ and their ‘helper’ - an extension of their sensory surface. Some visually impaired people rely on their dog day after day and, in time, might not be able to orientate or move themselves through space without the dog’s help. The dog’s support may result in people losing their ability to process spaces and finally losing spatial experience. Therefore, mobility trainers recommend blind people stay motivated and keep training their sense of spatial orientation and movement without the support or assistance of people or dogs (Fig 3.12).

**Exploration Strategies**

While hands, arms and tools allow people to explore their immediate surrounding, if people who are born blind want to explore, and gain an impression of the entire environment, they need to move every part of their body.

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120 Until 2006 different colours of canes existed in Belgium. While yellow canes were used by people with visual impairments, white canes were restricted to blind people. Since December 25th 2006, the Belgian law has been reformed and yellow canes are no longer used. All people who have a visual impairment of at least 60% (based on the Belgian Disability Scale) or who have a prescription of a doctor are allowed to use a white cane.

121 In 1944 he was assigned to a centre for blinded soldiers where he developed a technique to use a cane as a tool to trail an arc in front of the body from one point to another.

To our knowledge, very few studies have been conducted into movement strategies and the visually impaired. Researchers investigating this topic are John Fletcher, Everett Hill, Purvis Ponder, Florence Gaunet, Catherine Thinus-Blanc and John Rieser. Various studies confirm that blind people perform as well as sighted people, or people with low vision, when it comes to learning a route. Nevertheless, people with visual impairments might show a tendency to veer when attempting to follow a straight path. To avoid these deviations, different strategies can be used to explore novel spaces. Sensory experience is transformed into knowledge though thought, and understanding can also be referred to as the process of cognitive mapping.

In the research on cognitive mapping, two main exploration strategies are noted to code spatial information in non-visual conditions: the route strategy, and that of the map. The map strategy is a representation in the form of a map, or floor plan, and relies upon multiple perspectives of the space. The route strategy means an exploration of the space via a linear route that unfolds in a sequence of events or elements. Many blind people experience the environment sequentially, as opposed to in a more complex and interrelated spatial manner. We therefore focus on the different kinds of route strategies as recognised in research.

In general, the strategies establish five important phases when exploring a new space:

1. establish the goals;
2. establish a clear starting point (landmarks);
3. select the most appropriate systematic search patterns;
4. utilize appropriate mobility techniques to adapt the search patterns;
5. select and implement search strategies facilitating the development of an object-to-object relationship for future travel.

It is clear that the exploratory patterns largely contribute to the exploration of novel spaces. Based on research on cognitive mapping, we distinguish seven patterns of exploration:

1. perimeter
2. grid
3. object-to-object
4. perimeter to object
5. home base to object
6. cyclic
7. back and forth

The first three patterns are frequently described in research studies, whereas the latter four are more like variants and blends of the object-to-object strategy.

The perimeter is a pattern in which people explore the boundaries of an area, while the grid pattern investigates the internal elements of an area by measuring straight lines. In the object-to-object pattern people repeatedly move from one object to another. Perimeter to object is a pattern of exploration between the object and the perimeter. Home base to object is a spatial pattern in which people select a landmark as home base and explore the space while returning several times to the home base. The cyclic and back and forth patterns are identified by

<table>
<thead>
<tr>
<th>pattern</th>
<th>description of identification</th>
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<tr>
<td>perimeter</td>
<td>exploring the boundaries of an area to identify from starting point along perimeter to starting point</td>
<td>Hill et al.</td>
<td><img src="image1" alt="Graphical View" /></td>
</tr>
<tr>
<td>grid</td>
<td>investigating the internal elements of an area by taking straight line, paths from one side of the layout to the other in order to demarcate landmarks</td>
<td>Hill et al.</td>
<td><img src="image2" alt="Graphical View" /></td>
</tr>
<tr>
<td>object to object</td>
<td>moving repeatedly from one object to another, or feeling the relationship between objects using hand or cane</td>
<td>Hill et al.</td>
<td><img src="image3" alt="Graphical View" /></td>
</tr>
<tr>
<td>perimeter to object</td>
<td>moving repeatedly between an object and the perimeter</td>
<td>Hill et al.</td>
<td><img src="image4" alt="Graphical View" /></td>
</tr>
<tr>
<td>home base to object</td>
<td>moving repeatedly between the home base (origin point for exploration) and all the others in turn</td>
<td>Hill et al.</td>
<td><img src="image5" alt="Graphical View" /></td>
</tr>
<tr>
<td>cyclic</td>
<td>each of the four objects visited in turn, and then returning to the first object</td>
<td>Gaunet and Thinus-Blanc</td>
<td><img src="image6" alt="Graphical View" /></td>
</tr>
<tr>
<td>back and forth</td>
<td>moving repeatedly between two objects</td>
<td>Gaunet and Thinus-Blanc</td>
<td><img src="image7" alt="Graphical View" /></td>
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</table>

Fig. 3.13 & 3.14: The different patterns of exploration.

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Gauinet and Thinus-Blanc. The cyclic strategy investigates several parts or objects of a space in a sequential manner. In between each object, the person returns to the home base. If explorers have investigated all objects, they return to the first object. The back and forth strategy is an exploration pattern in which people move repeatedly between two objects. In figure 3.13, we summarize all the strategies and link their terms to the descriptions and the researchers who investigated the topic.

In addition, we add seven schemes relating to the different strategies and apply them to the plan of a room (Fig. 3.14). The data provided by Hill et al. indicate that the perimeter and grid pattern support the efficient localization of objects in isolation, but not the representation of the whole space or the object-to-object relationships. It is interesting that many orientation and mobility trainers (O&M specialists) teach their students to keep these different patterns in mind when acquainting themselves with new spaces. Warren contends that educators should be encouraged by the fact that the performance of people born blind is sensitive to training and experience. Studies have highlighted the importance of early training for people born blind and the learning of body movements. Lilli Nielsen points out, for example, that those hand movements are the eyes of blind children because they enable them to ‘see’. She proposes that all activities encourage hand training.

3.3.2.2 Blind People’s Expertise in Environmental Interpretation

In this Paragraph, we look at how people born blind give meaning to stimuli and the type of stimuli that are important for their experience of the built environment. The spatial coding used by blind people is a topic of investigation, as is the subject of how meaning arises within the coding process. Research recognizes many different theories about the spatial abilities of people born blind as a result of differences in spatial perception or spatial coding. Spatial perception refers to the sensation triggered by stimuli, as well as the spatial exploration, whilst spatial coding defines a mental representation of the perceptual information. It is this mental representation that supports people’s spatial abilities. Spatial abilities describe the way people perform as a result of spatial representation. Spatial experience results out of spatial coding and performance.

Theories about the Spatial Abilities of People Born Blind

Using the different research approaches when studying the spatial abilities of people born blind, John Fletcher developed a system of categorisation. He distinguished the theories of deficiency, difference and inefficiency.

In line with the medical model of disability, several researchers are convinced that people born blind suffer from an impairment that requires a medical cure if they aspire to experience space in the same way as sighted people do. This points to a crucial lack of spatial perceptual information. In this research approach, the spatial coding of people born blind is considered to be insufficient for their spatial abilities to support good spatial experiences. This theory is also called the deficiency theory.

Followers of the deficiency theory believe that spatial coding is impossible in people born blind and that visual experience in some parts of life is essential for even a minimal understanding of space. David Warren defended this theory in his early work, for example, and Sigmund von Senden is another of its proponents. According to von Senden, people born blind are not capable of understanding the spatial environment. Although people born blind do understand how to walk a staircase or reach their arms, von Senden believes that they do not form a true appreciation of space.

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135 From that point on disability studies have experienced a shift from a Medical Model over a social to a Cultural Model and these developments also left their mark on the study of blind people’s spatial experiences and consequently resulted in different movements.
Fletcher defines the inefficiency theory as the idea that people born blind develop spatial concepts and representations of space, but that these are functionally inferior to those of sighted and people who go blind later in life. Therefore, the problem lies in a functionally inferior spatial coding process. Poor spatial ability is the consequence. Researchers found that people born blind have difficulty in mentally updating their position in an environment that is experienced through locomotive exploration. This suggests that it is not the lack of visual stimuli but the constraints in coding strategies that contribute to the ‘handicap situation’. To this end, researchers have shown that people born blind are able to construct representations of environments that are experienced through locomotion. They do this in terms of linear routes that consist of a sequence of paths linked by decision points. Fletcher himself is a follower of this theory, as are Christopher Spencer and Mark Blades, for example.

The third theory identified by Fletcher is that of difference. According to the difference theory, visually impaired people can build up a set of spatial relations and conduct spatial processes that are functionally equivalent to those of sighted people, but it is done more slowly and through different means. Gordona Miletic reminds us, however, that these delays may relate to the absence of effective information (normally visual), rather than to the absence of vision. The difference theory consequently points out that spatial perception and spatial coding is identical, but that the spatial abilities of people born blind suffer due to the lack of spatial perception.

Followers of this theory are Roberta Klatzky, Reginald Golledge, Susanna Millar, Jack Loomis, Jyrki Juurmaa, Manuel Carreiras and Benito Codina. The two latter researchers describe the difference theory as follows: “It is assumed that internal spatial representation is not linked to any specific sensory modality. According to this hypothesis, blind persons are able to preserve and process spatial images in a similar way to that used by sighted persons, although such processing may require less time when vision is involved. If given sufficient training, blind persons are assumed to be able to acquire a configurationally spatial representation, and solve spatial problems with strategies similar to those employed by sighted persons.”

According to this theory, training in orientation, mobility and rehabilitation can improve the interpretation of cognitive mapping and the quality of life of people who are visually impaired. Millar also stresses the importance of building on the information and coding strategies that are available to the blind person and of progressively integrating new sources of reference information with these existing ones.

Both theories, inefficiency as well as difference theory acknowledge the fact that the socio-material environment can be adapted to enable its users, but that the spatial abilities of visually impaired differ from those of sighted users.

As a result, the difference theory recognizes that the difference in spatial abilities is not only due to the lack of vision. The environment also contributes to the support via additional sensory information. The difference theory therefore fits in with the social model of disability. Current research largely discredits von Senden’s position and researchers no longer focus on the inequalities of people but look, instead, at their abilities. As our approach is rather new, it does not yet have a scientific name or classification. We call it, therefore, the opportunity theory. Differences between people are viewed as opportunities for the improvement of society in general. For example, as a result of cultural studies on the expertise of people born blind, the Belgian Government decided to hire blind detectives.

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in November 2007. It said that they are better at listening attentively to audiotapes.145

The opportunity theory covers studies in which people who are visually impaired employ the same perceptual and cognitive processes as sighted people but that, for some information, they rely on different, or additional, data from the senses (or other sources of information).146 Blind people’s spatial perception is different and, consequently, their spatial coding, abilities and experiences are also different - but this does not mean that these cognitive processes are inferior. The challenge lies within the differences, that are viewed as opportunities and this theory is therefore linked to the cultural model of disability. Differences exist because of intensive training, the nature of the stimulus and the characteristics of the modalities receiving it. Expertise and knowledge are due to practice, the kind of sensory information that people rely on and the intensity of the stimulus.

**Processing Environmental Information: Ego- and Allocentric Reference Frames**

The processing of spatial information begins as soon as spatial cues are available. People born blind are excellent at processing different sensory stimuli at the same time.147 This is the result of them simultaneously assimilating different sensory information on a daily basis. Eventually, all sensory information merges.

Scientists assume that reference frames are required if spatial information is to be interpreted.148 A reference frame means a framework that includes spatial information. Different spatial characteristics occupy different locations in space and a reference frame links these different positions together. In the words of Roberta Klatzky: “A reference frame is a means of representing the locations of entities in space.”149 Research into human spatial cognition distinguishes two kinds of reference frame: egocentric and allocentric (also called exocentric, or geocentric).150 Evidence has shown that these reference frames support the different functions ascribed to different parts of the brain.151

_Ego_ is Greek for ‘I’, and is often used in relation to the self and identity.152 The egocentric reference frame links the body with basic primary orientation. It provides information about the relative directions of up, down, left, and right, ahead and behind. Egocentric locations represent the particular perspective of the viewer, or perceiver.153 People rely upon an egocentric reference frame for motor actions, or to grab or designate something, for example. The information gained is dual: 1. the position of environmental stimuli in relation to the own body (and not in relation to the environment) and 2. the movements performed.154 It is particularly relevant to know where an object is in relation to the body, or where the body is in relation to the environment. Jean Piaget defined the body-centric spatial reference frames and the kinaesthetic memory as egocentric.155 Body-centric coding uses the body’s meridian as a reference frame, and this process links directions and locations to it (Fig. 3.15).

_Allo_ comes from the Greek _allos_, which means ‘other’ or ‘different’.156 Allocentric implies reference to another human, but in fact the term covers a broader

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156 http://oxforddictionaries.com/view/entry/m_en_gb0357670&rn_en_gb0357670, April 30th 2011
context. Indeed, allocentric reference frames relate to objects and environments that are related to each other, irrespective of the observer’s position. For example, when planning a route on a map, different aspects are consciously considered by means of an allocentric reference frame.

It is generally assumed by researchers into difference, both those engaged with inefficiency as well as deficiency theories, that people born blind rely primarily upon body-centred, self-referent frames and movement, or the egocentric reference frame. An egocentric reference frame turns out to be more reliable than an allocentric frame for people born blind. Millar’s experiments, for example, showed that blind children between seven and thirteen years old did not make use of an allocentric reference frame. This is not because children born blind are less capable or developmentally delayed in processing spatial information. Instead, absence of sight changes the balance between body-centric information, and information that is externally based. In the absence of vision, a great deal of information relating to distant characteristics is missing. Moreover, Millar explains that people born blind tend to use body-centric information and movement coding because their proprioceptive and kinaesthetic information is normally a far more reliable source of orientation and reference than external cues. Several researchers conclude that when these cues are absent, or there are differences in perceptual information, people born blind perform with delay or with difficulties in mental spatial reorganization and rotation. For example, if a blind person changes direction in the middle of a walk, and no other sensory cues are available, their performance will be slower. However, other studies show that when performing navigation tasks in a real environment, blind people exhibit little or no difference from sighted people, using the available cues.
Visual experience facilitates the use of egocentric and allocentric frames, but people born blind mostly rely on an egocentric system, or representation of a route that is self-referential. According to Sander Zuidhoek, it is easier to build up a spatial image if allocentric reference frames are available. According to Zuidhoek, the fact that people born blind have more difficulties in certain spatial explorations might be due to the lack of a visual allocentric reference frame. Psychological and neurological findings show, however, that blind people may have built up a visual allocentric reference frame. This visual allocentric reference frame is able to retrieve prior visual and spatial information during spatial exploration. Consequently, this past information might still serve as an allocentric reference frame. In the mid-20th century, Karl Lashley conducted studies on the function of the visual cortex using rats. First, researchers trained the rats to find their way in a maze. Secondly, Lashley removed the animals’ eyes and later placed the rats back into the maze. Remarkably, they could find their way through it using non-visual cues. However, in the next phase, the visual cortex was removed. Post-recovery, the rats were totally disoriented. This was a revealing study as it showed that adventitiously blind rats still depended on their visual cortex. So having had visual experience for a certain period is likely to have influence on spatial experience.

People built up their visual frames of reference early on in life. Studies are ambiguous about the duration of visual experience in relation to the creation of visual, allocentric reference frames. New insights that are derived from neuroscientific research affirm that the visual cortex changes when vision is lost early in life. Neuroscience also proves that the majority of changes in the brain begin 28 days after conception (in the embryo) and continue until a child is approximately five years of age. However, the area connected to vision in blind people’s brains may be adopted by other non-visual sensory perceptual systems if vision is lost before that crucial stage. If people had more than five years of visual experience, they may have built up a visual reference frame. Theodore Schlaegel found that most individuals who had become blind after the age of six reported visual images, but that none were reported by the participants who had been blinded prior to that age. Gordon Dutton, an ophthalmologist, confirms that the first seven years are critical for the development of vision, hearing, intellect and social development. Warren et al. also point out that the issue has been conceptually oversimplified and he suggests that it will take several extra developmental eras before research is able to reveal all the advantages of vision. Consequently, it is not easy to draw the line at three to five years of age, since researchers ought to keep in mind the nature of the performance that is involved.

For Sander Zuidhoek, the crucial age is three and it is this age that determines the development of visual reference frames. Others thought that the “per cent of life spent blind” is a more appropriate way of judging abilities.
Researchers who conducted surgery on people born blind (in order to return their sight) affirm the importance of early visual experiences in life. Most adventitiously blind people did not experience problems, but people born blind preferred to live without regaining sight. As explained before, our research focuses on the experiences of people born blind who have no visual history.

However, the fact that people born blind have no visual experience does not mean that they do not rely on an allocentric reference frame, since the allocentric reference frame is more than visual information. Auditory information, for example, may also provide enough cues for the creation of an allocentric reference frame. Susanna Millar states that blind people create their own spatial reference frames. She compares this with the experience of sitting in a stationary train. Whilst waiting for it to leave, the train on the adjacent railway track suddenly departs. When relying on the visual allocentric reference frame you are under the impression that it is your train that is leaving. Yet, in this situation, it is better to rely upon the egocentric reference frame. It is quite difficult for blind people to get enough distal cues in order to be able to understand the relationships between locations in a large open space. According to Millar, blind people are able to construct an allocentric reference frame. She is a difference theorist and therefore believes that training may help with the building up of an allocentric frame. With no visual cues as to spatial arrangements, blind travelers may go to a wall and search along it until they find a location, for example.

To summarize, people who are born blind tend to rely more upon their egocentric reference frames. Blind children in particular rely primarily upon egocentric knowledge. Consequently, from the perspective of ecologists and in the light of our opportunity theory, this training makes them experts in the type of spatial coding that is based upon an egocentric reference frame. They may know more variations of the egocentric reference frame, as based upon body-centric and kinaesthetic information.

In the context of our research, the most important conclusion is that people born blind are experts in kinaesthetic and proprioceptive information and a spatial coding system that is based upon a body-centric reference frame, and that they use these to explore their environment. Not surprisingly, many of the guidelines aimed at creating environments for visually impaired people contend that they prefer orthogonal environments. This might be because they feel safe in orthogonal structures, as they do not require an allocentric reference frame: orthogonal structures tend to rely entirely upon the egocentric reference frames, as the routing is parallel to the body-centred meridian. This is also the reason why a linear corridor connects all the spaces in an orthogonal way in the Life Learning Center for the Blind in Boston.

The Spatial Experiences of People Born Blind

For years, researchers have argued that blind people are not capable of spatial imagery. People with congenital blindness can tell us about non-visual perception in the built environment, but the nature of the imagery is not necessarily the same for them as for sighted people. Theodore F. Schlaegel was one of the first researchers whose results showed, in 1953, that blind adolescents reported images of sound, touch, smell and temperature, amongst other things. However, it would not be until the 1970s that these tests were conducted. One of the pioneers of this type of research was Roger Shepard. At Stanford University, he conducted research into spatial imagery with people born blind. His most famous experiments related to mental rotation tasks. The latter showed that participants were not only recalling things they had seen in the past, but also that they were capable of performing every day experiments in order to help them plan their future actions. The question remains as to whether spatial imagery is strictly visual. Mark Hollins presented evidence that haptic mental imagery exists in congenitally blind people, but he questions whether visual imagery

fades in adventitiously blinded people and whether it is substituted by haptic imagery. Studies show similarities, as well as differences, between visual and haptic imagery. Differences exist in the same ways that the haptic perceptions of congenitally blind people differ from the perceptions of sighted people. One difference is that sighted people are more adept than blind people are at recognizing tangible pictures, namely two-dimensional representations of three-dimensional objects. People born blind, on the other hand, seem to have a greater ability to perceive both the front and back of a palpated object at the same time.

The question of Molyneux also stimulated researchers and philosophers to start thinking about the relationship between non-visual representation and visual representation.

Gunnar Karlsson is one of the few researchers to have made a qualitative study of the meaning of spatial experience and spatial imagery for people born blind. His aim was to find the essential constituents of congenitally blind people’s spatial experiences via semi-structured, in-depth interviews. Karlsson considers the notion of space to be a fusion of several different sensory impressions. In line with other researchers, he points out that vision, and the sense of touch, are the most important senses that are able to constitute spatial experience. His phenomenological approach emphasises the experience itself and also the ‘logos’ of the phenomenon. The participants described their spatial experiences and what it was they imagined. Karlsson’s findings showed that the comprehension of space amongst people born blind could be divided into three categories:

1. comprehension in terms of image experience;
2. comprehension in terms of notions;
3. comprehension in terms of knowledge.

People born blind rely on these forms of comprehension for their experience of the environment.

**Comprehension in terms of Image-Experience**

Despite the fact that the term ‘image’ conjures up visual concepts, the level of comprehension in terms of image-experience refers to all ‘perceptual experiences’. This is because people born blind also use the word ‘image’ in relation to other non-visual perceptual experiences. Karlsson considers this to be the real-time level at which all actual perceptual stimuli occur. In other words, the perceptual stimuli are based on triggers from spatial elements and objects instead of memories. “It is the form in which spatial experience is most clearly and concretely lived,” states Karlsson. Within this categorisation, Karlsson subdivides the comprehension of image-experience of people born blind into three different types of image experience (Fig. 3.16):

1. image experiences requiring a relatively intact visual sense;
2. image experiences based on former, or very weak, visual impressions;
3. image experiences of people born blind, who have never had any remnants of vision.

Karlsson delimits the third category from the first two by explaining that the image-experience of people born blind is not identical to the experience of sighted people. He also shows that blind people with a degree of access to visual remnants, and/or weak visual impressions, can have a type of image-experience that differs from the third category. The third category covers the image-experiences of people who were born blind and who have no residual vision or visual memories that support spatial imagery. The comprehension by means of image-experience is characterised by three features explaining the characteristics of Karlsson’s definition of image-experience: a. the experience of the whole b. synthetizing/harmonizing c. spontaneous presentation of the whole.

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192 As earlier explained ‘born blind’ does not mean that people do not have visual history or residual vision. See Section 2.1 for thorough discussion.
a. **The Experience of the Whole.** ‘Whole’ refers to the fact that the spatial object or element is grasped in its entirety. In the case of people born blind, however, this “grasping in its wholeness” does not literally mean that the whole object is perceived at once. On the contrary, Karlsson follows Révész, who found that people born blind first perceive the structure through touch. However, in the context of visual perception, shape is experienced first. The experience of the whole requires what Karlsson describes as “a putting together of different parts by means of cognitive processes over time”. This is different from the immediate appearance of shape through vision. For people born blind, it is structure that is experienced first.

b. **Synthesizing/Harmonizing.** ‘Synthesizing/harmonizing’ is in line with ‘the experience of the whole’, and refers to the capacity of people born blind to synthesize or, in other words, put together all sensory stimuli and memories into a whole so that a synthesized image appears. These stimuli can come from different kinds of sensory receptors.

c. **Spontaneous Presentation of the Whole.** ‘Spontaneous’ refers to something that is given immediately. ‘Presentation of the whole’ refers to a way of touching and imaging things over time using the senses. It is an image-experience that appears as a result of ‘sedimented’ perceptual processes. In other words, the spontaneous appearance of images that appears when perceiving familiar objects or elements. This feature relies on movement and there are two particular types: movement of the body and the movements present in the environment. Over time, these movements are adapted through practice, training and experience. Asking people born blind to think about a jar is a good example of this type of experience. The jar can be a cookie jar, and it can be round, or rectangular, etc.

These three types of image-experience are accomplished through the following channels: haptic (tactile) experiences, inner horizon, familiarity and emotional investment. These specify the conditions that make image-experience possible.

1. **Haptic (Tactile) Experiences.** Karlsson is convinced that the image-experience of people born blind is initially based on tactile impressions. Moreover, although he recognises that other sensory stimuli may contribute to image-experiences, he is convinced that an image-experience for people born blind cannot exist without tactile stimuli. Karlsson also distinguishes between active and passive touch, as we explain in the last section when defining the haptic sense.

2. **Inner Horizon.** In his use of the term ‘inner horizon’ Karlsson refers to Gurwitsch and Husserl, who defined this as a general term for all of the ‘perspectives’ in which an object or environment can be perceived.

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In other words, it refers to every possible kind of ‘representation’200 that might result from the different positions taken by the explorer: “The difference between the sensorily given and the image experience is ‘filled up’ in terms of an inner horizon.” For example, if you feel two sides of the table, you may already have the impression of the whole table by means of the size of the sides or the height of the table. In order to constitute an image, the number of different stimuli needs to be limited. In addition, the contact surface between the body and the environment cannot be larger than the actual part of the environmental aspect that is touched. For example, when you walk along a table and you touch one side of it, you do not touch the whole table. Still, you might have the impression that what you felt is part of a table. However, the inner horizon of the table counts much more than the experience of feeling few sides of a table, or its height or part of part of a leg. With the inner horizon, the aspect of size, structure (complexity) and materiality is important. For example, a hexagonal table would be much more difficult to explore because the number of sides is much higher than the tables familiar to people born blind. In addition to size, structure and materiality also support the inner horizon.

3. **Degree of Familiarity.** The degree of familiarity, or recognisability, is important for the creation of an image-experience. The more familiar an object or element, the faster a person will recognise it by means of its characteristics. Vision has the power to catch a spatial overview in one image, whilst other senses often need different clues for impressions to form. If vision is absent, people rely on partial information, and it is this that offers the ability of contribution to full spatial impressions and identification. However, if a full spatial overview is the aim, this often requires more time and physical effort, although the spatial capacities and knowledge of the explorer are the same. Therefore, it is good that non-visual stimuli are recognizable. This means that specific stimuli may refer to spatial memories. Révész affirms that it is important for people born blind to recognize something immediately if they are to identify spaces and objects.201 Compare this to the process of putting together a large puzzle. When you make a puzzle of more than 100 pieces, you start with the most recognizable pieces, usually the ones that mark the edge of the puzzle. The more pieces that fit, the more complete the spatial impression. Camilla Ryhl links this process of spatial exploration to reference points. She states that: “It is easy to feel lost and helpless without a point of reference.”202

4. **Emotional Investment.** The fourth and last condition is that of emotional investment in an object or element. In other words, it is the degree of interest that the object has for the viewer. This can be achieved by a personal desire to create an image (direct motivation) or through familiarization, for example by repeatedly touching a surface (indirect motivation).

**Comprehension in terms of Notion**

This particular aspect of comprehension is situated between the comprehension in terms of image-experience and the comprehension in terms of knowledge. It is characterised by the fact that it involves slight sensory contact, such as that required for image-experiences. ‘Comprehension in terms of Notion’ differs from the type of comprehension that occurs through image-experience because it involves only slight sensory contact. Besides, memories are important for spatial comprehension in terms of notion, as well as in terms of comprehension. Spatial cognition at this level of comprehension is similar to comprehension in terms of knowledge.

It is argued that people born blind are better trained in terms of memory. Lusseyran states that: “The memory of a blind man is better than that of a seeing person, given equal talent. And when we say ‘memory’, we imply at the same time that other valuable ability: the ability...”

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199 The concept “inner horizon” is developed by, among others, Gurwitsch and Husserl. The phenomenological analysis of object perception shows that one perspective in the perception of the whole object has a privileged position, namely the present perspective from which the object is perceived (the sensorily given, while other perspectives are given as possible other perspectives from which the object can be perceived. These other possible perspectives together make up the inner horizon of the object. In Karlsson, Gunnar. “The Experience of Spatiality for Congenitally Blind People.” Human Studies 13 (1996): 303-330.

200 Representations is considered here in terms of haptic image experience.


to combine facts and ideas to compare, to perceive new connections.”203 He goes on to clarify: “There is no mystical reason for the better memory. It is simply that the blind in the course of time are forced to remember more than are the seeing.”204 Repetition of experiences encourages the creation of more, and different, networks in the brain. It is a form of brain training.

**Comprehension in terms of Knowledge**

Karlsson describes ‘comprehension in terms of knowledge’ as an abstract form of comprehension linked to cognition. This is because of its large cognitive character, since this form of comprehension is only constituted by means of cognitive processes.205 It is a form of knowledge that is different to body knowledge, in that it does not cover personal experiences. It is not based upon personal sensory experiences. Instead, it is knowledge that is characterised by a general description, conveyed by other people. Knowledge relies on memorized impersonal facts, which means that it is derived from concepts, instead of personal experiences. Consequently, this form of comprehension is not contextual. For example, the concept of ‘the moon’ is only clear to a person born blind through the descriptions of other people.

The understanding of illusions is also part of this level of comprehension but, in general, this level covers cognitive mapping and spatial imagery.

Studies on the spatial imagery of people born blind are contradictory. On the one hand, several studies206 have shown that people born blind have a more limited capacity to generate mental spatial images than those who are sighted.207 On the other hand, some studies demonstrated that mental representations of people born blind are similar or even better than mental representations of sighted.208

Spatial imagery is based on representation. In his explanation of imagery, Stephen Kosslyn refers to the act of counting the number of windows in your home when you are not at home.209 The average sighted person succeeds in this exercise, as he or she recalls a pictorial representation. Spatial imagery is based on this action of representation.

Perhaps one of the most extreme examples of comprehension in terms of knowledge is the ability of people born blind to draw perspective. John M. Kennedy is one of the most influential researchers conducting research into the cognitive representation of people born blind. His research shows that blindness does not hamper spatial insight into drawings or the environment. Kennedy’s research shows that blind people are able to use and integrate perspective in drawings.210 Moreover, people born blind are able to distinguish objects in 3D-spaces and to recognize different views.211

However, his opponents conducted studies in which drawings from people born blind show large differences.212 For example, these studies show that blind people do not respect perspective, and draw objects in two dimensions and in a completely deconstructed manner.213 For people born blind, it remains difficult to identify tactile drawings,214 which may be due to them coding spatial information differently. Some researchers even demonstrated that
blind people’s knowledge, and world experience, relies on tactile experiences and representations.215

This can be summarized in a single example. When people born blind touch a window that is within reach, they comprehend the window in terms of image-experience. However, if they know that there is a window in the attic but they have never touched it before, they can form an image (without having actually touched the window before). This is an example of comprehension in terms of notion. The sun and the moon can only be perceived by means of visual perception and thus imagination is based on impersonal experiences and general scientific knowledge. This is comprehension in terms of knowledge. In general, it is clear that the most crucial difference between the three levels of comprehension lies in the way sensory impressions are experienced: based on direct perception, memories or knowledge.

3.3.3 Discussion: Blindness as an Expertise

The previous Section presented the particular expertise of people born blind in relation to experiencing the built environment and also looked at the different ways in which they understand these experiences. This expertise is of utmost interest for the design of the framework of haptic design parameters.

This approach is in sharp contrast with the moral model that considered disability as punishment(s) from the god(s). The same is true for the medical model of disability that identified blindness with a bodily impairment requiring either an adaptation of the body or a medical cure. With the appearance of the social model, people questioned the shortcomings of the environment, in its broadest sense, for the very first time. Consequently, the social model of disability considers disability to be the result of a dialogue between the body and the environment.

Our research, however, takes the cultural model approach and starts from the belief that the spatial experiences of people born blind are equivalent to those of sighted people. Furthermore, they are considered to be experts in haptic perception and mediators between the visual and the haptic world. This approach leads us to a more contemporary version of the Molyneux-question. The perceptual abilities of people born blind are no longer questioned and their differences are valued as opportunities, whilst their experience is seen as a type of expertise.

Although there is very little current research into the expertise of people born blind, the number of different research domains interested in this subject continues to grow. We define this new approach as the ‘opportunity theory’, since it involves research that considers people born blind as experts, and their differences as opportunities.

Regarding the expertise of people born blind, we subdivide the perceptual expertise into two categories: expertise in environmental exploration and expertise in environmental interpretation. To summarise, it is clear that people born blind are more attentive to non-visual sensory sensations. To be more precise, their preference is for the haptic and auditory senses. They are experts in non-visual exploration, for which movement is indispensable. In experiencing the built environment people born blind rely on three main levels of comprehension: comprehension in terms of image-experience, in terms of notion and in terms of knowledge.

After analysing these levels of comprehension, it appears that the levels of comprehension based on how people born blind experience the built environment show significant similarities with the levels of mental processes that come into play when experiencing architecture.

The level of perception, is similar to what Karlsson understands as the level of comprehension of image.
experience. Similar to the level of perception, this level of comprehension considers actual perceptual actions in real-time. The level of memory is the level that supports architectural experiences through memories. The same is true for the level of comprehension in terms of notions. On this level, people born blind rely on memories formed by personal perceptual experiences. The last level, in the context of experiencing architecture, is the level of meaning. On this level meaning is given through abstract cognitive knowledge and skills. The content of this level is similar to what is understood by Karlsson at the level of comprehension in terms of knowledge (Fig. 3.17).

Fig. 3.17 Similarities between the levels of mental processes for an architectural experience and those for an environmental experience of blind people.
3.4 The Built Environment and Haptic Experience

“A feel is worth a thousand pictures.”
Tim Cranmer

So far, this Chapter has outlined the meaning of architectural and haptic experiences, and shown these to be a form of expertise possessed by people born blind. Although we are aware of the interaction between all the different senses, it was impossible to investigate all the senses (and their respective relationship to spatial qualities) for practical reasons. We therefore focus on one non-visual sensory system - the haptic sense. As explained in Chapter 2, the haptic sense, or the sense of touch, largely contributes to the experience of architecture. Pallasmaa even points out that: “All the senses, including vision, can be regarded as extensions of the sense of touch – as specialisations of the skin. They define the interface between the skin and the environment – between opaque interiority of the body and the exteriority of the world.”

It is for this reason that we feel the haptic sense, rather than other non-visual senses, is the most appropriate one to investigate. In addition, and as revealed in the preceding Section, the best-trained sense that people born blind possess is the haptic one.

Although the contribution of haptic characteristics to architectural experiences should not be underestimated, to the best of our knowledge only one researcher has actually conducted a study into the haptic qualities of architecture and the related experiences. Máire Eithne O’Neill visited rancher’s farmsteads in rural Montana and investigated the way people accumulated their place-related experiences in a haptic way (Fig. 3.18 & 3.19). Unlike most scientific studies, a small investigation into architectural projects shows that some architects intuitively master the principles of the haptic sense.

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Fig. 3.18 Extracts of plans based on the study of O’Neill
Alvar Aalto, Peter Zumthor and Juhani Pallasmaa, who all create remarkable architecture, are key figures. What is the reason for this lack of research into the haptic sense and architecture? As explained in our problem definition, a contributing factor might be the visual bias that is evident in Western architecture. Furthermore, some researchers state that in relation to design, the sense of touch is difficult to investigate in controlled experiments.\(^2\) In addition, the sense of touch is not neutral, and it is a sense that can provoke extreme likes and dislikes. These extremes, and the mixed feelings they can generate, might explain the cautious attitude taken by researchers. People either have a strong preference, or a dislike, for this sense. Whatever the reason, there was a great lack of scientific research into the sense of touch up until the 18th century. From that point onwards, several branches of humanities based research began to consider the haptic sense. It was perceived as a challenge and consequently researchers in philosophy, psychology and sociology, all began to conduct studies. These were as varied as the disciplines devoted to it, as Martin Grünwald observed.\(^2\) This Section starts with an historical overview that explains how the haptic sense was either viewed as the primary sense, or regarded with contempt.

There is no comprehensive theory on the sense of touch.\(^2\) Moreover, depending on the research field, ‘haptic’ can mean different things. Therefore, the next paragraph looks at the meaning of ‘haptic(s)’, and its significance in relation to DfM.

Subsequently, we outline the specific characteristics of the haptic sense. The sense of touch is, in large terms, a body related instrument that can be used to measure, react, discover and communicate. Most of the characteristics are linked to the strong impact of the body on haptic perception.

The perceptual process itself, and the haptic properties of the built environment, are also investigated.

Finally, the aspects that influence a haptic experience linked to context, material and shape are summarized. Using the analysis of Marks, it is clear that the haptic space forms the basis of spatial cognition. The Section concludes with an overview of the most remarkable aspects of haptic experience by linking them to the experience of architecture and the expertise of people born blind.


3.4.1 The Sense of Touch - A Historical Perspective

Through history, touch was viewed with either contempt or respect. It is therefore the sense that is characterised by the most extreme propositions. It is the sense that is always considered to relate closely to the physical, immoral and sexual.

In prehistory, touch, along with smell, was one of the primal senses because primary needs and survival depended upon it. As our ancestors gradually started to walk upright, touch systematically contributed to the development of knowledge and experience. The environment that man was able to explore expanded. The surfaces of contact were no longer restricted to the floors upon which early man crept but, because the hands were free, every surface around the body could be felt.

The Greeks were the first to scientifically register the sense of touch. They famously categorized the senses as vision, hearing, smell, touch and taste. Unlike the other senses, Plato did not connect the sense of touch to a specific organ, or body part, as he was convinced that the whole body was receptive to haptic stimuli. He linked all the senses to a cosmic body: vision was correlated to fire and light, hearing to air, smell to vapour, taste to water and touch to earth.

Aristotle, on the other hand, did link touch to a human body part: the heart. Despite the fact that touch was not considered to sit at the top of this sensory hierarchy, Aristotle nevertheless recognized its importance: "In respect to touch we far excel all other species in exactness of discrimination. That is why man is the most intelligent of all animals." In his book De Anima, he considers the sense of touch to be palpable and therefore the sense that is most closely related to the elements. The sense of touch lived on in an independent and unified sense.

In the Middle Ages, Albertus Magnus took over Aristotle’s idea when he released his own De Anima. Although he acknowledged the richness of sensory information that the sense of touch provides, Aristotle ranked it as the lowest sense. The De Anima of Thomas Aquinas continued to endorse the hierarchy of the senses, prompted by the association of touch with sexual desire. Nevertheless, according to the Arab scholar Avicenna, a contradiction existed in the Greek philosophy of touch: it was with respect and honour that the primacy of sight lived on, but in terms of natural aptitude the sense of touch merited priority. Aquinas developed this idea further and created two hierarchical systems: the traditional hierarchy, in which vision reigns, and a second system in which touch takes the primary role.

After the Middle Ages, the sense of touch fell back into disrepute. Using Greek sources, Renaissance scholars continued to describe the five senses in terms of a hierarchical system, from the highest sense (vision) to the lowest (touch). Again, this hierarchy was linked to the image of the cosmic body, such as the one described in Timaeus by Plato. Moreover, the invention of perspective put the eye at the centre of the perceptual world, together with the concept of the self. The primacy of the eye lived on for centuries.

Dutch paintings depicting scenes and objects of daily life captured a form of representation that expanded beyond the boundaries of perspective. In them, the environment is almost palpable, and they heralded a revival of interest in the sense of touch (Fig. 3.20).

Baroque paintings introduced a type of vision characterised by hazy edges, soft focus and multiple perspectives. They present a distinct, tactile invitation that entices the viewer to travel through the illusory space.

Christianity, however, strongly linked the sensory hierarchy with the cosmic body, and the Christian religion began to dominate scientific research in Western society. Consequently, research into the sense of touch is still regarded with contempt.

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After the French Revolution, Christianity began to have less of an impact. Besides, as Gert Mattenklott points out, if a culture is in crisis, there is a boom in terms of interest in the haptic sense. Such a cultural crisis took place at the end of the 18th century. Johan Gottfried Herder contributed to the revival of interest in the haptic sense. In 1778, he wrote an essay entitled *Plastik*, and defined the sense of touch as the origin of all the senses because it is the one that is closest to the body. The Enlightenment created an environment in which the sense of touch received a considerable amount of attention once more. This period was also characterised by the philosophical discussions that were inspired by the observations of blind people. This was the starting point for more general discussions about the senses. Indeed, the senses were one of the most important topics of the 18th century. For example, Denis Diderot published his *Lettre sur les aveugles à ceux qui voient* in 1749. In it, he impressively explained the central role that the hands and, more precisely, the fingertips play to a person born blind. According to Diderot: “If ever a philosopher born blind and deaf were to define man according to Descartes, he would locate the soul in his fingertips, for it is there that man’s principal sensations and all his knowledge originate.” In the second half of the 18th century, the impact of the senses is clearly recognized by architects and they designed architecture with the senses in mind. For example, Louis Bouillée redefined the usefulness of the arts and stated that they were controllable via sensory impressions. Bouillée believed that an architect should use every talent available in the quest to create sensory effects in the design. For him, drawings were the medium. This was the way to rule the senses: “Architecture is an art which rules our senses by means of all the impressions that it imparts.” At the end of the 19th century, two of the most significant sociological writers linked the city to sensory experiences: Georg Simmel and Walter Benjamin. They described the city in terms of sensory engagements and stated that it was these that structured the individual's experience of modern urban life. In the meantime, the first scientific studies on the sense of touch also appeared. In the German-speaking countries, as well as in the U.K., France and the U.S., philosophers, physiologists, medical doctors and psychologists all started to investigate the sense of touch.

Ernst Heinrich Weber, Max Von Frey, Marc Dessoir, Geza Révész and David von Skramelik were the German pioneers, whereas in U.K. Sir Charles Bell, Sir Charles Sherrington, Sir Henry Head and Lord Adrian began scientific research into the sense of touch. Meanwhile in France, research into the sense of touch evolved out of two kinds of studies: 1) observations on blindness and 2) empirical research into the sense of touch. The most famous French researchers were Denis Diderot and Louis Braille (who invented braille, the reading method of choice for about 8%...
of blind readers). Other people conducting groundbreaking work were Pierre Villey, Jean Itard, Henri Piéron, Alfred Binet and Henri Beaunis. In the U.S., the study of haptics began with the use of tactile cues by Laura Bridgeman, a deaf woman. Samuel Gridley Howe, G. Stanley Hall, Edward B. Titchener and Karl M. Dallenbach were the U.S. pioneers.

Up until the mid-20th century, the idea of senses as independent systems lived on. Researchers believed that cross modal processing was not present at birth, but achieved through learning and training.

In the early 1960s, a nativist concept appeared. Studies revealed the intermodal integration and the cortical bases of the sense of touch. Ecologists redefined the categorization of the senses into sensory systems. Eleanor and James Gibson focussed on the perceptual abilities common to most senses and an increased number of neuroscientific studies revealed the interactive mechanisms between the different senses. Ecologists also argued that the haptic sense required a functional study before the relationship between the environments and users could be understood. The first reviews of the work on haptic perception appeared in the 1980s and the beginning of the 1990s. Today, Susan Lederman, Roberta Klatzky and Susanne Millar are the leading researchers working on the sense of touch. The results of Lederman and Klatzky are important as they consider the haptic system to be an expert system: depending on the kind of object, specific movements such as exploratory procedures, for example, may help a person analyse it.

At the turn of the century, the discussion on the hierarchy of the senses is not yet finished and is, in fact, undergoing a revival. Some anthropologists of the senses, such as David Howes, Constance Classen and the architect and critic Juhani Pallasmaa, still follow a hierarchical approach (after the Greek tradition) to explain the bias in Western culture towards vision as the primary sense. They claim that our technological culture has separated the senses even further. This is a sociological approach, whereby values and meaning arise through a hierarchical classification of the senses. Others like Tim Ingold, Sarah Pink, Anet Hecht and Jo Tacchi refer to sensory metaphors as ‘natural’ differences, and in which different modalities of sensory experience are inseparable from a biological point of view. Therefore, from their research standpoint, dominance in a particular sense cannot occur naturally. Some academics even relate the processes of perception to different modalities of sensory perception that are inseparable. They connect to Avicenna’s vision, and consider sensory metaphors to be more like ‘natural’ differences, in which different modalities of sensory experience are inseparable from a biological point of view.

It is clear that the haptic sense has reached a new era in which it has permeated the domain of technology. Today, we cannot imagine life without touchscreens, computer mouses and digital button. Haptic technology is more available than ever before. A few years ago, haptic tele-surgery became widely available. Haptics have entered daily life and habits. Architecture needs more time than music, IT, fashion and literature, for example, before it can assimilate new social phenomena. However, at the start of the new millennium, architecture will almost certainly follow, and begin to incorporate, the new insights that become available about the haptic sense.

3.4.2 Defining Haptics

Haptic perception can be interpreted in various different ways. The term ‘haptic’ is derived from the Greek *haptoς* (adj.) or *haptein* (verb), meaning ‘able to lay hold of’, ‘pertaining to the sense of touch’ or ‘relating to, or based on, the sense of touch’.247

Révész, the father of the psychology of the blind, introduced the term ‘haptic’ in 1931, as a study in itself, and in relation to people born blind.248 He even distinguished between opto-haptic (optical haptic), when referring to the sense of touch in relation to sighted people, and autonomic haptic, when referring to touch in relation to people born blind.249 In 1956, Jean Piaget and Bärbel Inhelder adopted the term and assimilated it to the French stereognostique. For them, haptic perception relates to “perception of an object by means of the sense of touch, in the absence of visual stimulation.”250

Like Révész, Martin Grünwald and Mark Paterson identify ‘haptics’ as the science of touch.251 Grünwald based his definition on the theory of Max Dessoir, philosopher and psychologist, who was the first to link the term haptic to the sense of touch, as a form of teaching in line with acoustics and optics.252 According to Dessoir’s definition, John Kennedy and Igor Juricevic define haptics by comparing it to vision: “Just as vision is the psychological science of the optic input, haptics is the science of what is tangible.”253 Paterson explains in the introduction of his book *The Senses of Touch* that he considers haptic as that what relates to the sense of touch in all its forms.254 In this context haptic is rather considered to a science, similar as optics to vision. Alois Riegle’s philosophy emphasises a strong connection between the haptic and the optic. This inspired Gilles Deleuze and Felix Guattari to show the importance of ‘non-optical functions’ within vision: “Haptic is a better word than ‘tactile’ since it does not establish an opposition between two sense organs but rather invites the assumption that the eye itself may fulfill this non optical function.”255 It is through a synaesthetic processing of memories of touch, and vision, that we can apprehend our spatial environment.

Besides the meaning of haptic as a noun for the science of touch, researchers also use it as an adjective for describing the haptic system as one of our sensory systems, to refer to the kind of touch based on the sort of stimuli or as a mode of touching, more precisely active touch. These different applications may work confusing.

Consequently, if people refer to the haptic system, their approach may refer to the sense of touch in particular, or a sensory system that connects all the touch related processes or a perceptual system triggered by movement in general.

It is clear that society’s view of the sense of touch has evolved over the course of centuries. The senses were repeatedly categorised and classified differently. The most common and well-known categorisation is the one that was first described by the Greek philosophers: vision, touch, smell, taste and sound. However, James J. Gibson introduced a new classification in the 1960s because he considered the senses to be: “aggressively seeking mechanisms rather than mere passive receivers”.256 In other words Gibson considered perception not as based on sensations but he rather prefers to stress the modes of perception. He therefore categorized the senses into five sensory systems: visual, auditory, taste-smell, basic orienting and the haptic system.257 Gibson defines the haptic system as follows: “It is an apparatus by which the individual gets information about both the

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http://www.merriam-webster.com/dictionary/haptic, November 24th 2010
environment and his body. He feels an object relative to the body and the body relative to an object. It is the perceptual system by which animals and men are literally in touch with the environment.”

Nevertheless, what is confusing for other researchers is that Gibson uses the adjective ‘haptic’ also in relation to the modes of touch or the kinds of perception. To explain this more into detail we first zoom in on the background information on stimuli regarding touch.

All touch related stimuli are somatosensory stimuli (Fig. 3.21). The somatosensory receptors lie in the skin, organs and muscles and are activated through movement (mechanoreceptor), pressure (mechanoreceptor), temperature (thermoreceptors), vibration or chemical receptors (chemoreceptor). Within the somatosensory stimuli, there are three sub-categories: cutaneous, kinaesthetic and visceral stimuli. Cutaneous stimuli are exteroceptive, meaning that they are external to the body and felt by ears, eyes, mouth and skin. Cutaneous perception receives input from the mechanoreceptors, sensors close to the surface of the skin. These mechanoreceptors respond to stimuli felt by receptors in the outer surface of the body (skin and associated nervous system). Kinaesthetic perception refers to stimuli in the muscles, joints and tendons. It provides an awareness of static, as well as dynamic, body posture, known as proprioception. The interoceptive system relates to the visceral stimuli provoked by the internal organs. For kinaesthetic perception, motor activity is required. Cutaneous and visceral perception are passively assimilated.

In the context of the haptic system Gibson identifies two sensory subsystems: the cutaneous and the kinaesthetic system each representing the functions as described above. In the general broad approach Gibson considered cutaneous touch as passive touch (see Section 3.3.4.1) and kinaesthetic touch as active touch (see Section 3.3.4.1). However, he was not consistent in his description of these two modes of touch. In one approach, which is defined by Loomis and Lederman as the broad approach, Gibson points out that haptic touch is similar to active touch. In the narrow approach, on the other hand, he states that active and passive touch are both haptic in nature and uses the term in relation to both modes of touch like for example: “passive haptic perception”. As Gibson considered the subsystems as closely interacting and he preferred to stress the interaction between the two systems, we assume that he would not prefer to speak of haptic as a kinaesthetic touch as this would contradict with his theory that perception is not based on sensations.

Researchers who follow the broad approach contend that haptic perception is limited to proprioception, for which a conscious experience or exploratory action is required - in other words, movement. They define haptic as the condition in which people actively take hold of an object in order to perceive it. In relation to this broad

<table>
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<tr>
<th>somatosensory system</th>
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<th>movement, pressure, temperature, vibration, chemical receptors</th>
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<td>somatosensory modalities</td>
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<td>somatosensory receptors</td>
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<tr>
<td>location of somatosensory receptors</td>
<td>location of somatosensory receptors</td>
<td>skin, muscles, joints, organs</td>
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Fig. 3.21 Somatosensory system responsible for the perception of the sense of touch

approach, Deborah Hauptman refers to philosophers who link haptic sensation to distant stimuli and tactile sensation to proximal stimuli.\(^{264}\) However, this is rather superficial as proximal stimuli can still require movement of the muscles. In other words, not all proximal stimuli are cutaneous.

Other researchers adopt the narrow approach that corresponds with the view of Loomis and Lederman who state that haptics covers both cutaneous and kinaesthetic touch.\(^{265}\) This is also referred to as tactiliokinaesthetic. Yvette Hatwell, for example, states that: "for haptic perception the motor system is involved in the exploratory activity of the hand which in turn can activate the whole shoulder-arm-hand system. In cutaneous perception, because the corporal segment stimulated is stationary, only the superficial layers of the skin undergo mechanical deformations and are therefore involved in perceptual processing. In haptic perception, the deformations of muscles, joints and tendons resulting from exploratory movements are added to cutaneous perceptions."\(^{266}\) In this view on kinaesthetic and tactile perceptions, the spatial context is not considered. For tactile perception, information on the body’s posture is missing, and in kinaesthetic perception the observer lacks spatial (or textural) information.\(^{267}\) For these researchers haptic perception, encompasses both tactile and kinaesthetic perception. Haptic technology, for example, fits this approach because it offers feedback to users about the physical properties and movements of virtual objects represented by a computer (e.g. a joystick).

Other researchers follow Dessoir’s definition, which considers haptics to be a system that is similar to the optic and acoustic system. He acknowledges that these systems constantly interact with each other.\(^{268}\) Consequently, the haptic sense encompasses all somatosensory stimuli. This holistic approach recognizes that the processing of cutaneous and kinaesthetic stimuli takes place in relation to the wider context.

An extreme position in this approach, is given by Tony Hiss who states that haptics: "involves the integration of many senses, such as touch, positional awareness, balance, sound, movement, and the memory of previous experiences."\(^{269}\) For him haptic experience of the environment goes far beyond the sense of touch. Máire Eithne O’Neill agrees with Hiss that haptic perception covers more than cutaneous perception.\(^{270}\) She links the haptic sense to architecture and affirms the complexity of experiencing architecture. For example, our footsteps can give us an impression of balance, an awareness of our position and the ground’s texture and dimensions. Yet the sound that is produced by our shoes can also provide us with haptic architectural information. In this context touch is considered to be the very life of things and indispensable to human existence, as explained by Pallasmaa and Marshall Mc Luhan.\(^{271}\) It is a sense that is directly linked to the human body. Consequently, the haptic sense evokes very much the interaction between the body and other sensory stimuli.

As the built environment is intrinsically three-dimensional, any experience of it relies upon three-dimensional information. Besides cutaneous and kinaesthetic information, the haptic system provides links to our basic system of orientation and relies on movement and memories.

In our research we consider ‘haptic’ as the noun for the science of touch in general. Besides we use ‘haptic’ as the adjective covering all different modes of touch as well as all kinds of perception and stimuli relating to the sense of touch.

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\(^{267}\) Hatwell, Yvette, Sterri Arlette; Gentaz, and Edouard Gentaz. Touching for Knowing. Published Company, 2003:3.


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In our research we consider ‘haptic’ as the noun for the science of touch in general. Besides we use ‘haptic’ as the adjective covering all different modes of touch as well as all kinds of perception and stimuli relating to the sense of touch.
3.4.3 The Characteristics of the Haptics

Every sense has characteristics that influence the way stimuli are perceived. Haptic perception is proximal, successive, metric and interactive and has its own body language. These characteristics relate to the nature of the haptic perceptual process. Therefore, to understand the perceptual process of the haptic sense, it is necessary to have an insight into its specific characteristics.

3.4.3.1 Proximal Sense

Whereas vision and hearing are ‘far’ senses, and responsible for intercepting distal stimuli, the haptic sense is a ‘near’ (proximal) sense, like the gustatory or olfactory senses. Haptic exploration takes place in a direct proximal situation and requires direct physical contact. The degree of the latter varies according to the context of the perceiver’s body. Mellaerts and Devlieger contend that the maximum perceptual height that can be ascertained through direct and active touch is about two meters.\(^2^{72}\) This assumption was probably reached by only considering proprioceptive stimuli. If we actively explore a wall, our largest body parts (our arms and hands) limit our reach. We might also rely upon ‘facial vision’ to feel the width, height and length of a room but the actual distance that can be felt depends upon the personal training and abilities of individuals and the context of their body. The fact remains, however, that whilst we might be able to see a tower from a distance of two kilometres, haptic stimuli need to be within reach of the body. Rachel Sullivan points out that: “Touch differs from the other senses in that it always requires the presence, at once and separately, of the body or object we touch and our body with which we touch. We feel something inside ourselves when we touch.”\(^2^{73}\) To some extent, we agree, because the actual stimuli need to be within reach of the body. Yet this does not mean that haptic perception requires proximity of the source of stimuli. For example, we can perceive vibration, temperature and chemical receptors even though we might be far away from their source. Katz showed that vibration is not actually proximal because it can travel long distances before our bodies detect it.\(^2^{74}\) The same is true for the warmth of the sun’s rays. Consequently, only the haptic stimuli that trigger the receptors need to be within reach of the body.

The proximity of the stimuli might be regarded as a limitation in the perceptual process. For example, visual stimuli can often be recognised from great distances. Moreover, the body does not always need to be present at the same time. To explain the latter, think about the virtual environments created in pictures, paintings, movies and games. However, the haptic system compensates this limitation because the whole body can touch, inside as well as outside. Consequently, the number of receptors on the body surface is higher than those that are available for vision. To see, we rely on our eyes and our maximum visual field is 180°. Also, the receptors are restricted to the surface of the eyes. Ryhl describes the body as one large sensory surface: “Our body is one large sensory surface; with our fingertips we feel a single grain of sand, our feet register the vibrations of the floor and with our whole body we enjoy the warmth of the sun and the touch of water.”\(^2^{75}\) Thus, the range and variety of different stimuli involved in haptic experiences enriches the complete perceptual process.

Obviously, this proximal characteristic also has consequences. It means that the tactile perceptual field is limited to the contact zone with an object or the environment. In addition, the perceptual field is limited to the exact dimensions of the bodily surface that is in contact with the stimulus.\(^2^{76}\) In return, the haptic sense requires movement and exploration for additional information. It is not possible to switch off our haptic sense. Moreover, the proximity of stimuli leads to a preference for details and a tendency to notice differences in spatial properties.

3.4.3.2 Interactive Sense: Perception for Action or Action for Perception?

It is possible to close your eyes to visual stimuli, to shut off your ears, or nose, and to avoid taste, but it is impossible to put touch aside. A living being is constantly sensitive to haptic perception, consciously or unconsciously.

As the haptic sense is a proximal sense, it is characterised by intense interaction with the environment. The haptic sense is the only sense that is capable of changing the environment. For example, if we take a seat on a leather chair, the chair deforms in response to the pressure. The reverse is also true: haptic perception can change the body. This is linked to the fact that movement is required for haptic perception, be it performed by the body or in the environment. Consequently, “Walking itself is a way of perceptual input by touch.” Révész showed that invisible movements take place even when the hands appear to be still.

Before David Katz’s research, little attention was given to the importance of movement as a formative force. In Der Aufbau der Tastwelt, he drew attention to the fact that surface properties are better determined when the body is in motion. Révész confirmed these findings and applied them to his research into art for the blind. Indeed, when looking at an object you might immediately recognize the visual properties, but the haptic properties influence the movements required for haptic perception, whereas other stimuli may subsequently trigger an action. Susan Lederman and Roberta Klatzky first made the distinction between ‘action for perception’ and ‘perception for action’. Yvette Hatwell, however, remarked that both are closely linked in haptic functioning and Frans Veldman stated that touching is moving, and moving is touching. It is not a one-way process. To use the words of Paul Rodaway: “To touch is also to be touched.” This refers to the potential of touch to create a dialogue with the environment - we can change the environment through touch and, at the same time, the environment can influence us through touch. Besides the interactive process, the haptic sense stimulates people to touch. Révész defines this as ‘the stereo plastical principle’.

To induce visual and auditory perception, open eyes and ears require no specific actions in terms of scanning the environment. With taste, smell and touch, it is different. While all senses are always stand-by, the haptic, olfactory and gustatory experiences require a heightened exploration. In blind conditions, spatial exploration might be required in order to have enough information about the environment. Researchers even found that blind babies start to develop specific hand explorations as exploratory procedures, for example fingering and rubbing. This allows them to examine different structures.

Consequently, the relationship between action and perception is extremely important to the haptic sense since this relationship may result in several perceptual abilities that can influence the haptic process. For instance, through the movements required for haptic perception, it is possible to constantly change the size of the perceptual field. For example, you can slide your fingertips along a handrail, or you may use the whole hand to hold it. Besides the size of the body part that is used, haptic perception is influenced by the characteristics of the body and the speed of movement.

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287 Based on “verplaatsingskaracteristieken” by Wijk, Maarten, and Ita Luten. Tussen mens en plek. Delft: DUP Blue Print, 2001:70
This leads us to a second consequence: haptic perception through action in the built environment is three-dimensional because the body is the prior reference point.

As mentioned before, we all rely on our haptic perception system. According to Sullivan, however, touch differs from the other senses in that it always requires the presence of the element that we touch and the body part that we touch it with. Eisenbach states that, as a result, there is an intertwining effect of space on movement and of movement on space.

3.4.3.3 The Sequential or Successive Sense

In order to distinguish different types of stimuli, haptic perception requires different exploratory procedures. Haptic perception of the environment requires a successive or sequential approach as opposed to instantaneous exploration. In other words, the process focuses on object orientation instead of focus orientation. Object orientation also known as sequential exploration means that an object or environment is gradually explored. This sequential process is comparable to completing a puzzle. Blind people scan the environment by perceiving different parts and afterwards combine these parts into a whole percept. Sighted people, by contrast, first perceive the environment in terms of an overview and, after careful viewing, may discriminate the different components.

This successive process is opposed to the simultaneous nature of vision that allows for the immediate apprehension of most visual properties. Although vision does sometimes require movement in order to obtain additional information, the movements in general are much more limited. It is this that led Hatwell et al. to observe that touch is more sequential than vision. The visual process is the reverse of this in that the whole is seen first, but more time is required for an analysis of the structure. Révész compares the haptic successive process to sketching. If you start drawing you do not immediately have an overview, but you sketch step by step. By means of sequentially drawing the different elements, you gain insight into the structure.

This successive perceptual process has three main consequences for haptic perception: 1. a constant interaction between analysis and synthesis, 2. the incorporation of the factor time and 3. the structural evaluation.

The interaction between analysis and synthesis refers to what Révész defines as the successive-analytical process, or the fact that the environment needs to be analysed before it can be synthesized into a whole. Christophe Baillieux describes this as a process of ‘decomposition’ and ‘re-composition’.

If the whole is to be experienced successively, time has to be considered an important factor. In relation to haptic perception, some researchers even consider time itself to be a form of measurement. This is because, firstly, time is part of life in general and, secondly, because movement is connected to speed. “Vision places us in the present tense, whereas haptic experience evokes the experience of a temporal continuum,” states Pallasmaa. Consequently, haptic exploration generally takes more time than visual exploration. Ronit Eisenbach states that many architects forget this. He invited architects to take part in a game that taught them to place objects, or movements, in an order that created a context for action.

Besides time and an analytic-synthetic process, successive exploration also results in an awareness of structure before form. For example, we feel the corners

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of a table, its sides and its legs before we actually have an idea of the form. Structure can be compared to the lay out of the environment. When we first see the table we register its form and, after the perception of the form, we start to analyse its structure. This process thus takes the opposite direction. Whereas visual information is derived from a parallel perceptual process during a single fixation, haptic stimuli are serially encoded. They generally entail a sequential contour-exploration strategy. Blind people are better at detecting structure in the environment because their exploration of space is successive. Révész explains that people born blind, unlike sighted people, are more interested in ‘form-recognisability’ than in ‘form-perception’. “Form governs the visual, structure the haptic world.” Although Révész still uses the word ‘form’, several researchers warn us of the different interpretations of form in relation to haptic perception. Instead of form, ‘structure’ is a more appropriate term to use since it considers different parts of a whole environment that are successively perceived instead of the immediate, simultaneous perception of the whole.

### 3.4.3.4 Metric Sense

The fact that the haptic sense is strongly related to the body means that it is, in fact, a metric sense. According to Révész, the hands are the most important tool related to this metric characteristic. Invariable units characterize the hands: thumbs, fingers and the spaces between the fingers, for example. The hand can be understood as a measure in itself. In fact, it is possible to view the whole body as a unit. Remarkably, the body unconsciously stores all movements by linking them to experiences. This is what most researchers understand as muscle memory based on kinaesthetic stimuli. Kinaesthesia controls the way we move our hands and feet to touch and feel space. It is delimited by relevant sensations for the body position and its movement through space. Some researchers consider kinaesthesia to be a sense in itself. Ryhl, for example, points out that: “The kinaesthetic sense registers the position and movement of our limbs, muscles, tendons as well as the body itself. The kinaesthetic sense, along with our balance, ensures that our body movements reflect the size and shape of the space. The kinaesthetic sense controls the way we move our eyes to see, our hands to feel and our feet to sense when we experience space.” Järvinen also defines kinaesthesia as ‘a moving sense’ and not as ‘a sense of movement’ because it might depend on the perceiver’s abilities of that moment and the other stimuli available. To be more precise, Järvinen believes that kinaesthesia refers to the active movement of the body.

Muscle memory, or movement imagery, provides the basis for the non-visual coding process. Research into the haptic sense is rather new and these processes have not been completely studied nor understood.

### 3.4.3.5 The Language of Haptics

The lack of research into haptics has certainly contributed to the fact that the vocabulary used to describe it is very limited. This makes it difficult to communicate haptic experiences. Joen Fagan suggests that, in order to communicate interpersonal affection, touch is the first language that needs to be learnt. She distinguishes different kinds of touch that range from the public to the personal. Yet it is remarkable that the vocabulary used when talking and

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writing about the sense of touch is so limited. Max Dessoir indicated that the terminology for the sense of touch is insufficient. Meaning that there is a lack in language to express haptic experiences. Despite this lack and unlike the other senses, the sense of touch in general has a remarkably rich terminology to refer to the sense or system itself: tactility and tactile, haptic and haptical, touch and touchable, tactician and tactual, feel and feeling, tangibility and tangible, palpable... When it comes to different stimuli, however, or describing the difference between haptic experiences, language is very limited. Our daily language has a range of different nouns and adjectives to specify and/or describe - tactician and tactual, feel and feeling, tangibility and tangibility and tactile, haptic and haptical, touch and touchable, other senses, the sense of touch in general has a remarkably insufficient. 311 Meaning that there is a lack in language to express haptic experiences. Despite this lack and unlike the other senses, the language exists, then it is a scientific language that is often too complex for daily use. Moreover, the terminology might differ depending on the branch of research. For example, we have many names for the colours on a wall, but we have only two words that refer to its texture: rough or smooth. We do not speak about a 'light rough wall' or 'medium rough wall'. John Hull agrees: "When you are blind you do become aware of how much of our language is dependent upon images drawn from sight." 312 If a haptic language exists, then it is a scientific language that is often too complex for daily use. Moreover, the terminology might differ depending on the branch of research.

There are different reasons why this is so:

1. Firstly, communicating a sensory experience in the built environment is challenging at the best of times. In general, people are not taught to articulate their sensory experiences.

2. Secondly, more than other senses, the haptic experience is considered to be a non-verbal experience, or a body language. It is therefore it is difficult to put haptic experiences into words. 314

Despite the difficulty in expressing haptic experiences and finding the words to describe the haptic sense, the search for a language that expresses environmental properties has already begun.

Mike Ashby and Kara Johnson’s research into the aesthetics and perceived attributes of materials suggests that agreement on perceptions is possible, although it remains risky. 315 They therefore propose a language that expresses the attributes of different materials. 316 This haptic language should not just be restricted to materials but cover every possible haptic experience of the built environment.

3.4.3.6 Cross-Modality with other Senses

“The hands want to see, the eyes want to caress.”

J.W. Goethe 317

As explained, this research adopts a holistic approach towards haptic perception and recognises that the haptic sense interacts with other senses. David Katz has written extensively on the relationship between the different senses. Katz always used a phenomenological approach to study the sense of touch. 316

In this approach, different senses may compensate for an impaired or obstructed sense. Katz was not the only researcher to adopt a phenomenological approach towards the sense of touch, and several others have followed in his footsteps. The perceptual process is multimodal, meaning that different senses simultaneously participate in the perceptual process. 319 In relation to the built environment, the work of Camilla Ryhl and Seema Vavik is noteworthy. 320

Rick Schifferstein and Pieter Desmet conduct research into product experience, but also refer to the importance of the interconnectivity of the senses within the built environment.321

From a phenomenological point of view, the fact that we focus on the haptic sense might already be a discussion point. Moreover, several researchers describe how difficult it is to distinguish between the senses in the perceptual process.322

However, if we want to know more about the haptic sense in particular we have to, for pragmatic reasons, focus on this sense. However, this does not mean that the interconnectivity with other senses is not recognised. On the contrary, the following paragraph outlines the different connections between the haptic sense and the other senses - vision in particular. Although our research questions the visual bias in architecture, the language used by architects is primarily visual. Therefore, if we want architects to pay more attention to haptics in the design process, it is necessary to understand, in particular, the links between the visual and haptic sense.

As explained before, Molyneux’s question was the starting point for research into the interconnectivity of the senses. Morton Heller warns us, however, to be cautious when comparing the haptic and visual sense, in order to avoid generalising sensory perception.323 As we have outlined in the foregoing sections, the haptic process has unique characteristics that influence the sensation, and perception of haptic stimuli. On the other hand, many studies have revealed cross-modal priming between vision and haptics.324

The most extreme form of interconnectivity is synaesthesia. Certain sensory stimuli are replaced by means of other stimuli that differ from the sense that perceived them. These changes in connections may result in people ‘seeing’ sounds and ‘hearing’ colours, for example. Research into brain plasticity looks at synaesthesia in extensive detail. It is more common in babies than in adults, because a baby’s brain contains brain regions that are absent in an adult’s.325

There are, for example, connections between the auditory and visual cortices, and others between the retina and the part of the thalamus that takes in sound.

Whereas synaesthesia is an extreme form of interconnectivity, there are daily interactions between the different senses. These often occur unconsciously. To provide haptic information, our brain processes also maintain connections between the haptic and the visual, auditory, olfactory or gustatory regions in the brain. For example, when you hear a sound in space, you might have an impression of the shape and associate this with a haptic experience. Blind people, for example, may detect a trashcan prior to touching it because of the sound it makes. This information enables them to move in the right direction and, if they want to touch the trashcan, they know in advance that their hand will follow a smooth round line. With your tongue, you can even feel material characteristics like the texture, density or the temperature of an object. However, the connection between touch and vision is very intense in relation to spatial experiences. Visual perception often generates haptic information prior to the environment being physically explored.

**Haptic versus Optic**

*Vision reveals what the touch already knows.*326

In relation to the built environment, the interaction between optic and haptic perception should not be underestimated. According to Piaget and Inhelder, we should not forget that we once learned to give meaning to our environment through the interaction between the visual and haptic sense.327 The philosopher George Berkeley was one of the first, and most well known, people to write about the relationship between touch and vision. Berkeley pointed out that touch is the only sense that provides the mind with spatial information, which it understands without training, and he explains that visual understanding of materiality, distance and spatial depth is impossible without a haptic memory.328

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Moreover, learning to see is dependent upon haptic spatial perception. For example, a sighted baby crawling on the floor suddenly notices a toy on the table, which the child asks for by reaching arms and hands above his/her head. This action makes the baby realize that the toy is above his/her head. It is true that for babies and children these optic-haptic interactions are the most essential perceptual processes behind information gathering. The fact that vision is strongly connected to the sense of balance, and that kinaesthesia contributes to spatial expertise, triggers children to explore the world. Consequently, this forms the basis of the experience that will later enable them to identify objects and environments.

For example, in the context of functional spatial imagery, there is a functional equivalence between touch and vision regarding the characteristics of objects, materials and the dimensions that differentiate them. Touch remains at least as good as vision when it comes to detecting finer surface textures, if not better. In terms of space, both optics and haptics are sensitive to Gestalt principles such as symmetry. However, due to the fact that the haptic sense is successive in nature it is less sensitive to the Gestalt laws of organization and spatial configuration. Both senses share the same properties. Scale, symmetry and complexity are all aspects people rely upon when using vision as well as haptics to identify objects, for example.

The haptic perceptual process also distinguishes itself from vision on several levels: it emphasises material properties rather than form, it is successive in nature and, in contrast to the fact that vertical symmetry is always present in vision, this is not the case with haptic perception. According to Hollins, however, these differences should not be regarded as an overall advantage in either vision or haptics. He points out that: “Each modality has its strengths and weaknesses.”

What is more important is that the environmental properties on which each sensory process relies for the perception of its stimuli, are similar. This is quite interesting as it may suggest that the design language for architects, which is primarily visual, may be able to incorporate haptic properties. On the other hand, it is clear that the haptic process is more appropriate to identify structural and material properties whereas form is visual. For example, while we recognise the temperature of a heated floor or the edge of a cupboard via the haptic sense, visual perception is required for the recognition of forms. It is therefore argued that touch is not very useful when identifying objects represented in a picture. The most fundamental problem, however, is that most pictures are

two-dimensional representations of three-dimensional objects. They therefore employ visual conventions, such as an emphasis on outline and the use of perspective - things that a blind person might not be able to interpret without training. Studies by John Kennedy and Nathan Fox showed that it is difficult for sighted people to interpret haptic pictures. Congenitally blind, on the other hand, showed that they can identify drawings correctly (and can recognize these drawings). Moreover, a later study revealed that they could even draw pictures themselves.

Therefore, although similar properties are required to distinguish or recognize environments and objects, the way that this information is gathered and processed differs at certain points, as the perceptual processes are not identical. According to Hatwell, the two main reasons for this are: the successive nature of haptics (which results in fragmented information, whereas visual perception is more holistic in nature) and their interactive nature that means constant contact is required with whatever is observed.

Consequently the stimuli, as well as the process of optic and haptic perception, might differ. As the haptic sense is proximal, the environmental sensation can be both two and three-dimensional in nature. Visual stimuli, on the other hand, are not the result of direct exploration and are immediately converted into two-dimensional images of three-dimensional experiences on the retina of the eye. In fact, the visual projection of the image of the environment is a two-dimensional stimulus in itself. Therefore, visual stimuli can be regarded as images, whereas haptic stimuli are classified in categories apart.

When it comes to vision, a person always has to consciously decide whether or not to open their eyes. It is an active decision. In the haptic condition, because of the interactivity between the environment and the body, the body can decide to consciously touch but, vice versa, the environment can also touch the body. It works two ways. Besides, unconscious feelings are ever present and different modes of touch exist (as explained later in this Chapter).

Interconnectivity first and foremost allows the rapid gathering of as much perceptual information as possible, but there are side effects. Studies show that visual information can distort haptic information, and vice versa. For example, when viewing a rectangular object while feeling a square object, people still confirm it to be rectangular. Although many studies affirm that it is the visual information that is dominant, other studies reveal that this can easily change if the visual information is distorted or changed, or when people are asked to focus on the haptic sense. The Belgian artist Hans Op de Beeck created a sculpture 300 m² for the Venice Biennale in 2011. One of a Thousand Ways to Defeat Entropy depicts a living room, a sink, fountain, a Chesterfield, a bed and sheets made out of concrete. The lighting was so minimal that visitors were surprised when they touched the furniture or architecture. They did not feel what they expected to. The artist is playing with the intense interaction of visual and haptic perception in his work (Fig. 3.22). Pallasmaa poetically describes it as: “Even the eye touches; the gaze implies an unconscious touch, bodily mimesis and identification”.

### 3.4.4 Haptic Perception of the Built Environment

In the context of our research, haptic perception is considered to be a process that stresses the interactivity between the body and the environment. This approach
accords with the recent revival of an ecological approach within the field of environmental anthropology, and the growing interest in phenomenology at the start of the new century.

As Révész explained, people rely on context, materials and forms for their haptic perception of the built environment. However, as explained, ‘form’ does not exist in haptic perception. It is structure that is more important. We therefore replace the term ‘form’ with ‘structure’, and conclude that the relationship and interaction between structure, materials and context characterizes haptic perception (Fig. 3.23). In ecological terms, action is important for perception. Therefore, this Section starts with an explanation of the different modes of haptic exploration. These different modes are the result of the type of stimuli perceived and the sort of movements made. Subsequently, the impact of the body on haptic experience is explained. Both the constitution and the location contribute to differences in experience. In addition to the physical environmental properties, the environmental context also has an impact upon experience. As we consider materials and structure to be part of the built environment, and as a category in itself, the following Paragraph focuses on the natural environment. Designers may have little impact on natural sources but, nevertheless, these resources can still be adapted towards a certain haptic experience. Structure and materials are, together with context, the two other categories that influence a haptic experience of the built environment. Both categories are physical properties of the built environment. The latter is explained in the next Paragraph. The Section concludes with an overview of haptic representation and how haptic orientation, identification and meaning interact.

3.4.4.1 Modes of Exploration: Active, Dynamic, Passive

Movement is a requirement of haptic perception. It can be induced by the body, or the environment.

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Depending upon the source of movement, however, and the kind of stimuli that triggered the movement, we can distinguish three different kinds of touch in relation to the built environment: active, dynamic and passive. Many researchers only distinguish between active and passive touch, and relate these to the absence or presence of proprioceptive activity. Gibson introduced this classification. Several researchers, such as Susan Lederman, Roberta Klatzky and Edouard Gentaz, have adopted it. As explained before, it is possible to find different interpretations of the term ‘haptic’ depending upon the research field. Morton Heller explains that some researchers use ‘tactile’ to mean passive perception, and ‘tactual’ or ‘haptics’ to mean active perception. For him, both ‘tactile’ and ‘tactual’ mean ‘touch’, and he distinguishes active touch by using the term ‘haptics’.

In relation to architecture, haptics means something broader than ‘tactile’, in that it involves not only cutaneous perception, but also the positional awareness, balance and movement that takes place within an architectural haptic experience. Consequently this research views haptics as the umbrella term that covers every kind of touch that takes place in relation to the built environment. In other words, haptic perception covers active, dynamic and passive touch in our research. However, it was object exploration that primarily gave rise to this classification. Therefore, we start by outlining the different kinds of touch and their relationship to environmental experiences.

**Active Touch**

Active touch means that the body has to move before actual perception can take place. It is the result of an exploration (or manipulation) of the environment through the hands, feet or other parts of the body. The environment provides feedback through active exploration and the movement of the body.

The source of the stimuli is the movement of the body itself. These interoceptive stimuli may be felt by the kinaesthetic, visceral and cutaneous sensors. Active touch is generated through the stimulation of the mechanoreceptors in the skin, muscles, tendons and joints, as generated by the exploration of an object in space. It requires the body to be in contact with the stimuli. Active touch makes it possible to identify an object, or some of its distinguishing features such as size, shape, weight, position or the material it is made of. Although haptic perception is a constant, never-ending process, active touch also requires that people actively seek stimuli. Researchers have identified different names for the exploration of objects that are actively touched. The techniques of the hand have been studied in depth by

Fig. 3.23 Haptic perception relies on structure, materials and context
researchers such as Apelle, Davidson, Révész, Klatzky and Lederman. Consequently, these different actions result in a large range of terms. Schellingerhout and Smitsman outline the general hand movements as follows: mono-grasping, bi-grasping, scooting, hitting, swinging, banging, rubbing, fingering and rotating. Mono-grasping takes place when one hand enfolds the object. Bi-grasping takes place when both hands enfold the object. The terms hitting and rotating are self-explanatory. Scooting occurs when people move an object against a table surface. Banging refers to an object being banged against a surface. Moving an object back and forth is swinging. Rubber is a movement across the object in which one (or more) fingers remain static, with respect to the hand and each other. When the fingers do change position with respect to the hand during the movement across the object, it is called fingering. Dexterity is referred to as a motor skill that is determined by a range of arm, hand and finger movements and the ability to manipulate with the hand and fingers. It comprises both manual dexterity and fine finger dexterity. To our knowledge, there are no specific scientific terms relating to the feet. In general, we speak of walking, running, shuffling and sauntering, for example. ‘Mouthing’, on the other hand refers to all activities involving the mouth. Each kind of procedure can result in a different kind of property being distinguished. Accordingly Lederman and Klatzky developed a classification based on the link between haptic strategies and the observed properties of the explored object.

They grouped the hand movement profiles into distinct exploratory procedures, or EPs. Certain EPs are able to differentiate different characteristics. For example, enclosure and static contact can identify texture and hardness. The profiles are grouped into six broad EPs:

1. **Lateral motion**: rubbing the fingers across the surface of an object > information on texture;
2. **Pressure**: squeezing or poking an object > hardness, density;
3. **Static contact**: holding the fingers static on the surface of an object > temperature, shape, size, texture, hardness or density;
4. **Enclosure**: holding or grasping an object with the hand > global information on temperature, shape, size, texture, hardness or density;
5. **Unsupported holding**: holding an object unsupported in the hand > weight;
6. **Contour following**: tracing along the contours of an object with the fingers > precise knowledge on shape, size and vague knowledge on texture and hardness.

Lederman and Klatzky considered motion as an attribute required for object recognition. Eberhard explains that the haptic system easily discriminates the vibrations that are transmitted when objects are grasped with the hand, and that the roughness of a road can be felt in the vibrations of a car’s steering wheel, for example.

According to Lederman and Klatzky, these EPs can be likened to ‘windows’ through which it is possible to view the haptic system.\textsuperscript{368}

However, it is important to stress that these EPs cannot be practiced simultaneously. They must be performed successively because, in terms of locomotion, they are incompatible. For example, it is impossible to simultaneously produce lateral motion on a surface with the hands while contour following the edges of the object. As a result, these sorts of actions are more time consuming and, in addition, some properties might not be perceived immediately.\textsuperscript{369}

In the built environment, however, it is possible that that whilst the feet explore the ground laterally, the hands touch the edges of the ground. These exploratory procedures are thus part of larger exploratory strategies involving the whole body. The strategies we referred to in the Paragraph on non-visual environmental exploration are good examples of this. In relation to the structure of the built environment, the most appropriate techniques are contour following and static contact (but additional information on the links between EPs and strategies are also required). Moreover, the time factor will also have an impact on the haptic experience. For the identification of materials in the surroundings, these EPs are sufficient and excellent.

**Dynamic Touch**

Dynamic touch was first defined by Gibson as touch resulting out of skin and joints together with muscular exertion.\textsuperscript{370} The term is adopted and further developed by by Michael Turvey.\textsuperscript{371} Although Turvey defined this kind of touch in relation to objects only, we expand it to the built environment and describe it as the environmental exploration through the use of a tool, object or aspect of the environment that is external to the body or the environment that is being explored. People have the capacity to touch the environment through other objects, a capacity that Gregory Burton refers to as ‘feeling through’.\textsuperscript{372} Turvey observed and researched dynamic touch as an exploration style. It is a style in which people swing objects to get a feel of them. It allows the perception of properties such as size, geometry and weight, but is especially suited to the exploration of an object’s moment of inertia - its reaction to rotation. Exploration through this type of movement is the basis for understanding how to use an object as a tool: it allows you to know how to hit a nail with a hammer.

Dynamic touch sits at the intersection between active and passive touch. Perhaps the best-known example is when people with a visual impairment use a white cane to explore the environment. Less obvious examples are being able to experience the density of a road when riding a bicycle, or discovering the thickness of a wall through a handrail. The example of the latter gives a new dimension to the experience of dynamic touch in relation to the built environment. This is because we consider tools to be not just independent objects but also the parts and details of the environment that can guide a person through its different areas. In this way, a handrail and a door handle can both be viewed as tools.

**Passive Touch**

Passive touch is the opposite of active touch because movement comes not from the body but from the environment. The outer surface of the body is touched by an external object or being. The stimuli are exteroceptive. With passive touch, the skin is touched and information is mostly provided by the skin receptors.

Passive touch occurs indirectly as movement does not emanate from the body. Instead, the body reacts to external sources. We feel, for example, the heat of the sun or the humidity of the atmosphere.

Passive touch is sometimes regarded as less accurate. For example, Weber found that passive finger contact with objects of various sizes resulted in object recognition that was less accurate than when the objects were actively explored.\textsuperscript{373}

However, passive touch does contribute to our experience of the built environment and this should not be underestimated. The stimuli result out of movements within the environment that are external to the body.


The following example summarises this: we actively walk into our office and passively feel the warmth of the sun shining on our skin. The weight of the door is felt dynamically through the door handle.

Nevertheless, it remains very difficult to distinguish between active, passive and dynamic touch based on a person’s consciousness. The most important difference relates, once again, to movement. According to Sonneveld: “In actively reaching out to manipulate and touch the world, our attention is directed towards the object, whereas in being touched, your attention is directed towards the sensations caused by that touch. But in interaction, one can be made aware of both. Thus, although we know the difference between touching and being touched, in human-product-interaction it is not evident where active touch ends and passive touch begins.”

In other words, and this applies to the built environment if we actively move our body, our consciousness goes out to orientation and we focus goes to the static built environment itself, whereas if movements come from the built environment we focus on the sensations within our body (Fig. 3.24). This might imply that active touch will focus more on function and orientation within the built environment, whereas passive touch primarily pays attention to the atmospheric experience of the body.

### 3.4.4.2 Body Condition

In the haptic experience of the built environment there is a strong connection between the body and environment. It is therefore logical that the constitution of the body also has an impact on a given experience. Although designers do not have impact on the physique itself, their designs do. Therefore, it might be interesting to know the limitations and possibilities as they relate to age, training, adaptations, disabilities or, quite simply, the human physique and haptic perception.

People are born with certain sensory skills and anatomical characteristics that may be different, or similar, to those of other people or living organisms.

The condition of the body might change over time due to age, accident, disease, and even the way people dress.

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most sensitive regions of the body (the hairless regions), and are responsible for the detection of small vibrations and movements of light objects over the surface of the body. The body surface is represented in the somatosensory cortex where there are multiple topographic maps of the body parts. These maps can change over time, even for adults, depending on the relative use of the mapped area.\textsuperscript{377} Wilder Penfield charted these regions in the 1950s and demonstrated that the entire body surface is similarly represented on the brain’s surface. For example, the region of the arm lies next to that of the elbow.\textsuperscript{378}

The better the haptic sensitivity of a certain body region, the more brain space it therefore demands.\textsuperscript{379} This is also known as a brain space race.\textsuperscript{380} For example, heat receptors are most numerous in the skin of the fingertips, nose and bend of the elbow whereas cold receptors abound, particularly in the skin of the upper lip, nose, chin, chest, forehead and fingers.\textsuperscript{381}

In addition to the receptors located in the skin, they can also be found in muscles, tendons and joints. These are called kinaesthetic receptors. These receptors provide information about posture, location and the movement of the limbs and other mobile parts of the jointed skeleton in space.\textsuperscript{382} Kinaesthetic information is often stored in the form of muscle memory and it is what allows us to perform habitual movements. For instance, our muscles remember how to climb stairs or move around a specific room if the dimensions remain the same. However, as soon as the dimensions change we must refocus our attention on determining the locations of objects and surfaces.\textsuperscript{383} These muscles, joints and tendons also send information to our internal model of gravity, as represented by our egocentric reference frame. James Lackner and Paul Dizio define this frame as ‘perceptually transparent’, as we are not aware of the sensory and motor accommodations made in relation to gravity.\textsuperscript{384}

As explained, different body parts have different cells and each cell can detect different haptic changes. Different regions on the body and body parts can have a different sensitivity that results from the presence, number and kind of receptors. For example, the more receptors that are present the more sensitive a body part will be.

**Body Sensitivity**

Ernst Heinrich Weber, an anatomist and physiologist from Leipzig (1795-1878), revealed the differences in sensitivity of the body parts. In 1840, he postulated the Weber law because of an experiment on sensory thresholds in the human sense of touch. This law states that the change in a stimulus that will be just noticeable is a constant ratio of the original stimulus.\textsuperscript{385} These sensibility thresholds are still used today as a neurological diagnostic tool.\textsuperscript{386}

Weber also showed that, depending on the body part, bodily sensitivity could differ.\textsuperscript{387} Sensation is finest and most effective in the organs of touch, and in the muscles that belong to those body parts that are the richest in nerves or in sensory receptors (Fig. 3.25).\textsuperscript{388} These are situated in the hands, feet and face, to be more precise, the regions around and inside the mouth, lips, fingertips and the soles of the feet. The legs, arms, back and shoulders have much higher thresholds.\textsuperscript{389}

Compared to other areas, the fingertips and lips contain the greatest number of sensors per mm\textsuperscript{2}.\textsuperscript{390}

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Hands are very sensitive and are able to make contact with almost every other part of the body. Consequently, they contribute the majority of information in respect of the sense of touch. For example, contact of the hand with a stationary surface overrides deficient or aberrant proprioceptive signals from the legs. Thanks to its sensitivity, some even consider the hand as an organ of the sense of touch. This has been a controversial topic for philosophers, anatomists, biologists and psychologists for centuries. Philosophers even link the hands to the organs of thought. In architecture, it has long been the tool for measure and scale. The majority of humans are right handed (85%-95%) when performing most actions, as opposed to left hand preference in perceptive activities. Weber observed that the left hand was much more capable of determining differences in temperature than the right, and attributed this effect to the difference in the thickness of the skin. 

The fingertips, palm of the hand and the soles of our feet are the best receptors of vibrations. Yet this decreases with age.

**Ageing**

Indeed, sensitivity is also linked to age. Studies show that there is a huge preference for texture before the age of five to six, and that interest in shapes grows after the age of eight. Children prefer substance-related information, for example texture, while adults prefer to rely upon structure-related attributes like size or shape. Besides, the skin can be affected not just by age, but also by use. According to Sekuler and Blake, areas of the skin in frequent use, such as the index finger, tend to form calluses: “These calluses make the skin less elastic and therefore less sensitive. This is easily demonstrated when

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we compare our index finger’s perception of a surface versus the ring finger’s perception of the same surface. The calluses on the index finger result in a softer perception by the ring finger experience than the index finger experience even though you touched the same surface. In this context, Weber also found that the left hand was more sensitive than the right hand and that this was because of the thickness of the skin. Furthermore, it has been shown that the frequency of synaesthetic experiences declines with age. On the other hand, aging may have a positive influence on the storage of haptic knowledge. For example, the ability to discriminate between the material properties of objects, especially texture, is salient in young children but it is very finely developed in adults. Studies show that blind adults are more advanced in tactile sensitivity than blind children, but that this derives from the fact that adults have a superior capacity for movement. It is possible that some deficiencies in blind people are caused by limited experiences of movement. Although most people have similar regions of sensitivity on the body, we must recognize that some people prefer tactile or kinaesthetic information, whereas others are more visually oriented.

Physical Injuries

An accident, disease or stunted growth might impair the body’s constitution. Consequently, haptic perception might be different for people with disabilities or injuries. For instance, if you burn yourself, you might damage the skin. This might result in skin that is more, or less, sensitive to certain environmental properties. For example, Weber showed that burnt skin is sometimes more sensitive to pain, but less sensitive to differences in textures or temperature. Due to alcohol intoxication people’s haptic perception might decrease, for example, and thus they lose balance. In other words, damage to the haptic system might influence people’s haptic abilities.

Adaptations of the Body: Clothes and Training

Sometimes, people choose to change their haptic condition themselves. By wearing specific clothes, for example, the skin might receive less direct environmental stimuli. In this context, gloves influence dexterity. A study conducted by Havenith and Vrijkotte showed that wearing gloves decreases fine finger dexterity by up to 70%, and hand dexterity by up to 40%, when compared to naked hands. Dress may change according to the function, climate, social and cultural characteristics of the environment. People dress differently in cold climates compared to hot in order to keep their body temperature in balance. The more people cover themselves with clothes, the less skin that can be touched by direct stimulation. Joy Monice Malnar refers to the impact of shoes on our haptic impression of what is underneath our feet: “Both the sidewalks, and the shoes that separate us from them, have contributed to our society’s being immune to what is underfoot. We tend not to watch our step, instead placing this responsibility on others.” In contemporary Western society, people are expected to wear shoes. The guidelines for driving a car, for example, explicitly state that suitable shoes are worn. Besides, most streets and paths are paved and not wearing shoes could even result in injury. Therefore, we are culturally inclined to forget the haptic skills of the feet.

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Sonneveld states that although we cannot train ourselves to become more sensitive to subtle haptic stimulation, we are able to improve our haptic perception by experience.\textsuperscript{409} It is true that extensive training of our haptic skills contributes to more expertise during lifetime. A good example is balance. When learning to ride a bicycle the first time, you think you will never succeed, but once you have learned, you never lose the experience again.

**Acceleration**

A human body can move at a certain speed. This speed certainly influences haptic perception. For example, the faster you move your hands along a handrail, the more warmth that will be produced as a result of the friction. In relation to the built environment, we suggest that speed can be converted into the notion of time.

### 3.4.4.3 An Unchangeable Environmental Context for Designers of the Built Environment

Besides the impact of the body itself, the environmental context of the body will influence the haptic characteristics of the built environment and the related experience. This Section focuses on the environmental conditions that are not created by designers of the built environment. Moreover, they are seldom changeable. The different seasons, for example, characterise different environmental temperatures. In the cold, our blood and physical constitution reacts differently compared to when staying in a hotter climate. Other such aspects include culture, geography and time.

Nevertheless, environmental contexts are rarely specified in studies. Yet it is important for the design process, and its applications, because research shows that different contexts may vary people’s perceptions of different objects in the environment.\textsuperscript{410} According to Maarten Wijk, we judge environments based upon what we recognize and understand.\textsuperscript{411} This mostly takes place in an unconscious way. In addition to the impact of individual characteristics, Wijk makes us aware of the impact of different external influences. As Geert Bekaert explained, these influences all define the cosmos of each individual. According to Bekaert, each person possesses a cosmos created by the body in interaction with its environment and this is a continuous dynamic process. Bekaert explains that: “Architecture involves the deepest meaning of human existence in the quest to place ourselves in a self-created universe. That creation of the cosmos does not take place once, but consists of a continuous dynamic process. That cosmos in which we live, does not fall from the sky but it arises out of history.”\textsuperscript{412} Culture, climate, gravity and time all have impact on our individual cosmos.

**Climate**

Climate will certainly have an influence on our haptic perception of the environment. Temperature, humidity, the displacement of air, and light, can all contribute to the haptic experience. For example, when it is freezing and we touch a wall, the material’s conductivity determines whether we stick to it and almost burn our skin, or not. If it is constantly raining, our skin is wet, our body temperature goes down and we feel colder. When people are in a cold environment, the body temperature of their extremities drops first as a result of their skin being in contact with cold air. If the skin cools down, the blood flow to these areas decreases. This results in less heat dispersion to that part of the body.\textsuperscript{413} In this way, the temperature of the skin further decreases, and people feel the cold. When the skin is cold, every other haptic sensitivity decreases, except for the sensitivity to vibration.\textsuperscript{414}


The geographic climate is largely perceived through air. It is invisible, unless chemical reactions take place. Ulrike Passe explains that in classic and pre-17th-century thought, air was perceived to be animate. Today, however, most designers have forgotten the impact of air and consider it to be something neutral, or static.415 According to Bruno Latour, this is the result of the focus placed on other movements, and he explains that revolution, modernization and emancipation have desensitized us to the environment.416 Michelle Addington states that, for the last hundred years, designers have been representing air in the shape of lines.417 However, like sound, the displacement of air does not follow the pattern of a straight line. Although it would take until the start of the new millennium for architects to actually begin thinking about the impact of air during the design process, the 20th century saw an interest in air as a result of ‘climate art’. The Futurists used ventilators, it was Yves Klein, in the 1960s, who created the first project to be called ‘architecture of air’ (Fig. 3.26). Klein’s design was a utopian city characterized by a single ‘air-roof’, in which all the other physical boundaries had disappeared.

Klein’s design made people think about the displacement of air but did not result in any further attention being paid to the experience. It would not be until the 1970s, when the energy crisis forced engineers and designers to think about heat transfers, that designers of the built environment become more attentive to air displacement in their own work. In 2002, the architecture of air functioned as a role model for the ‘Blur Building’ designed by Diller and Scofidio for the Expo in Switzerland. (Fig. 3.27)

Peter Sloterdijk writes that air-design has become more important in the new millennium. He partly refers to the air-conditioning systems that are being placed in new public environments.418 These technological systems support human life by supplying oxygen. Consequently, we rely on these air-systems to survive. Sloterdijk explains that we are being thrown into a new kind of ‘spherology’.419 With the rise of air-conditioning, the term human comfort has become common, as it is now possible to create artificial climates. According to Passe: “Air quantified for thermal comfort is neutral: no smell, no air movement, 50% humidity, mean radiant temperature is equal to air temperature, the human activity is assumed to be sedentary, with no special behaviour or clothing.”420

**Culture**

The meaning of the haptic sense appears to differ within societies. It consequently means different things in different cultures. Some cultures express knowledge, and describe experience, using different mixes of sensory metaphors, which is not only limited to visual experience. Therefore, smell, touch and taste can also be subject to cultural capital. Indeed, as explained earlier, the senses are often ordered into a hierarchy. In one society or social context, sight will head the list of the senses whereas, in another, it may be hearing or touch. Such sensory rankings are always allied to the social rankings that are used to order society.421 Beside the influence of social rankings,
Fig. 3.27 Expo Switzerland, Blurb Building designed by Diller and Scofidio, Yverdon-les-Bains (CH), 2002
education, training or profession might also give meaning to the haptic sense. According to Edward T. Hall, we have an extreme tendency to dissociate material from cultural knowledge. As a result, Hall concludes that the language of our material surroundings has deteriorated. However, the opposite is also true, and when people daily perform actions and habits resulting in haptic experiences, they tend to speak using more of a haptic language. For example, O’Neill’s studies show that ranchers seldom mention the visual appearance of their buildings and focus instead on the tactile and kinaesthetic qualities of the way the buildings were constructed. Ranchers are constantly involved in the maintenance and adaptation of buildings, in order to keep them operational and up to date with changing needs. O’Neill therefore concludes that they understand the structures largely in terms of this labour. It is no surprise, therefore, that in traditional cultures where a visual bias is non-existent, people tend to construct things in a more physical way. Pallasmaa even states that this is similar to the way a bird shapes its nest through the movements of its body. Zulu’s, for example, do not have knowledge of perspective and, as a result, build and plough in a circular manner. Likewise, Eskimos do not perceive a horizon that separates the earth from the sky. For Indians, the sense of touch is associated with the wind; one of the five elements in ancient Indian philosophy, and the skin is considered to be the meeting point. Consequently, the social and cultural background influences people’s behaviour in, and interaction with the sense of touch that gives meaning to environmental characteristics. This is evident, for example, in the case of distance. The distances of interpersonal space, or privacy, may vary between cultures.

Besides cultural characteristics and the frequency with which people are exposed to sensory stimuli, research itself also contributes to a cultural interpretation of the senses. As explained earlier, research opinions are divided and we can distinguish two directions: 1. the anthropologists of the senses who relate the sensory experience to social constructs in which people have given values and meaning to their hierarchical classification of the senses and 2. others who refer to these sensory metaphors as more ‘natural’ differences in which different modalities of sensory experience are inseparable from a biological point of view.

**Gravity**

Gravity, identified by Newton in the 17th century, is the attracting force between two masses. It is through gravity that everything in our environment has a downward thrust. The haptic sense is the only sense that actually feels the power of gravity. For example, if we hold a can for a long time in the same position we feel the power of gravity has direct influence on both the physical movements, and movements in the built environment. It largely influences the construction of a building, its methodology and its appearance. The way things are constructed largely depends upon gravitational forces.

**Time**

Time is inherent to human life and is a general environmental condition that has a large impact on the body and the environment and, consequently, on the perceptual process.

On the one hand, time is structured through the environment, by means of the position of the earth in relation to the sun and other planets. This results in cycles that are referred to as day, night, week, month, year, decennia and millennia, for example. This experience of time might be felt, or estimated, in various ways. For example, the temperature drops during night, whereas in daytime it rises. Thus a difference in time is felt through a difference in temperature. Here, time is felt through direct perception but it might also influence a more indirect experience, like the ageing of materials. Ashby and Johnson refer to the aging of metals and

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their acquisition of a patina that makes them more attractive than when newly polished - for example bronze sculptures, pewter mugs and lead and copper roofs. Thus, the perception of materials tells us not only about place but also about time (Fig. 3.28): “Natural material expresses its age and history as well as the tale of its birth and human use. The patina of wear adds the enriching experience of time; matter exists in the continuum of time.”

Besides the environmental structure of the earth, time is given meaning through the body. Each human possesses an internal bio-clock, better known as their individual bio-rhythm. Each person is characterised by his or her own bio-rhythm which influences fatigue, for example, which in turn influences the perceptual awareness of other parts of the body. Roth and Sugarman explain this as follows: “The experience of human temporality is measured by meaning and concern before it is calibrated by counting and calculation. This lived time is qualitative, heterogeneous, discontinuous, and purposive. Mathematical time is quantitative, homogeneous, and continuous. The reduction of lived time to mathematical time reduces the human subject to an object.” Although body-related time is personal, designers can estimate its value or impact.

It is clear that time is an important aspect in the experience of space and place. Moreover, Pallasmaa rightly points out that we have forgotten how to inhabit time: “I would like to suggest that we have lost our capacity to dwell in time, or inhabit time. Time has turned into a vacuum in opposition to the “tactile sense of (time)” in Proust’s writings, for instance. We live increasingly outside of the continuum of time; we dwell solely in space. It is tragic, indeed, that at the time that we have entered the age of four-dimensional or multidimensional, space in scientific thinking, we are experientially thrown back to Eucledian space. The remains in the literary, artistic and architectural works of past erase.”

The acceleration of the body is a form of haptic perception that occurs through the movement of the whole body. It also provides information about time and, to be more precise, our biological clock can influence the acceleration of the body. Besides our muscle memory

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can inform us about the best practice regarding speed. Consequently a person can influence an experience of the environment by speeding up, or slowing down.

If designers are aware of this time-aspect, they can create differently. Their designs could involve movement and behaviour, light and temperature, and knowledge of the past and future.

### 3.4.4.4 Physical Properties in the Built Environment

We explained the differences and possible varieties in haptic perception based on the condition of the body and the context, as well as the modes of exploration. Designers can be aware of the body, the environment and the user’s exploration. They can influence them, but cannot change them. Yet, what are the physical properties that designers of the built environment rely upon in terms of designing and creating better, or different, haptic qualities? Which physical properties can designers make use of to provide more, or less, haptic qualities in the built environment?

To our knowledge, no research has been conducted that explicitly classifies the different physical properties regarding the sense of touch in the built environment. Marta Dischinger and Camilla Ryhl, in the margins of their research, did refer to possible environmental properties for the sense of touch, but their list was limited to a few properties (without an explanation or identification based on extensive research). Moreover, Ryhl and Dischinger both follow a different interpretation of the meaning of the haptic sense. According to Ryhl, the sense of touch provides information about structure, texture and temperature in the built environment. For her, kinaesthesia is a sense in itself. This might explain why she has not addressed a property like density or vibration into her notion of the sense of touch. Dischinger, on the other hand, follows Gibson’s classification of both the haptic and basic orienting systems. She is very explicit about the exploration of object properties: “Exploratory touch (basically using the hands) can bring information about forms, volumes, consistency, weight, texture and temperature of an object.” However, her list regarding the built environment is restricted to the sources of stimuli, and different types of stimuli, instead of their actual properties (Fig. 3.29). If we analyse all the sources of stimuli, together with the stimuli linked to the haptic sense as described in our research, thus including the basic orienting system, it is clear that Dischinger considers the following as possible sources for haptic stimuli: wind, sun, shade, own movement, surfaces of support, dimensions, forms, levels and texture. Wind can provide information about pressure, temperature and the vibration of the air. Sun and shade can inform about temperature and light, whereas movement of the body provides information about gravity, acceleration, sequential events, deformations and time. On the other hand, the surfaces of support, dimensions, forms, levels and texture give stimuli to the joints, deformation of tissues and forces of gravity. This classification does not explicitly mark the differences between body stimuli and environmental stimuli, but mixes both. For example, our own movement is a bodily source whereas surfaces of support are an environmental source. As explained at the start of this Section, we acknowledge the interaction between the body and the environment. A designer can influence the well-being of the body by means of designing appropriate physical properties in the environment.

Taking Dischinger’s list, we can make a distinction between potential body related information (equilibrium, direction, acceleration, body position, duration, rhythm) and environmental information (directions, temperature, intensity air, light, dark, glare, earth contact, mechanical encounters, object shapes, material states, solidity and viscosity) but she does not explicitly describes architectural properties.435

However, we did find a wide range of studies into object exploration. Hollins et al. conclude that the ‘feel’ of an object probably depends on a combination of perceptual properties.436 By ‘feel’, they refer to the haptic impression that appears as a result of the exploratory procedures that have taken place. These perceptual properties are analysed by Lederman and Klatzky, and classified into different groups with different properties: material, geometric and

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<table>
<thead>
<tr>
<th>Source of Stimulus</th>
<th>Perceptive channel</th>
<th>Stimulus obtained</th>
<th>Resultant information</th>
<th>Potential meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>Haptic and Auditory system</td>
<td>Different pressures and temperature felt by the skin</td>
<td>Directions, intensity and temperature of the wind, sound of the wind</td>
<td>Wall’s openings, location of streets, geographical orientation, street corners, known windy places, cover up or alters other sound information</td>
</tr>
<tr>
<td>Sun and shade</td>
<td>Haptic system</td>
<td>Different temperature felt by the skin, vision of light (for persons who can still distinguish light)</td>
<td>Different temperatures, light and dark Glare effects</td>
<td>Street sides, presence of vegetation, buildings and vertical, horizontal surfaces, geographical orientation, notion of time</td>
</tr>
<tr>
<td>Own movement</td>
<td>Basic orienting system and haptic system</td>
<td>Forces of gravity and acceleration, deformation of tissues, joints configurations Instant and sequential events</td>
<td>Body equilibrium, direction, acceleration of movement, positions of body, duration and rhythm</td>
<td>Relative position in space, speed, rhythm of movement, direction and distance, notion of movement and actions, notion of sequence, rhythm and duration of movement and events</td>
</tr>
<tr>
<td>Different sounds</td>
<td>Auditory system</td>
<td>Vibration in the air</td>
<td>Nature and location of all kind of vibratory events</td>
<td>Meanings of human communications, recognition and location of close and distant events and activities, confirmation of relative positions in space, ‘rooms’ dimensions, location of vertical walls and openings</td>
</tr>
<tr>
<td>Different smells</td>
<td>Taste/smell system</td>
<td>Chemical substances in the air</td>
<td>Nature and location of activities and spatial elements which posses smell</td>
<td>Can confirm the location of a place (smell of smoke marking an industrial area) or identify activities (smell of a bakery, pharmacy) and consequently to confirm relative location in space</td>
</tr>
<tr>
<td>Surfaces of support - dimensions, forms, levels, texture</td>
<td>Orienting system and Haptic system</td>
<td>Deformations of tissues, configuration of joints, forces of gravity</td>
<td>Contact with the earth, mechanical encounters, object shapes, material states, solidity or viscosity</td>
<td>Hierarchy and function of routes, declivity, textures and types of materials of surfaces, forms and dimensions, distances and directions - location in space</td>
</tr>
</tbody>
</table>

Fig. 3.29 Sources of non visual information and potential meaning by Martha Dishinger
hybrid. They distinguish seven properties that may support object identification through haptic perception: shape and size (geometric properties), texture, hardness, temperature (material properties), motion and weight (hybrid properties).

Similarly, Gentaz and Hatwell classified object properties by means of haptic perception into material and spatial properties. Shape (global shape, curvature, angle size), orientation, localization, length are considered to be spatial characteristics, while texture is considered as the main category for material properties.

Based on the information and classification of object properties, we investigate the environmental properties.

Are these object properties, as grouped into material, spatial (or geometrical) and hybrid properties, also adaptable to haptic perception in the built environment? This is the topic of the following Paragraph.

**Material Properties**

The fact that haptic perception favours material properties is due, in part, to the early availability of these properties during the haptic perceptual process (or at least earlier than the spatial properties). In haptic conditions, identification thus largely depends upon material properties. Indeed, in terms of spontaneous haptic explorations, research shows that the most prominent properties are texture, temperature, and hardness.

Besides their importance at recognition level, materials also largely contribute towards the expression of an object or environment’s origin, history and use. In fact, haptic habits and uses are appropriate through time and, according to Pallasmaa, these details are particularly well reflected in natural materials (Fig. 3.30).

In relation to the built environment, researchers and critics often refer to texture and temperature, but density is less present. Dischinger does not refer to this property literally, but uses vaguer terms instead, such as material state, solidity and viscosity. We do believe that density also has an impact on an environmental experience and therefore integrate it into the classification of haptic material properties in the built environment.

**Temperature**

The perception of temperature is one of the first haptic skills that babies learn. As Gibson and Pick explain, it is important in terms of specifying comfort. In addition, temperature provides information about safety and security.

Materials are characterised by specific temperatures, but can also form a medium for transmission of warmth and cold through radiation or conduction. We are most familiar with the thermal qualities of materials, as expressed through terms like warm, cool, humid, airy, radiant and cosy. This allows the observer to notice thermal conductivity, which is "the rate at which a surface..."
draws heat away from a hand that’s touching the surface”. The temperature of materials is traced back to the coefficient of conductivity (for example, steel feels much colder than wood due to its high coefficient of conductivity). The perception of coldness is due to the process of warmth extracted from the skin. The object cools one’s skin and becomes warmer itself. If the process is fast, the material has a high thermal conductivity. This is the case for steel that has a low temperature resistance. The feel of steel is ‘cold’. If the process of temperature resistance is slow, we consider the object to be ‘warm’. Due to this process of temperature flow, the temperature of objects and surfaces appear to change over time, eventually leading to neutral thermal perception. For example, polymer foams and low-density woods are warm and soft, and so are balsa and cork. Ceramics, stone and metals are cold and hard, as is glass. Polymers and composites lie somewhere in between.

The thermal condition of an object is best distinguished through static contact. The perceived temperature is dominated by the differences between the temperature of environmental aspects and the skin. High thermal conductivity results in a cold sensation that comes from touching materials such as cement, stainless steel and oak. Low thermal conductivity materials include, for example, bench wood and various plastics. What appears to affect a material’s conductivity is its hardness or density. This is why metal at room temperature feels cooler than wood at room temperature: a hard surface is a better conductor of heat.

Texture

Texture as material property of the built environment is probably one of the most studied tactual phenomena in psychological studies. Moreover, texture is the property that appears to provide the most important information for haptic perception. Studies show the importance of texture in pattern recognition during the process of identifying objects. Texture is also compared to a surface property or quality, a ‘tactile signature’. Texture refers, on the one hand, to the material characteristic of the material itself but, on the other hand, it can also refer to any small structures created on surfaces. Therefore, Lederman and Klatzky define texture as “the microstructure of surfaces, as opposed to the large-scale macrostructure of objects, for example its shape.”

Moreover, they define all the properties that can characterise a surface’s microstructure as texture: roughness, hardness, elasticity, and so on. In the context of this research we do not consider temperature or density to be part of the overall texture. Instead, we adopt the definition of texture that means all the properties that relate to the pattern on a surface. This structure of the surface is the result of the material characteristics, the production techniques and the applied surface treatment. Material characteristics that may influence these properties are for example: viscosity, hardness, permeability and reflection.

Consequently texture might give us information about the relative roughness/smoothness, hardness/softness, wetness/dryness or stickiness/slipperiness of materials. The texture of a material gives direction, reflects
light and describes its roughness. Therefore, textures are important properties for the identification of objects. Texture is a property that 4-month-old babies can already recognize. However, texture recognition is no prior skill for babies as it is only later in life, when fingerling becomes a skill, that texture receives meaning. David Katz insisted on the requirement of movement for the perception of texture.

In order to perceive texture, a simple movement over the surface suffices. According to Klazky and Lederman, lateral motion provides the most information, although static contact, enclosure, unsupported holding and contour following may also support the perception of texture. Despite the controversy that exists over the superiority of active touch, there is experimental evidence that active and passive touch give equivalent results for the perception of texture. Research shows that for patterns, at least 3% of difference is required if two different textures are to be distinguished. The difference itself refers to the increase of the height of the raised material, or the increase in the separation between the raised pieces. The perception of texture is also dependent upon the constitution of the patterns, the pressure on the surface and, to a lesser extent upon the speed of movement.

Research shows that the rough texture of stones might be experienced through other senses and memories before they are actually touched. However, in non-visual conditions, stimuli should be close to, or in contact with, the skin of the perceiver for the texture of a surface to be felt. This characteristic is derived from the proximity of the haptic sense. Regarding the importance of haptic stimuli, Helen Keller affirmed that texture is one of the most meaningful perceptual properties for people born blind. Bloomer and Moore even suggest designing a house for the blind as “choreography of movement by means of texture”. People who are more attentive to this property, like blind people, might reveal the richness of information that texture retains. John Hull describes how it took him quite some time to learn to appreciate the information that texture provides: “I am beginning to enjoy the different textures of materials. One of my teacher friends is using a heavy, velvet bag to conceal an object from her children. They have to feel it through the bag. I love the way the fibres wiggle as your hands pass over the bag, this way and that. There is a delightful contrast with the smooth clean sharpness of the metal bracelet in the bag. I am surprised that it should have taken approximately five years to begin to appreciate experiences of this kind.” Research into drawings with blind participants shows that they prefer matt embossed surfaces to smooth and shiny ones.

Unlike temperature, there is a strong cooperation between the perception of texture and the shape of the perceived element. John Hull points out that it would be accurate to say that shapes and textures are inseparable, but distinguishable. According to Hull, texture can

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support shape perception. Millar’s research affirms that texture can improve a person’s ability to judge size and shape. 475

De Visser states that shape in relation to texture also reveals ‘the hand of the designer’. 476 He distinguishes the ‘schriftuur’ (writing) and the ‘factuur’ in texture, in which factuur is the information about the making of the artwork, whereas schriftuur is the handwriting of the artist him/herself and varies from person to person. Similarly, Mark Paterson explains that through texture and technique an artist may appeal to a tactile sensitivity. 477 This sensitivity gives meaning to haptic perception. For example, in the book Leuven horen en voelen, David Mellaerts, a blind city guide refers to ‘feeling’ the stones of the old city hall that were all hand made by stone cutters. 478 Thanks to the ‘schriftuur’ Mellaerts is able to feel the history of this stone and its character.

**Density - Hardness**

We feel the hardness of a material, or its density, through the skin by means of skin pressure and corresponding movement of muscles, tendons and joints. Material can be hard or flexible, rigid or pliable. In 1964, in a study into softness, Harper and Stevens found the exponent for the power law in density. 479 Hardness and softness judgements were reciprocally related.

The hardness of an object is usually described as either solid and dense, or flexible and moveable. Human ability to perceive vibrations is largely dependent upon the medium through which vibrations are travelling. Some media work better than others at transmitting vibrations. Water has a greater density than air, which allows it to be the better transmitter. Yet, solid materials conduct vibrations best.

**Spatial - Geometrical Properties**

Besides material characteristics, researchers in the field of object exploration also distinguish spatial or geometrical properties. Gentaz and Hatwell classify shape, orientation, length and localization as important haptic spatial characteristics. 480 Lederman and Klatzky restrict what they define as geometrical properties to shape and size. While all of these researchers mention shape and length, orientation and localisation are not mentioned by Lederman and Klatzky. However, in order to be comprehensive we also discuss these properties and investigate their necessity in terms of the built environment.

**Shape**

According to Gentaz and Hatwell, shape is a complex property. 481 Moreover, the perception of shape through touch is less accurate than it is through vision, simply because it takes longer and is less efficient. 482 However, this does not mean that it is not important to the haptic perceptual process. On the contrary, when it comes to identification, several researchers conclude that shape is a particularly important attribute. 483

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Klatzky and Lederman’s studies show that, when an object is categorized by its most common name, the identification process largely relies on the characteristics of shape. Besides, other studies affirm the relevance of shape by stating that, in all age groups, people who are in search for haptic information actually use it. Moreover, studies affirm that infants as young as two to four months are already able to recognize objects based on shape. However, as Millar states, research into haptic shape perception is much rarer than studies into visual shape perception. As a consequence, less information is available.

According to Lederman and Klatzky, contour following is the best way to explore shape. Other exploratory procedures like static contact and enclosure may also provide global information but it is less precise than that obtained through contour following.

The constituent elements of shape, as defined by Gentaz and Hatwell, are global shape, curvature and angle size. The global shape considers the complexity (the number of sides of each shape), the size and symmetry. Remarkably, these constituent elements are similar to the visual shape attributes. Curvature is defined as the "converse of the radius of the corresponding curve. For example, a curvature of 0.8m-1 is defined by a circle having a radius of 1.25m (1/08)." Angle size is the measured angle between two lines or surfaces.

Similarly, Lederman and Klatzky also classified different constituent elements for the properties of shape. They additionally add surface discontinuities, such as edges and holes:

- continuous 3D surface contours: curved versus flat
- orientation of surfaces: horizontal, vertical or slant
- edge (no edge versus edge).
- hole (hole versus no hole, shallow hole versus deep hole)

Studies indicate that force cues also have a large impact on haptic perception. For example, Gabriel De-La-Torre and Vincent Hayward show that: "when sliding a finger across a surface with a rigid bump on it, the finger moves over the bump while being opposed by a force whose direction and magnitude are related to the slope of the bump. The steeper the bump, the stronger the resistance." Moreover, their studies show that in shape identification force cues even dominate geometrical information. When combining the force cues of a bump with the geometry of a hole, De-La-Torre and Hayward found that subjects perceived a bump. Conversely, when combining the force cues of a hole with the geometry of a bump, subjects typically perceived a hole.

Millar states that this is why it is often very difficult to study shape recognition through haptic perception. The information that is received on the haptic features of shapes comes from different sources. Although this is not unique for the haptic sense, the difficulty lies in the fact that the relative influence of all these sources may differ with the size, depth and composition of the shape itself, but also with the bodily context of the perceiver. Besides, touch is less sensitive to Gestalt laws such as organisation and configuration than vision.
Orientation

According to Gentaz and Hatwell, orientation is the spatial property that indicates how a stimulus relates to the reference frames of the perceiver. Consequently, this property is strongly affected by the position of the body and the position of the head, the conditions of exploration, memorisation and the reproduction of stimuli. Orientation also provides information about the relation of the gravitational forces on the explored element as the vertical and horizontal axes of the reference frames correspond with the direction of gravity. Each orientation is encoded through kinaesthetic sequential body movements. Whereas the oblique effect in visual perception results in a better perception of vertical and horizontal orientations, compared to oblique orientations, this effect in haptic perception is debatable.

Length

Length is the structural property that provides information about a measured distance, the dimension of the perceived object or the distance between the object and the body. It is a property that is learned throughout a lifetime and that also improves with age. Depending upon the research field, different methodologies are used to study length in relation to haptic perception: psycho-physical function analysis (linking physical length of stimulus to estimated size by means of EPs), length bi-section (estimating point that splits object in two equal parts) and inferring Euclidean distances (estimation of Euclidian distance between two points). Distances seem to be partially encoded through sequential movements.

The most important characteristic of length is that it depends upon the proximity of the body and is measured in relation to the body. Consequently, length relates to proportion and movement. For proportion, the smallest and largest measure will depend on the body’s physique. The smallest differences in surfaces are immediately recognized in a non-visual situation, whereas this might not be the case when vision is present. For symbols to be distinguished, the absolute minimum distance between two points or lines (which also depends on the size of the symbols) is 3 mm. Because movement is itself a source of haptic stimuli, time is also a measure for haptic perception. Movement and time provide information in relation to the determination and estimation of distances, and the way these are remembered.

If vision is absent, certain aspects that contribute to the interpretation of length disappear (depth and large distances, for example). We cannot perceive large distances by means of the haptic sense, other than by being aware of them through travel. Depth is associated with descending a staircase, or swimming in a pool, but this is still a very different meaning to ‘depth’ as it is interpreted in a visual context.

One of the side effects of the notion that proximity relates to length is that length and distance seems smaller when perceived in a visual context. Thus, objects or environmental elements will appear smaller after a haptic exploration if vision is present. For example, a small dimple in the wall is palpable to the haptic sense and may seem like a large bubble in the wall. As soon as the visual system is available, it might be very difficult to find the very same dimple in the pattern of the wallpaper. Consequently, holes or bumps might seem much larger in a purely haptic condition than when vision is present. Research also shows that...
when stimuli have very rough textures their length tends to be overestimated but underestimated if the stimuli are finer. Blind people store all this information in the form of muscle memory and bodily dimensions.

**Localization**

Some researchers combine localisation and orientation. Gentaz and Hatwell, however, consider localization to be the property that localizes the explored objects’ position when it is not in proximity to the body. The difference with orientation is that position of the body first has to change in order to localize the object. In other words, it relies on the information provided by length and direction. For example, people learn to put their hand in light contact with a stable surface as this can serve as a support in the control of their body position.\(^{509}\)

The encoding of localization operates in a spatial reference frame (egocentric or allocentric).\(^{510}\) Ernst Heinrich Weber has indicated the impact of what he defines as ‘the sense of locality’: “The sense of locality helps us to better know the movements of our limbs and with the help of the movements of our limbs dependent upon our own free will - we get to know our skin and orient ourselves on one and the same (the skin). Both abilities, from the beginning extremely limited, compliment and complete each other.”\(^{591}\) Localization is acquired through training. Children learn it by revealing their body location in relation to the environment as often as possible. The more they move through space, the more they learn in terms of localization.\(^{512}\)

This property is therefore a challenge to people born blind as they largely depend on body related information. They thus have difficulty relating this with allocentric information.\(^{513}\) Research shows that they often experience difficulties in inferring the position of an object after its displacement, or the displacement of the subject.\(^{514}\)

**Hybrid Properties**

Some properties, like weight, rely on information provided by a combination of material and geometric properties.

**Weight**

Weight, for example, is determined by the density of the material and the size of the element that is being explored. Weight is the amount that something weighs. This is mostly a very important aspect in object exploration but, in a haptic perceptual process, its impact is more noticeable through gravitational forces. Klatzky and Lederman identify it as a hybrid property that reflects both density and size.\(^{515}\) The weight of an object is usually described as heavy, light or something in between. The weight of a small object is usually determined by ‘unsupported holding’. However, for more heavy objects, the exploratory procedure requires lifting the hand and moving it up and down in order to estimate the effort required to lift.\(^{516}\) Besides active exploration, passive touch may also provide an impression of weight or mass.

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### 3.4.4.5 Haptic Space

David M. Mark presented a model of three ‘sources of spatial information for human spatial cognition’ (Fig. 3.31). He discusses spatial cognition in general but, remarkably, he places the haptic space as the first source of information that is required for human spatial cognition. Depending on the perceptual cognitive source of information, he distinguishes haptic space, pictorial space and trans perceptual space.

Haptic space is a consequence of direct sensing by touching and bodily interaction. It considers sensorimotor and haptic perception, and provides information about the spatial information received from the proximal senses and direct immediate perception.

The pictorial space is associated with remote sensing and, although it is primarily understood through visual experiences, auditory and olfactory senses also play a role. In other words, it is the cognitive interpretation of taste, smell, sound and visual senses. Mark explains that pictorial space is metaphorically grounded in haptic space.

The transperceptual space is primarily learned through inference during way finding. In this context way finding means not the actual movement itself but the cognitive element of navigation. It is the tactical and strategic part that guides movement.

These three cognitive sources of information are hierarchically arranged: sensorimotor and haptic perception is the first spatial knowledge that reaches the mind and is, by this means, the most basic (Fig. 3.32). Thus haptic space is understood as the more fundamental (or basic) information from which pictorial and trans perceptual spaces are metaphorically derived. Mark interprets these metaphorical extensions in terms of Lakoff’s definition of a metaphor: a fundamental cognitive process by which an unfamiliar conceptual domain is understood in terms of a familiar one.

These three sources of spatial information could, in fact, serve the levels of mental processes involved in an architectural experience that, in their turn, could generate the levels of comprehension upon which people born...
blind rely for their spatial experiences. The idea behind the sources of spatial information has many similarities with the other schemes. The latter scheme represents the three levels and sources on which a spatial experience is formed. In addition, the haptic, pictorial and transperceptual space focus on the stimuli themselves. This affirms the importance of haptic information for spatial experiences once again because it is the primary source from which all the other spatial sources are derived. Consequently, like the other levels, these three sources also have a hierarchical relationship. In common with the level of perception, the haptic space covers direct perception. Pictorial space characterises remote sensing or indirect perception, which the level of memory or level of notion also refer to. The terminology of the trans perceptual space is limited to way finding, but also covers the whole system of giving meaning to navigation and movement through space.

3.4.5 Discussion: The Haptic Sense

The Section on the haptic sense revealed that ‘haptic’ is a term that carries different connotations amongst researchers from different disciplines. In general, we consider haptic to be the science of touch and our research specifically refers to haptics being an holistic sense that encompasses all somatosensory stimuli (kinaesthetic, cutaneous, visceral), as well as the interaction with other senses. Proximity, interaction between the body and environment, successive exploration, the fact that the body itself is the measure for perception and the lack of a language all characterise the haptic sense. In addition, the crossmodality with other senses is outlined, particularly vision. Movement is the most essential condition for haptic perception and is generated by the environment or the body. Depending on the movements involved, three kinds of touch can be distinguished: active, dynamic and passive. Active touch requires movement of the body, passive touch relies entirely on movements in the environment and dynamic touch is a mix of both active and passive touch. Consequently, the latter relies on environmentally generated and bodily movements. Haptic experience in the built environment relies on context (body and environment) and materials and structure. The different environmental properties are outlined and classified according to their material, geometric (or spatial) and hybrid properties. According to David Mark, haptic space is the primary source of spatial cognitive knowledge. Pictorial and transperceptual space are metaphorically derived from haptic space and may serve the levels of mental processes that are involved in architectural experiences as well as the levels of comprehension derived from the way blind people experience space.

3.4.6 Theoretical Framework of Haptic Design Parameters

Based on the findings of the theoretical track we can compose a theoretical framework that summarises the levels of mental processes involved in a haptic experience in the built environment based on the expertise of people born blind. We recognise three levels: the level of perception, the level of memory and the level of meaning. The level of perception considers the physical reality and the mental processes that result from direct haptic perception. This level is based on haptic space for its information. The level of memory covers all the personal memories that are evoked through slight sensory contact. On this level habits are directed. The level of meaning relies on impersonal knowledge that results from no immediate sensory contact. This level largely contributes to giving meaning and affection to our experiences. All the levels closely interact. Together they outline the basis for our haptic experiences in the built environment.
Levels of Mental Processes required for a Haptic Experience in the built environment based on the expertise of people born blind

- level of perception
  - physical reality
  - direct haptic perception
  - based on haptic space

- level of memory
  - personal memories
  - slight sensory contact
  - habits

- level of meaning
  - impersonal knowledge
  - no immediate sensory contact
  - meaning / affection
Chapter 4: Empirical Track

4. Haptic Experience in Practice
4.1 Introduction

The literature study in Chapter 3 revealed that although many studies have been conducted into why people born blind explore the built environment using their haptic sense, much less is known about what is actually touched and, more importantly, when and how. In order for architects to be able to design inclusive environments, they need to know which architectural elements support haptic perception and why people use the built environment haptically. Different gestures can tell designers about certain perceptual actions. Yet, as Ronit Eisenbach argues, architects seldom take gestures into account: "We tend to generalize gestures in our spaces. Perhaps, we consider the impact a counter height or location of a door handle might have on a space, but rarely do we have the opportunity to consider and observe the interaction between gestures and place." ¹

An empirical track has therefore been set up to investigate the environmental cues related to haptic experience. Moreover, the empirical track also questions how blind people perceive these cues. This track is made up of three empirical studies (Fig. 4.1):

1. home visits with adults born blind
2. observations of children born blind
3. focus group interviews with caregivers

The reasons for working with people born blind, and employing a qualitative research method, are discussed in Chapter 2. The subject and focus of this Chapter are the actual studies and the results. We describe the three studies in full detail and summarize the results at the end of each Section.

Each summary explains how participants explore the built environment haptically, what they haptically perceive within it, and why they pay attention to certain aspects of their surroundings.


Fig. 4.1 Scheme illustrating the relationship between the three conducted empirical studies
4.2 Home Visits with Adults Born Blind

The main aim of the home visits was to investigate when and how people haptically experience the built environment and which environmental characteristics and properties they pay attention to during haptic perception.

As explained in Chapter 2, there are theoretical and methodological reasons for working within the home environment.

To guarantee the validity of the interviews, the home visits were not restricted to just in-depth interviews but were combined with video tours. This was because we wanted to collect as much information as possible during a visit and because it is recommended to combine in-depth interviews with other methods when undertaking qualitative research.

The in-depth interviews were part of a cyclical process in which the analysis followed the interview. The results fed into the preparation of more focused questions for a subsequent interview. The implication, therefore, was that we would need to return to the participants several times. As it was very hard to find participants, and because they were rather suspicious about home visits, we began with the expectation that we would only have one opportunity to visit each person. For this reason, we decided that it was important to collect as much information as possible from the different methods at the same time.

From a methodological point of view, researchers explain that in-depth interviews can sometimes result in information that is, in fact, very limited. Nickpour and Dong explain: “It can be argued that interviews and questionnaires describe a limited method for understanding the users and their situation as it only relies on what people ‘say’ rather than what they ‘do’ in reality; users do not and cannot necessarily express and reflect on exactly what they need, prefer or wish. In other words, users do not always say what they want and do not always what they say they want.” This effect is also described by Donald Norman as the ‘too obvious to notice’ effect: “If you ask people to describe what they see in the room in which they are sitting, they are apt to leave out the obvious: floors, walls, ceilings and sometimes even windows and doors. People may not have reported what they truly liked because that might have been too close to them, to enmesh in their lives. Similarly, they might have missed the disliked things because they were absent.”

On the other hand, it would not be enough just to use video, because the medium cannot represent the complexity of the whole human sensory experience. For example, passive touch is invisible and can only be traced via in-depth interviews.

For these pragmatic and methodological reasons, the in-depth interviews were complemented by guided tours given by the participant that were recorded on video. This resulting video ethnographic study was complemented by annotated plans. The video tours allowed us to observe the actual movements related to active and dynamic touch.

The guided tours were given greater meaning through the in-depth interviews and the additional plan annotations with which they were combined.

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Before the actual home visit took place, we spent a lot of time informing all participants through e-mails, letters and telephone calls about the general research approach and, more specifically, about the ethics that underpin it. The PHL Legal Review Board approved the study protocol. Each participant was asked, via e-mail or during the home visit (see appendix 10.1), to sign an informed consent document. Thus the participants could read the informed consent document themselves, or we could read it through with them during the interview.

Between July 2007 and July 2008, we conducted 22 home visits. Each visit followed the same structure:

- acquaintance and introduction to the research
- in-depth interview
- video tour
- filling in drop off form

As soon as we arrived at the home of the participant, we tried to make them feel at ease and explained the general research set-up. The participant chose the location for the in-depth interview and, afterwards, the participant guided us through the home for the video tour. At the end of each interview, the drop off form was filled in with the participant. The form collects additional information, for example the participants’ coordinates, date of the interview, aids used during environmental exploration, family situation, profession and medical information (see appendix 10.1).

4.2.1 Context: Participants and Homes

For the home visits, a call was sent to people born blind inviting them to participate in the research project. The call was disseminated in autumn 2006, through various information channels:

- **Bliksem**, a well-known forum for blind people;\(^6\)
- the regional association for the blind, Blindenzorg licht en liefde sent an e-mail to all their user/experts;\(^7\)
- the Belgian Confederation for Blind and Visually Impaired People\(^8\) sent an e-mail to their members;
- an article appeared in the bimonthly journal, ‘Knipoog’ of the association of persons with a visual impairment;\(^9\)
- a call was made to all schools and institutes for the blind in Flanders.

Besides all the formal channels, friends and acquaintances also introduced participants. Eventually, 22 participants responded positively to the call and invited us to their homes. Fig. 4.4 presents an overview of all of the participants and their specificities. For reasons of anonymity, we use codes instead of names in this study.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Count</th>
<th>Gender Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-30</td>
<td>7</td>
<td>4 male &amp; 3 female</td>
</tr>
<tr>
<td>30-45</td>
<td>4</td>
<td>3 male &amp; 1 female</td>
</tr>
<tr>
<td>45-60</td>
<td>8</td>
<td>6 male &amp; 2 female</td>
</tr>
<tr>
<td>60+</td>
<td>3</td>
<td>2 male &amp; 1 female</td>
</tr>
</tbody>
</table>

Fig. 4.2 Summary table of participants’ average age

The majority of the participants are men (15). The average age of the participants is 42 years (Fig. 4.2); the oldest person was born in 1934 and the youngest in 1987. During the first contact, they all confirm that they had been born blind. However, some participants had actually seen for five, or more, years. Four participants even have some residual vision.

Fig. 4.4 also presents an overview of the impairments of the participants\(^10\) and their visual history. Only 13 out of 22 participants had been born blind, of which nine had never had a visual experience. The latter were in a privileged position when it came to talking about their haptic experiences. Out of the total of twenty-two participants, 13 retained perception of light.

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\(^6\) Forum created by Kim Bols who is born blind herself: http://www.kimbols.be/

\(^7\) http://www.blindenzorglichtenliefde.be/

\(^8\) Harry Geyskens, coordinator of the Belgian Confederation of Blind and Visually Impaired People made a call to all members. BCBS, Georges Henrilaan 278 1200 Brussel - Woluwe 2

\(^9\) Knipoog is a bimonthly journal published by vzw Blindenzorg Licht en Liefde, VEBES (Vereniging voor blinden en slechtzienden) and KMBS (De Koninklijke Maatschappij voor Blinden en Slechtzienden vzw)
Fig 4.3 Pictures of the different home typologies of the participants
<table>
<thead>
<tr>
<th>code</th>
<th>gender</th>
<th>year of birth</th>
<th>impairment</th>
<th>congenitally blind?</th>
<th>age onset visual impairment</th>
<th>residual vision?</th>
<th>light perception?</th>
</tr>
</thead>
<tbody>
<tr>
<td>M001</td>
<td>male</td>
<td>1934</td>
<td>accident WWII</td>
<td>no</td>
<td>7</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>M002</td>
<td>male</td>
<td>1954</td>
<td>Retinitis Pigmentosa</td>
<td>yes</td>
<td>49</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>M003</td>
<td>male</td>
<td>1940</td>
<td>Glaucoma</td>
<td>yes</td>
<td>23</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>F001</td>
<td>female</td>
<td>1967</td>
<td>Tunnel vision + Usher syndrome type 2B</td>
<td>no</td>
<td>0</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>M004</td>
<td>male</td>
<td>1948</td>
<td>Deuteranopia (Daltonism) + Myopia</td>
<td>yes</td>
<td>10</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>M005</td>
<td>male</td>
<td>1979</td>
<td>Leber’s Congenital Amaurosis</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>F002</td>
<td>female</td>
<td>1972</td>
<td>Retinopathy of prematurity</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>M006</td>
<td>male</td>
<td>1980</td>
<td>Leber optic atrophy</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>M007</td>
<td>male</td>
<td>1980</td>
<td>Chorioretinitis caused by toxoplasmosis (pregnancy)</td>
<td>yes</td>
<td>13</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>M008</td>
<td>male</td>
<td>1963</td>
<td>Retinitis Pigmentosa</td>
<td>no</td>
<td>18</td>
<td>no</td>
<td>yes (limited)</td>
</tr>
<tr>
<td>F003</td>
<td>female</td>
<td>1958</td>
<td>Retinopathy of prematurity</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>F004</td>
<td>female</td>
<td>1945</td>
<td>Retinitis Pigmentosa</td>
<td>yes</td>
<td>11</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>M009</td>
<td>male</td>
<td>1969</td>
<td>Retinitis Pigmentosa</td>
<td>yes</td>
<td>26</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>M010</td>
<td>male</td>
<td>1981</td>
<td>Leber’s Congenital Amaurosis</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>F005</td>
<td>female</td>
<td>1981</td>
<td>Retinopathy of prematurity</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>F006</td>
<td>female</td>
<td>1987</td>
<td>unknown by doctors</td>
<td>no</td>
<td>15</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>M011</td>
<td>male</td>
<td>1956</td>
<td>Retinitis Pigmentosa</td>
<td>no</td>
<td>20</td>
<td>no</td>
<td>no (up till age 20)</td>
</tr>
<tr>
<td>M012</td>
<td>male</td>
<td>1968</td>
<td>car accident: lost eye nerves</td>
<td>no</td>
<td>23</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>M013</td>
<td>male</td>
<td>1963</td>
<td>neurological toxoplasmosis</td>
<td>no</td>
<td>21</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>M014</td>
<td>male</td>
<td>1973</td>
<td>Senior-Løken syndrome</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>M015</td>
<td>male</td>
<td>1952</td>
<td>Retinitis Pigmentosa</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>F007</td>
<td>female</td>
<td>1981</td>
<td>Glaucoma</td>
<td>yes</td>
<td>0</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

Fig. 4.4 List of participants in the home visits and additional information
Several participants have professions that rely on non-visual information (the information used was mainly auditory). For example, two participants work in a call centre, one works as an administrator in audio transcription and another was educated as a musician and now works as a radio presenter. Two are self-employed and have their own recording studio. One retired participant is a former piano maker and another is a retired interpreter. In a way, lawyers and social workers also have to be auditory experts because they need to listen very carefully in order to be

Fig. 4.5 Overview of home typologies and locations of participants’ homes

<table>
<thead>
<tr>
<th>code</th>
<th>gender</th>
<th>home typology</th>
<th>urban environment</th>
<th>moving in year</th>
<th>owner / renting</th>
</tr>
</thead>
<tbody>
<tr>
<td>M001</td>
<td>male</td>
<td>farm style house</td>
<td>rural</td>
<td>1975</td>
<td>owner</td>
</tr>
<tr>
<td>M002</td>
<td>male</td>
<td>farm house</td>
<td>rural</td>
<td>1983</td>
<td>owner</td>
</tr>
<tr>
<td>M003</td>
<td>male</td>
<td>villa</td>
<td>rural</td>
<td>1994</td>
<td>owner</td>
</tr>
<tr>
<td>F001</td>
<td>female</td>
<td>semi-detached house</td>
<td>urban</td>
<td>1968</td>
<td>owner</td>
</tr>
<tr>
<td>M004</td>
<td>male</td>
<td>semi-detached house</td>
<td>suburbs</td>
<td>1978-1979</td>
<td>owner</td>
</tr>
<tr>
<td>M005</td>
<td>male</td>
<td>terraced house</td>
<td>urban</td>
<td>2005</td>
<td>renting</td>
</tr>
<tr>
<td>F002</td>
<td>female</td>
<td>terraced house</td>
<td>urban</td>
<td>2001</td>
<td>renting</td>
</tr>
<tr>
<td>M006</td>
<td>male</td>
<td>apartment</td>
<td>urban</td>
<td>2007</td>
<td>owner</td>
</tr>
<tr>
<td>M007</td>
<td>male</td>
<td>studio apartment</td>
<td>urban</td>
<td>2004</td>
<td>renting</td>
</tr>
<tr>
<td>M008</td>
<td>male</td>
<td>terraced house</td>
<td>urban</td>
<td>1994</td>
<td>owner</td>
</tr>
<tr>
<td>F003</td>
<td>female</td>
<td>terraced house</td>
<td>urban</td>
<td>1991</td>
<td>owner</td>
</tr>
<tr>
<td>F004</td>
<td>female</td>
<td>apartment</td>
<td>urban</td>
<td>1978</td>
<td>owner</td>
</tr>
<tr>
<td>M009</td>
<td>male</td>
<td>terraced house</td>
<td>suburbs</td>
<td>1998</td>
<td>owner</td>
</tr>
<tr>
<td>M010</td>
<td>male</td>
<td>apartment</td>
<td>urban</td>
<td>2007</td>
<td>renting</td>
</tr>
<tr>
<td>F005</td>
<td>female</td>
<td>villa</td>
<td>suburbs</td>
<td>1993</td>
<td>parents</td>
</tr>
<tr>
<td>F006</td>
<td>female</td>
<td>semi-detached house</td>
<td>suburbs</td>
<td>2006</td>
<td>parents</td>
</tr>
<tr>
<td>M011</td>
<td>male</td>
<td>semi-detached house</td>
<td>suburbs</td>
<td>1987</td>
<td>owner</td>
</tr>
<tr>
<td>M012</td>
<td>male</td>
<td>terraced house</td>
<td>urban</td>
<td>1995</td>
<td>owner</td>
</tr>
<tr>
<td>M013</td>
<td>male</td>
<td>semi-detached house</td>
<td>suburbs</td>
<td>1990</td>
<td>owner</td>
</tr>
<tr>
<td>M014</td>
<td>male</td>
<td>terraced house</td>
<td>urban</td>
<td>2005</td>
<td>owner</td>
</tr>
<tr>
<td>M015</td>
<td>male</td>
<td>villa</td>
<td>suburbs</td>
<td>1979</td>
<td>owner</td>
</tr>
<tr>
<td>F007</td>
<td>female</td>
<td>terraced house</td>
<td>urban</td>
<td>2003</td>
<td>owner</td>
</tr>
</tbody>
</table>
able to interpret the sentences and arguments pronounced by clients, colleagues and judges. The health consultant, on the other hand, relies primarily upon the haptic sense for information. For example, when giving advice about food, a practitioner relies on the experience of taste.

Concerning the social environment, we discovered a mix in terms of civil status. Ten participants are married; two have a LAT (Living Apart Together) relationship and three live together with a partner. Six of the participants are single and one person is divorced. Most of the participants living together point out that their partners or family support them, where possible. Single people, and a few of the others, also frequently ask friends to guide them. If they go out, all participants rely on human, or non-human, support. All participants possess a cane and five of them also have a guide dog.11

Participants were preferably Dutch speaking as this is the mother tongue of the researcher. Therefore, the call was disseminated in Flanders (the northern part of Belgium) and the Netherlands. However, in the end, all the participants were found in Flanders. Sixteen own their own home whilst four participants rent accommodation and two participants still live with their parents (who own the house). Eight participants have been involved in the purchase or the renovation of their house. Eleven owners, including the parents, decided to buy an existing home whilst seven others built new homes for themselves. Several caregivers and social workers point out that people with a disability have the lowest incomes and worst housing circumstances.13 This assumption is confirmed in literature.13 In our study, however, participants live in different home typologies, scattered across the Flemish countryside (Fig. 4.5). Fig. 4.3 presents an overview of the different housing typologies that are represented in this study.

Most of the participants, 12 out of 22, live in an urban context and seven live in the suburbs. Only three homes are in a rural area (Fig. 4.6).

This is not surprising. It is because most blind people rely on public transport and choose to live in an urban context close to public facilities. The three participants living in a rural area are all men married to caring women who maintain the villa or farmhouse. Most townspeople (eight) live in a townhouse. One participant lives in a studio, while the others live in an apartment. The oldest house dates from 1968 and the participant has lived in the house for almost 40 years. The most recent dwelling was completed in 2007. The average amount of time that a participant has resided in the same house is 14 years.

<table>
<thead>
<tr>
<th>Type</th>
<th>Rural</th>
<th>Suburbs</th>
<th>Urban</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmhouse</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Villa</td>
<td>1</td>
<td>2</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Semi-detached house</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Terraced house</td>
<td>1</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Apartment</td>
<td>3</td>
<td>3</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Studio apartment</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>7</td>
<td>12</td>
<td>22</td>
</tr>
</tbody>
</table>

This assumption is confirmed in literature.13

10 Most suffer from Retinitis Pigmentosa: six out of 22 participants. Two people were born with Glaucoma, two with Leber’s Congenital Amaurosis and two had suffered from Toxoplasmosis. Scientists are still trying to diagnose the actual impairment in one person. Two other participants had had an accident in which the loss of the eye nerves resulted in blindness. Apparently, it is not unusual to suffer from two visual impairments. One person has tunnel vision as well as Usher syndrome type 2B. Another person has Deuteranopia Daltonism and Myopia. Two participants have hearing loss and one person is recovering from a kidney transplant. Another participant is recovering from a broken ankle but most of the participants (18) have no additional impairments.

11 Although guide dogs are still rather rare because the waiting periods amount up to two to three years, some participants deliberately choose not to keep dogs because they are allergic or because it is less hygienic.

12 Based on personal meetings with the manager of de Markgrave December 5th 2006, manager of ‘Blindenzorg Licht en Liefde’, February 22nd 2007, managers and care givers of Spermalie.

4.2.2 In-Depth Interviews

The draft of the semi-structured interview guide was based on the concept of ‘movement’ as an important aspect of haptic, as well as architectural, experiences (see Chapter 3). Movement stimulates haptic and architectural experiences and the interview guide therefore focused on questions regarding circulation, and places for circulation. The questions arose out of the different themes categorized in Francis Ching’s book *Architecture: Form, Space and Order*. These are circulation (approach, entrance, configuration of the path, path-space relationship and staircase), light and materials (see appendix 10.1.2 & 10.1.3 & 10.1.4). The semi-structured questions were designed to find the haptic perception of people born blind and encourage participants to talk about their own feelings and experiences.

In order to ensure quality, and because finding the participants was hard work, the researcher tested the procedure and the interview guide in a pilot study using sighted participants.

In June 2007, we interviewed eight friends and family members in their homes. This pilot study revealed that some of the questions were too difficult for lay people to answer and others were too suggestive. For example, not all participants immediately understood the following question: “If we talk about circulation space, what does that mean to you?” All participants asked what the term circulation space meant.

The procedure itself appeared to work very well, but required a huge amount of concentration. Thus, the research set-up worked, but the interview guide needed to be reformulated using everyday language.

After reviewing the questions, appointments were made for 22 actual home visits. All interviews were recorded using a digital dictation machine (an Olympus Digital voice recorder DS-4000) and transcribed word for word. Afterwards, data were analysed twice on paper and four times with qualitative data analysis software (ATLAS. TI). This software helped us to add codes to different quotations in a structured and clear manner.

The codes grew out of the participants’ answers and consequently became key words summarizing the themes discussed by the participants. This is an open coding strategy as defined by Anselm Strauss and Juliet Corbin. The software allowed us to categorise all the quotations according to the different codes and thus retrace them. Besides, it was also possible to have an overview on the most common codes, and the number of times the different codes were mentioned.

Fig. 4.7 provides an overview of the codes that were extracted out of the six analyses. Because the empirical studies were conducted simultaneously with the literature study, some codes do not correspond with the terms found in theory, or the final terminology that is used in the framework of haptic design parameters. However, the findings show strong similarities with the theoretical and empirical studies.

The first analysis distinguishes ‘good’ and ‘poor’ haptic experiences. In both good and poor experiences, participants differentiate between material and spatial stimuli. This led us to our decision to analyse the interviews for a second time but with ‘materials’ and ‘spatial characteristics’ as the main focus.

The findings that relate to the material and spatial characteristics caused us to deepen the differences and outline the ‘spatial and material properties’ in a more detailed way. Consequently, the third analysis focused on the spatial properties in non-visual situations. This resulted in codes such as ‘form’, ‘interior’, ‘lay out’, ‘length’ and ‘light’. Moreover, this third reading revealed codes that affirm the sensory awareness of people born blind in relation to touch, acoustics, and echolocation. In addition, the aim of perception is revealed. Participants explained that their perceptual attitude changes according to their aims. To be more precise, they adapt their actions according to the purpose of their perceptions, and vice versa. We therefore added the code ‘aim of perception’. A third reading also led us to implement different codes like ‘kinaesthesia’, ‘path’ and ‘tools for blind people’. Additional information on participants’ impairments and their status is also marked with the codes ‘impairment’ and ‘status’.

The fourth coding paid more attention to the perceptual process and, in particular, the way people born blind interpret haptic stimuli in the built environment.
Codes like ‘boundary’, ‘landmark’, ‘node’, ‘orientation / way finding’, and ‘path’ were created. The participants also explained that they wanted to avoid uncomfortable environments and aspired to ‘comfort’, which led to another code, together with ‘discomfort’. As this research focuses primarily on haptic perception, the fifth reading...
marked the different quotes with reference to haptic perception. In this context, we immediately distinguished between ‘active’ and ‘passive touch’. Finally, we focused on the material characteristics. The sixth coding analysis looked at design methodologies in general and the material properties that contribute to haptic perception. Additional codes relating to the perceptual process, covering general information as well as haptic, were created, such as: ‘density’, ‘temperature’, ‘texture’, ‘design’, ‘design style’ and ‘construction methods’. Indeed, several participants referred to style or design as being aspects that contribute to the properties felt during haptic experiences. This sixth and final coding session also describes the importance of movement through haptic perception, as revealed by the code ‘sequential experience’. Several participants also referred to ‘time’ as being important to haptic perception. As a result, ‘time’ is another code used in our analyses. The codes reveal information about the actual properties that result in a haptic quality or constraints.

After the six different analyses, we cross-analysed the different quotes in search of a structure in the complexity of quotations and codes. It is possible to group the different codes in terms of main codes, or ‘families’. This is a common qualitative research method that brings the overarching themes to the fore.

The main codes that we assigned were: ‘sensory awareness’, ‘status’, ‘spatial properties’, ‘haptic’, ‘aim of perception’, ‘impairment’, ‘perceptual process’, ‘material properties’, ‘cognitive knowledge’ and ‘design in general’.

4.2.3 Video Tour

To validate the in-depth interviews on haptic perception, we decided to ask the participants to guide us through their homes on a video tour. We assumed it was highly likely that we would see when, and how, participants actively and dynamically touch the built environment. Conducting research with a camera and people born blind might seem challenging from a pragmatic, ethical and methodological point of view. Pragmatically, participants who are aware of the camera might not act spontaneously or naturally. Ethically, this method could be questioned because we are able to film more than the participant is actually aware of. This could consequently throw the relationship between participant and researcher off balance. Finally, video is a visual research method that focuses primarily on visual information. It could thus prove difficult to analyse haptic experiences using this medium.

However, when it came to the pragmatic concerns, it turned out that from the very start of the guided tour the participants were not very aware of the camera. This is presumably because most of them have no residual vision. All participants acted in a very spontaneous and natural way.

From an ethical point of view, the point remains very sensitive. However, all participants of the video tour agreed with the way the research had been set up. Moreover, as Brigitte Jordan and Austin Henderson point out: “Video recordings replace the bias of the researcher with the bias of the machine. The recording process becomes to some extent, automated, and thereby removed to a greater degree than other methods from the reconstructive bias of individual researchers.”

When it comes to sensory research methods, video is a surprising one. It appears to be a useful tool for revealing haptic perception and the related architectural elements that support it. On the one hand, video once again affirms the strong connection between optic and haptic perception. According to Michael Taussig and David MacDougall, haptic and visual perceptions underlie the filmic sensory experience. Similarly, we could state that Haddon’s filmmaking is a form of ‘haptic cinema’. His film invites people to ‘feel’ or ‘touch’ the image. Watching films can evoke haptic experiences even though the haptic perception is not actually occurring in real time. In general, we learn to store haptic experiences in our memories and this enables us to retrieve haptic information through visual perception. This can be explained from a phenomenological point of view, because our bodies are the place in which they are lived.

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19 In 1898 Alfred Cort Haddon was one of the first academics who used film for his expedition to the Torres straits Islands, a large multidisciplinary expedition to study scientifically the Island’s people. Griffiths, Alison. Wondrous Difference. New York: Columbia University Press, 2002:142-143.
subject and object come together.\textsuperscript{20} The perceived object, in this case the gestures and movements of the actors or participants in a film, may recall haptic experiences for the viewer.

Movement acts as a messenger between the body and its surroundings and is indispensible to the haptic sense. Consequently, the tour itself contributes to a place gaining meaning. While we are able to see the space, participants walk the space sequentially through touch, or are touched themselves. Participants literally make space through movement, which John Gray describes as: “walking as place making”.\textsuperscript{21}

Additionally, Sarah Pink explains that ‘walking with video’ supports a phenomenological approach as it relates to sensory elements of human experience and place making. According to Pink, walking with another person allows researchers to learn about the participants’ experiences empathically.\textsuperscript{22} Her assumption is motivated by Steven Feld’s anthropological phrase: “as place is sensed, senses are placed; as places make sense, senses make place”.\textsuperscript{23} According to MacDougall, visual study offers a second route to sensory experience.\textsuperscript{24} Through guided video tours, we may understand the created space in a phenomenological way. Consequently, a video camera would appear to be the ideal tool with which to conduct research into sensory experiences.

All the guided tours took place in the participant’s home and, if they had one, the adjacent garden. The research set-up of the video tour followed a non-structured open interview with minimum questions. This was because we wanted the participant to speak in an as relaxed and spontaneous manner as possible.

During the guided tours, we followed the participant and focused the camera on the participant’s movements, acts and gestures (Fig. 4.8). However, as pointed out in studies on qualitative research, researchers find it very difficult to decide what the focus should be.\textsuperscript{25} In this study, we literally follow the movements of the participant for the entire film. However, we sometimes film an overview of the room, as it is tempting to film space while people are showing us its different characteristics and properties. Sometimes, it was difficult to keep up with the participants because they could not see whether we were following them. Nevertheless, the videos all illustrate the body language of the participant during sensory exploration and perception.

\begin{footnotesize}
\footnotesize
\begin{enumerate}
\item Merleau-Ponty, Maurice. Phenomenology of Perception. London: Routledge, 2002 (1945)
\end{enumerate}
\end{footnotesize}
We collected the video data using a home video camera (Panasonic NV-GS230). The records were converted into AVI-files with KINO conversion software. The size of each person’s home and the participants’ personality influenced the length of each video. They are longer or shorter depending on the size of the home, whether participants are talkative or not and because of privacy considerations (some participants guide us through the whole house and others show only parts). We filmed a total of 313 minutes and 49 seconds and an average video of a guided tour lasts about 15:38 minutes. The duration, however, varies between 02:10 minutes to 42:36 minutes. Two participants refused us permission to film and two did not want to show us the whole house, for privacy reasons. In two homes, the space is very limited (these videos take less than five minutes). The analysis is made through video coding and by annotating plans.

4.2.3.1 Video Coding

The video coding started with an in-depth look at all 20 videos whilst making notes on paper. We registered, for example, gestures that were striking or the items that were touched.

During a second viewing session, we focused on the participants’ movements. At this point, every action that supports the haptic sense received our attention. Finally, we went through the videos for a third time and took stills of the movements that were most striking. We needed to bear in mind that the videos only showed the movements that relate to active and dynamic touch, and that we were probably missing part of the passive touch (as this is invisible and only noticeable when participants describe it). Therefore, the study called for careful concentration and analysis. The video analyses offer insights into haptic perception and haptic habits, and the elements of the built environment that support these. Accordingly, these findings are linked to the results of the in-depth interviews.

4.2.3.2 Plan Annotations

By annotating plans, we gained a more articulate insight into the link between movements and the supportive elements within the built environment. In general, the plan annotations register haptic movements as well as information about haptic actions. John Zeisel explained the usefulness of plan annotations when he stated that: “it is a useful communication method to identify neuroscience and behavioural issues in plans – to point out which are significant to the use and impact of the eventual environment, to identify which have been addressed to or not, to indicate which have been adequately responded to in design or not, and so on. Annotation simply means writing observations, comments, and hypotheses directly on architectural plans to make issues explicit and to share them easily with others”. Drawing is, of course, part of a designer’s way of working. Designers can express their ideas to themselves, or somebody else, through a drawing. As this research aims to improve architects’ knowledge of haptic perception, drawing seems an obvious way of bridging the gap between research into perception and the process of designs. However, it is still an exceptional research technique.

Fig. 4.10 Plan annotation showing the trail of the participant while guiding us through his room with the green lines representing the participant reaching out and the red dots represent landmarks (image left). Plan annotation visualising the space for movement or inverted space (image right).

Fig. 4.11 A version of the above 2 drawings combined.
We started the analysis by drawing the plans of the homes. During the visit, the researcher asked the participants whether plans were available. Only three participants had the plans of their houses [F003, M003, M004]. For all the other projects, we relied on sketches of the homes that we made ourselves and pictures taken during the home visits (Fig. 4.9). All two-dimensional plans were drawn on a computer using Autodesk AutoCAD.

We restricted the plan annotation to the participants who have no residual vision left (16) and those who gave us permission to use the plans (14).28

In other words, out of 22 home visits, 14 homes were selected for plan annotations, resulting in 27 floor plans (some homes are multi-level).29

The analysis follows the video coding, and annotations were made on printed plans while watching and analysing the videos for a fourth time. The fifth and final viewing session revealed additional haptic movements.

On each plan - ground floor as well as any other levels - a line was drawn that follows the trail of the participant guiding us through the home (Fig. 4.10). These lines resulted in loops representing a sequence of movements through a series of spaces. When the participant touched or reached out to an object, this action was marked with a circle, or a circle with a line. Landmarks were marked in red. Besides the notations of routing, the whole space in which participants can move is analysed and visualised (Fig. 4.11). Drawing stimulates us to link the interview analysis with the guided tour and the architectural representation of the haptic qualities and constraints. We also noticed relationships that were invisible during the visit but which became evident when drawing the plans. Written keywords explain the meaning of certain marks, or remind us of important behavioural or haptic elements.

4.2.4 Findings Home Visits

4.2.4.1 How do People Born Blind Explore the Built Environment Haptically?

Sensory Attention

In general, this research endorses the inseparability of the senses and, as a consequence, we approach the senses as being interconnected.

Findings show that people born blind rely in large measure upon non-visual sensory information. Depending on the available perceptual stimulation and personal preference, participants choose to rely on auditory, haptic, gustatory or olfactory information. It appears that participants prefer either acoustic, or haptic stimuli, within the built environment.

Acoustics and the experience of sound contribute to the whole environmental experience. The participant M006 referred to the wall in his kitchen and the opening in it. He decided to ask the builder to make an opening in the wall so that he would feel closer to the living room and the office (Fig. 4.12) [M006]. Besides, several participants [M001, M003, M004, M005, M006, F004, M009, F005, M012, M013] referred to the contribution that acoustics make to the atmosphere of an environment. Some participants even identified auditory landmarks like pianos or fountains [M005, M001, F003]. Olfactory experiences are frequently mentioned in relation to passive touch and in relation to wood [F007], but taste is never mentioned.

Although many participants stated in advance that they did not rely on haptic perception in their home environment, they did recognise the importance of ‘facial vision’ or ‘obstacle perception’.

28 Two participants did not give us permission to film [M004, F002] and the others had seen longer than the age of five or had residual vision.
29 However, as most plans (12) are based on sketches, the dimensions need to be cautiously interpreted and compared.
Moreover, they all noticed their own haptic habits and tools whilst guiding us through their living spaces. One participant remarked: “Oh yes, now I’m paying attention to it, I do use my hands (...) yes, I use my hands a lot, I wasn’t aware of this.” [F004]\(^{30}\). Participants born blind are used to relying upon the haptic sense and touching becomes a subconscious routine in familiar environments. These habits become clear while watching the video tours and drawing the paths of movement on the plans and annotating them.

The first analysis revealed both good and poor haptic experiences. 180 codes were found for good haptic experiences and 146 codes for poor experiences.

A good haptic experience relates, for example, to the feeling of a smooth wall:

F004: *I have a friend who has an apartment and the walls are very smooth... so beautiful, they feel like silk and yet they are so hard. I thought, wow, I would love to have walls like this in my apartment.*

R: *And do you know what material it is? Is it wallpaper, or is it...?*

F004: *No, it is painted ... yes, yes, but very smooth, very smooth, almost like marble, but not as cold as marble...*

R: *Yes, plastered probably, very strong and very evenly polished...*

F004: *Yes, and I even think that it is shiny, or at least it feels that way.\(^{31}\)*

Poor haptic experiences are less frequent, but also cover a wide range of topics. For example, the fear of hurting oneself is a very frequent topic in the discussion of poor haptic experiences:

M001: *... and here, upstairs, I would love to show you that. Those rafters of ...*

Partner: *that is really very bad.*

R: *Yes.*

M001: *...made of oak... in the beginning [when they had just moved] I bumped my head on those rafters over and over again.*

R: *Yes.*

M001: *...on those particular rafters of the roof and that is why I raise my arms when I want to move quickly and ... I am at peace when I have touched the rafters to orient myself, by my computer, for example, there is a rafter. Up above, I pull out the plug every evening and, in the morning, I turn it on again, and then I need to orient myself to that oak beam.*

R: *Yes.\(^{32}\)*

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\(^{30}\) Dutch excerpt [F004]: “Oh ja, nu dat ik er aandacht aan geef, merk ik dat ik mijn handen veel gebruik (...), ja ik gebruik mijn handen veel, ik was me hier dus niet bewust van.” (video-ethnography)

\(^{31}\) F004 Dutch excerpt: “Ik heb een vriendin die heeft een appartement en die heeft volledig gladde muren zo...héél mooi, het voelt aan als harde zijde zo en ik heb al eens gedacht wooooooooooooooaat dat zou ik ook in mijn appartement aan de muren willen hebben.R: en weet je welk materiaal het is? Is het behangpapier of is het...P: neen het is geschilderd...ja ja maar héél glad héél glad bijna euhm...bijna als marmer maar niet zo koud als marmer...I: ja waarschijnlijk heel sterk uitgepleisterd en heel vlak opge- schuurd, jajaja P: jaja en ik denk zelfs dat er een beetje glans opzit, zo voelt het aan.” In P12: ATLAS F004.rtf - 12:39 [Ik heb een vriendin die heeft ...] (108:114) Codes: [good haptic experience] [temperature]
The plan annotations show that participants largely rely on stimuli that are in close proximity.

**The Interactivity of the Haptic Sense: Haptic Perception for Action or Action for Perception?**

Haptic perception can be provoked through action, or result in it. This ‘action for perception’ or ‘perception for action’ phenomenon is represented during the home visits through movement. Movement is a requirement for the reception of haptic stimuli. Moreover, the type of movement may contribute to the aesthetic appreciation of the environment, or elements within it. For example, some participants choose furniture that requires a certain action in order to use it, like cinema chairs, for example. One participant likes them a lot because of the mechanism. She also bought a cupboard with many drawers [F004]. Although this cupboard is primarily meant for storing things in a structured way, the participant confirms that she enjoys opening the different drawers. On the other hand, perceptual information can also trigger action. For example, one participant knows he has to walk to the left to reach the letterbox if he feels the drainage grate in the driveway, or he has to turn back to avoid the street [M003].

**Non-Visual Environmental Exploration**

**Diversity and Contrast**

In non-visual conditions, diversity seems to be the most important keyword when it comes to supporting the exploration of the built environment. ‘Diversity’ is not linked to an eclectic architectural environment but to contrast, and the uniqueness of the materials and structure – things that are sometimes invisible to the eye but which are very present through haptic perception. For example, the contrast created by placing two surfaces, one soft and the other hard, next to each other, or the fact that many participants place doormats on the floor to mark certain points [M001, M002, M003, F003, F004, F005, M009, M011, M012, M013, M014].

**Modes of Exploration: Active, Dynamic and Passive Touch**

During the home visits, it is active and dynamic touch that is most noticeable and most frequently discussed. In the videos, it is much more difficult to trace dynamic touch. On the other hand, passive touch is observed when participants explicitly refer to it. For example, one participant explained that she goes onto her terrace every morning to

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92 M001 Dutch excerpt: [“P: … en hier gelijk boven, ik had u dat ook eens willen laten zien. Die scheerpoten van….euh W: dat is;..dat is erg hé P: van eik…in het begin heb ik daar verschrikkelijk veel mijne kop aan gestoten hé R:ja ja P: aan die eigen scheerpoten van het gebinte en daarom als ik boven een beetje vlot wil bewegen dan zet ik met mijn armen in de lucht en en... ik ben maar gerust als ik die die scheerpot geraakt heb om mij te oriënteren hé, aan mijn computer bijvoorbeeld is er zo een. Hierboven en ik trek elken avond de stekker uit en ’s morgens steek ik die stekker in maar dan moet ik mij oriënteren aan dienen eiken balk hé.”] In P 1: ATLAS M001.rtf - 1:74 [W: ... en hier gelijk boven, ik ...] (336:344) Codes: [poor haptic experience] [boundary] [design] [discomfort]
feel whether the sun is shining [F004]. She performs an action related to haptic perception and, in this case, passive perception.

**Exploration Strategies**

Additional tools in the form of objects, like canes, are not used inside the homes of the participants while guiding us. However, one participant does use a cane in the form of a willow branch, that he takes with him outside when showing us the garden [M001].

Most participants walk the whole guided tour of the house to show every place in which they can move (Fig. 4.13) [M001, F005, M006, F004, M010, M003, F003, M015, M014]. However, three participants [M005, M004, F002] do not do this because they remain seated. Others showed only parts of the house, or did not always show their movements by walking the whole space [M011, M009, M007, F007]. At crossing points, where movements change, participants start to actively and dynamically touch.

Participants pointed straight to an object, or a place, with their hands and feet to show us haptic elements (Fig. 4.14). They also frequently make use of active touch at reference points.

While following their routes and paths, cupboards, showers and seats, for example, were briefly touching in order to show them. Some participants explicitly stamped their feet to show differences in the texture, density or the elasticity of floors [M001, M002, M003, M006, F005, M009, M011].

The palms of the hand were used to stroke a ‘sticking out’ element, or as ‘a control touch’ for the environment. We introduced the term ‘control touch’ to denote active touch that takes place at crucial points in the environment and that assures the participants, while moving through space, that they are on the right track. The more this ‘control touch’ is performed, the more it becomes a habit. For example, almost all participants touch the door cases with the palm of their hand (Fig. 4.15). It is a crucial point in the environment that marks
the edge between two places, as well as being the boundary that marks the doorframe. Another example is the participant who always touches his piano in passing [M005].

Trailing with the back of the hand, when participants slide their hands following the edges or paths, is mostly used in conveniently arranged environments. For example the participants start trailing along paths or long corridors, as well as over furniture or walls. In unstructured, or open spaces, most participants start to reach out their arms to avoid unexpected elements (Fig. 4.16).

The plan annotations reveal that, when approaching a space that lacks haptic cues, or when the corridor is too wide, they start reaching out their arms to find a clue. In short, participants do this when they feel uncomfortable or unsafe. Landmarks and barriers are useful for orientation. In spaces that have too many corners or edges, it takes more time to find the right way and sliding is more frequent. Participants often use just one hand to touch a landmark or barrier. Interestingly, participants always use the right hand to touch a clue when they want to turn to the right. When turning to the left, participants touch with the left hand.

Although, when moving, most participants use only one hand to touch, some of them use both hands at decision points [F005, M014].

Sequential Perception

The environment is experienced through movement. An environment becomes a space by means of movement. In non-visual conditions, the body moves from one point to another. It is a sequential action, as explained in the in-depth interview by M012: “Well, yes when you are blind you walk from one place to another, step, step, step.” 33 This is also clear in the video tours, as people explicitly move from one point to another. This sequential movement is literally drawn onto the plans.

4.2.4.2 What do People Born Blind Haptically Perceive in the Built Environment?

Both the in-depth interviews and the video tours revealed that the participants rely upon material and geometric properties for haptic perception in the built environment. They also pay attention to the construction method, as well as the style of the design and the natural conditions. All of these aspects contribute to the haptic experience. The following Section reports the most important results pertaining to the haptic properties of the physical environment of the homes visited. In addition to looking at these properties, we briefly look at the impact that the construction method and the natural environment have on the built environment.

Material Properties

Assessing materials is a very personal act. The participants’ likes and dislikes in relation to materials depended upon their haptic perception, as well as the context of the material itself. The material’s context is characterised by the physical, social and cultural properties of a place, the participant’s memories, and its function, use and behaviour. Some participants, for example, do not like materials that are difficult to clean [F002, F007]. Their opinion is based on their experience of certain materials. Temperature, density and texture are the haptic material properties that participants refer to during the home visits.

Temperature

Temperature is one of the material properties most frequently referred to in the context of active, dynamic and passive touch.

In general, we measure temperature in relation to our body temperature. Participants do not like extreme temperature differences. The most common experience is the active and dynamic touch of materials. For example, if participants actively touch the floor in the living room,
warm materials are preferred. Several participants refer to the warmth of a wooden floor [F002, F003, M008, M007].

M007 explains: "Well, the floor [pause], I try not to think about it from a practical point of view but, from my experience … well, not a cold floor. But I don’t know which material it needs to be. I like wood, and wooden floors … a bit like parquet, which is nice. At my parents' place, there is a fireplace, and there is no parquet, but it is a wooden floor and that always gives a nice atmosphere, a bit old-fashioned."\(^{34}\) Participants also prefer warm materials over cold for walls: "I can’t remember why I didn’t choose wallpaper, but I did think, yes, it is cold a wall."\(^{35}\) The temperature of materials can also be passively felt. For example, some participants explain that they feel the warmth of walls when walking along them [F004, M015]. Walls made out of brick will re-emit absorbed heat and consequently people can feel the warmth when passing by. Temperature may help participants orientate themselves, but this does not happen very often. Instead, temperature largely contributes to the overall atmosphere of the environment [F006, F005]. One participant, for example, immediately links the experience of temperature to his preferred location [M012].

Density

Although we did not expect density would be referred to, some participants did literally show us differences between densities. For example, one of the participants walks into his garden every day to feed his sheep [M001]. At one point, he arrives at a large area of grass and there is no available path. However, he feels the difference in grass density. Thanks to many years of taking the exact same route, the ground on which he walks has a much higher density than the rest of the grassy surface (Fig. 4.17). Most participants make use of the difference in density between carpets and floors to mark boundaries in their homes [M001, M002, M003, M007, M008, F003, F004, M009, F005, M010, M001, M012, M013]. They move through space from one carpet to another (Fig. 4.18). M012 has already implemented this idea in a sophisticated way by creating a line of floor tiles from his entrance hall, through his living room, and towards his kitchen (Fig. 4.19). This way he can feel the guiding line through his house via the differences in density between wood and stone. In relation to comfort and passive touch, soft materials are preferred. However, one participant points out that chairs and seats can be hard as well, as long as they remain comfortable [M014].

\(^{34}\) Dutch Excerpt M007: ["Qua vloer, goh, ja (pauze) even denken…. Ik probeer het niet praktisch te bekijken maar vanuit mijn beleving... (goh) misschien gene koude vloer, maar ik weet niet in welk materiaal dat dan hoeft te zijn. Hout, hout vind ik wel een aangename vloer…zo’n beetje parketachtig, dat is wel leuk. Bij mij thuis bij mijn ouders die hebben zo’n open haard, dat is geen parket maar wel een houten vloer, maar dat is altijd wel een leuke sfeer, zo’n beetje ouderwets.”]

\(^{35}\) Dutch Excerpt M006: ["(pauze)... ik weet niet meer waarom ik nu geen behang heb genomen maar ik heb inderdaad wel gedacht van tiens, het is op zich wel koud hé zo’n koude muur.”] P 8: ATLAS 070827 M006.rtf - 8:37 (167:167)
When asked about material properties, and texture in particular, participants generally refer to roughness. In certain contexts, participants appreciate roughness. A rough material on a staircase means that the participant is less likely to slip. In relation to active, dynamic and passive touch in general, the participants prefer soft and smooth textures over rough. Smooth textures are associated with cosiness. Rough textures, like stucco plaster or rough bricks, are best avoided for walls that are actively touched. They can damage the fingertips, as F001 explained: “Yes for walls, here, I would never want to have this [a stone wall made out of stacked slate]. It’s a wall that I would never touch with my hand, so I would never use an interior wall made in such a material, mmm... we have also fiberglass wallpaper and, well, that isn’t good either, because you can scrape yourself if you rub your arm against it”.

On the other hand, the participants react positively to regular wallpaper because it feels soft [F004, M006]. Participants also prefer smooth materials, like mosaic tiles. One participant explicitly refers to the tiles used in a Sicilian restaurant:

M005: ...and it’s like that with a lot of materials. In ‘L’, I don’t know if you know it, ‘A’, it’s a Sicilian restaurant.
R: No, I don’t know it.
M005: Well, you should absolutely go there one day. It’s a must!
R: OK!
M005: There they’ve got those tile tables...
R: Yeah! Tables in wood, with inlaid tiles.
M005: Yeah! Well, each time I visit the restaurant, I

Texture

Fig. 4.18 Carpets in home environment to mark boundaries and edges of rooms and places

Fig. 4.19 Example of a guiding line in the floor of a living room of a participant who asked to place a stroke of tiles with a different texture and density from the entrance door throughout the living room.
would love to take a table back home.
R: You should ask them, or you can make one yourself!
M005: Yeah but then you have to find the tiles. Where can you find them?
R: Yeah, that’s true.
M005: But I find it extremely pleasant and if I could have a table like that ...
R: Yes.37

Another participant confirms the pleasant feeling generated by mosaic tiles; he has bought a house in which the hallway is decorated with just such tiles. He explains that, for him and his family, it is one of the qualities of the house. A Moroccan family had lived there before and M014 kept the tiles because he liked them (Fig. 4.20). Moreover, the edge between the tiles and the wallpaper acts like a guiding line along the staircase, in parallel to its angle.

Another participant does not refer to these tiles during the in-depth interview, but explains his choice of mosaic tiles while guiding us through the bathroom [M012]. F005 points out that the smooth tiles in the bathroom provoke a pleasant feeling.

A rough texture might also reveal a certain pattern - a structure that gives direction. A pattern that supports movement is appreciated. For example, it is much better if the pattern runs in the direction parallel to the movement. In a way, you could state that the joints of the mosaic tiles support the structure of the overall feeling of this material. These junctures follow a certain pattern that the participants appreciate in terms of orientation [M014].

Light Permeability

Several participants [F004, F007, M001, M002, F001, M005, F002, M006, M007, M008, F003, F005, M013] affirm that the warmth of the sun is extremely pleasant. Sun light is felt via ‘bundles’ of warmth. When materials are light permeable, like glass, participants can feel the sun in their house.

Geometrical / Spatial Properties

Layout - Structure

One of the most frequently discussed topics in relation to the non-visual experience of space is ‘layout’. This was therefore coded in the in-depth interviews. All of the participants, except one [M011], refer to layout (or structure). F005 explains the importance of structure:

R: What is, for you, the most important aspect of the way you live?
F005: Well...yes... that it is structured. Yes, that things don’t need to be moved around every three minutes. Because then you don’t know where you have put...
The following materials are explicitly mentioned by the participants: laminate, wood, sandstone, brick, marble, natural stone, aluminium, bronze, copper, iron, glass, concrete, plaster, fabric, plastic, fiberglass wallpaper, wallpaper, fabric, cardboard and sand. However, wood is one of the materials most often cited; eighteen participants refer to it. Moreover, most participants immediately mention wood when referring to their favourite material. In total, participants refer to wood 36 times, of which 28 quotes are positive. Only six quotes explain the more negative characteristics of the material. Therefore, we briefly look at the advantages of wood, as described by the participants.

The interviews were analysed again (a seventh coding), this time with the focus on wood. Participants link wood to the following positive terms, or circumscriptions: velvety, characterful, less smooth, less dangerous, warm, pleasant in a tactile way, cosy, good acoustics, natural and clean - “it gives something” [M005]. From building shell to interior, wood is a common material, associated by the participants with doors, floors, stairs, furniture and roofs. There are several reasons why wood tops the list of favourite materials. In addition to being a frequently used building material, it also evokes positive experiences. As one participant states when asked if he has any special preferences for materials: “Wood. Wood in many ways it is a very pleasant material.” The pleasant feeling of wood comes up frequently amongst the participants. One explains that he had the idea of creating a wooden seat on top of a stone wall. He wanted to make a place next to the fireplace where he could get warm [M001]. It is true that wood conducts heat slowly, which is probably why several participants associate wood with a feeling of warmth. It even sometimes determines the character of the house.

One participant decided to buy his house because it had many wooden details. He explains that the previous owner had been a carpenter [M013] (Fig. 4.21). Other participants built new houses but explicitly chose wooden boards on the attic floor for their warm character [F003]. One participant states very clearly: “Well... parquet. I find it, yes, that there is warmth of course, and yes, it makes things very cosy and a stone floor, well, that’s useful.” It is possible to create a great many details out of wood, an aspect of the material that is much appreciated. One participant explains haptic aesthetics by referring to the difference between two pianos in terms of wood: “This may sound really strange but I’m the piano player in the house and well ...and you have two kinds of piano’s. In fact, there are two kinds of wood out of which the pianos can be made. There is contoured wood like this one, or varnished wood. The latter feels much rougher. Most brown pianos are not smooth and, well, I prefer smooth pianos much more than brown ones. It is a question of pure, yes, absolutely pure, tactile aesthetics.”

However, in a certain context, six participants do not like wood. This relates specifically to safety. For example, if a wooden stair is rotten it requires replacement [M009] and rough wood can have splinters that cause injuries [M002]. One extreme example concerns someone who does not like wood because the wooden front door was vandalized. Remarkably, when asked to describe the qualities of environments with a good atmosphere, the same participant refers to wood: “Yes, well, I knew a certain café, which is closed now, but I knew that the tables were wood and there were chairs and seats. It was full in there, but cosy.”
things the last time and yes...that the whole structure remains, that’s the most important part.\textsuperscript{43}

A little later, she points out: “The kitchen is good because I feel it is structured, you can ... constantly follow the cupboards.”\textsuperscript{44}

Only one participant denies the importance of of structure:

\begin{quote}
R: “And do you think that the structure of your home directs the way you move? For example, when you are here, is there a wall on which you can orient yourself? Or is there a certain structure in the home that is simple and clear? Is that important as well, because it creates order, an order in the space?
M011: Well, to me, this isn’t really important because I know the distances…
R: By footsteps you mean?
M011: Yes, yes, and I don’t think I really need references…”\textsuperscript{45}
\end{quote}

Although he denies that structure might be important, it is already part of his memory. This participant admits that he relies on structure by referring to the known distances. For these distances, his muscle memory comes into play. Indeed, a bit further on in the interview he points out that structure is very important. At this point, he interprets structure in the context of orientation by referring to landmarks, which he does not need in his own house any more, as he knows the distances by heart.

Curvature

Participants also refer to structure with respect to the shape of the ground floor and the shape of the surfaces surrounding this ground floor. In general, the shapes of the horizontal surfaces they refer to have a rectilinear, round or square form. When participants need orientation, or in conditions of active and dynamic touch, they avoid round spaces, walls and corners. When orientation is important, rectangles are preferred to squares. For example, a coffee table with curved sides, in a triangular shape, is considered to be a very difficult and unsafe element within the interior [F005].

One participant remarks that she discovers the best and least well structured places through vacuum cleaning [F005]. She literally cleans the whole shape of the walkable ground floor and consequently feels its structure.

Nevertheless, in a context where participants are primarily looking for cosiness, round shapes are welcome and sometimes even preferred. Although the questions focus on the shapes of rooms and the environment in general, participants also spontaneously link shape to interior objects. The same preference is true: a rectangular table supports movements, whereas a round table is cosier. Despite its unsupporting aspect six participants have a round table [M004, F004, M001, F003, M005, M007] (Fig. 4.22).

Diversity, or contrast, is the reason for these orientation preferences, as explained previously. A rectangle has sides of two different lengths, whereas the sides of a square are all the same length. Circular forms do not have

\textsuperscript{43} Dutch excerpt:[“R: Wat is voor u belangrijk bij wonen? P: euhm...ah ja dat dat...gestructureerd is. Ja dat zo niet alles om de drie minuten moet verzet wordt of verplaatst wordt want ja dan vind je het toch niet meer terug waardat het de vorige keer stand en ja...en geheel dat de inrichting blijft, da’s het belangrijkste.”] [P15: ATLAS 080626 F005.rtf - 15:15 (J: Wat is voor u belangrijk bij..) (33:34) (researcher) Codes: [comfort] [lay out]
\textsuperscript{44} Dutch excerpt F005: [p: “: euhm...goh waardat ik ...de keuken is goed omdat ik dat zo gestructureerd vind dat is, ge kunt ....constant de kasten volgen. ”] P15: ATLAS 080626 F005.rtf - 15:15 [En voor de rest in de living z..] (61:62) (researcher) Codes:[lay out] [path]
\textsuperscript{45} Dutch excerpt M011: [ R: ”En denk je dan dat er ook een bepaalde structuur is in uw huis die ook die u ook een richtlijn geeft van hoe dat je loopt als je bijvoorbeeld ergens hier zijt, is er dan altijd bijvoorbeeld een muur waarop je je richt voor naar ergens anders te lopen of een bepaalde structuur in de woning dat je zegt dat is voor mij heel klaar en duidelijk,...? Is dat dan ook belangrijk want dat is eigenlijk ook een beetje orde scheppen, maar dan orde in de ruimte he...”] P: aww...ik denk niet dat dat echt belangrijk is voor mij omdat ik de afstanden ken...R: ja...bij...bij voetstappen dan P; ja ja...ik denk niet dat ik echt referenties nodig heb “P17: ATLAS 080630 M011.rtf - 17:17 [En denk je dan dat er ook een ..] (137:140) (Researcher) Codes:[cognitive knowledge blind] [good haptic experience] [lay out]
sides that can be measured through a difference in length, and nor are there any corners to count.

Orientation

For many participants, the surfaces that are used for orientation also serve a structural purpose within the environment. An orthogonal path, or a path running parallel (or perpendicular to) the body’s mid-axis, is immediately linked to the direction of one’s own body movement. As explained in Chapter 3, every person has an egocentric frame of reference and vertical and horizontal planes support egocentric related movements. The participants mostly prefer orthogonal planes. However, the orthogonal structure cannot be forced, as people born blind do not like to walk in an unnatural way [F004].

Moreover, orthogonal structures are sometimes thought to restrict the experience. Structure supports movements. Therefore, the direction of interior elements should ideally follow the direction of movement. Corridors are welcome because, when logically built, they have a clear structure. For this reason, the walls in passageways turn out to be the ones that are most frequently touched.

As one participant points out:

F004: I would love to make the corridor in that glossy material.
R: In the corridor of...?
F004: If you enter, yes, I would make the corridor here...These are the walls I touch the most! I notice...
R: Less in the living room?
F004: Less, I touch the walls less frequently there.
R: Yes, but...
F004: ...and the other corridor to the bedroom, and so on, I would love to have those in that material as well.46

When asked about their favourite doors, most of the participants didn’t recognize any difference or advantage in using doors. In the in-depth interviews, participants point out that they are used to adapting themselves. However, during the video tours they admit to touching the frames of doors in passing. Moreover, when they think about it, they prefer sliding doors. Again, it seems that movement support is crucial - sliding doors do not barricade space.

A wall without a function in front of a participant is considered as an obstacle that needs to be avoided. Unexpected spatial elements are also obstructive, unless they serve as a landmark.

The plan annotations reveal that the exploration strategies used inside the home are identical to those used outside the house. In townhouses, of the type that consists of three main rooms on the ground floor, it is remarkable that the space in the middle is so often used as transit space, and that the furniture is placed as close as possible to the sides of the wall [M002, M005, F002, M006, M007, F004, M009, F005, M011, M012, M014, F007]. Two participants explicitly identify this as "the style of people born blind" [F004, M006]. The location of furniture is ideal because it enables movement. In other words, parallel to the running-line, or along the sides of the walls [F004]. Curiously, while sliding doors do not obstruct movement, nobody has sliding doors inside the house (except for terrace doors). Information relating to orientation can also sometimes be passively felt. For example, air displacement through buildings may reveal a sense of direction.

Configuration

Rhythm

For most participants, a staircase gives structure and is not difficult to ascend. When it comes to movement, people prefer regularity and rhythm. In this respect it might seem strange that, for example, spiral stairs are not so difficult, provided they are regular and if handrails are present [M008, M012, F005, F002]. Moreover, one participant even finds climbing a spiral staircase a very pleasant experience [F005].

Connection

Connections between rooms, and observed surfaces, are also important. Supporting elements are, for example, kitchen bars. For different participants, a kitchen bar is a welcome unit in the house. Participants cannot explain why, but it is one of their favourite elements [M003, F001, M006, F005, M011, M012]. These bars generally mark the edges of the kitchen space, so they are helpful when it comes to knowing where boundaries and corners lie. They can also connect the kitchen with other spaces (Fig 4.23).

Moreover, the kitchen bars are static. They are thus very reliable because their position never varies. Participants prefer fixed elements. The most extreme example is that some participants prefer fixed furniture that cannot be moved or changed [M001, M003, M011, M012, F007]. M001 renovated a cowshed and designed the interior with his wife. They decided to keep certain walls and elements as fixed, and they built the rest of the interior around them (Fig. 4.24).

In some homes, we observed other original interior design ideas that supported movement by way of a ‘connection’. For example, one participant cut a standard door in two, like a stable door, in order to structure the corridor while the door is open [F007] (Fig. 4.25). In a few cases, participants have literally asked for supporting walls, or fixed elements, that can direct them from one place to another. The importance of connecting architectural elements is therefore very clear [M001, M012] (Fig. 4.26).

Participants also recognise the importance of air temperature. By means of openings such as doors, open
windows or other openings in the environment, differences in room temperature can be felt. Moreover, some participants are able to use these differences to orientate themselves. For example, in winter, certain rooms might be colder than others. The same is true in summer. Participants can feel the differences between rooms from the differences in temperature. M009: “No ... I notice the difference in warmth ... the warmth that you get from sunlight, for example. It is much warmer in the kitchen now than in here.”48 One participant also refers to the advantages of being able to orientate using air [M015]. He explains that in the city, small alleys (which used to prevent the spread fire in the Middle Ages) give him a reference point. He senses which way the air is blowing through the alleys and knows where he is.

**Direction**

The meeting points at which different surfaces connect within the environment are characterised by certain angles. The angle at which two surfaces connect provides information about the direction of the architectural elements. For example, as explained by M009: “Yes...so...yes, in fact it is just a sink with ... a table around it. That’s ideal, and the bath is behind it. Like this, the bathtub is parallel to the sink. It is a rectangular room and the shower is in a corner and the heating in the other corner. The bathroom is beautifully structured, I think. Yes, the bathroom is good, I think.”48

If environmental elements follow the direction of the

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47 Dutch Excerpt M009: [“neen neen... het verschil dat ik alleen merk is aan de warmte euh...die ge krijgt door zonlicht bijvoorbeeld hé, in de keuken is het nu veel warmer natuurlijk als hier euhm...”] P13: ATLAS 080707 M009.rtf – 13:80
participant in space, it is appreciated. However, if elements hinder the movement of participants, because they are not placed in the right direction, for example, they are considered obstacles. M007 refers to the unpredictable canopies of shops in the city centre (Fig. 4.27) and a bus stop that is in the wrong place next to the road. The bus stop cannot be entered without passengers having to move onto the street. The sides of the bus stop lead visually impaired people to the street instead of to the waiting place. This situation is not safe and, in terms of connection and direction, it is considered to be a poor haptic element (Fig. 4.28).

If too many ‘stimuli’ are present, participants complain about chaos [M002, M003, M004, M005, F002, F003, F004, M009, F005, M012, M014] (Fig. 4.29). For a structure to be good, they all prefer environments that have enough architectural triggers, but in a balanced way. Too many haptic stimuli are also undesirable. For example, as M009 explains:

48 Dutch excerpt F005: [“P: “jah...dus euhm ja maar jah dan euhm...het is eigenlijk gewoon een lavabo met zo...een eeuw tafel er rond da’s wel ideaal en daarachter is het bad dus mooi evenwijdig met de lavabotafel en het bad staat evenwijdig van elkaar dus...dus rechthoekige ruimte, de douche in de hoek en de chauffage in de andere hoek. De badkamer is wel mooi gestructureerd vind ik, ja de badkamer is goed, vind ik.”] P15: ATLAS 080626 F005.rtf - 15:80 [I: jah...dus euhm ja maar jah da... (254:254)] (Researcher) Codes: [form] [lay out]

49 Dutch excerpt M009: [“P: euhm...euh voor ons is een modern, bijvoorbeeld als het over structuur gaat...hé want ge hebt gij zo van die woningen, met hoeken en kanten en bochten en (...) tweeth (maakt geluid tussen tanden) dat dat mogen ze dus nooit niet doen zoets doen, zo’n huis zou ik niet willen hebben eigenlijk da’s da’s... moeilijk maar dat wil niet zeggen dat dat niet modern mag zijn. Allez jah ge kunt gij daar zo’n speciaal dak opzetten of ge kunt gij daar, aller ja da’s ... dat mag hé, dat is...en sensorieel goh euh...ik vind dat veel architecten en dan spreek ik eigenlijk algemeen, tegenwoordig, gelijk welke woning dat zij maken, dat zij zetten der rekening houden dat die toegankelijk is voor iedereen.”] P13: ATLAS 080624 M009.rtf - 13:98 [I: goh belangrijk...ja ik kom i..] (579:581) (Researcher) Codes: [good haptic experience] [lay out]

50 Dutch excerpt M009: [“Ja awel rechthoek, vierkant, een woning die rechthoekig over vierkant is. Of dat mag zo zelfs een beetje zo’n beetje is dat trapzez?”] P13: ATLAS 080624 M009.rtf - 13:101 [I: maar die kunnen ze misschien... (635:654)] (Researcher) Codes: [lay out]
“Because the kind of homes, with corners, edges, curves... fweeth [makes noise between teeth] well...they shouldn't be allowed, a house like that isn't for me. This does not mean that it cannot be modern. You can certainly place a special roof on top, or you can...well that's allowed...that is...sensory too. I think many architects, and then I speak in general terms...currently any home, made by architects, should take accessibility for all into account.”63 The participant stresses the number of corners and edges, as well as the combination of different kinds of connections, as a complicating characteristic of a space. In fact, he is not the only one who mentions this [V004; M009; M011]. One participant compares a home with few ‘corners and edges’ by using the image of a rectangular or square shape: “Well a rectangle, a square, a rectangle or square home. Or it may even be a bit like a trapezium.”64 For him, a complex house with too many corners is one with an polygonal ground floor. He refers to a house both of us know: a family home of an architect built in the 1980s made of steel, concrete and stone.

M009: “Well they have there in any case...it is a very strong home...I ask myself...well, I don’t know, steel, but why? Maybe it’s for fire safety...or, I don’t know...but downstairs it is straight, that is OK, but upstairs it appears to be something hexagonal.

R: Yes?

M009: Yes, like a cube and a hexagon... well, it looks like a fairground attraction to me.”65

The fact that the first floor is shaped like a hexagon is not appreciated by M009. He is not familiar with this shape and, moreover, the high number of corners makes it overly complicated to him.

Besides the impact that the number of corners or edges can have, if the number of spaces are linked in a complex way they can also be confusing: “For practical reasons you don’t need forty-five rooms here that you can walk in and out of.”66

In general, we can summarize that the number of stimuli (surfaces, corners, edges,...) needs to be sufficient - but not overwhelming.

Size - Length

Size refers to the dimensions of the surfaces touched by participants, as well as the distance required between participant and architectural element as part of haptic perception. In other words, size identifies the height and width of the touched surface itself, whereas length gives information about the distance in relation to the body of the perceiver.

In general, participants agree that they need enough space on the ground floor in order to move around. However, spaces must not be too large either - like a huge square without any reference point, for example [M005]. Most of the participants fear large empty places or, as one participant [M011] says, “abstract spaces”. Abstract spaces are, for him, woods or a large square. He supports this statement by explaining why he prefers the urban environment to the rural:

M011: Well, in the woods, it’s nice as well, in nature...but, well...I don’t know, in the city I get a more general image of the environment...of where I am.

R: And do you know the reason for this?

M011: Well, yes...I think that it may be due to the way of life and the kind of people...there [in the city] and so on...

R: So, for you, going to the city is almost like going on

63 Dutch excerpt M009: [*P: ja ze hemmen daar...jaja ze hebben daar in elk geval...Het is zeker een stevig huis, ..ik vraag mij...allez ik weet niet of staal, maar waarom, misschien is dat tegen brandveiligheid of zo...ik weet niet...maar dus beneden is dat recht, dat gaat nog, maar boven is dat dus precies zoets zeshoekigs...].] P13: ATLAS 080624 M009.pdf - 13:101 (J: maar die kunnen ze misschien...]

64 Dutch excerpt M011: [*“P: allez in een bos is ook fijn, in de natuur en euh...maar euh jah...ik weet dat niet meer in de stad krijg ik meer een algemeen beeld van een omgeving...daar kan ik niks plaatsen R: jajajaja” ] P17: ATLAS 080630 M011.rtf - 17:37 (P: en zo...allez dat hebt ge, he,..] (248:255)   (Re

65 Dutch excerpt M009: “ja...dus voor u is naar de stad gaan een beetje met vakantie gaan eigenlijk...P: jaja mmm de eethuisjes, de restaurantkes, de terraskes, de...en de winkel in winkel uit en...R: en wat vind je dan goed aan steden, kan je je daar gemakkelijk oriënteren?P: ja toch wel...].]

66 Dutch excerpt M009: “[J: misschien...maar dat was hier...]

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holiday?
M011: Yes, the brasseries, restaurants, cafés, terraces and...walking in one shop in and out the other.
R: And what do you like about cities? Can you orient yourself easily in a city?
M011: Yes, I can!
R: And what would be the reason for that? Do you have an idea?
M011: The way a city is built and ... well ... and I remember we went to Ostend on a holiday a couple of times.... I remembered that while we were walking to the hotel, it was the one in which we had stayed the year before ... I felt it.
R: Oh yes?
M011: And I was right too! From that point onwards, I knew where we were, how far we were from the beach and how we could walk to the beach."

M011: And so...well you've got it, it is structured, and that is important...to me.
R: Yes.
M011: And in a square, the woods, or another more abstract building, I cannot place anything in those places.
R: Yes.

The participant explains that cities have far more, and varied, environmental stimuli and that they are located at a noticeable distance from each other. He enjoys staying in a city for this reason. Abstract spaces lack easily reachable reference points for the perceiver and are akin to non-palpable environments. If spaces cannot be too large, we ask participants about the ideal width of a circulation space. Some refer to their body [M001, M014, F004, F005, M009, M010, M011, M012] as a reference point, or a measure for explaining the ideal width. M012 defines his ideal width very precisely: 1.6 - 2 meters. In general, the ideal width seems to be limited space to twice the user’s body width.

One person puts it very clearly:

R: If you consider the entrance, is that large enough for you?
F005: Yes, yes, absolutely. It doesn’t need to be that large...for me, in fact, the smaller the spaces, the handier they are.
R: Yes.
F005: I’m not saying that small rooms are practical but, in fact, bearing their usefulness in terms of orientation in mind, small rooms are perfect, yeah ... because it isn’t possible to walk the wrong way, because you will quickly...
R: A small space is, in fact, a small corridor that you move through?
F005: Yes!
R: Because a space can be large, but the cupboards can be placed in such a way that you know how to orient yourself perfectly.
F005: Yes, in fact, it is actually that...

Besides the perception of size and length through movement (i.e. active touch), some people refer to other palpable experiences through passive touch, such as the sense of ceilings.

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53 Dutch excerpt F005: “R: als ge zou kijken terug naar den inkom terug, is die groot genoeg voor u? P: jaja absoluut ja dat moet zelfs zo groot... voor mij is zelfs hoe kleiner de ruimtes, hoe handiger eigenlijk R: ja P: ik zeg net dat dat praktisch is kleine ruimtes, ma eigenlijk met handigheid naar oriëntatie of zo, is kleine ruimtes ideaal, ja...omdat je niet veel kunt verkeerd lopen omdat je sowieso vlug... ja R: een kleine ruimte is dan ook vooral een kleine bewegingsruimte waardoor je beweegt? Hé P: jaa! R: want de ruimte kan groot zijn, maar de kasten kunnen zo goed geplaatst zijn dat eigenlijk dat je je perfect weet te oriënteren.P: ja ja het is eigenlijk dat! P15: ATLAS 080626F005. rtf - 15:25 [J: als ge zou kijken terug naar..] [86:93] (Researcher) codes: [body language] [form] [good haptic experience] [lay out]
14 participants point out that they feel, or hear, differences in ceiling heights but, in general, the preference is for low ceilings [F002, F004, M001, M003, M004, M006, M007, M008, M009, M010, M011, M013, M014, M015]. Two people even suggest that changing the ceiling height can aid orientation [M005, M008]. Eleven participants prefer small spaces but with sufficient space in which to move [M001, M005, M006, M007, M008, M013, M014, M015, F004, F005, F006].

In general, the notion of length and scale differ according to whether an object is touched or viewed. While most visual landmarks tend to be large, haptic landmarks can almost be invisible to the eye. For example, a small bump in a handrail is sometimes enough to identify a location [M008]. A haptic landmark can, in fact, be very discrete.

Strikingly, participants do not differentiate between interior and exterior dimensions. In haptic conditions, the preferred geometric and material properties remain the same whether they occur inside or outside. With vision, for example, the preferred dimensions in the exterior environment tend to differ from those inside, but in haptic perception the age-old architectural premise of ‘inside/outside’ fades away. Haptic perception is primarily derived via proximal stimuli and movements and, as a result, participants prefer dimensions that support their own body physique. The latter remains true for interior spaces, as well as exterior.

Why do People Born Blind rely on Certain Properties in the Built Environment?

Two participants associate ceilings with inclined walls (or walls that are not at right-angles). Interior ceilings can be at an angle because of a sloping roof. Surprisingly, blind participants define ceilings as walls, which could suggest that they experience the boundary of space more as a whole [M003, M004, M005, V003, M009, F005]. Participants also mention ceilings when discussing the atmosphere. For example, one participant explains that her favourite place in the house is the toilet. This room is situated under the sloping roof and, for her, it has feels cosy because of the inclined ‘wall’ [F005]. In the context of atmosphere, it is clear that the participants combine personal experiences with their knowledge and preferences. Temperature is often mentioned as an important factor in the creation of the whole atmosphere within an environment. As F002 points out: “…Not too big a space; it can be a big space, but then it needs a lot of people in it, it must make you feel warm - then you feel good.”

Dutch Excerpt F002: [“jah geen te grote ruimte, het mag een grote ruimte zijn, maar er moet dan wel veel volk zitten bij wijze van spreken, het moet een warme sfeer geven en dat voel je dan wel”] P7: ATLAS 080707 F002.rtf – 7:68
Fig. 4.33 Screenshots showing daily ritual of one participant walking from the front door to the letter box, while he orients himself on landmarks, paths, nodes, edges and boundaries in his environment.
The construction process influences both the geometry and the materials within an environment. Many participants [M001, M002, M005, F002, M008, F003, F004, F005, F006, M011, M012, M013, M014] refer to the advantages of craftsmanship and suggest that this is the best way of establishing the built environment. There are several reasons for this preference. Firstly, artisans often pay more attention to small details (Fig. 4.31). Every new creation deviates a little in detail and this is what guarantees diversity. Moreover, certain unforeseen details might be very useful for haptic exploration. One participant explains that, for him, the good haptic qualities lie in the imperfections [M008]. He refers to architecture constructed in a traditional manner, in which you feel the authenticity of its production. For example, a little twist in an armrest can be an excellent orientation point. There is a handrail to a staircase in the house of M008 that contains a small mistake. However, it is the mistake – the twist - that indicates his location. When he reaches it, he exactly knows where he is (Fig. 4.32).

When sensing a spatial environment, an individual builds a cognitive map of the space using a combination of sensory information and a lifetime of accumulated experiences. People rely upon their memories of perceptual experiences.

Corners, openings, lines, boundaries, nodes, paths, landmarks and edges – all these represent ways of creating order and structure within the home environments of people born blind. One participant shows us how he walks to the letterbox each morning and uses the paths, corners, edges, boundaries and nodes within his environment to find his way (Fig. 4.33). From the threshold at the entrance that marks the boundary between inside and outside, he uses the exterior wall of the house as the reference point for his path. The corner between the wall and the garage functions as a node and tells him where he is. One step further and he turns to the left, at which point he follows the boundary marked by the hedge. A drain marks the edge of the drive and the grate over this leads him straight to the letterbox. Kevin Lynch described boundaries, nodes, paths, landmarks and edges as the five crucial elements that help form a visual mental map. Remarkably, these elements also support the sequential movement that is specific to haptic experience. Openings in walls are positive because they support communication between different spaces and the orthogonal boundaries of openings betray direction and thus provide orientation.

Landmarks are spatial elements that do not need to be regular. This is because their irregularity can provide information. A texture or line, for instance, can be a very positive environmental element. This leads us on to material characteristics.

Haptic landmarks, unlike visual ones, can be derived from the material properties of an object. For example, many participants have doormats throughout their homes. Mostly, these mats mark edges within the built environment [M001, M003, F003, M009, F005, M011, M012, M013]. As our feet already touch simply by walking, these mats help the participants pay more attention. Thanks to the difference in texture, larger carpets can mark an area in the house, for example the transition between dining room and living room. The location of these mats helps the participants orient themselves through their perceptual memories. All of the doormats are placed on, or next to, the lines that mark paths or borders. For example, one participant shows us how he uses the edges of a grass mat to mark his terrace. In so doing, he knows perfectly where the table is [M009].

Corners and doorframes are actively touched landmarks - as are openings, thresholds and barriers. An obstacle can also become a landmark. For example, a letterbox sticking out from a facade can announce the approaching door in a very haptic way. Another example is a subsidence, or a manhole in the sidewalk [F007, M014, F002].

The plan annotations reveal that three participants frequently touch landmarks in their own house. They are all congenitally blind and have never seen [F005, M001, F003]. In total 110 active touches are registered on the plans. It is also interesting to note that the difference between an interior and exterior environment is much less clear in the haptic world. In the context of haptic landmarks (such as paths, edges, boundaries and nodes), the participants touch in exactly the same way whether inside or outside. Walls, floors and ceilings are considered as equally informative as furniture. This means that every touchable element can play an important role in terms of orientation or atmosphere. Memories refer to the usable haptic memories that facilitate orientation and atmosphere.

4.3 Observations of Children Born Blind

Observing children born blind allows us to study how they haptically perceive the environment. Very few studies have yielded information that sheds light on the development of exploratory procedures (EP’s) in blind infants. In the context of this research, it was felt that it would be interesting to observe children and that this might reveal new information relating to haptic perception. However, the spontaneity of the children and lack of enculturation (which had, at first, seemed a major advantage) made acquiring information about haptic experiences quite challenging. It forced us to look for an appropriate research methodology. Eventually, it was one of the children who came up with the solution by triggering us to begin a photo-ethnographic study. This Section briefly outlines the context of this study and goes on to explain the research set-up, analysis and results.

4.3.1 Researching Haptic Perception together with Children Born Blind

As explained in Chapter 2, the participants were children with visual or hearing impairments, or autism, who lived at a boarding school (Spermalie in Bruges). In brief, we chose to work with blind children for a number of reasons: their spontaneity, expertise in haptic perception and their sensitivity towards poor environmental stimuli.

Firstly, children in general are a particularly interesting group of people to involve in our research because their perception is very primary. Anna Halprin praises the spontaneity of the child: “Because what I am saying is that somehow or other we’ve lost the ability to experience as children experience and I use the child because the child has such an instinct to ritualize and create spaces; the child hasn’t yet been deadened.” 59 In this respect, children are truly honest and pure.

In addition to their honesty, children are the ideal participants in a study on haptic experiences because, as John Rieser points out, our children are always changing position. They do this both in terms of their physical movements and in relation to the layout of external spaces.60 For children born blind this phenomenon is even more prominent. According to Roelof Schellingerhout these children rely on an egocentric way of perceiving space.61 This means that, on the one hand, they perceive their position in relation to their own body (and less in relation to the environment) and, on the other hand, it means that they perceive spaces in terms of movements that need to be made.62 Consequently, a blind child’s perception largely relies on haptic sensation.

Finally, Bjarne Fjeldsenden states that children who are born blind are very sensitive to poor environmental stimuli and concludes that such children are very grateful when asked to participate in research dealing with the less striking factors of the environment. O’Neill affirms this by pointing out that childhood experiences in the landscape represent an important phase of intense tactile and kinaesthetic learning.

These arguments made it clear that the expertise of children would be of great value to our research. Consequently, we put out a call to all the schools for visually impaired children in Flanders. Representatives of these schools attend a monthly meeting in which upcoming research projects and calls are discussed. During one of these meetings we were invited to present our research topic and set up. As it is important for our research to observe children with few, or no, additional impairments, the members of the group agreed that Spermalie would be the best location for our research, as most of the children there do not have additional impairments. Besides, this is the oldest institute for the education of children with a visual or hearing impairment or autism in the country. It currently takes care of 81 children with visual impairments. The observations were conducted at the primary boarding school for children with a visual impairment between three and 13 years.

Before the actual observations began, we joined the children on outings to an amusement park and conducted a tandem bicycle tour to the coast. This enabled all parties involved in the upcoming observation (children, educators, and researcher) to get to know each other.

In November 2007, the actual observations started with participatory activities on Wednesday afternoons. Until March 2008, we went every Wednesday to the school. On holidays, or at the supervising caregiver’s request, some visits were cancelled. Weekly reports summarized each observation session and outlined the main issues, plus the most important, or striking, aspects of each day.

We worked closely with the care supervisor of the group at all times in order to find an appropriate observational setting. The care supervisor carefully picked out four classes, which we were able to follow alternately. They also identified five children born blind, spread over these four classes, who eventually became the candidates for our photo-ethnographic study (Fig. 4.34). The school’s policy is to provide parents with an informed consent document at the start of each new school year in connection with all the research studies planned for the following year. Parents can agree and give permission to let their child participate in research activities. For the publication of the photo-ethnographic study, the researcher asked additional permits from the parents involved (they all agreed). The educators informed all the children about the study, but not about its actual set-up. The children did not know that it relied upon the expertise of people born blind.

SPE M01 is a nine year-old boy, born with Leber’s Optic Atrophy, an inherited defect of the optic nerve affecting the retina. He lost his sight during his first year of life but still has some light perception in his left eye. The second participant, SPE F02 is an 11 year-old girl born with Norrie disease, a genetic disorder that primarily affects the eye and leads to blindness at birth, or soon after. She also had an enucleation of the eye, which means that her eyeball had been removed, but leaving the eye muscles and remaining orbital contents intact. Although Norrie Disease often also results in deafness, this girl has no other impairments. The third participant, SPE F03, is an eight-year-old girl born with perinatal Retinopathy of Prematurity and with less than five per cent vision in her left eye. This is an eye disease that affects premature babies. Medical research assumes that the disorganized growth of retinal blood vessels causes scarring and retinal detachment. This participant also has impaired mobility. Retinopathy of Prematurity is also the impairment of our youngest eight-year-old participant, SPE F04, who has no residual vision and no light perception. Similarly, our fifth participant, SPE F05, an 11 year-old girl, lives with Retinopathy of Prematurity. She still has light perception in her right eye and less than five per cent vision in her left eye.

All participants stay at school for the entire week, except one. SPE F04 often leaves the boarding school early on Wednesday afternoons. Her irregular Wednesday afternoon school pattern made us decide to leave her out of the photo-ethnographic study that was eventually conducted with the following four children: SPE M01, SPE F02, SPE F03, and SPE F05.

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During the first two months of the observations, no study related activities were planned and we kept a low profile.

Once mutual trust had been established, more focused activities were initiated. The actual research set-up required a methodology that invited children to talk spontaneously about their environmental experiences in a self-confident and independent way. However, it became clear that a lot of creativity would be needed if the children were going to participate in this research.

In January 2008, one of the teachers decided to organise a game in the hope that it would enable the children to talk about their environmental experiences. Together with the teacher, we established a possible research approach for the game after school. The idea required further scientific elaboration and we make a proposal to the teacher two weeks after the first brainstorming session. We prepared a semi-structured questionnaire, a topic for the game and a time schedule. The schedule runs over two afternoons: one afternoon to prepare the game and one afternoon to actually play it. The challenge is dual: 1. gaining information on haptic perception and 2. meeting the needs of a pedagogically sound exercise. Prior to the game, the idea was to talk about environmental experiences with the participants who had been born blind. We started this study with the 11 year-old SPE F03.

After a brief explanation, SPE F03 was invited to participate and asked to think about an actual tour through the building, the hints and the questions that she wants to ask. Our common theme is ‘places at school’. The game involves all the children in the class and is guided by SPE F03. For the preparatory phase, we accompany SPE F03. She decided to walk through the building while inventing the different tasks for the game. However, the girl is too timid to take the initiative, which results in us becoming too involved and making suggestions. This consequently made the output unusable. The game takes place and the children have great fun, but we had to continue the search for a different and more reliable interview technique.

One day, SPE M01 asked to use our camera because the buttons on it intrigued him. The boy mentioned that he had asked St. Nicholas for a camera but, unfortunately, had not received one. Besides, his parents had told him that he would never be able to use it properly. Inspired by his story and questions, we start to reflect upon a photo-ethnographic study.

In the visual world, the concept of a photograph mainly originates from a visual trigger, or the description of a visual scene. However, our research approach turns the world of photography upside down. The characteristics of photo-ethnography resonate with the general objective of our research and this made us decide to use photography as a vehicle for communication with children born blind.

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<th>gender</th>
<th>visual impairment</th>
<th>onset visual impairment</th>
<th>residual vision %LE (Left Eye) %RE (Right Eye)</th>
<th>light perception?</th>
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<td>RO : 0% LO : 1/20</td>
<td>RE: light perception</td>
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Fig. 4.34 Overview of the participating blind children in the photo-ethnographic study
about their sensory experiences. A digital camera became a way of focusing the children’s attention on their daily thoughts, behaviour, reactions and experience in response to their school environment. To begin with, each child received brief verbal instructions on the use of the camera (a Canon Digital Ixus 750, 7.1 megapixels, zoom lens 3x). As soon as the child showed photographic interests and abilities, the photo tour started. The children were given full control and allowed to decide independently when, how, and where they would take a picture.

Nevertheless, to encourage the children to focus on their school environment when taking pictures, we had prepared a semi-structured questionnaire with questions like: “Take a picture of the place in or around the institute which you feel is the most pleasant. Why did you choose this place? What are the most pleasant materials in the institute? Why? Where do you use the sense of touch? Why? How?” At the start of the tour, the semi-structured questions encourage the children to take photographs and the children’s answers help clarify the reasons why the pictures were taken and the subjects chosen.

This technique is better known as photo-interviewing, an interview technique in which a participant is questioned whilst taking pictures. Photo-interviewing appears to facilitate communication with children born blind about their haptic experience of the school environment. During the interviews, we focused on the layers of thought, behaviour, reactions and experiences of the children whilst engaged in taking a picture.

The photographic tours take an average of two to three hours and are recorded on a dictation machine (Olympus DS 4000). We make notes during the tour on the subjects of the pictures taken, any remarkable perceptual actions of the participants that we noticed, or the reasons why certain pictures were taken.

After each photo tour, all pictures were uploaded onto computer. We printed out all images, ran through and labelled them according to subject. Each photo tour provided us with a list of different pictures. However, some pictures were, at first, unclear and it was only after a first listen to the digital recordings that we were able to complete the list. Further details as to why, or how, the pictures were taken were revealed during a second listen to the tapes.

Firstly, we classified the photographs according to subject (wallpaper, computer, classmate, elevator, ceiling, corridor, own classroom, elevator button, bed, physiotherapy room, garden...). The second classification focused on the identification of similar topics across the several photo interviews via general keywords like classroom, people, corridor, stairs, elevator, room, door and object, for example. This analysis also revealed that some pictures need to be viewed as isolated images, whilst others are part of a series. Series of pictures were grouped together, as they represented the image of one environmental element or space. The third classification linked the keywords to the semi-structured questions. The fourth classification paid attention to the triggers for taking the pictures as related to the senses stimulated. These stimulations were also be classified into three groups:

1. actual sensory perceptions or
2. memories about sensory perceptions or
3. meaning given to certain environmental elements or aspects.

Accordingly, we also classify our findings into three main groups: the expertise of children born blind and the way they haptically explore the built environment, the question of which haptic stimuli might trigger children born blind and the reasons why they took pictures of certain haptic elements. We conclude with a brief summary about photo-ethnography as a methodology for sensory research.

4.3.2 Findings Photo-Ethnographic Study

The children’s use of the camera, their stories and the actual pictures all provide unique insights in the role of non-visual perception in the built environment, and the haptic sense in particular. We can categorize our findings according to how, what and why children born blind take pictures of the built environment.

4.3.2.1 How Do Children Born Blind Explore the Built Environment Haptically?

In general, the photo-ethnographic study affirmed the interest of the children born blind in non-visual stimuli. Auditory, haptic and olfactory stimuli are all present in the pictures. However, most often subjects of photographs relate to haptic and auditory stimuli. For example, the participants enjoy talking about the elevator. Asking why they want to register the elevator, one girl literally says that she can hear where she is, which makes the elevator hall so extraordinary [SPE F02]. This girl reflects upon photographing the elevator, before we pass by, suggesting that her picture is triggered by an auditory memory (Fig. 4.35). In contrast, two other children decide to photograph the elevator when stimulated by its voice or its tactile buttons (Fig. 4.36). Something similar happens to a girl on her way to the playground of the secondary school. When SPE F05 recognises the sound of the sliding external door, she wants to record this experience (Fig. 4.37).

Another auditory trigger is a radio for the bathroom in the shape of a dolphin smiling out of a window (Fig. 4.38). When not actually in the bathroom, this plastic animal is attached to a window with a suction cup. The dolphin is silent in the picture, but it had left a deep impression on SPE M01. As soon as we were inside his private room, he took a picture of this audible object while explaining his bath ritual. Every time he takes a bath, he listens to the dolphin. The same story holds true for his clock-radio, which has so many tactile buttons that the boy is intrigued and wants to learn every single haptic action that it affords. Both the dolphin and the clock radio are objects that call up haptic and auditory memories. Olfactory triggers are also present in this photo-ethnographic study, but occur less frequently. When passing by the herb garden, SPE F02 starts taking photographs enthusiastically. While she holds the camera between the chive, parsley, coriander and rosemary plants, her fingers seek the camera’s button. The lens registers the sand, moss and weed between the few herbs present in the garden (Fig. 4.39). Although herbs are rare in February, her olfactory memory prompted this girl to capture her experience in a picture. It is different when children actively receive an olfactory trigger like the smell of the kitchen. SPE M01 takes a picture in the direction of the kitchen, as he smells the kitchen when passing by (Fig. 4.40).

The most frequent triggers are, however, haptic in nature.

Together, these examples show that the children are actively looking for non-visual stimuli and that the active perception of stimuli may result in an action, in this case, the act of taking photographs.
Fig. 4.36 Picture of the elevator triggered by the feeling of tactile buttons

Fig. 4.37 Image representing three pictures taken in the direction of the auditory stimuli made by the sliding doors

Fig. 4.38 Picture of the bath radio in the form of a dolphin, triggered by an auditory memory

Fig. 4.39 Picture of the herb garden based on the olfactory memories
4.3.2.2 What Do Children Born Blind Haptically Perceive in the Built Environment?

The analysis revealed that we could classify the participant’s triggers according to both their material and geometric properties.

**Material Properties**

The children paid remarkable attention to materials and, accordingly, materials were frequently photographed. Besides, the pictures themselves also possess material characteristics due to the handling of the camera, as we will explain later.

**Temperature**

Temperature is not visible on the actual pictures. However, all the children refer to the importance of temperature when explaining why they like, or dislike, certain materials or spaces. For example, the radiator is photographed because it is an unsafe element. When the children follow the guiding line in the corridor, they automatically bump into the radiator. This iron element can cause burns. Cold spaces are identified as unpleasant. One explicit example is a picture of the ‘cold corridor’ named after the materials from which it is made and the experience they generate. SPE F03 takes a picture of this passage because she frequently walks through this corridor but, in fact, she dislikes the space because of its temperature. Pleasant rooms or materials are warm. A warm material is, for example, wood. Wood is often referred to and the participants frequently take pictures of wooden elements.

**Density**

The children have more than one favourite place in the school in common, but the one they are most enthusiastic about is underneath the roof and called the ‘judo room’, a reference to the judo mats inside (Fig. 4.41).

In the judo room, the children can turn head over heels, jump, run in circles and, in short, be themselves - without fear of being hurt. As a result, the room is associated with freedom. It is one of the few places in the school where no restrictions, limits or guidelines for physical movement apply. The room seems to offer the children freedom, inviting them to explore all possible movements and to perceive the environment freely. This is, in part, due to the judo mats installed. These floor mats have a very pleasing density, as all the participants notice when using the judo room and the objects in it. It is comfortable and the participants do not hurt themselves if they fall.
Fig. 4.41 Pictures of the judo room, considered by the participants to be one of the most pleasant spaces in Spermalie

Fig. 4.42 Picture of the leather texture of a seat
Texture

The children frequently register texture. It is interesting to note that they frequently photograph the textures of materials, as well as the textures that result out of the manipulation of materials. For example, one participant registered the grain of a leather seat [SPE F05] (Fig. 4.42). The grain is an intrinsic characteristic of leather. The bumps in the glass bricks, on the other hand, are the result of the mould into which the glass was poured (Fig. 4.43). Both textures are actively felt and appreciated. The same counts for the ‘smooth’ tiles in the corridor [SPE F03]. The ‘smoothness’ of elements and materials is largely enjoyed. The children do not take pictures of any unpleasant textures.

Geometrical / Spatial Properties

The geometric, or spatial, properties of an environment include the layout (or all the structural characteristics) of the environment. ‘Orientation’ provides information about the relationship between spatial elements and the body of the perceiver, while ‘configuration’ refers to the relationship and interaction between different spatial elements. ‘Size’ denotes the size of the subject photographed, as well as its dimensions in relation to the body of the participant.

Orientation

Children take pictures of all the surfaces that surround them while walking through the building: ceilings, floors, walls and windows, for example. This indicates their awareness of the position of surface planes in relation to their own body. Actively touching these surfaces also prompts the children to take pictures. If the planes or surfaces point in a certain direction, this direction may also be subject of their photo. The angle of surfaces is interpreted in relation to their own bodies. For instance, they place the camera parallel to the inclination of a surface, such as the slope in the playground (Fig. 4.44), or they literally point the lens perpendicular to the surface, or the boundary between the two surfaces. This marks the difference in direction, or the noticeable angle. For example, SPE F05 takes a picture of the horizontal line where the wall meets the low incline of the fiberglass covered ceiling (Fig. 4.45).
Configuration

Unlike the relationship between plane and body that results in ‘orientation’, the connection between planes is part of ‘configuration’. It is striking that all the children take pictures of the boundaries of spaces and places, even if they are not actively touchable.

If planes are actively touchable, special attention is paid to the connection between them. The meeting, or connection, between two planes attracted the attention of all the children and resulted in pictures of boundaries between surfaces. This meeting can be a boundary between two planes, or an opening in a plane. Children are attentive to contrasts between two surfaces or planes, like the boundary between wood and fiberglass. It is clear that by following the perimeter of space, as taught by the educators, the number of surfaces marking the route is always perceived. Children also register the doorframes and doorsteps as crossing points that require decisions in terms of movement.

If the number of planes along the route is rather high, complexity increases and additional landmarks are added in the form of corners, for example. Several children [SPE F02, SPE F03, and SPE F05] appreciate rhythm. SPE F03 explains that she took a picture of the corridor and the windows made of glass bricks. She likes to feel the openings and corners while walking by. She sometimes even counts them. The repetition triggers her to take a picture and thus, the rhythm and number of planes seems to support the recognisability of elements in the built environment, despite the level of complexity.

Size

Analysis of the photographs taken by the children revealed that images of surfaces at the touching height of the hands (or feet) are most common. This suggests that these are the most actively and dynamically touched places. As explained before, passive touch is less visible and therefore not traceable on the pictures.

On the one hand, participants take pictures of small details in a space and, on the other hand of ‘views’ of large spaces - in which they must not be afraid of bumping into other people [SPE M01, SPE F02, SPE F05].

Remarkably, analysis of the pictures suggests that a wide view of larger scale environments, or elements, is based on memories or knowledge, such as the photograph of the outdoor playground.

4.3.2.3 Why Do Children Born Blind Take Pictures in the Built Environment?

Not all pictures are the result of actual sensory triggers (whether material or geometric). Sometimes, the participants fall back on their memories and knowledge for inspiration without any direct sensory relationship.

One girl leads us to the playground and takes a picture of the shelter (Fig. 4.46). For her, the place reminds her of rainy days as the roof protects her from getting wet and cold [SPE F03]. She holds the camera upside down, with the lens in the direction of the roof that features in her auditory and haptic memories.

Another place in the institute that is frequently recorded by the participants, based on their memories, is the ‘big hall’. All participants [SPE M01, SPE F02, SPE F03, SPE F05] remember this as a pleasant space, a place in which the children do sport and play games. In terms of function, it is similar to the judo room, but the spatial qualities are extremely different. Whereas the judo room is a cozy space with limited daylight, the ‘big hall’ is bathed in light. It is two stories high and huge. Above all, it is the size of the hall and the existence of a tactile mat that makes this place so popular. All participants decide to take pictures of the tactile mat (Fig. 4.47) in the big hall, better known as ‘the tingling
Fig. 4.47 Compilation of pictures of the tactile mat
This ‘tingling mat’ was created by the teachers and helps the children orientate themselves haptically at a very difficult point: the door between the secondary school and the primary school. This tactile mat hangs against the wall in the big hall that leads to the entrance door. It marks the end of a guideline on the floor. The rough, bristly hair framed by soft wooden slats is like poetry for the hand. The memories of the ‘tingling mat’ prompted the children to take pictures of this tactile landmark in space.

Fig. 4.48 Pictures of the exercise ball

Fig. 4.49 Picture of the sky

Besides remembering physical stimuli, participants also remember immaterial stimuli. The latter are for example moving objects like the exercise ball. This exercise ball is not felt coincidentally, but all participants consciously decide to take a picture of it. They all know where it is stored and carefully pick the ball out (Fig. 4.48).

It becomes clear that memories play an important role in giving meaning to the children’s experiences of the built environment.

Some participants also decide to take pictures of things that can never be touched, or at least not there and then, but which still mean something to them. For example some participants [SPE01, SPE F03, SPE F05] still have light perception and consequently a powerful light source might capture their attention and compel them to take a picture. For example, one participant took a picture by pointing his camera to an artificial light source [SPE M01].

When light perception is absent, the knowledge on light and the sky is based on information given by others. Very telling in this respect is a picture of the sky (Fig. 4.49) taken by one of the girls. The sky is abstract but verifiable visually. If you have never seen, your knowledge about the sky relies on people’s stories and the information gained over time. SPE F02 held the lens in the direction of the sky. On this beautiful sunny but cold winter day, she records a
blue sky hidden behind the branches of a tree. It is as if she points at the sky with the camera, longing to touch it with her hands.

Another example that demonstrates a participant’s reliance on impersonal knowledge is the picture taken by SPE M01 of two goldfishes in a clear glass bowl. It was taken just as he ran into his classroom. SPE M01 knew that the fish bowl was on the cupboard and the fast photographic process resulted in four pictures. Starting with a haptic exploration, he first takes a picture above the fish bowl. Gradually the child holds the camera ever more inside the bowl (Fig. 4.50). Perhaps he does not know that the fish bowl is made of glass, or he knows but does not fully grasp the notion of transparency, something evident to sighted people. This clearly shows he was inspired to take a picture based on his memory of the daily ritual of talking to, and taking care of, this pet.

4.3.2.4 Photo-Ethnography as a Methodology

Many pictures illustrate haptic stimuli within in the built environment. However, haptic perception is also unexpectedly revealed when observing the children. The way that the children handle the camera reminded us that, for them, the world is at their fingertips. It is as if their fingers act as detail seekers, while their body acts to understand the bigger picture.

This study also focuses on ‘how’ these pictures are taken. Sarah Pink stresses the importance of “how-questions” in photo-ethnographic studies, or the way other people can read the image, and refers to the anthropologist Banks. Banks summarises social research with the help of pictures into three sets of questions: (1) What is the image of, what is its content? (2) Who took it or made it, when and why? In addition, (3) How do other people come to have it, how do they read it, what do they do with it? Context is also important and the meaning of content is given by the image itself, as well as via the participant who took the image. Analysis reveals that the findings are not limited to the actual images. How children born blind perceive haptically became clear through our observation of them while making photographs. This observation

allowed us to study the sensory triggers, the process of perception and the way in which the camera was handled.

From the onset of the photo tours, it became clear that children approached the camera in tactile and auditory way. The resulting photographs relate to the radius of the children’s physical body space. Most of the time, the lens was put against the object while the image was taken. Moreover, the children preferred to physically engage with, and hold, the lens while taking a picture. As a result, fingers and feet become part of the scene. This suggests that the children considered the camera as an extension of their body (hands or feet) and that the camera is directed along the trajectory of their limbs or the position of their bodies.

In addition, the act of pushing the button became an experience in itself, a haptic and auditory experience. Feeling and hearing the button going up and down was an affirmation for the children that the picture was being taken. One participant followed the fingers of his left hand with his right, while sequentially taking pictures from the perceived tactile spot. This explains why so many images have been taken of one subject, and why many images show fingers and thumbs (Fig. 4.51). The pictures capture the sequential
character of haptic perception. At times children literally photograph the process of experiencing space.

For example, all children take pictures of the door to their room before photographing what they really want to record - the interior (Fig. 4.52).

Moreover, SPE M01 takes pictures while actually opening the door (Fig. 4.53). One hand operates the camera while the other pushes the door handle, as if he wants to record the movement. Several children repeat this cinematic way of taking photographs in other places, several times over, and it seems to reflect a time related way of perceiving the world. It also seems to suggest that ‘motion’ may act as a stimulus in itself.

The proximal characteristic of the haptic sense is also apparent. The children hold the camera very close to their bodies (Fig. 4.54). Consequently, many pictures show images of objects close to the lens and the hands. In the case of material triggers, all children touch the objects they want to photograph before deciding to push the button on the camera. The proximal character of haptics is also evident in the participants’ interest in materials and the way they focus upon small details. A small bump, invisible, might represent a huge haptic stimulus and become the trigger for a picture.

Besides its power to register haptic stimuli, elements and perception, the camera also contributed to the self-confidence of the participants. Having children create their own documentation of experiences in their school offers several benefits: they gain confidence (happiness, relaxation, and excitement), the role of being an expert (ownership, pride, freedom, and remembrances), a voice (independence, self-expression), and the opportunity to be self-reflective (awareness of surroundings self-alteration by experience).67

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4.4 Focus Group Interviews with Caregivers

The focus group interviews relied specifically upon the expertise and knowledge of professionals working with visually impaired people. The daily contact that they have with blind people gives them a degree of expertise into their spatial experiences. We therefore paid attention to the professionals’ perception and knowledge of the haptic experiences of people born blind.

4.4.1 Research Set-Up

Together with the supervising caregiver of LAVI\(^68\) and the rehabilitation coordinator of the department for visually impaired children at Spermalie, the institute for the blind in Bruges, we started recruiting participants. They could be special educators, occupational therapists or physiotherapists. By the end of November 2007, 22 people had agreed to participate. Two focus group interviews were planned and each group was limited to a maximum of 12 participants.

Ten participants participated in the first focus group interview: seven women and three men. The youngest participant is 40, the oldest is 60 and their average age is 51 years. All ten are trained as occupational therapists. Additionally, one participant graduated as a secondary school teacher in biology and physical education.

Nine work as occupational therapists at Spermalie. One participant works as a home educator and coordinator. Six participants work full time at Spermalie, while the others work part time. Most part time workers combine their job as therapist with a job as independent occupational therapist, ‘GON’-teacher\(^69\), mentor, educator or mobility instructor, at Spermalie or elsewhere.

The second focus group interview engaged 12 other participants: 11 women and one man. The youngest participant is 22 years and the oldest 56 and their average age is 42 years. The group consists of two educators and ten participants who are trained as remedial teachers and ten participants who are trained as occupational therapists. The group also includes people who work as educators at Spermalie. Five participants are working full time, while the others work part-time (Fig. 4.55).

All participants signed an informed consent document at the beginning of the interview.

Two researchers were involved in this study: one moderator and one observer.\(^70\) While the moderator followed a list of possible themes to discuss during the interview, the observer took notes. The researchers did not communicate with each other during the focus group interviews, unless for practical reasons or to clarify something.

On February 25\(^{th}\) 2008, the focus group interviews took place as part of a monthly meeting about common scientific knowledge in Spermalie, Bruges.\(^71\) Twelve tables were placed in the form of a square in the meeting room. As a result, there was no head of the table - this is supposed to contribute to the acceptance of the moderator as

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\(^{68}\) LAVI is an abbreviation for ‘lagere visuele’ [primary visual] referring to the primary school and the visual impairments.

\(^{69}\) ‘GON’ is an abbreviation for ‘Geïntegreerd Onderwijs’ and is a platform of teachers and educators between regular and special education. These teachers support and help people with an impairment when following regular education.

\(^{70}\) Due to her weekly observations, we are very familiar with most of the participants. Therefore, we chose to involve a second researcher to perform the role of moderator, as she has no prior contact with the participants. We observe the interview, make notes and assist during the opening question. In this way familiarity is reduced to a minimum.
part of the group. The room accommodates 30 people, and the participants are thus guaranteed their ‘personal space’. Each interview lasted about an hour and a half.

At the beginning of each focus group interview, the moderator explained the research set-up and told the participants about the researchers and the research topic. More precisely, the objectives of the research were explained and a definition of ‘haptic’, as we understand it, was given. Each participant also ran through the folder they received upon entering the meeting. This folder contained a letter containing general information about the research, the contact details of the researchers, an information form (asking for details like name, date, hour of focus group interview, date of birth, training, profession, function or job at Spermalie and vacant hours), a consent form, a rating scale and three sheets of blank paper.

Participants signed the consent form and made a name card. After this short introduction, the moderator started the actual interview using an active interview technique. The participants were asked to write down three items that reminded them of how people born blind haptically interact with the environment. This resulted in a range of terms that helped the participants discuss the topic in general. After this opening question, the moderator adopted a brainstorm technique using a topic list with different key words (Fig. 4.56). These topics covered the general subjects we wanted to discuss. They were based on the first results of our literature study, as well as on the first in-depth interviews. The participants answered the questions spontaneously.

A digital dictation machine (Olympus Digital voice recorder DS-4000) was used to record both focus group interviews. The tapes were transcribed word for word.

4.4.2 Analysis

We analysed the interviews on paper using a coding strategy. The most important sections were highlighted in different colours. A total of three coding sessions took place. The first coding session grouped the different answers according to the topic list used by the moderator, and the topic list was used as the coding list. The second session refined the first analysis by marking good and poor haptic qualities. The third coding session highlighted the most important quotes and codes by refining the ‘topics’ used in the first session. Finally, this last coding classified the different codes into four main categories, or ‘families’:
1. environmental properties 2. experience 3. haptic and 4. orientation (Fig. 4.57).

Whereas ‘environmental properties’ and ‘haptic’ refer to elements in the built environment, ‘experience’ and ‘orientation’ refers to quotes that referred to the caregivers’ view of the expertise of people born blind regarding haptic perception.

Although some results could be classified under different headings, this first classification under the four main categories helped to give a clear overview of the most striking findings. Finally, the findings were linked to the theoretical framework and the results classified accordingly.

4.4.3 Findings Focus Group Interviews

The participants’ answers revealed their profound knowledge. For example, they immediately refer to the implications of haptic perception in its broadest sense. In general, the findings relate to the haptic experiences in the form of the expertise possessed by children or adults born blind and to the architectural examples and characteristics supporting haptic perception and exploration. In general, the participants agree that ‘functionality’ and ‘orientation’ is their priority. However, the impact of identification and atmospheric elements is not denied [CARE 1, 3, 5, 8, 18, 22 + all].

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71 All colleagues at Spermalie are encouraged to read and talk about new scientific insights and developments as often as possible. Spermalie maintains its own library and asks the employees to report their knowledge during a monthly common meeting with the principal and close colleagues.
74 Dependent on the need, participants could make use of a rating scale to express their meaning. This rating scale is also projected on screen throughout the interview. Although the moderator informs all participants about the use of the rating scale, nobody makes use of it.
<table>
<thead>
<tr>
<th>code</th>
<th>gender</th>
<th>year of birth</th>
<th>education</th>
<th>function at Spermalie</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARE 1</td>
<td>male</td>
<td>1949</td>
<td>occupational therapist</td>
<td>occupational therapist</td>
</tr>
<tr>
<td>CARE 2</td>
<td>female</td>
<td>1967</td>
<td>occupational therapist</td>
<td>occupational therapist</td>
</tr>
<tr>
<td>CARE 3</td>
<td>female</td>
<td>1956</td>
<td>occupational therapist</td>
<td>occupational therapist; coordinator mobility aids</td>
</tr>
<tr>
<td>CARE 4</td>
<td>male</td>
<td>1962</td>
<td>occupational therapist</td>
<td>occupational therapist; mobility instructor</td>
</tr>
<tr>
<td>CARE 5</td>
<td>female</td>
<td>1954</td>
<td>occupational therapist</td>
<td>occupational therapist; home coordinator</td>
</tr>
<tr>
<td>CARE 6</td>
<td>female</td>
<td>1960</td>
<td>occupational therapist</td>
<td>occupational therapist; educator</td>
</tr>
<tr>
<td>CARE 7</td>
<td>female</td>
<td>1947</td>
<td>occupational therapist</td>
<td>occupational therapist; GON-educator</td>
</tr>
<tr>
<td>CARE 8</td>
<td>male</td>
<td>1951</td>
<td>occupational therapist</td>
<td>occupational therapist</td>
</tr>
<tr>
<td>CARE 9</td>
<td>female</td>
<td>1955</td>
<td>occupational therapist</td>
<td>occupational therapist</td>
</tr>
<tr>
<td>CARE 10</td>
<td>female</td>
<td>1962</td>
<td>occupational therapist</td>
<td>home coordinator</td>
</tr>
</tbody>
</table>

Fig. 4.55 List of participants Focus Interview 1 Caregivers (top) & participants Focus Interview 2 Caregivers (bottom)

<table>
<thead>
<tr>
<th>code</th>
<th>gender</th>
<th>year of birth</th>
<th>education</th>
<th>function at Spermalie</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARE 11</td>
<td>male</td>
<td>1956</td>
<td>educator</td>
<td>care supervisor</td>
</tr>
<tr>
<td>CARE 12</td>
<td>female</td>
<td>1977</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 13</td>
<td>female</td>
<td>1986</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 14</td>
<td>female</td>
<td>1979</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 15</td>
<td>female</td>
<td>1951</td>
<td>educator</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 16</td>
<td>female</td>
<td>1955</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 17</td>
<td>female</td>
<td>1981</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 18</td>
<td>female</td>
<td>1960</td>
<td>remedial educationalist; educator</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 19</td>
<td>female</td>
<td>1952</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 20</td>
<td>female</td>
<td>1957</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 21</td>
<td>female</td>
<td>1963</td>
<td>remedial educationalist</td>
<td>educator</td>
</tr>
<tr>
<td>CARE 22</td>
<td>female</td>
<td>1960</td>
<td>occupational therapist</td>
<td>occupational therapist; educator</td>
</tr>
</tbody>
</table>
### 4.4.3.1 How Do People Born Blind Haptically Explore the Built Environment?

**Sensory Attention**

Except for gustatory stimuli, participants mention haptic, auditory and olfactory stimuli, as well as visual, in the context of environmental perception. All the participants recognise the interconnectivity of the senses by referring to the interaction of different sensory stimuli [CARE 1, 8]. Nevertheless, too many sensory stimuli are problematic. Just like a space that echoes too much, the result is chaos [CARE 11, 17, 20]. In this sense, it can also be disorientating or even threatening [CARE 6, 11]. In these conditions, auditory information will not support users, but distract them.

The participants frequently refer to haptic and auditory stimuli and remark that hearing and feeling are inseparable and interactive [CARE 1, 8]. However, they recognise the difference between haptic and auditory stimuli in terms of sensation. While the haptic sense is a proximal sense, the auditory sense is a ‘far’ sense [CARE 11 + all]. If both sensory systems are triggered, the participants agree that blind people have a much better experience within the environment.

People can be recognised and identified through sound, and the sound of shoes can also reveal people’s identity [CARE 16]. Sound can identify things and it can also create landmarks [CARE 1, 3, 5, 8, 18] - the opening of an automatic door, or sound device for traffic lights [CARE 17], for example. If blind people pass by, they hear the sound and know where they are. The white cane is therefore an interesting tool because it supports both touch and sound [CARE 6].

Auditory stimuli can come from the environment, or can be provoked by the explorer as he or she makes a noise in the quest for environmental information [CARE 6, 10]. The clicking of the tongue, or the stamping of feet, results in usable information [CARE 10]. Yet this is not considered to be socially acceptable by many parents and friends. However, caregivers agree that the auditory information is not fully exploited [CARE 9, 10]. Although sound can play a functional role, it can also make an important contribution to the atmosphere of a place [CARE 11, 16, 21].

<table>
<thead>
<tr>
<th>English</th>
<th>Dutch</th>
</tr>
</thead>
<tbody>
<tr>
<td>people who are congenitally blind without vision (light perception allowed)</td>
<td>mensen met congenitale blindheid zonder visus (lichtpercepie toegestaan)</td>
</tr>
<tr>
<td>space</td>
<td>ruimte</td>
</tr>
<tr>
<td>description: what?</td>
<td>omschrijving: wat?</td>
</tr>
<tr>
<td>experience?</td>
<td>beleving?</td>
</tr>
<tr>
<td>representation?</td>
<td>representering?</td>
</tr>
<tr>
<td>form? (observation / impression)</td>
<td>vorm? (observatie / impressie)</td>
</tr>
<tr>
<td>situation: environmental influence on emotions</td>
<td>situatie: invloed omgeving op emoties</td>
</tr>
<tr>
<td>orientation</td>
<td>oriëntatie</td>
</tr>
<tr>
<td>time-length</td>
<td>tijd-lengte</td>
</tr>
<tr>
<td>qualities in the built environment</td>
<td>kwaliteiten gebouwde omgeving</td>
</tr>
<tr>
<td>constraints in the built environment</td>
<td>beperkingen in gebouwde omgeving</td>
</tr>
<tr>
<td>haptic qualities and constraints</td>
<td>haptische kwaliteiten en beperkingen</td>
</tr>
<tr>
<td>haptic / the sense of touch</td>
<td>haptisch / tastzin</td>
</tr>
<tr>
<td>what?</td>
<td>wat?</td>
</tr>
<tr>
<td>how?</td>
<td>hoe?</td>
</tr>
<tr>
<td>orientation</td>
<td>oriëntering</td>
</tr>
<tr>
<td>how?</td>
<td>hoe?</td>
</tr>
<tr>
<td>structure? [limits, paths, nodes, boundaries, landmarks]</td>
<td>structuur? [grenzen, paden, knooppunten, gebieden, landmarks]</td>
</tr>
<tr>
<td>materials? (texture, density, temperature)</td>
<td>materialen? (textuur, densiteit, temperatuur)</td>
</tr>
</tbody>
</table>

Fig. 4.56 Topic list Focus Group Interviews
Olfactory stimuli, on the other hand, are only mentioned in relation to atmosphere and identification (of persons and environments). Participants refer to their perfume being noticed by the children born blind [CARE 16]. The smell of the kitchen reveals its location and thus also contributes to the atmosphere. The smell of pancakes, for example, evokes positive feelings [CARE 11, 16]. Although participants are aware of the non-visual focus of this study, they still refer to visual stimuli. This might underline the strong impact of visual perception on environmental experiences. One participant explains that she finds most of the interiors in which people born blind live to be very colourless [CARE 3]. Moreover, she remarks that this is even down to the parents who, because the children are not able to see the visual elements of the interior, do not seem to mind its blindness.

However, all caregivers agree that people born blind need to know how sighted people experience the environment in order to make their home socially acceptable. If they invite friends, family and acquaintances to visit them, the visual elements are important on a social level [CARE 5, 6 + all].

**Haptic Perception**

Participants all recognise the importance of haptic perception and also confirm the proximal characteristic of the haptic sense [CARE 3, 6, 10 + all]. The importance of haptic perception is recognised. However, the hierarchy between haptic and auditory stimuli is less clear. Several participants point out that some people have an auditory preference while others prefer haptic information.
In line with their preference some blind people constantly touch while others do not touch at all. As CARE 16 said: “Some do but not all of them, you have children who will touch the walls very often even if they are outside. Then it becomes a habit to feel.”

If blind children touch, they will touch frequently. Touching people, and the environment, becomes a habit. It is generally assumed that if people are not interested in touching, it is due to a lack of recognisability or stimuli. CARE 13 explains: “I also notice that if something is known, or recognizable, that they will find their way much faster and that they will also find their way back because the materials handle smoothly. Well, yes, once something is well known, it goes much faster.”

Whereas only two caregivers [CARE 8, 18] state that auditory information is always the start for spatial exploration, most participants point out that environmental exploration is primarily haptic. CARE 10 states: “Anyway the real exploration of space takes place by means of the haptic sense, as it’s the only source of information and meaning. Also, in order to orient themselves, it has to be haptic... because, for them to apprehend, and... if somebody is talented and touches... who has a sense of locality and orientation, then this person will immediately comprehend. Someone might identify landmarks, but some don’t, because I’ve noticed that people who are blind will not spontaneously do this. If they are not taught to touch, they won’t do it...”

Haptic perception provides a huge source of sensory information. However, it is generally agreed that it is a very tiresome process [CARE 14 + all] and that the evaluation of haptic qualities is a very personal matter.

**Non-Visual Environmental Exploration in the Environment**

The findings show that environmental exploration relies, ideally, upon auditory and haptic perception.

‘Stimulation’ and ‘recognisability’ are notions that are strongly interconnected. The more you are stimulated to explore the environment in a haptic way, the more haptic stimuli you will know, and the more often you will recognize aspects of the environment [CARE 1].

Remarkably, participants agree that children born blind do not spontaneously start touching things actively [CARE 1, 6, 10, 11, 18]. They tend to hesitate when it comes to exploration. In fact, the participants explain that the children are trained to search for haptic information. Caregivers stimulate them to explore the environment. Stimulation is crucial, as this caregiver explains:

CARE 6: “I have young children and the first thing that I have written down is ‘being passively present, but creatively discovering’, so it actually starts with nothing...”

The participants therefore stimulate blind children to explore the environment. Regardless of their visual history and abilities, participants point out that they train all blind people to evoke sensory experiences in the built environment. For example, some people born blind are afraid to touch new materials. Education and training can help them overcome this fear. One participant [CARE 6] refers to her slogan for blind children: “Dare to move, it is the start for your learning [CARE 6].”

Some children really do need to be taught about new materials because they possess a natural fear of unknown things. During their education, children are stimulated to take their socks off so they can feel with naked feet. As soon as a material is haptically known, it is ‘recognizable’ and therefore safer.

The most important aspect for stimulation is that the environment is challenging enough:

CARE 18: “In fact they are partly depending on us so, as a companion, the more they are positively stimulated, the more they feel challenged to explore. For example, there was a child who did not know that there were two holes in a sink. The first time, she discovers one hole, and...”

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75 Dutch excerpt: [care 6: ik heb jonge kindjes en het eerste dat ik opgeschreven heb is ‘passief aanwezig zijn, maar creatief ontdekkend’, dus dat dat eigenlijk begint met niks...]
76 Dutch excerpt: [care 6: durven bewegen is het begin van alle leren!]
77 [care16: sommige wel maar niet allemaal, ge hebt bepaalde kinderen die heel veel aan muren voelen ook als ze buiten zijn dat ze zodanig een gewoonteforming is om constant te voelen care 13: ik merk ook wel dat eens er iets gekend of herkend is da ze daar rap mee weg zijn en dat ze rap hundere weg terugvinden omdat er vlotte omgang is met materiaal, alles jah ne keer dat dat gekend is, dat dat wel vlot gaat...]
78 [care 10: nu het echt verkennen van een ruimte moet sowieso met tast gebeuren, als zij daarin enige informatie hebben, die van hen van betekenis is, dat ze daarin kunnen oriënteren, moet dat met tast te maken hebben. (...) omdat voor hen te vellen en... iemand die dan al begaafd is en die voelt,... oriëntatiezin heeft die is daar dan al mee weg. Die ook oriëntatiepunten uitzet, maar sommigen doen dat maar ik heb ook gemerkt dat blinde mensen dat dus niet spontaan doen. Als ze het niet aangeleerd zijn dan doen ze dat niet...]

suddenly she starts to explore by herself. She then comes back to tell me that she had found another hole as well.”

Nevertheless, as a result of this intense guidance by caregivers, it is generally agreed that blind children rely too heavily on personal support [CARE 10 + all].

**Diversity and Contrast versus Similarity and Homogeneity.**

In order to recognise haptic stimuli, children born blind focus on diversity and similarity. For example, contrast between the textures of different floors might provide important haptic information to children with visual impairments. CARE 4 explains:

*CARE 4: Somebody who, well ... went to a certain room and who was ‘dragging his feet’, touches [scanned] the ground for the changes of the floor structure.*

*M: Of the floor, yes...*

*CARE 4: Yes, so he can orient.*

*M: Yes.*

*CARE 4: So he can make the transition.*

*M: Did other people have the same experience? ... Yes*

The difference in textures between floors, such as the contrast between wooden and carpeted floors [CARE 5, 11, 14], also applies to walls. Besides the material characteristics, participants also refer to the contrast between interior and exterior [CARE 1]. The barrier between the man-made environment and the natural environment gives meaning to a place.

Besides the impact and importance of contrast, the aspect of uniformity also contributes to recognisability. If, for example, all the light switches or door handles are placed at the same height [CARE 8], this might help blind children find these objects, or help them to orientate themselves.

**Modes of Exploration**

Participants do not mention the difference between active, dynamic or passive touch explicitly. Most participants limit their answers to active touch, as conducted by the feet and hands. However, they do stress the importance of body movements, and bodily stimulation, for haptic exploration and perception.

In passive conditions, or relaxing situations, participants agree that people born blind do not actively touch, but rely on passive stimuli [CARE 5, 6, 8].

*CARE 5: Yes, for example, if we are in a relaxing situation, talking, I notice that people without vision never pick things up or start tinkering, while we ... when we sit here we take out our pen ...”*

*M: [laughing]*

*CARE 5: Or we start drawing, we keep busy but they just sit, there is little...*

*CARE 8: If it is not functional, blind people don’t use touch that often.  
M: [laughs]  
CARE 5: Very static.*

*CARE 8: But they will have typical ‘blind-isms’ like crossed eyes, or rocking, or another nervous tick, relaxed or otherwise.*

*CARE 5: Or sitting on their bag, more often than not they don’t do it.  
CARE 6: And during games too, a blind child is completely different ... if they play with a doll, than the child will take the doll and play in a verbal way. The child will not dress and undress it, the child will actually talk and perform the basic movements: putting the doll to sleep, taking the doll out of its bed.  
M: They do...  
CARE 6: But they don’t do the really sophisticated things... certainly not if they haven’t been taught it, because otherwise ... and even if it has been taught, they will always choose the easiest way.*

90 Dutch excerpt: [P: eigenlijk zijn zij een stuk van ons afhankelijk eigenlijk als een begeleider dus hoe meer dan zij positief gestimuleerd worden hoe meer ze uitgedaagd worden om verder op verkennings te gaan, bijvoorbeeld bij ons was’ ter een kindje die niet wist dat er twee gaten in de lavabo zaten. Den eerste keer ontdekt ze één iets en dan gaat ze opeens zelf op verkennen en komt ze vertellen aah ik heb nog een gaatje gevonden.]

81 [care4: iemand die euhm naar een bepaalde ruimte toestapt en die sleepvoetend de grond aftast, de veranderingen van structuur van de grond  
M: van de vloer jah...  
Care4: ja dat hij zich zo kan oriënteren,  
M: jaja  
Care4: dat hij zo de overgang kan maken  
M: ja waren er nog mensen die dat voorbeeld hadden? ...ja]
When asked about how people born blind touch, participants point out that most will touch the walls, and certain fixed elements like walls and corners, first.

**Exploration Strategies**

The strategies used to explore the environment differ depending upon the age [CARE 3, 5], experiences [CARE 1, 6, 10, 11], knowledge [CARE 1, 6, 10, 11] and personality [CARE 11+ all] of people born blind. They have to overcome fear in order to touch [CARE 6].

According to caregivers, the fact that people who are blind have seen before does not necessarily contribute to their sense of locality. They describe it more as a gift, or a talent.

**CARE 8: Orientation is something ... you either have it, or you don't.**

All: [noisy]

M: And has this to do with the fact that they have ever seen, or not?

All: No!

M: So we cannot distinguish people who have seen before from people who haven’t?

**CARE 8: It is a gift that you have.**

Although blind people might often explore their environment haptically, this does not mean that they have affinity with orientation or mental mapping [CARE 1, 2, 3]. One of the participants is a mobility instructor and he explains that the techniques are based on an orthogonal system [CARE 4], meaning that all the children learn to orient on perpendicular organisations, based on their egocentric reference frame that refers to up-down, left-right and ahead-behind, for example. Moreover, children with visual impairments are first taught to feel with their hands and feet. They learn to shuffle through space, to read tactile models and to use their white canes. Interestingly, each caregiver may use a different pattern for exploration, or strategy [CARE 11, 20 + all]. One participant explains that most of the landmarks taught to children born blind are visual landmarks for the caregivers themselves [CARE 21]. Caregivers encourage children born blind to feel and touch because “the environment does not challenge” [CARE 14]. The way people born blind are educated will certainly contribute to their future exploration techniques [CARE 4, 18, 20, 21, 22 + all].

In terms of knowledge and abilities, it appears that children born blind find it very difficult to explore two things at the same time.

According to the participants, children born blind will often focus on objects instead of routes [CARE 20].

Remarkably, they explain that children born blind sometimes prefer touching elements on their left side, while others prefer the right side. One participant assumes that this is also linked to whether they are left- or right-handed [CARE 16].

If blind people can rely on different sensory information, like haptic and auditory stimuli, the participants explain that they move faster [CARE 1, 10]. Familiar environments are more recognisable and consequently both support, and result in, faster movement [CARE 11 + all]. Moreover, the importance of light perception is indicated as being an important aspect of orientation. If blind people retain light perception, this ability can help them orientate themselves [CARE 10, 22]. However, if people have no light perception it is very difficult for them to know when lights are on - except if the light switches reveal this through haptic information [CARE 10].
Sequential Movement

According to the participants, children born blind experience pressure while exploring space because they only receive ‘partial information’ and miss the bigger view. Exploring the whole space often requires more time than when vision is present.

Time passes differently and the participants assign this to the sequential nature of haptic perception: “People born blind lack the immediate overview, they always receive pieces of information” [CARE 5].

As a result of the sequential exploration strategy, several participants [CARE 1, 5, 8, 9, 13, 16] explain that people with visual impairments are much slower in their actions than sighted people:

CARE 9: “And it’s also immediately a part of protection .... It’s all very slow isn’t it, shuffling or touching... it’s all very slow because, on the one hand, you need to assimilate part of the information, but in the mean time...”
M: Keep a safe distance?
CARE 9: Yes [nodding]

4.4.3.2 What Do People Born Blind Haptically Perceive Within the Built Environment?

Haptic qualities are created through differences in materials, or geometric properties [CARE 5 + all]. For example, a carpet that runs from an entrance towards a terminus facilitates haptic experience. The contrast between the material characteristics of the carpet and the floor indicates a path. Visual elements are often lacking, or less important. Besides the haptic qualities appreciated by most people born blind, we also need to be aware of the fact that age and personality contribute to ‘how’ people appreciate haptic characteristics [CARE 3, 5, 14, 17, 18, 19].

Material Properties

Material characteristics appear to be very useful for indicating differences. Participants point out that people born blind are sometimes afraid to touch materials because they don’t know them [CARE 13 + all]. Once they are familiar with a material, some like to touch it frequently whilst others do not.

Temperature

The temperature of spaces [CARE 11] and materials contributes to the atmosphere of an environment. In general, children born blind prefer an average temperature that is “not too warm or too cold” [CARE 21]. Materials that are perceived as cold are disliked [CARE 3, 5, 9, 11, 20]. Wood is regarded as a warm material [CARE 1, 10, 12], whereas a plastic bathtub is preferred to one made of zinc [CARE 19]. The latter feels too cold. All participants agree that people born blind feel the warmth of the sun.

Viscosity

According to the participants, very sticky elements are unpleasant [CARE 6, 16]. Participants noticed this during meals. Kiwi’s and pears are not very popular [CARE 12, 15, 16, 18, 19]. The stickiness of these fruits seems to impair the haptic sense. This may explain why some people born blind do not like finger painting either [CARE 14, 20].

Density

Participants all agree that the children in both the primary school and the secondary school appreciate the cushions in the judo space [CARE 6, 15 + all]. Participants point out that the density of the mats also contributes to the experience of safety, and that ‘soft’ experiences (cushions and stuffed animals, for example) are appreciated by young and old [CARE 6, 7, 8, 10, 21, + all]. Soft materials are appreciated unless they are unsafe, or seem unsafe. In these situations, hard materials are preferred [CARE 6, 9 +

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83 Dutch excerpt: care5: “Ze hebben geen overzicht hé, het is altijd deelinformatie.”
84 Dutch excerpt: care 9: “En ook een stuk al meteen al een stuk van die bescherming zo van allez ja... al. Het gaat allemaal heel traag hé, allez al schuifelend of al tastend...het gaat traag omdat het enerzijds toch denk ik een stuk informatie verwerken is maar tegelijk ook een beetje van...”
M: “op een veilige afstand blijven?”
care 9: “veilig” [ja knikkend]
The ideal density is something that is not too hard, nor too soft [CARE 11, 18, 20], like linoleum [CARE 16, 18].

**Texture**

The participants give several examples of how texture is recognised. It is most often referred to as a landmark. For example, participants state that the tactile mat in the big hall is often used as an orientation point [CARE 3]. The tactile mat is made from very rough bristles (Fig. 4.58). It is a haptic landmark, marking the endpoint of a path that links the primary school with the secondary school. Besides providing information that helps with orientation, texture might also guide movement, or disable it. In unexpected situations, in particular, rough materials can be disturbing [CARE 9], for example, rough plaster [CARE 8, 9] or peeling paint [CARE 5]. When touching these textures on walls, children born blind may hurt themselves. Sometimes, rough textures are considered pleasant, for example, when participants consciously search for rough stimuli [CARE 3]. Participants use ‘Duplo-blocks’ for active touch training. Once children born blind are happy feeling strong stimuli, they will often look for softer stimuli again. Polished wood [CARE 1] is a nice soft texture.

The texture must certainly not be slippery. For reasons of safety and comfort, slippery textures are very unwelcome. An extreme example is the unpleasant slippery effect of eating pears [CARE 19]. Although this is not related to the environment, it illustrates the irritation the participants feel if they encounter slippery textures.

Besides texture being appreciated in respect of orientation or its physical qualities, the personality of children born blind may also contribute to their preferences. The participants explain that children born blind may like mosaic tiles because it is a new, unknown feeling [CARE 5, 8, 10]. However, this is contradictory, because they also previously stated that familiarity would increase appreciation.

**Weight**

One participant refers to the fact that heavy doors are an obstacle to haptic perception [CARE 20].

**Fig. 4.58 The tactile mat hanging at the end of the tactile pavement in the big hall serves as an orientation point**

**Geometrical / Spatial Properties**

**Structure**

All participants agree that structure, in terms of the space and the elements within it, are very important in relation to the environmental exploration of people born blind. Structure involves more than just the place [CARE 19]. Participants also refer to the contents of the room.

Participants train children to recognize structures in the environment [CARE 14]. They explore the place step by step, literally. The participants memorize this. Moreover, any additional elements in a room, or environment, need to have a certain recognisable structure. It is also important to take the construction method into account. If concrete pillars are placed randomly in a room, children born blind will experience these as obstacles [CARE 1]. But if the pillars follow an orthogonal pattern (meaning that they are placed on a perpendicular grid), they can become a supportive structure within the environment.
[CARE 4] points out that people born blind explore the ‘structure’ of the floor by shuffling their feet. In doing this, people born blind feel the changes in the floor. In addition, they will actively touch the walls and the corners [CARE 21]. However, when standing still, they still have an impression of form [CARE 1, 10]. Consistency in structure is important [CARE 5].

One of the places participants refer to as structured is the ‘speleotheek’, a library of toys that the children can borrow but that also offers a space in which to play [CARE 15].

Curvature

In general, the participants did not mention specific shapes or forms. In terms of movement, the participants state that for orientation orthogonal forms are favoured [CARE 5]. Round corners need to be avoided because there is neither a start nor an end point [CARE 5, 6, 11].

Orientation

Participants explain that the best-designed spaces are the ones in which the furniture is pushed to the sides of the room [CARE 5, 7, 8, 12 + all]. A coffee table can be an obstacle. For example, a good orientation surface is a playground where the start and end points are clear to the users [CARE 11, 18].

Participants do not explicitly discuss architectural elements and the impact orientation has on haptic perception. Only a few statements refer to the orientation of environmental elements. An opening in a surface can be an orientation point and a rectangular door tells the passenger about the expected direction of movement and the orientation of the walls. However, some openings can be very dangerous - like the open space under a staircase. This oblique surface does not follow the direction of movement and is often too low to walk under.

Direction

Places that give direction to movement, for example a corridor or a rectangular space, encourage movement [CARE 3]. Direction is given through certain elements within the space. Rectangular spaces and elements are preferred to square ones [CARE 5] because the long side gives an impression of the whole form. If the direction does not stimulate movement, and users are not aware of it, participants claim that the elements are actually obstacles. For example, chairs placed incorrectly under the table and chairs with a complex shape, like the ‘trip-trap chair’ for children (Fig. 4.59). This chair has a Z-shape and many children fall over its legs [CARE 18, 21]. Therefore, supporting elements are elements that follow the direction of movement. One participant formulates it this way: “I think about all the places in which there are lines that you can follow, like a wall or a dividing wall.” [CARE 11]. Besides walls, they also mention cupboards and staircases (if the staircase is climbed).

Configuration

The more complex the environment, the more difficult it is to explore [CARE 10]. Complex structures and constructions are disabling. Buildings, or environments, in which there are too many objects or elements, are
considered complex. If, on the contrary, no elements, boundaries, or tactile aspects are felt, the environment is disabling [CARE 11, 13, 16].

Specific openings in the environment can act as landmarks [CARE 5]. Open and closed aspects are felt through facial vision [CARE 9].

Furthermore, people without vision will often count steps, or other aspects within the built environment, for guidance in orientation [CARE 20], and they remember these steps. Active stimulation can lead to the counting of recognizable aspects in the built environment. This counting can help with guidance and orientation in future explorations of the same place, or if blind people already know how many elements they can expect. Continuity is appreciated, for example when handrails run along the entire staircase [CARE 3, 5, 18, 19]. Repetition and cadence support movement.

Corners between walls, floors or surfaces may provide information about structure [CARE 5, 15, 17, 19]. However, corners must not be too sharp, otherwise they are very sticky [CARE 15].

Participants also discuss the corners in a more figurative way: in the context of places within larger spaces, a corner is a place [CARE 6, 13]. Interestingly, all of the discussions suggest that blind people perceive the built environment as planes, and that furniture is as important as the walls or floors. This could also be important information for architects when it comes to the design process.

Motion, as a stimulus for haptic perception, can refer to physical movement as a means of orientation [CARE 3]. It can also refer to the movement, or handling, of environmental elements [CARE 19]. For example, some elements support certain movements better than others. One participant refers to the handling of a can. Each group has its own can, but they are not identical. Some children preferred certain cans to others because their ergonomic shape facilitated handling. The process of movement is stored in the memory [CARE 18]. One participant explains how these bodily stimuli are retained:

CARE 7: Yes, I can give you an example of this. I work with children of six and seven years old. If there are more landmarks at the other side of the corridor, they will say: ‘yes and I have to turn first and then cross ... voila... all directions are there.’
CARE 6: Yes, cross over, while we are in the corridor? I think it is way too small to talk about crossing it.³⁶

These movements gain significance by means of environmental landmarks [CARE 3], or a combination of both the perception of movements and landmarks.

Landmarks, must keep to a fixed position [CARE 3, 5, 9, 11, 21, 22]. If elements change position, they are unpredictable and can even be perceived as an obstacle. This often happens with chairs, doors and windows, or the open doors of a cupboard [CARE 1, 5, 6]. It is also important that landmarks are solid so that they can withstand multiple collisions [CARE 6]. If people unexpectedly bump into a fixed element then it mustn’t move. For example, swing doors can be very disabling: if people move slowly they may be hit in the back by the door [CARE 10]. Participants point out that run lines, or other guide-lines, such as handrails that guide from one place to another, also help with orientation. Round and oblique corners can be distracting as guides, as can be mobile objects without a fixed direction.

All the participants agree that air displacement contributes to environmental experiences. Participants are convicted that buildings can radiate certain stimuli that are felt by people who are blind [CARE 3, 6, 10].

Direction

The displacement of air can also give direction to the environment [CARE 6].

Size / Dimensions

According to the participants, spatial proportions are perceived differently through the haptic sense. Compared to other senses, haptic perception relies on the

³⁵ Dutch excerpt: [ care 11: “Ik denk alle plaatsen waardat er duidelijk volgbare lijnen zijn, de muur of de wand.”]
³⁶ Dutch excerpt: [ care 7: ja een voorbeeldje daarvan zo, ik werk bij de kinderen van zes zeven jaar. Als die dan...als die dan langs de andere kant van de gang beter kunnen gaan omdat ze daar meer herkenningspunten hebben dan zeggen ze: “ja en ik moet eerst mij omdraaien en dan oversteken en voila...dat zijn allemaal richtingen hè”
care 6: ja terwijl wij in die gang, oversteken? Allez da’s veel te klein om over oversteken te spreken]
scale of the body. Indeed, the sense of touch is a proximal sense. Consequently, one participant points out that it is very difficult for people born blind to estimate distances [CARE 10]. Sound can be perceived from a distance, while haptic characteristics are perceived only when they are nearby.

However, some participants refer to children who do seem to be able to estimate distances. The children sometimes develop their own tricks to help them remember dimensions. One participant refers to a child who is deaf and blind and knows the exact width of a street while he crosses it [CARE 3]. It is assumed that he has counted his footsteps once and remembers the number.

It is important for people born blind to always have sufficient elements in the environment upon which they can rely for exploration and movement. The larger the space, the greater the free space between user and environment and this can make orientation difficult. Moreover, the open space can often contain non-fixed obstacles [CARE 10, 13]. One participant agrees with his colleagues [CARE 11] and explains that: “For me, this was also the first thing I wrote down, ‘the largest barriers are no barriers’, nothing... [laughs]” If there are no reference points near to the area being explored, it can be experienced as being too large.

A small object, or detail, can be perceived as a huge landmark. Participants explain that people born blind have a different notion of proportion and scale and CARE 7 states: “...and also spatial proportions...these are so very different...for them...they... all well... they all think that if there is a small obstacle in the right hand track than they say, yes, we have to go to the left and then to the right etc., while we say, oh, that’s a corridor that’s always straight on. Of course, that makes it very complex and they have to put it more in perspective.” Details are considered to be very important in terms of the haptic exploration of the environment [CARE 3].

This suggests that the corridor is not evaluated through the dimensions of the separating walls, but through the free space that is available for movement within it.

The dimensions are also important in relation to the body itself during exploration [CARE 1,5,6,7,8]. Supporting elements for haptic exploration should be designed on a human scale. One participant refers to the fact that some walls do not reach the ground and, as a result, cannot be felt at the (virtual) point where floor and wall should meet [CARE 8]. When moving forwards using a cane, this might be problematic. The same is true of obstacles in an unexpected place, like certain road signs [CARE 8], shop canopies [CARE 5, 8], undetectable elements [CARE 10], impalpable elements at eye level [CARE 5], unpredictable elements like ladders, a gauntry or a small pole [CARE 1, 5, 6], elements without direction [CARE 6], a letterbox at an unexpected height [CARE 11], cupboards or their doors [CARE 5, 7, 18] and fire extinguishers [CARE 1-10]. In case of the fire extinguisher, the participants covered the element with foam and rubber to protect the children in the school from hurting themselves.

Differences in heights between floors also need to be carefully designed [CARE 10].

Regarding the dimensions of passages, participants agree that these should not be too wide. They should be wide enough to pass through, but not too big – since big passages need to be divided into ‘compartments’ [CARE 5, 6]. The same is true of spaces and rooms [CARE 10, 17]. Small spaces are easier to explore [CARE 10, 11, 13, 16] and consequently it is easier to have an overview. This makes people feel safer [CARE 3, 5, 7, 8, 10]. Empty, open spaces are very distracting.

According to the participants, this is because blind people feel the boundaries of space more easily [CARE 5, 7] and because boundaries and haptic elements are nearby [CARE 3].

They all agree that the difference in how scale is perceived might be an important aspect that designers ought to bear in mind.

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87 Dutch excerpt: [care 11: ik heb dat ook als eerste opgeschreven, de grootste hindernis is geen hindernissen is niets...(lacht)]
88 Dutch excerpt: [care7: en ook zo de ruimtelijke verhoudingen zo...die zijn zo heel verschillend euh...van hen...ze...alle ze denken alles als er...een klein hindernisje is in een recht parcours dan zeggen ze jah ik moet naar links en dan naar rechts enzo terwijl dat wij zeggen oh da's ne gang da's altijd rechtdoor en dat maakt het natuurlijk wel ingewikkeld en ze moeten dat natuurlijk een beetje kunnen relativeren...]
4.4.3.3 Why Do People Born Blind Rely on Certain Properties in the Built Environment?

Memorising objects is generally considered to be very helpful for collecting memories about landmarks in the environment [CARE 22 + all]. Participants refer to light switches [CARE 14, 15, 21, 22], textured wallpaper [CARE 15] and stuffed animals placed at the door handles of the children’s room as being landmarks [CARE 13].

Participants also refer to the fact that memories of haptic perception can result into restraint within haptic exploration. For example, if something reminds a person born blind of an unsafe or painful situation, they hesitate to touch [CARE 5]. A cleaning cart in the corridor may help them to orient themselves [CARE 10] because they remember that the cleaning carts are always placed on the left side of the corridor.

Muscle memory makes children born blind depend upon habit and routine [CARE 20]. In addition to man-made triggers, the stimuli can also come from the memories people born blind have about movement [CARE 5].

Memories support recognition and this is very much appreciated [CARE 6, 9, 20].

Recognition is a form of meaning. When drawing a mental map of an environment, sighted people will draw streets to explain the distance that has been travelled, while blind people will draw what they experience, and how they move. The act of movement will be the subject of their drawings, as explained by one of the participants, CARE 5: “Asking blind children in a secondary school to draw a map, they literally draw how they act, how they move and walk, whether when we draw a map, we say yes, here you go straight on and then first left. Thus we only draw the streets.”

In other words, they do not draw ‘what’ they feel but ‘how’ they feel in space. The participants conclude that visual representation is based upon personal experiences of physical movement [CARE 5].

An architectural environment, or element, is given meaning when people assign certain significance to it. In this focus group interview, participants refer to a group of terms that give meaning: safety, comfort, predictability and recognisability [CARE 1, 6, 8, 9, 10, 11, 19, 21, 22 + all]. Safety is frequently referred to. According to the participants, one of the safest rooms in Spermalie is the judo room [CARE 11, 16, 19, 21]. Safe places encourage exploration [all]. A participant refers to one person born blind who remembers places in order of safety. Although he knows the way by heart, he is afraid to move around by himself [CARE 1].

Predictability is also an important factor in the exploration of environments [CARE 1, 5, 9]. Recognisability is supported through the use of landmarks [CARE 1].

Some participants refer to spatial representation and state that people who lack visual information have to work harder on their spatial representation [CARE 5, 7]. On the other hand, participants point out that spatial representation and mental mapping is a talent, a gift [CARE 6, 8, 19 + all]. They all agree that mental mapping is not linked to visual history. It is a gift. Through training, this ability can be improved.

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89 Dutch excerpt: [CARE 5: gelijk als wij in het secundair kinderen een planeke laten tekenen, als wij een planeke tekenen dan zeggen we ja rechtedoor eerste zijstraat links en dat zijn gewoon de straten dat we tekenen. Zij tekenen eigenlijk wat zij afleggen, hoe zij stappen...]

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To conclude this empirical track, we present a brief summary of the various findings. Interestingly, the findings were not restricted to haptic qualities or constraints alone, but also revealed insights into the characteristics of haptic perception and how haptic exploration takes place. In addition, some research methods turn out to be excellent for sensory investigations.

In general the research set-up worked very well. The triumvirate of home visits, observations and focus group interviews was a good way of investigating the haptic qualities and constraints from different points of view. Moreover, by combining three different methodologies, using the main and similar research focus, the findings can be verified at different levels: how, what and why do people born blind explore in the built environment? If there are contradictions, we can look at the different research sources. For example, some participants convinced us during the in-depth interviews that they did not rely on haptic stimuli at all, whereas the video tour, the photo-ethnography and the focus group interviews show the opposite.

Besides different methods, this empirical track also relied on different analysis-strategies. The analysis was not restricted to just coding the transcriptions. The video-ethnography and photo-ethnography were also coded and thus revealed insights into haptic perception and the elements that contribute to it. The findings are a combination of code-words, quotes, screen-shots, plan annotations, pictures and classifications.

The 22 home visits showed us that, at first sight, the homes of people born blind are not very different from those of sighted people. Analysis revealed different kinds of housing typologies; participants live in rural as well as urban environments. However, it is clear that participants living in a rural environment rely on the help of a partner. Regarding the design of the homes, our study points out that stress is placed primarily on the acoustic and haptic stimuli. Participants do not need tools at home, but the home visits do reveal that their whole environment supports both their exploration and their experience. In fact, the home and its interior becomes a tool in itself. The photo-ethnographic study has demonstrated that ‘native image making’ offers more than visual data - in the sense that it provides visible data. The digital camera acts as a tool that allows us to gain intimate insight into the blind children’s haptic perception of their school environment. As such, it offers a vehicle towards further discussion on spatial considerations, and in particular towards a better understanding of lesser-known haptic experiences.

This photo-ethnographic study results in “non-visual sensory images”, providing us with images of non-visual perception. At first sight, the pictures might appear to be failures to people who do not know the intention, or story, behind each photo. Besides, we found that the action of taking a photograph also reveals haptic perception. As the children explore their school environment, they take pictures following the sequence of haptic perception, and the direction of auditory and olfactory signals. When they are triggered by haptic stimuli, taking pictures of one subject can lead to a whole series of photos, as they take a shot every time they move their hand. As a result, the picture registers the action necessary for haptic perception. In addition to the emphasis placed on action, we found that through each photographer’s set of images, the story of the person becomes clearer. While guiding us through the school building, the children take pictures that relate to direct stimuli, as well as perceptual memories or objects and elements or persons to which they give meaning. The photo-ethnographic study revealed that this method could serve as a vehicle for research with children on spatial experiences in their school environment. The spontaneity of the children is an advantage, as well as a challenge, that the researchers had to overcome. By using a camera as a catalyst for a discussion of the spatial aspects of their
school, the children show their interests as well as how they assign meaning to their school environment.

The focus group interviews contemplate the insights of educators who provide a mixture of daily impressions and professional information. Whereas the in-depth interviews and photo-ethnographic study reported on the experiences of blind people themselves, the focus group interviews are based on the perception of people working with congenitally blind children. Besides, caregivers know the most about the children’s school environment. Their years of experience mean that the meaning of haptic experiences and perception is immediately clear to them.

Moreover, they extensively explain the way in which they train children to rely on haptic stimuli. This study showed the impact of education on haptic perception in adults. The caregivers focus on the link between haptic perception and orientation and pay less attention to haptic perception supporting atmospheric experiences.

Chapter 5 will show how the different results, as described above, are triangulated and confronted with the results generated by the literature review.
Chapter 5: Design Track

5. A Framework of Haptic Design Parameters
5.1 Introduction

The previous Chapters examined the role of haptics in the built environment and the expertise of people born blind. We addressed multiple perspectives in order to better understand haptic experiences in the built environment. This Chapter endeavors to bring the key issues raised by the previous Chapters into sharper focus and aims to set out a design framework for haptic design parameters that can support architects during the design process. The parameters should help designers pay more attention to the creation of more inclusive environments supporting haptic experiences. A haptic experience in relation to architecture relies upon perceptual stimuli as well as memories, knowledge and the personal meaning given to them by the perceiver.¹ Chapter 3 revealed that many studies have been conducted into ‘how’ people born blind haptically explore the built environment. Nevertheless, very little is known about exactly ‘what’ it is that is touched within the built environment and ‘why’. We also have little understanding of ‘when’ touch supports our environmental experiences. In other words, researchers know a lot about the perceptual process but lack information about the environmental aspects supporting a haptic experience and the reason why some of these aspects are important, and others not. Therefore, the framework of haptic design parameters will provide information to designers of the built environment about the implementation of haptic qualities.

As the composition of the framework for haptic design parameters is a design in itself, it is but logical that we rely upon a ‘Designing for More’ process as described in Chapters 1 and 2. The theoretical and empirical track laid the foundation for our concepts and the design of the framework of the haptic design parameters. This Chapter focuses on the final results of the actual design of the framework of the haptic design parameters.

Based on a triangulation of the three empirical studies in addition to a cross analysis from the theoretical and empirical track of the findings, we designed a framework of haptic design parameters. The design process is an iterative process and the design of the framework is constantly evaluated at each stage. We followed a cyclical design model based on the expertise of people born blind. Consequently, each proposal was constantly evaluated against the findings of the previous research tracks. Throughout the theoretical and empirical track, we tried to investigate which architectural elements support haptic experience, how these elements are perceived and why, or when, meaning is given to these elements.

We begin by introducing the design and set-up of the framework of haptic design parameters. After providing a general definition of what we consider ‘a parameter’ to be in the context of architectural design, we focus on the concepts that the framework is based on. As soon as the operation of the framework is clear, each parameter is described by means of a definition, the findings upon which the concept is based, its variables and values and an example of a haptic quality and constraint in the built environment.

The framework provides designers with answers to the basic questions: how, what, why and when do people perceive haptically?

The final Section explains the way in which parameters can be introduced into the design process and gives a brief explanation of the techniques used to evaluate the haptic design parameters during design. These techniques rely on three well-known spatial design practices in architecture. The Chapter concludes by the main outlines of the framework.

¹ See findings in Chapter 3
5.2 Defining a Framework of Haptic Design Parameters

The framework and the parameters do not intend to prescribe, or impose, a particular design method. Instead, the framework seeks to facilitate a more inclusive design attitude by informing architects and helping them to think differently. The framework of haptic design parameters must be easily applicable and needs to supply information, inspiration and feedback.

The information used to create the framework comes from the expertise of user/experts that was called in during the empirical track. Our research takes a phenomenological approach and this provides an opportunity to insert phenomenological issues into the design process when they are considered to be important from the perspective of a user. For example: how do people touch, and why? Besides the contribution of user/experts in supplying information on haptic information, this approach also aims to question the well-known visual language that designers habitually use. A purely visual approach may convince clients and designers but it does not deal with the usability of the environment and this is one of the primary concerns in the DfM process. Wolfgang Preiser rightly explains that: “Designers’ clients are usually not the users of the environment or products they design. To bridge the gap of not understanding and of possible misinterpretation in the interface between designer and user, more direct channels of communications must be established. Gaining relevant information from users themselves about their particular needs and behaviours will help ensure satisfactory functioning of the new designs.” Consequently, the primary aim of the framework is to provide reliable information that helps bridge the gap between users, clients, designers and constructors.

In addition to information provision, the framework is meant to inspire designers. It needs to trigger their creativity. Instead of defining guidelines, or a norm-based instrument with prescriptive characteristics, the framework aims to reveal possibilities and opportunities to designers. As explained in the previous chapters, haptic experience is influenced by both behavioural and contextual factors, memories and personal knowledge. Therefore the framework is based on these conditions that influence the design: context and experience. Depending on the values of these different parameters, the experience might change, as might the context or the design. Consequently, what might offer a haptic quality in one situation may become a constraint in a different context. If designers want to take the broader picture into account, they require an overview of all the variables that can contribute to the haptic qualities and constraints. They also need a description of the ways in which different parameters can interact.

Finally, the framework aims to provide a mechanism for providing feedback on the haptic qualities and constraints within existing designs. Quality in architecture is a controversial issue, as explained by Dana Cuff. Designers are still discussing quality and how best to define the conditions that give rise to it. Whereas most architectural critics search for different architectural characteristics as an inherent quality of the building itself, this framework of

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haptic design parameters adopts Cuff’s definition of quality as a phenomenological entity that is perceived by individuals. Consequently, we tried to create a framework based on the needs of the people who will finally judge the haptic quality of the built environment: the designers and users of the built environment (and in the future, we also hope to integrate the constructors).

As this research aims to support designers with the implementation of haptic qualities during designing, the information needs to be available, accessible and applicable at any given point in the design process. For example, the information needs to be inspiring at the conceptual stage of the design process but it must also be applicable to the evaluation of the end result.

Besides, architects want the freedom to be able to apply the information according to their own design methods. This implies a descriptive framework that inspires and informs designers, rather than forcing their hands or putting them under obligation. In terms of content, the information must not be limited to the way in which people perceive haptic information. It also needs to provide information about the haptic experiences that take place in certain contexts, or after a specific design decision. Architects often design an environment with a view to creating an experience that is not limited to the result of actual stimuli alone. Yet, it is created through the interaction of perceptual stimuli with memories and knowledge.

The way to offer information, inspiration and feedback on the parameters is via qualitative descriptions rather than quantitative prescriptions. Literature on haptic experiences and qualities in the context of Inclusive Design, Universal Design and Design for All is mostly limited to inspirational information, or guidelines with very prescriptive data that is comparable to the quantitative data available in Neufert (Fig. 5.1), for example. This framework aims to provide information that goes beyond the values of the variables, as well as creating the desired flexibility within the design process. This inspired us to think in terms of ‘parameters’, since parameters can take variability into account and allow us to build a descriptive framework.

To summarize, the main objective of the framework of haptic design parameters is to achieve a qualitative approach that highlights the values of the variables, as well as creating the desired flexibility within the design process. This inspired us to think in terms of ‘parameters’, since parameters can take variability into account and allow us to build a descriptive framework.

In the context of this research, 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.

The term ‘parameter’ is new Latin dating from mid-17th century, derived from the Latin prefix ‘para’ and the 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. Nevertheless, most design related aspects are not translated into parameters. To our knowledge there is no clear definition of a parameter in the context of architecture. The Dictionary of Architecture and Landscape Architecture does not include a definition of a parameter. On the other hand, the cultural

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7 Definition of a ‘parameter’ on www.oxforddictionaries.com/definition/parameters on september 16th 2009
dictionary that covers a broader cultural field, defines a parameter for a cultural framework as follows: "A parameter takes up different meanings but the central idea for a parameter is that it is a variable with a constant value during the experiment/operation." 9 10

The parameters in our research are meant to assist designers in the creation and evaluation of environments that take haptic experience into account.

Fig. 5.1 Extract from Neufert, Architects Data written by Erns Neufert, 1936

10 Free translation from: "Het cultureel woordenboek" (Dutch) p.614-615: Heeft verschillende betekenissen met als kern dat het een variabele is met een voor de duur van de proefhoming (of behandeling of rekenkundige operatie) constant gehouden waarde.
5.3 Main Outline for the Framework of Haptic Design Parameters

The literature study showed that hardly any research has been conducted into the haptic experience as it relates to architecture. Haptic qualities or constraints are unfamiliar to most designers of the built environment. The framework of the haptic design parameters aims to support architects during the design process and provide the inspiration and information that is needed for haptics to play a greater role in the creative process. The aim of the parameters is to help designers think differently and to encourage them to pay more attention to non-visual elements in their work. They offer designers a tool through which design proposals can be evaluated. By understanding the haptic implications of design decisions through an assessment of the parameter values, a designer can gain an indication of the haptic qualities and constraints.

The design of the framework of haptic design parameters needs to take into account the preferences that relate to ‘how’, ‘why’, ‘when’, ‘what’ and ‘where’ people perceive haptically. The questions that need to be discovered and understood in relation to inclusive design\(^{11}\) correspond to the very same questions that need to be addressed if the haptic experience in relation to the built environment is to be understood. Unfortunately, the questions are not answered by single set of parameters. Instead, different values interact with each other at different levels. As explained in the theoretical and empirical studies, a haptic experience is closely linked to context. Moreover, a haptic experience depends on three levels of mental process: perception, memory and meaning. Architecture can influence these perceptual stimuli. In other words, ‘how’, ‘when’ and ‘where’ haptic perception takes place relates to the context. Whereas the reason ‘why’ people perceive haptically is linked to the experience, ‘what’ is haptically touched is represented by the design. It is therefore clear that context and experience will influence the design properties but that these are closely interlinked.

The following Section describes the main outlines upon which the framework of haptic design parameters is built. The Section starts with the context. The concept of movement is important in relation to the context, as is the idea that the built environment is haptically perceived in terms of surfaces or planes and the sensitivity, and insensitivity, of the body.

Because haptic experience arises out of the interaction between the levels of mental processes we link the parameters to these different levels.

Finally, the Section looks at the haptic design parameters that relate to the material and geometrical properties that can contribute to a haptic experience in the built environment, or that can provide a context.

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5.3.1 Context

5.3.1.1 Movement as a Trigger for Haptic Perception: Active, Dynamic and Passive Touch

As described in Chapter 3, movement is an important trigger for haptic experience. Moreover, researchers have distinguished three kinds of touch (active, passive and dynamic touch), based on three kinds of movement that relate to haptic stimuli. Active touch requires the perceiver to actively seek and move the body, while dynamic touch refers to indirect touch, meaning that properties of elements are felt through different tools or architectural elements. Nevertheless, dynamic touch also requires movement of the perceiver’s body. Passive touch, on the other hand, happens when the body remains static and the movement occurs in the environment. For example, air is displaced when a door opens and the person standing in front of the door feels it. Another example would be the passive sensation of vertical displacement when using an elevator, even though the body itself remains static. In relation to architecture, we examine all three kinds of touch because they each have a role to play in experiencing the built environment.

It is clear that different movements give rise to different types of touch. Designers need to bear in mind that different kinds of movements, or touch, trigger different kinds of experiences.12 Because behaviour can differ according to the type of touch, appropriate design solutions need to be found. Active touch in the built environment requires procedures that allow people to have control over their movements, while dynamic touch takes place when people start trailing, or sliding, with a tool. This tool can be a cane, but it can also be furniture, or any other architectural element that can become an extension of the body. On the other hand, passive touch refers to movements that are external to the body over which the perceiver has no control.

Architecture is perceived through movement. According to Mark, perceptual movements and the resulting ‘haptic space’ form the first spatial information that people can rely on. Movement is indispensible for experiencing architecture.13 Ching states that “Architecture is experienced through movement in space-time, approach and entry, path configuration and access, sequence of spaces, light, view, touch, hearing and smell.”14 Architects manipulate space to influence the environment in which we live, and through which we move. Architecture has been described as “the art into which we walk; it is the art that envelops us.”15 Kenneth Carruthers defines this as the ecology of space, which is experiential and based on movement, passage and arrival.16 The definition refers to the work of James Jerome Gibson that focuses on human movement as an essential source of information in the ecological psychology of perception.17 Although Gibson’s research gave priority to visual perception in the first place, his concepts are also transferable to other sensory ‘systems’. First Gibson focussed on human movements as an essential source of information and explained that the motion of things in the environment differs from the motions of bodies in space. Similarly, we found that the kind of movement that takes place as a condition for haptic perception defines whether touch is identified as active, dynamic or passive touch. Graafland and Hauptman state that this is the value of architecture that can be lived in and that has the possibility of an ever-varying viewpoint for observation.18

More often than not, the blind user/experts in the empirical studies refer to active touch. This could be because caregivers stimulate it via teaching and training. In the photo-ethnographic study, several participants took pictures whilst actively touching. For example, all participants took pictures of the action of opening the door to their room. During the in-depth interviews, participants explain how they make use of active touch to find their way through the environment. Some people even actively touch

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walls and doorframes to orient themselves. Dynamic touch in the built environment uses an additional element in the room, or environment, to support the haptic perception of the whole space. One interviewee explains that he always uses a cane to walk outside in the garden [M001]. In this way, he dynamically explores his garden by means of the cane. Strictly speaking, you could state that walking with shoes is also a form of dynamic touch. Moreover, to some extent, all furniture and decoration has the potential to be a tool through which the environment can be dynamically explored. Caregivers, as well as the participants born blind, all referred to the use of doormats as orientation points. These mats give direction to movement and support the users in their perception of the whole environment. One participant in the photo-ethnographic study took a picture of a vertical tactile mat in the boarding school. Some participants took pictures of materials, or shapes, that accidentally touched them. Remarkably, passive touch always results in pictures of details and nearby surfaces. For example, passive touch triggered one participant to take a picture of the sheets of the bed while passing by. It is clear that we can (under)take action to perceive, but we can also perceive by (under)taking action.

5.3.1.2 Unfolding the Built Environment into Planes

Based on different findings, theoretical as well as empirical, we argue that the built environment is haptically perceived in terms of surfaces, or planes. This is a useful aspect for designers as it puts haptic experiences into more of a design perspective. A summary follows of the observations that have led us to consider the built environment, in relation to haptics, as a world of surfaces or planes.

Firstly, haptic perception is related to the body and is proximal in nature. This limits the acquisition of information to the immediate area surrounding the one that can be effectively tactually accessed. This is also seen in the exploration techniques relevant to haptic experience. The theoretical track revealed that the most common strategies are perimeter, object-to-object and grid. All these strategies rely on trailing, sliding or walking along the surfaces of certain architectural elements, objects or rooms (walls and floors). To summarize, touching with the skin results in a surface being felt. The kineasthetic movements send information to the body parts in relation to the surfaces that are haptically perceived.

The empirical studies confirmed that people haptically perceive the environment in terms of different surfaces that afford and support different actions. The studies also confirmed that spatial characteristics like depth and volume are not directly perceived, but only ‘known’ to be present. The exploration strategies, for example, became clear in the plan annotations, which clearly showed that people always follow the sides of objects, elements or rooms (Fig. 5.2). In the plan annotations, the lines that follow the exploration of the participants determine the supporting walls and planes. One participant explains that: “In fact if you want to describe something by means of haptic perception, you have to follow the walls” [F004]. F003 agrees that the most important elements in her house are the walls. Some participants also identify all the structural planes of the house that are vertical or smoothly inclined as ‘walls’. For example, one participant defines the ceiling of her toilet room as a wall [F005].

Moreover, participants do not describe the thickness of the walls or the volume of a room, but instead describe the feelings of surfaces creating the space and the experiences of surfaces supporting movement and the additional boundaries.

Many pictures from the photo-ethnographic study show two-dimensional surfaces, instead of objects or three-dimensional spaces. Some pictures literally show surfaces or planes. Besides the empirical evidence, the concept of surfaces or planes is also substantiated by theoretical studies. Millar states that the haptic sense is actually the best complementary source of information about the relation between surfaces: “Haptics provide much of the inputs that are relevant to the use of body centered references. But haptics can be put to important use in conveying

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\[\text{F004 Dutch Excerpt: “Eigenlijk als je iets op de tast gaat gaan beschrijven, dan ga je langs de muren.”}
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the relation between surfaces, and in restoring informational redundancy.\textsuperscript{21}

In his book, \textit{The Ecological Approach to Visual Perception}, Gibson wrote that he considered surfaces to be part of our perceptual environment: “We live in an environment consisting of substances that are more or less substantial; of a medium, the gaseous atmosphere; and of the surfaces that separate the substances from the medium. We do not live in ‘space’.\textsuperscript{22}” Gibson’s theory starts out from visual perception, but the fact that surfaces are the dividing elements between atmosphere and substances is also very relevant to haptic perception.

We found one case study, by Kent Bloomer and Charles Moore, which described the house of a family in which the father was blind. Their experience of the design and building of the house led Bloomer and Moore

to conclude that the blind live in “a world of surfaces.” Surfaces are part of the architectural language and are architectural elements, which may enable architects to address haptic experiences in the built environment. An example from Ching might clarify this approach: “Entering a building, a room within a building, or a defined field of exterior space, involves the act of penetrating a vertical plane that distinguishes one space from another and separates ‘here’ from ‘there’.” Surfaces are part of the architectural language and are architectural elements. This may enable architects to better address haptic experiences in the built environment. In other words, a surface is a boundary between an environmental element and the atmosphere. It can be haptically perceived from one side and its junctions are edges or corners.

**Affordances**

Surfaces can ‘afford’ certain types of behaviour. Gibson defined ‘affordances’ as the notion that forms or configurations offer possibilities, availabilities, actions or conveniences to us. These affordances are not inscribed in space, but rather activated through people’s sensory experiences. This supports phenomenologists’ claims that individuals are involved in active sense making. Moreover, affordances escape the ancient philosophical dichotomy between ‘subject’ and ‘object’. This is clearly explained by Gibson when he refers to a tool as an extension of the body: “This capacity to attach something to the body suggests that the boundary between the animal and the environment is not fixed at the surface of the skin but can shift. More generally it suggests that the absolute duality of ‘objective’ and ‘subjective’ is false.” Consequently, the recognition of dynamic touch fits into the ecological perspective of perception. In this context, clothes become part of the body like a second skin.

Whereas Gibson explains the role of surfaces regarding perception in general, Eberhard specifies that textures and surfaces are the aspects to which the sense of touch, in particular, responds. Moreover, our findings indicate that the experience of a surface depends on its use: is a surface used with an eye to orientation or pleasure, to offer safety or comfort? Architects can design an environment that supports orientation and creates a pleasant atmosphere. With the theory of affordances in mind, surfaces can afford a place to sit (e.g. seat), a place to walk or move forward (e.g. floor), a place to shelter (e.g. a ceiling), a place to rest (e.g. bed),… Different functions ask for appropriate haptic qualities which designers of the built environment can help determine. Providing opportunities and choice in ways of use is one of the principles of Universal design, as is designing for simple and intuitive use.

**Movement Plane, Guide Plane, Rest Plane**

Gibson distinguishes between surfaces and planes: “Surfaces and the medium are ecological terms; planes and space are the nearest equivalent geometrical terms.” He proposes the use of ecological terms in architectural language when he points out that “The definitions are subject for revision, but terms of this sort are needed in ecology, architecture, design, the biology of behaviour and the social sciences, instead of planes, forms, lines and points of geometry.” However, we believe that instigating a new language might prevent architects understanding and adopting the approach in its entirety. For example, the layout or structure of the built environment is defined as the ‘enclosure’. Consequently, we choose to adopt the surface-layout approach and concepts of the ecological psychology but with a mix of geometrical language for clarity.

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Depending on the use of the surfaces, we distinguish between the three main uses of planes: the movement planes, the guide planes and the rest planes.

Movement planes support the movement of the body parts through active or dynamic touch (Fig. 5.3). They support according to the function-related exploratory procedures and the most appropriate body part, e.g. a floor in the underground, or the steps of a staircase.

Movement planes are judged according to direct perception.

Guide planes are planes that guide and inform body parts and are most often located next to, or nearby, movement planes and rest planes (Fig. 5.4). A guide plane primarily supports active and dynamic touch. It literally guides and supports people, and offers information through the slightest touch of the edges (or boundaries) between the guide plane and another. As a result, the difference between the two planes is not only felt through the geometrical properties. A difference in materials can also be sufficient. Guide planes are part of a passageway, for example, and run parallel or perpendicular to the running or moving line. A handrail, for example, can be actively touched, but also indirectly provides information about the wall, or construction, upon which it is fixed.

Rest planes support the body in rest, meaning that they support the body when it is in a static or relaxed position, i.e. surfaces people can sit, sleep, relax, lean or hang upon (Fig. 5.5). The seat of a chair is a good example.

Whilst we can categorize the different planes according to their use, it is interesting to know that a movement plane can also be a guide plane and a rest plane, or that a rest plane can be part of a movement or guide plane. In terms of a design, an architect can choose depending on the most crucial aspects.

Figure 5.6 illustrates this complexity: it shows a fountain on a city square, a tourist attraction that, besides its ornamental function, structures the layout of the square and suggests a place to rest. Accordingly, the fountain can be considered to be composed of different planes, since some people sit or lean on its edges, while others focus on the border planes for orientation. The floor of the square itself can be considered a movement plane, while the fountain may serve as guide planes, rest planes, or even movement planes when children run from one side to the other (Fig. 5.7). It is assumed that if an architect can create a successful movement plane that supports guidance but also offers possibilities for rest, the actual experience will be very rich.

The movement plane, guide plane and rest plane each represent different affordances in the sense of the opportunities provided by the surface of an object or environment.
Besides the way in which we touch, it is important for architects to keep in mind which part of the body will touch or be touched, as different parts of the body can have different haptic reactions characterized by higher or lower sensitivity. For example, stimuli felt by the feet, back, arms and shoulders differ from those felt by the hands, or other parts of the body. For touch, the most sensitive regions are the lips and fingertips, whereas the back, shoulders, legs and arms have much higher thresholds. Moreover, we often use footwear and this makes the threshold even higher. In the built environment, we most frequently touch with our bare hands whilst the feet are enclosed in shoes. In other words, our hands actively touch while the feet, most of the time, touch dynamically. This means, for example, that surfaces supporting our hands call for different textures than the surfaces meant to guide and support our feet. This was also clarified in the home visits, as participants appreciated certain properties for the floor that they disliked for the walls. For example, one participant refers to the dolomite in his garden as a material that supports orientation [M001]. Although the texture of this material closely resembles chalkstone, rough plaster is not appreciated for vertical walls, as its uneven texture is unsafe and the participants disliked touching it with their hands [M002, M003, M005, M007, M008, F003, F004, M009, M013, M014]. In part, this may be because the feet are often in shoes: another participant [M005] refers to the rough texture of his kitchen floor and states that he dislikes walking on it barefoot.

In general, all participants in the home visits most frequently touch with their hands and feet. As for the photo tour, the fingers and thumbs on the pictures show that participants literally hold the lens while taking pictures, or that they photograph their feet when focussing on the floor. In addition, the caregivers in the focus group interviews mostly referred to hands and feet.

The values of the different parameters can change according to the sensitivity of the body part. Designers of the built environment can decide upon the degree of sensitivity that applies for their design. In a swimming pool, everyone is barefoot and the floor will need a different texture than one in a railway station where, in normal conditions, we dynamically touch the floors through our shoes. Designers need to take the sensitivity of the body parts into account. We place the two extreme variables ‘sensitive-insensitive’ on the grid of the context.

5.3.2 Experience

How surfaces can afford movement, guidance or rest is represented by the different values for experience. The haptic experience that these planes provide is generated by the levels of the mental processes: perception, memory and meaning. There is a strong connection and interaction between these three levels of mental processes and the interaction results in the expression of the haptic experience. The following paragraphs discuss the impact of the three levels on the haptic experience by cross analysing and triangulating the findings of the theoretical and empirical track.

5.3.2.1 Level of Perception

As elaborated in Chapter 3, the level of perception covers all direct physical stimuli as felt at a particular moment in time. Based on the common aspects in Stenros’ definition of her level of perception, Karlsson’s description of “the comprehension in terms of image-experience” and Mark’s approach to haptic space, we define the level of perception, in relation to haptics, as the level representing the information about the way in which we perceive and analyse an environment. It is the real-time level at which all the perceptual stimuli are sensed. The built environment is the trigger for this level of mental process. We also focus upon the environment and ‘how’ it is haptically experienced. Although Mark considers the haptic sense to be proximal and restricted to the capacity to perceive nearby stimuli, we do not consider the information at the level of perception to be just restricted to proximal stimuli. This does not mean that the perception of haptic stimuli is not characterised by the proximal nature of the haptic sense, but we consider the information on this level in relation to all the stimuli that can possibly be perceived through touch. The way in which these stimuli are perceived makes a difference to the haptic experience. The literature review and our empirical studies show that haptic perception involves sequential perception. Many researchers refer to the sequential nature of haptic perception.

Carlos Pereira, a blind architect, explains it this way: “when I explore a space, the sensation is the same as reading a book. I can’t feel all the space, but I can feel many details, as when we read and imagine a description on a book.” It is clear that these perceptual distinctions are partly a result of movement. This sequential nature of haptic perception is affirmed by our empirical studies. It was referred to by some of the participants in the in-depth and focus group interviews and explicitly revealed through the video and photographic tours. Caregivers affirmed the successive process of touch during the focus group interviews. Different kinds of touch, as well as the body part involved, are also analysed during the perceptual process. Regarding the perceptual process, participants state that they appreciate it when it is predictable.

Predictability versus Unpredictability

The level of perception thus considers the predictability of stimuli. In other words, if certain movements of the body, including guiding and resting, are supported in the way one would expect, this is appreciated. This does not mean that the design cannot be innovative. Designers need to keep the cultural, social and material context in

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mind. It is not appreciated if environmental elements, for which users have a certain expectation, do not perform as anticipated [M001, M002, M006, M009, M010, F005, M012, M013]. When this happens, the element is judged to be unsafe or uncomfortable. For example, a handrail that suddenly stops while descending a staircase, or the feeling of frames or paintings along a guide plane or wall and an unpredictable stone on a footpath. One participant calls this “the illogical things at practical level” [F005].

Examples include obstacles placed on the stairs [M001] or an obstacle in the middle of a door opening. If people expect an opening but instead bump into an obstacle, this is considered unsafe [M002]. Swing doors are also considered to be unexpected obstacles. The predictability can be easily taken into account by the use of certain architectural concepts. Strikingly, the architectural concepts for visual and haptic representation tend to rest on similar categorisations of mental maps. In his book The Image of the City, Kevin Lynch analysed the city and the way it is represented. Focusing on visual perception, he divided the visual mental map into five categories of networks: paths, nodes, landmarks, districts and edges. Judging from the interviews with people born blind, these categories also appear in haptic mental maps. For example, participants show that they make use of haptic landmarks in their orientation process: a twist in a handrail [M008], a vertical or horizontal tactile mat at an important crossing point [M001, M002, M003, F003, F005, M012, M014 SPE M01, SPE F02, SPE F03, SPE F05 + all CARE], a letter box [F007] and even subsidence in the pavement [M014] can be haptic landmarks. Similarly, we also found examples for the other categories. This is an interesting point in relation to architecture. If we want to implement haptic aspects into the design process, we can make use of predictable architectural concepts. This offers designers a tool through which they can translate the information in the framework about haptic experience into a useful architectural language. However, because of the distinct characteristics of the haptic sense, haptic landmarks, edges, paths, nodes and districts, for example, are likely to differ from the visual categories. In terms of the haptic sense, for example, a large tower in the city can be an excellent landmark for visual perception because of its proximity. However, when walking sightless around it, it isn’t possible to feel the difference between the tower and a building that is only two storeys high. Furthermore, whereas in visual conditions people tend to perceive the full picture, in non-visual conditions only the properties available can be relied upon.

This can be illustrated with a funny story about two blind men who both gave two completely opposite answers to the question, “What is an elephant?” after touching one. The one man who only touched the animal’s leg replied, “It is a tree”, while the one who touched only the animal’s body replied, “It’s a wall”. Both perceived a different part of the body of the animal. Consequently, it is not surprising that many participants in our empirical track explicitly, or indirectly, referred to the importance of predictability in the built environment. Unlike visual perception, haptic perception often needs the body to be physically displaced, and stimuli are often felt coincidently and always in parts. It thus requires some choreographic insights for designers to take all the possible types of perception into account, and to support their different uses. The concepts of landmarks, paths, nodes, edges and boundaries can be used as possible design solutions. The empirical findings show that participants link their predictable perceptual stimuli to spatial concepts like ‘landmarks, paths, nodes, edges and boundaries’. Whereas Kevin Lynch described these aspects in the context of visual memories, our results show that they are also applicable to haptic perception. For example, one participant [M003] walks to his letterbox every morning by using haptic points of reference stored in his memory.

5.3.2.2 Level of Memory

Whereas the level of perception covers all information resulting from direct stimuli, the level of memory comprises all the images generated by personal experiences, activities and places. At this level, memories are recalled that support our personal orientation techniques and

42 Dutch Excerpt F005: “ik zie dingen die praktische onlogischeheden aaah dat vind ik verschrikkelijk frusterend gewoon.” P15: ATLAS 080626 F005.rtf - 15:79 [i: zo’n dingen die praktische ...] (249:252) (Researcher) Codes: [cognitive knowledge blind] [unsafety]
personal experiences of atmosphere. Habits are therefore very important and help to identify different elements and properties. We relate the level of memory to the ‘comprehension in terms of notion’ as defined by Karlsson. Karlsson also refers to memories as the basic condition for ‘comprehension in terms of knowledge’ and he explains that this level is characterized by a slight sensory contact. Similarly, Mark considered the pictorial space as a level of mental process that is characterised by the ability to sense things indirectly. We consider this level to be the one at which the process of repetition is recognized. Although Mark also links pictorial space to the use of different senses, which is not the case for our framework, we do adopt the idea that the level of memory is metaphorically grounded in the level of perception. Nevertheless, we do not agree with Karlsson’s idea that familiarity is part of comprehension in terms of image-experience. Instead, we consider familiarity to be a notion, or a variable at the level of memory. As explained by Révész, familiarity and recognisability are important for the identification of spaces and objects. It is the way reference points arise, as stated by Ryhl: “For a blind person or someone with low vision, it is difficult to navigate as well as ‘read’ the general layout of a space without using the sense of touch. The acoustics are used to ‘read’ and understand its size, but both perceptions are needed for understanding the general layout and size. It is easy to feel lost and helpless without a point of reference”.

In the empirical studies, we noticed the difference between results that rely on direct perception, as explained at the level of perception, and the findings linked to the level of memory. On the level of memory, participants often refer to the process when discussing habits. It is also explicitly demonstrated during the video tour and photo tour when participants refer to reference points that are stored in their memories. The ‘control touch’ at the doorframes is an example. It is also possible to relate some of the pictures taken by the children to memories. The picture taken in the direction of the shelter roof over the playground is an example. It is based on the child’s memory of feeling comfortable when it was raining outside. All participants take pictures of the exercise ball stored in the corner of the room and it is their memories of the kinaesthetic experiences of the ball that trigger them to take the pictures. In addition, the focus group interviews with the caregivers revealed that, on the one hand, caregivers train people born blind to memorize their experiences and develop habits. For example, they train people to count their steps when crossing the street, and the children who count several landmarks on their way to school are relying on their memories. Besides the memories that arise through training, there are also habits linked to muscle memory like, for example, knowledge relating to the height of the light switches.

**Comfort versus Discomfort**

To the best of our knowledge, no prior research has been conducted into haptic experience and memories that are formed in, or from, the built environment. Therefore, the variables for the level of memory are based on the findings from our own empirical studies. The in-depth interviews during the home visits revealed many interesting perspectives on people’s habits, perceptual preferences and the way they dislike certain things based on their personal memories. Most participants explained what they thought was comfortable, or uncomfortable, in terms of maintaining the place, its location, orientation, dimension, usability and atmosphere. For example, the way in which a place can be cleaned and maintained made a large contribution to the final judgements [M001, M003, M004, M006, F003, F004, M009, M005]. A nice atmosphere can also evoke a sense of comfort [M001]. Some participants also link the size and dimensions of a room to their opinions on comfort [M005, F003]. Although the pictures based on memories in the photo-ethnographic study were quite rare compared to other types, it is clear that the shelter-picture [F003], the pictures of the big hall [SPE M001, SPE F002, SPE F003, SPE F005] and the picture of the judo room [SPE M001, SPE F002, SPE F003, SPE F005] were all based on memories relating to comfort. The focus group interviews revealed that caregivers try to train the children

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to remember aspects of the built environment so that they can navigate spaces with greater ease.

What all the descriptions of memories, and the pictures triggered by memories, seem to have in common is that they relate to comfort and discomfort. Consequently, we propose comfort and discomfort to be variables that characterize the level of memory.

5.3.2.3 Level of Meaning

The level of meaning directs the whole process of perception. It is what Stenros defined as the abstract level. Direct environmental stimuli are not required at this level and people can add additional information based on impersonal knowledge. In line with the ‘abstract level’ of Stenros, Karlsson describes ‘comprehension in terms of knowledge’ as an abstract form of comprehension. Although memories will be of great importance for knowledge, Karlsson considers them to be impersonal and different to embodied knowledge. We agree with Karlsson that knowledge built up by general descriptions, and derived from concepts instead of personal facts, exists. Mark also associates ‘transperceptual space’ with an abstract level upon which way finding takes place. However, we prefer to consider way finding as the result of a strong interaction between the level of memory and the level of meaning. We do agree, however, that the level of meaning takes place at an abstract level since it relies on concepts in the first place. For example, the photographs taken by the children of the sky, and of the goldfishes, refer to abstract concepts. For somebody who has never seen, the sky is an abstract concept. As defined in the dictionary: “The sky is the region of the atmosphere and outer space seen from the earth”. People born blind are unable to perceive the sky in a visual way. Consequently, their knowledge is based on other non-perceptual sources. The fact that the participants do not distinguish between an inclined ceiling that they can touch and a wall is also an example of a mental process that relies only on the level of meaning. Although direct perception is possible, additional information is required in order to ascertain that the wall is, in fact, part of the ceiling. During the focus group interview, the caregivers gave another example related to the level of meaning. They referred to one child who focuses on safety in quite an extreme way and who always learns road maps by heart. Nevertheless, he doesn’t dare to move. In other words, the child’s road map is based on the information provided by the caregivers and is linked, in all probability, to familiar memories - even though he lacks personal perceptual experiences about the route.

Safety versus Unsafety

Empirical research shows that if people primarily rely on their knowledge of the environment, and don’t react to perceptual stimuli or make links to memories of what is actually around them, then they tend to give meaning to the environment based upon their judgement as to whether it is a safe place, or a dangerous one. This level of meaning closely interacts with the level of memory. However, the difference lies in the fact that knowledge of the environment is based on impersonal knowledge rather than personal perception or memories.

For example, during the in-depth interviews that took place during the home visits, participants often referred to chaotic environments as being unsafe [M001, M008]. This is because, to the perceiver, the structure is invisible and unknown.

Participants explain that they judge an environment based upon their knowledge of its structure and materials, even before they have perceived it [F001, M004, M006, F003, F004]. If people know the materials, or structure, of certain walls and they judge them to be unsafe, they will probably refuse to touch them. F001 points out, for example: “Yes for walls, here, I would never prefer to have a slate wall, that is a wall that I will never touch with my hands, so I would never use this material for an interior wall, such a kind of wall...”. During the video tour she also explains that when planning a holiday she will always

carefully investigate the safety of hotel rooms [F001]. Many participants and caregivers also judge scaffolding to be dangerous [M004]. As meaning is primarily given through a judgement on the degree of safety, we assign safety and danger as the two variables relevant to the level of meaning.

5.3.3 Haptic Design Parameters

This Section presents an overview of the haptic design parameters as based upon the findings of the theoretical track and our empirical results.

Research into object recognition and our empirical research track both demonstrate that haptic design parameters can be divided into two categories: the material and the geometric. The material properties may seem quite familiar to most of us, as nearly all of these properties are also used in relation to object perception. Texture, the permeability of air, elasticity, temperature and specific gravity are the material properties that were identified through the research into haptic experiences. Most of the material properties can also relate to objects and do not particularly require the concept of planes. However, the geometrical properties are primarily based on the concept of planes. Curvature, orientation, configuration and size are the main parameters that describe the actual plane that needs to be designed.

5.3.3.1 The Material Parameters

Materials give the surfaces an identity through their temperature, texture, density, permeability, reflective qualities and elasticity. These constitute the different material parameters. In reality, the perception of a surface is a combination of perceptions of different properties, but very little research has been done into the way touch and the perception of different material properties combine.\textsuperscript{59} Temperature describes the coefficient of conductivity of a material (e.g. steel feels much colder than wood) and radiation. Contrary to what one might assume, the experience of light is a very important element within haptic experience. Light can be haptically experienced through fluctuations in temperature. Different materials can also deflect air, or allow it to permeate, which is one of the most typical experiences in relation to touch. Air that caresses our skin provides information about the structure of the environment. Materials can also breathe. In the summer, this difference can be felt by nestling into a garden chair made of fabric. The fabric lets the air through; a rubber mat doesn’t and makes you sweat. Texture gives direction, reflects light and defines the way that a material is felt. To support active touch, movement is encouraged through rough textures underfoot, whilst hands (and other body parts) demand surfaces that are much smoother. For example, rough stones are excellent for staircases, but to be avoided for walls that are regularly touched. On the other hand, when relaxing, the body also prefers smooth textures underfoot.

Elasticity is the extent to which a material exerts a counterforce or is transformed in response to an external force. A material is described as elastic if it returns to its original form when the external force is removed. If active touch has priority, as in public buildings, non-elastic materials are preferred. A judo mat might be a very pleasurable thing to have in a playground but be very inappropriate in a public building. Although it feels nice and soft, people risk tripping on the mat and twisting an ankle. In contrast, a grass surface next to a hard surface could be the ideal guide plane next to the run line.

Material properties can also influence each other. For example, as explained in Chapter 3, the elasticity of a material influences its conductivity.\textsuperscript{60}

In general, this research is limited to the solid qualities of materials. However, as the parameters themselves explain, some properties also take the conditions of air and humidity into account.

\textsuperscript{59} Dutch Excerpt F001: “Ja voor wanden, hier, zou ik nooit willen hebben, dat is een (stenen wand met gestapelde leisteen) dat is een wand waar ik nooit aankom met mijn hand, dus dat zou ik nooit voor een binnenwand gebruiken zo’n materiaal, euhm...” P 4: ATLAS 070806 F001.rtf - 4:27 (K: Ja voor wanden, hier, zou i...) (80:80) (Researcher)

### Overview Haptic Design Parameters

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<thead>
<tr>
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<td>dimensions (of plane)</td>
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<td>length (in relation to body)</td>
<td>width: 2 times body width / height at 'touchable' height</td>
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**Texture**

**Definition**

Texture is one of the most important properties in haptic perception and provides information about the microstructure of a surface in all its forms: natural characteristics, production techniques and the applied surface technique. Consequently, we distinguish between textures that result from the construction process of architectural elements and those textures that are consciously designed by the architect.

In the first instance, texture provides information about the roughness or smoothness of a surface. Certain textures might also have the capacity to reflect light or air. Moreover, texture might also refer to patterns in the material or resulting from the construction. These patterns can be directional (for which we refer to the geometrical properties).

Skin coming into contact with a surface, or a body part touching a surface (however slight the gesture) triggers the perception of texture. The texture itself can acquire meaning, but it can also give meaning to the geometrical properties.

**Cross Analysis and Triangulation of the Findings Relating to the Expertise of User/Experts Born Blind**

When relying on haptic perception in experiencing the environment, texture plays a crucial role. It provides a great deal of useful information and the empirical studies confirm this - all the participants refer to texture. However, instead of using the word ‘texture’, participants describe their experiences in terms of variables, such as ‘roughness’ or ‘smoothness’. In general, throughout the different empirical studies, when participants refer to texture they mean a surface property with rather small dimensions. Although, the literature study revealed that texture might mean hardness, roughness, viscosity, reflection and permeability, the participants more often than not refer to roughness, or the difference between rough and smooth textures. Therefore, we take texture to mean a property that provides information about the roughness of a material, the pattern (that gives rise to roughness) or the quality of smoothness.

Textures in the built environment are felt or explored in the same way as textures of objects. Most information is received through lateral motion but even static contact, enclosure, unsupported holding and the following of contours can also support the perception of texture. Lateral motion in relation to texture is the action most frequently referred to in the empirical studies. In general, there is evidence that active and passive touch give equivalent results for the perception of texture. The literature study revealed that the more experienced people are, the more they appreciate textures. In other words, it is a property that is gradually appreciated, by means of experience. For example, newborn babies cannot give meaning to texture because they need time to acquire the skill and, even if a person is familiar with several textures, it requires practise before the many differences can be recognised. After he went blind, it took John Hull five years before he began to appreciate certain textures. One of the participants stated during the home visits that smooth textures are safer. Many participants prefer smooth walls and one participant even compared her favourite walls with the smoothness of marble. However, this smoothness is not appropriate for public floors, because it makes them too dangerous and slippery. Moreover, it is difficult to find any landmarks in smooth and plain floors. Nevertheless, there is no preference for rough floors in houses.

Texture might result from the specific characteristics inherent in a material but can also relate to man-made patterns. Although participants do not explicitly refer to the differences between handmade and natural textures, some acknowledge that texture can be intrinsic to a material. But it is acknowledged that texture can also be changed or created through human intervention. For example, referred to the two different types of wood used to make pianos and clearly shows a preference for the contoured wood because it has the smoothest texture.

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Another participant refers to the experience of purchasing a dining table made of natural wood [F005]. According to her mother, the table was ideal. However, when she felt the table she disliked it so much that she decided not to buy it. A combination of materials can result in a more complex textural pattern. The arrangement of mosaic tiles, for example, is not just about the tiles but also the joints between them. The joints even have their own structure, a pattern that gives people a sense of direction in relation to their own body, and a sense of their body as part of the environment. In this case, whilst the tiles themselves may feel very smooth, the joints can feel rough. This experience is clearly demonstrated by the participant in the video tour who uses the mosaic tiles in his house for support as he walks downstairs [M014].

Bloomer and Moore also recognised the qualities of smooth tiles when they were designing a house for a blind client and his family: in the kitchen and the hallway on the first floor they used large, earth-coloured Mexican quarry tiles. The tiles are very much appreciated by the client because they give him a feeling of “unexpected adventure” beneath his feet, as they are bumpy and handmade. A variety of ceramic tiles were used throughout house because the client liked the cool, smooth surfaces and his wife liked the rich visual range.

The participants made it clear that materials are incredibly important in relation to haptic perception. However, the line between the information provided by materials, and that provided by the tectonics that are created via geometric properties, is a thin one. During the photo tour, the children took pictures of interesting textures that were intrinsic to the material, the leather seat for example, as well as textures that resulted from the fabrication of the material or structure, such as the glass wall. Pictures were also taken of elements that had a very remarkable texture and thus formed a landmark, for example the ‘tactile mat’ in the big hall, or the smooth teddy bears near the handles of the doors to their rooms. Similarly, caregivers often referred to texture as a landmark in non-visual conditions. As long as the patterns are felt at first touch, the properties can be defined as texture. We refer to the geometric properties of the environment when the recognition of a pattern requires a large relocation of the body position.

Textures can be discerned through ‘fingering’, and are thus given meaning. Meaning is attributed to textures through personal knowledge and memories. For example, one participant explained during the home visit that she dislikes rough wood because she is afraid of being hurt by a splinter. Although wood is often mentioned as possessing strong haptic qualities, F005 associates it with danger and it is this meaning that influences her experience. Eberhard, agrees that texture is sensed through memories as well. John Hull states that texture can support the perception of shape. Our empirical studies also confirm this assertion. For example, different kinds of doormats are placed so that the difference in texture is easy to feel. The mats all have a certain shape and the textures make them recognisable through this geometric property.

Values

In terms of the usable information that can be derived from the perception of texture, there is no difference between active, dynamic or passive touch. However, in terms of preferences, people like smooth textures if something has to be touched by a sensitive part of the body. Although smooth textures are also preferred if an insensitive body part is to touch something, these parts of the body can also tolerate rough textures. For example, if we wear socks, it is difficult to feel the roughness of the floor. Yet the rough pattern helps prevent us from slipping and falling when wearing socks. The empirical studies show that the preference is for smooth textures when it comes to passive touch. Although most participants also preferred smooth textures when touching things actively or dynamically, the appreciation of rough textures depended on the environmental context and purpose intended. To prevent

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65 x. “Extra Sensory Perceptions.” Progressive Architecture 78.4 (:): 82-85.
71 This is further explained in relation to the parameter of ‘temperature’ and ‘light permeability’.
72 x. “Extra Sensory Perceptions.” Progressive Architecture 78.4 (:): 82-85.
people from falling, for example, the entrance of a library cannot be overly smooth, just as a wall that is too rough prevents people from bending, leaning or trailing against it. Besides the use, or context, and the sensitivity of the body part, the most appropriate choice for texture also depends on the kind of touch that takes place. Movement planes for non-naked feet are likely to have a rough structure to prevent people slipping, whereas the floor of a day nursery with crawling babies might have parquet. A rest plane is also preferred to be smooth, whereas for a guide plane the stress is put on the difference between the adjacent planes. For example, there must be a difference of at least 3% in the height of the raised material, or in the separation between the raised pieces, for the difference to be felt.\textsuperscript{70} By means of differences, connections appear that can support movement based on the information that they reveal. If materials reflect light this can be felt through temperature.\textsuperscript{71} Texture can also deflect air. The section on air permeability explains how air is actually felt.

Examples

Texture can have a huge impact on architecture. In relation to haptic experiences, it can support haptic qualities through its material and geometrical properties. Bloomer and Moore also noticed this and paid attention to the different textures of the floors in the house of the blind client, linking different textures to different locations.\textsuperscript{72} For each specific location in the house, the architects used a different type of floor texture. As explained, texture is a unique property in that it can be the result of the natural characteristics of materials but also the result of the patterns made by designers. One well-known example is the architecture of Antonio Gaudi. For example, the different textures in the Parc Guëll in Barcelona are a delight when touched. The seats, rest planes, are covered with mosaic tiles (Fig. 5.8), the smoothness of which is very much appreciated. The columns in natural stone, guide planes, are at a touchable height and also covered with mosaic tiles (Fig. 5.9). The columns of the boutique hotel in Mexico, La Purificadora, do probably not support guidance and active touch. The architects Legoretta & Legoretta and Serranón Monjaraz Arquitectos show that they kept the sensory experiences of the building in mind. However, they made the columns in the restaurant out of old,
rough wood. During direct active and dynamic touch this material can cause injuries to the hands and splinters can hurt (Fig. 5.10).

**Elasticity**

**Definition**

Elasticity is the extent to which a material exerts a counterforce or is transformed in response to an external force. A material is described as elastic if it returns to its original form when the external force is removed. Regarding haptic experience of the built environment, experience is expressed in terms of hardness: hard, flexible, rigid, pliable, soft... This property is felt by means of skin pressure and the movement of muscles, tendons and joints. Through the values of elasticity, we can estimate the strength of possible vibrations.

**Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind**

In relation to ‘elasticity’, participants do not refer to the exact term but circumscribe its experience instead. During the home visits and during the focus group interviews, all of the participants indirectly described the perceptions triggered by characteristics linked to elasticity. The children born blind explained that they take pictures because they like the softness of something, or because they feel safe. In relation to elasticity, the caregivers also explicitly refer to safety. Soft elements are thought to be safer. However, in relation to the body in motion, a hard surface is more appropriate. The results derive from the home visits and the focus group interviews with the caregivers. Ideally, planes that support movement should not be too hard or too soft. For example, M001 showed us the hardness of his grass path within the larger grass plane. Here, it is clear that a dense path supports orientation and movement. Elasticity is referred to in relation to active, dynamic and passive touch. Active touch is mostly mentioned in relation to participants’ preference for highly elastic materials in relaxing situations. For example, soft chairs or seats are preferred to hard ones. A participant’s reference to how the pavement feels when he cycles with a tandem is a good example of dynamic touch [M003]. Passive touch occurs when the children accidentally bump into a wall in the judo room. The soft material of the walls is largely appreciated. In general, participants associate the qualities of elasticity with safety and comfort, and the constraints are respectively described as unsafe or uncomfortable.

**Values**

When selecting materials designers also need to take the production process into account. Hard materials can be made ‘soft’ by forming them into shapes in which they bend or twist, for example. Likewise, hard steel can be shaped into soft springs or glass woven into cloth. Ashby and Johnson state that to compare the intrinsic softness of materials (as opposed to the softness acquired by shape) the materials that need to be compared must conform to the same shape, only then is the elasticity modulus the key property.73 Whereas in active and dynamic touch the preference goes to hard materials (but not too hard), soft materials are better when it comes to passive touch. The more sensitive a body part, the more important it is to use soft materials. Higher density materials are more solid and therefore better at conducting vibrations than lower density materials.

For movement planes, hard materials are preferred. An ideal guide plane, on the other hand, ought to be soft so that the characteristics of the explored plane can be properly felt. A guide plane may also provide directions, like a grass surface next to a hard surface, for example, because it invites people to walk on the hard surface. A rest plane, on the other hand, is better when it is soft.

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Examples

In the courtyard of Museum M in Leuven, the path is made out of concrete while the rest of the surface is grass. People in a hurry will intuitively choose the concrete path. In both visual and non-visual conditions, users feel a difference in density, and thus perceive the difference, very easily. When going outside to relax, or read a book, visitors can also walk on the grass plane. This is a good example of density making a difference in a real life situation (Fig. 5.11).

It is better not to use a rubber floor in public environments. Although it feels nice because it is soft, people risk tripping and twisting an ankle. One day we noticed that rubber tiles had been placed in the railway station at Dendermonde. Quite frequently, we personally experienced the hazards inherent in this material while running to the platform for the train. In this context, a higher level of elasticity is not appropriate (Fig. 5.12).

Temperature

Definition

In relation to the haptic perception of materials, temperature is traced back to the coefficient of conductivity, the capacity to radiate warmth or cold, or the impact of light permeability. For example, steel feels much colder than wood, bricks can radiate heat and glass is transparent to the light and warmth from the sun.

Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind

The participants in the empirical studies often referred to temperature. In the photo-ethnographic study, it is much more difficult to trace because the property is invisible on the photographs. However, some children explicitly refer to temperature as being a reason to like, or dislike, certain rooms. Temperature is often mentioned in relation to comfort.

The qualities and constraints referred to by several participants in the empirical track are: warm, cool, humid, and hot. The literature study revealed that the most common terms in the context of architecture are: warm, cool, humid, airy, radiant and cosy. In general, the participants explained that materials should neither be too warm nor too cold. To quote the caregivers, materials should have an average temperature. Explicit temperature scales are not mentioned. Instead, participants give examples of cold or warm materials. For example, caregivers refer to plastic as being a warm material. The children who took pictures of the plastic judo mat because it is a nice material affirm this.

Besides the direct perception of the material’s temperature, participants also discuss the air temperature in

relation to ‘cold’ materials. The ‘cold corridor’, for example, is photographed because it has an unpleasant atmosphere. In this context, the participant refers to the chill in the air within that space. Safety is also related to temperature. Moreover, the participants consider the temperature of a room to be a source of information. Differences in air temperature allow them to differentiate between rooms based on the variations in temperature [M009].

Furthermore, different empirical studies affirm that temperature largely contributes to the general ‘atmosphere’.

According to Lederman and Klatzky, static contact is the best way to perceive thermal conditions. Participants most often refer to active touch in relation to the temperature of materials. Dynamic touch is never referred to in relation to temperature. Passive touch is referred to in relation to materials that radiate warmth or cold. In non-visual conditions, the users feel this radiation. One participant referred to a stove being a pleasant source of warmth during winter [M001]. Some participants explicitly referred to the pleasant feeling of the warmth of the sun. Moreover, sunlight can be passively felt through permeable materials. For example, F007 explained during the home visit that she likes to sit in the bedroom because this room faces south and she can feel the sun shining through the windows. For people who have no residual vision, sunlight is always mentioned as a haptic quality in terms of temperature and the contribution it makes to the atmosphere [M003, F001, F003, F004, F006, M005, M014, F002, M008, F005]. For a few participants with visual impairments, and little vision or the perception of light left, sunlight can hinder their efforts to acquire visual information [M002, M004, M013]. Several participants refer to the passive feeling of sunlight through the sensation of warmth [F003, F007, M009, M010]. Although the transparency of materials is mentioned in relation to sunlight, the reflection of sunlight by materials is also mentioned during the in-depth interviews [M004]. However, the passive experience of warmth from sunlight, or another source of warmth, is an aspect that is only referred to during the home visits.

One of the children did take a picture of the radiator as a dangerous element in the corridor [SPE F003] and another child likes the bathroom because it is nice and warm. Caregivers did not refer to sunlight as a form of haptic experience.

Values

In general, temperature is a property that is most appreciated when it is unnoticed by the perceiver. No extreme differences are preferred. For movement planes, designers have to bear in mind that movement itself may contribute to a heightened temperature. For a guide plane, there are no explicit values derivable, but the temperature must, nevertheless, be safe. For rest planes, we distinguish between architectural elements that radiate warmth (or cold) and which are not directly felt. In other words, they are sources of warmth or cold, and the materials or elements are passively felt without any movement of the body being required. For the latter, the same values count as for active touch, whereas more extreme temperatures are more acceptable for sources of warmth or cold that are not meant to be touched. The latter case also highlights that although these values primarily focus on materials, they can also be used in relation to the experience of temperature that results from light or air.

As we have stated before, the parameters are not prescriptive and thus the values of the temperature need to be considered in relation to the action or movement that takes place, and the actual body temperature. The skin easily adapts to temperatures between 20°C and 40°C, thus resulting in a thermally neutral perception of the object. Below 20°C and above 40°C there is no adaptation, and the perception remains of a cold, or a warm, object. Above 45°C, the skin tissue starts to be damaged, and the thermal sensation becomes one of pain. Elton et al. state that a thermally neutral testing environment is a climate between 19°C and 24°C.

temperature is higher when we are working out than in a bathroom, where we are naked and more relaxed. The sensory aspects of materials certainly contribute to the experience of temperature. According to Day: “It’s hard to make a cold-feeling room out of unpainted wood, or a warm, soft, approachable one of concrete. Beyond individual personal preferences, we respond to the history and ‘being’ of materials printed into their appearance. Our feelings are not random but relate to how appropriate this ‘being is to our needs of soul. They also are closely interwoven with the effects that each material has on the body. Materials are the raw ingredients of art. But they themselves affect our emotions”.

Examples

Wood is a very pleasant material that supports the haptic qualities of temperature, as mentioned by several participants. The Norwegian architecture office of Snohetta aims to design human environments with an eye to user involvement. Throughout the design process, Snohetta focuses on the input of a range of different players in the design process: “We place the highest possible emphasis upon input from all parties, from client to builder.” In the opera of Oslo, they created a volume out of wood into which they integrated most of the circulation space. (Fig. 5.13) Besides the fact that attention was given to handrails and parapets (which are placed at different heights so that they support users with different postures), the material of the entire stairwell is made of oak. This is the first space that every opera visitor experiences before entering the main opera house, once they have presented their tickets. A warm welcome is therefore an excellent start. The implementation of oak for both floors and guide walls contributes to this experience because most people consider wood to be a very warm material. However, some materials are such good conductors that they might be considered dangerous. Natural sand, for example, can become very warm in summer and it is possible for people to burn themselves on it. Some beaches have constructions that lead from the water to the street in order to help people move to and from the beach (Fig. 5.14).

Fig. 5.13 Staircase Norwegian Opera, Snohetta, Oslo (NO), 2008

Fig. 5.14 Construction at the beach to support movement from and to the beach

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http://www.snoarc.no/#/about/information/45/, August 13th 2011
Air (Permeability)

Definition

Air permeability is identified by the degree of air that can pass through materials, the direction of the air and the type of air flow. The air permeability of a material is strongly linked to its density. The harder a material, the less permeable it is.

Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind

The participants in the home visits, and the caregivers, explicitly refer to the level of information provided by air. However, the children did not take pictures related to the experience of air. Although some researchers consider permeability to be a characteristic of texture, we chose to identify it as a separate property. This is because the participants in the home visits explicitly referred to air as a kind of material in itself [F004, M008, M015] and because, for them, air is a requirement for facial vision, as explained in the literature study. The properties of air are felt most easily through static exploration techniques.

Participants do not immediately link the air permeability of materials to their experiences of air. They refer to air, or wind, and mainly talk about orientation and the qualities of certain rooms in relation to air [M008, F004, M007, M009]. For example, M009 opens his window during winter to feel the direction of air displacement in the room and to orient himself. The feeling of air, as supported by the structure of the building, is explained under the parameter ‘connection-opening’. Air can inform about directions and different temperatures in rooms are noticeable. There are no constraints mentioned in relation to air displacement. Caregivers actually describe the fact that air can support direction in movement. The architects Bloomer and Moore also paid attention to the ‘air experience’ by creating a naturally worked out ventilation system. For example, a ventilation window sends air through the living room and, depending on the orientation of the wind, different olfactory stimuli are blown through the space, from the smell of the peach orchard on the one side, to the fragrance of the pines that stand on the other side of the house.⁸⁰
Participants in the empirical studies only talk about the information gained from air in very positive ways. The experience of air is always referred to in relation to passive touch, and it can provide information about direction, permeability and temperature.

For movement planes, a high degree of air permeability is not appreciated as this can disturb the actual orientation on the plane.

A guide plane can have a remarkably different level of air permeability compared to a movement plane, or can radiate air with a noticeable difference, with the air temperature indicating the differences in planes.

Examples

In 2011, Mab architects designed the Plinthos pavilion using over 20,000 bricks (Fig. 5.15). The walls, floors and ceilings are made out of the same material - clay bricks. The results is a permeable surface. The architects, who want to celebrate the qualities of clay, call it an interactive multisensory room. As pointed out by Mab Architects: “Plinthos pavilion is a room that breathes. Visual transparency created by the perforated brick wall, becomes the channel of interaction between the visitors and the structure. A constant background sound-scape and an expanding RGB light communicate through the wall, transforming the structure into a living organism in which the visitor is completely involved.”81

This installation shows the quality of air permeability in materials.

If the air current is too strong, or blows in the wrong direction, it can be annoying. Many city squares have an underground car park and they are ventilated through the pavement. A visual solution is often found, but designers mostly forget about the haptic experiences when walking on the square. The Schouwburgplein in Rotterdam, designed by Adriaan Geuze (West 8), and realized in 1996 (Fig. 5.16), is an interesting example. In the square you can find, and feel, the grates through which the air escapes. When walking on these grates the unexpected feeling of air on your face might feel annoying. On the other hand, these can also form a clear barrier that marks a certain side of the square. However, the square is in the process of being rebuilt, the floor in particular, in response to the large amount of criticism since opening.

Specific Gravity

Definition

The mass of an architectural element is defined by its specific gravity multiplied by its volume. The specific gravity will contribute to the experience of mass. However, as some researchers consider mass to be a hybrid property, because it is linked to specific gravity as well as size, it is logical to speak about specific gravity in the context of our framework of haptic design parameters.

Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind

Unlike the other properties specific gravity cannot actually be perceived. It is the ratio of the density to size. In the empirical studies, only the caregivers explicitly mentioned the impact of mass on the haptic experience. For example, the weight of a door is felt while opening it. An element can feel ‘heavy’ or ‘light’. In an architectural context, mass is felt by putting pressure on an element, or lifting it.
Values

Mass is perceived by means of pressure, static contact or unsupported holding.\(^2\) For sensitive body parts, lighter materials are preferred. During active and dynamic touch, the body anticipates the weight of a material, whilst with passive touch the weight ideally needs to be light because the impact is uncontrolled.

The choice of a material as a function of its specific gravity strongly relates to the construction method and its use. In other words, the context will largely influence the choice. For movement planes, the mass has to support the pressure placed on the plane when moving forward. The potential pressure needs to be assessed in relation to the posture of the user’s body. A door handle, for example, informs us about the mass of the door as it functions as a guide plane. Ideally, the mass or specific gravity of the material used in a guide plane should differ from the adjacent movement plane. A rest plane has no specific requirements. For example, a hammock can be as supportive as a chair. The more heavy a movement plane, the safer people will feel.

Example

The feeling of a heavy door is one of the best known examples of the impact of specific gravity on architecture (Fig. 5.17). If used frequently, a heavy door might not be so very practical. However, in some conditions, heavy doors can contribute to privacy because they discourage entry. Also, when planes are meant to bend, or rest on or against them, a heavy material can contribute to a feeling of safety. It is clear that designers can use the impact of specific gravity in different ways.

5.3.3.2 Geometrical Parameters

Geometrical parameters relate to the way surfaces play a role in the larger built environment and define its structure. All structures are made up of surfaces that are characterised by certain parameters: curvature, orientation, configuration and size. Some parameters have underlying sub-parameters.

Similar to the material parameters, the geometrical parameters are derived from insights from existing research, as detailed in the literature study, as well as additional findings from the empirical studies. The literature study revealed that most studies on haptics are limited to object explorations. Consequently, they restrict geometrical properties to shape and size alone, or shape, length, orientation and localisation.\(^3\) As the scale of a building is much larger than the body and thus impossible to perceive whilst in a static position, we distinguish characteristics on the smaller scale of an architectural structure that consists of planes. Moreover, splitting the shape characteristics into several parts allows us to take into account the diversity of the different stimuli. It is clear that all the different

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properties interact with the size of the building and its composition or total structure. The classification in which Lederman and Klatzky distinguish the contours (curved versus flat), the orientation of surfaces, the edges and the holes, provided the first clue that led us to further investigate the subject of geometrical properties within the built environment.84

Geometrical parameters define the structure of the built environment and in general it is agreed that consistency is vital to a clear structure.

Curvature

Definition

Curvature tells us whether a plane is straight, convex, concave or wavy. Curvature is haptically perceived through force cues that determine the haptic experience of a plane.85

Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind

During the in-depth interviews that took place during the home visits, the participants stated that they do not like forms that are round. However, the video tour and plan annotations reveal that they do, in fact, often like round forms in their houses. Caregivers affirm the difficulty of round forms in terms of orientation and explain that it is the result of the fact that such forms lack a start and endpoint. A spiral staircase is different, according to one participant. This is because the spiral stair follows a certain rhythm and has a start and end point [F005]. When relaxing, the participants tend to like curved and round forms because they contribute to the atmosphere. The same is true of details or special landmarks. Small round details are appreciated because they support diversity in the environment and can sometimes even be a landmark in themselves, like the curved handrail of the staircase in one of the participant’s houses. The children born blind took pictures of the round exercise ball but they did not explicitly refer to round forms in the built environment, nor did they take pictures of round architectural elements. Nevertheless, the analysis reveals that there are hardly any round forms within the school environment. This is probably because the caregivers, and people born blind, generally agreed that straight surfaces are better for orientation. Consequently, the staff and caregivers do not buy round forms, or encourage their use within the school environment.

The plan annotations and the photo tour both reveal that the participants of the home visits tend to slide, or trail, their hands along a surface in order to feel its curvature.

Values

The empirical studies do not tell us whether touching with sensitive, or insensitive, body parts influences the preference for the kind of curvature of a surface. However, it is much better to bump into a rounded corner than a sharp one. Because of the smooth curves, round forms are appreciated in relation to active touch and dynamic touch as well as passive. However, preferences that are more specific require further investigation.

Straight planes are largely appreciated for orientation. In a more relaxed situation, round or curved planes are welcome.

However, rest planes ideally adopt an ergonomic curvature. For example, certain tables have round forms because people can sit around them and the round sides of the tables feel more comfortable. In terms of comfort, a round form is largely appreciated.

For safety reasons, it is generally agreed that movement planes ideally are straight planes. However, a small round detail in a movement plane can serve as a landmark. Guide planes, in addition to rest planes, can be wavy, convex or concave, as long as they support function.

Examples

Guiding or movement planes that are curved are not a problem when part of a recreational setting. If people want to rest, they are very much appreciated. The path in the Millennium Park in Chicago has a wavy form but...

Orientation

Definition

Orientation describes the way in which surfaces are placed in relation to the perceiver and his/her body (movement). The parameter directly relates to the perceiver’s reference systems. The property of orientation is expressed by means of the plane’s location, as well as its direction. Location represents the following values: up-down, left-right or ahead-behind. The direction provides information about the angle of the plane in relation to the perceiver’s body axis.

Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind

As explained earlier, the home visits revealed that in non-visual conditions ceilings, walls or floors are all considered to be ‘walls’, or ‘planes’. For example, if ceilings can be actively touched, under an inclined roof, participants identify these ceilings as walls. The plan annotations, in-depth interviews and the photo-ethnographic study show that active touch focuses on the floors, and the walls or planes that are within reach. These planes do not just have to be part of the construction - they can also be part of furniture. This blurs the distinction between interior design and the design of the construction and structure. In haptic perception, it is clear that people feel surrounded by planes. The children who took pictures perpendicular or parallel to the ceilings, floors and walls confirm this. The picture of the slope on the playground is a good example.

Although the basic orientation of each plane refers to our egocentric reference system, the caregivers also affirm that walls can support and provide information about direction. During the home visits, it was clear that planes in an orthogonal system, perpendicular (90°), or parallel to the body’s movement facilitate orientation. Consequently, a corridor can support movement. Inclined walls, if they hinder passage, are disliked. Some participants referred to inclined roofs or scaffolding. However, when these inclined walls are known, and people are familiar with them, they may support orientation and function as a landmark. This

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Fig. 5.18 Curved path, Millenium Park, Chicago, (U.S.)

Fig. 5.19 Railway station, Santiago Calatrava Liège (BE), 2009

in these built, people can take a rest and enjoy the view (Fig. 5.18). However, it is very different if you are actively searching and trying to orientate yourself in, for example, a public environment - a railway station perhaps. Santiago Calatrava designed an innovative and excellent solution for the railway station in Liège (Fig. 5.19). Although the ceiling and most of the structural elements have a curved form, the wall and structures at hand level are all placed in an orthogonal way, and are perpendicular in relation to each other.

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also applies to floors. A slope may function as a landmark. However, some participants remark that to create a relaxing atmosphere the planes ideally need to be placed spontaneously.

If there are obstacles, it is better to place them to the side because it does not support guidance. Caregivers explained that the cleaning carts are always placed at the left side of the corridor because this makes it easier for the children to orient themselves based on the planes to the right of their bodies.

The findings of the home visits and the focus groups affirm that people-born blind place their furniture along the walls as this supports direction in movement. Consequently, the orientation of planes has to be designed in relation to the body’s egocentric reference system. The way people are taught to orient themselves is very striking. This is also revealed by Julia Ionides who points out that many people born blind learned to understand spaces the way sighted people do. Caregivers also referred to the fact that their mobility training courses are all based on an orthogonal system.

Values

Perception in terms of orientation requires direct body contact and, more often than not, sequential body movements. The differences in direction and localisation between planes are best felt through active and dynamic touch. However, some people are able to localize planes by means of passive touch. In the context of the orientation of the planes, participants did not refer to the impact of the sensitivity of their body parts.

To locate the different planes in relation to the body, basic orientation refers to up-down, left-right and ahead-behind. The directions of the planes can vary from 0° to 90°, in relation to the perceiver’s body. If the plane is not straight, but convex, concave, wavy or round, the angle is calculated by means of taking the main axis of the direction of the plane in relation to the body (Fig. 5.20). The changes in direction in planes can be stored in people’s memories. Muscle memory allows directions to be stored and retrieved in relation to orientation.

In terms of functionality and orientation, preference is given to surfaces that are parallel or perpendicular to the egocentric reference axes. Whereas atmosphere is important when taking a walk in the park, unfamiliar or unexpected directions are welcomed in these situations. Even in the absence of sight, choices contribute to the experience of the environment.

For movement planes, the wall surfaces are best placed at 90° or above, while the floor ideally needs to have an angle of 0° or less than 3°. Rest planes, on the other hand, may deviate from the familiar orientations.

Examples

In the Hazelwood School for the blind in Glasgow (U.K), for example, (Fig. 5.21), the architects Gordon Murray and Alan Dunlop designed a ‘backbone wall’ in the middle of the school. It has several different functions. First of all, it is a cupboard for the children’s coats, canes and briefcases and the teachers’ work materials. Secondly, it creates a transit zone between the passage way and the classrooms and, finally, it helps the children with visual impairments orient themselves. This is because the wall is not orthogonally structured but twists through the building and makes blunt angles with the surfaces. As a result, the backbone wall draws a line through the building in a very kinetic way.

Similarly, the square in front of the VISIO school for the blind in Huizen also helps the children to orient themselves haptically. The square takes the form of a low slope and, although it was never meant to be inclined (it was an error on the part of the contractor), the children now know exactly where they are on the square (Fig. 5.22).

Another good example of planes that support orientation is the house designed by Bloomer and Moore, in which there is a puzzle of different rooms. All the different rooms are linked by means of the hall and corridors. No room has the same shape or scale because each space is unique. To achieve this, they made use of different angles for the walls in relation to the body. Consequently, it is easy to recognize the different rooms through their haptic characteristics. Although this design has, in some ways, an eclectic approach to the representation of the different rooms, the inhabitants experience the building as one whole (Fig. 5.23).

**Configuration**

**Definition**

Configuration describes the way in which planes are placed in relation to each other. This provides information about the number of planes involved in the whole structure, as well as the way in which the planes are connected. The edges of the planes are also described, as is the frequency (and/or the rhythm) in which the planes appear.

**Number**

The number of planes, corners and edges in a structure can be counted. The more planes, corners or edges that are felt during haptic exploration, the more complex the total structure becomes. This property tells us about the perceivable number of planes, corners and edges in relation to the total structure. The different ways of perceiving a plane, or the whole structure, corresponds to what Karlsson defined as the ‘inner horizon’, as explained in Chapter 3.89

**Connection**

The connection of a plane is its link to another plane. These connections can be felt in the form of corners, or moveable joints. Corners are formed when two planes are connected and linked by a line. The angle between the corners is different from 0°. The connection between two

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planes can also move - the hinge of a door, for example. If there is no connection between planes, there are two options: 1. There is an opening between two planes, in other words the planes are close to each other but not connected; 2. There is no plane in a haptically perceivable proximity and thus the plane stands on itself and is characterised by edges (see below).

**Edges**

This is a line joining two corners of a plane. An edge can be straight or curved.

**Rhythm and Frequency**

When planes are placed with a certain frequency from each other, this can support familiarity and recognisability in haptic perception. Frequently repeated planes may result in a kind of rhythm in the architectural elements. In this case muscle memory comes into play and supports orientation. A staircase is perhaps the best-known example of planes placed in a certain rhythm.

**Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind**

**Number**

Several participants in the home visits study referred to the fact that the number of sides, corners and edges needs to be sufficient but, at the same time, not be too overwhelming [M002, M003, M005, M008, M009, M014, F004, F007]. One participant referred to a chaotic room in the house and when we analysed this through plan annotations it was clear that there are many corners, edges and planes present. Besides, the home visits show that every small detail is explored and analysed as a composition of different planes. The caregivers explain that too many stimuli result in chaos. Nor is it good if there is an absence of stimuli. The importance of countability becomes also clear in the teaching and education given by the caregivers. They teach children to count as showed to us by one of the children [SPE F003] during the photo tour while taking pictures of the windows that she was counting in the corridor.

**Connection**

During the video tour and the home visits, we noticed how important connections actually were, when the participants actively touched certain connections to obtain information. For example, the connections between rooms and the other observed planes, such as the kitchen bar. It also became clear during the photo-ethnographic study that the children liked to take pictures of the connections present in corners or openings. These pictures mostly resulted from the children’s direct perception of a corner, or a proximal opening. The caregivers added that continuity is appreciated. By means of facial vision, it is possible to feel the difference between open and closed...
planes. However, the caregivers stressed that corners provide a lot of information but that they must not be too sharp. In general, the home visits, photo-ethnographic study and the focus group interviews showed that people born blind prefer static or fixed elements in the built environment. The caregivers explained that landmarks always needed to be static. Moveable planes are indicated as landmarks in non-visual conditions. However, if users are not familiar with these moveable planes, they can become an obstacle. Static spatial objects are easier to evaluate than dynamic ones. For example, it is obvious that furniture designed to be stationary will reduce the possibility of accidents.\(^{90}\)

Besides the moveable connections, Bloomer and Moore noticed that there was a problem with corners because blind people often bump into them and hurt themselves on the sharp edges.\(^{91}\) Therefore, they chamfered, or rounded, all the corners in their design to help the blind man move around his house more easily. Although this solution might be safer, corners can also support orientation quite comfortably. Corners are important decision points,\(^{92}\) and they can therefore also form points of reference.

**Edges**

During the video tours in the home visits, we frequently noticed that participants follow the edges of the planes to feel the direction of movement, or to search for the contours of landmarks or architectural elements. The same phenomenon took place during the photo tour. Edges can be formed by the contours of planes or by the junctions of two or more planes.

**Rhythm and Frequency**

The participants in the home visits explained that walking up and down staircases is very easy. One participant even runs up or down the staircase [M001]. One of our blind acquaintances explains that the staircase is the safest place for a person born blind, meaning that it has a clear pattern, follows a certain rhythm and, unless somebody has placed something on the stairs, there is a complete lack of obstacles.\(^{93}\) The children born blind also appreciate elements, or qualities, that are frequently repeated. One of the girls took a picture of the glass wall structure in a corridor. She likes to feel and count the repetition of the different openings in the several windows, also repeating, in the wall of the corridor.

**Values**

**Number**

The number of planes, corners and edges must be countable and in relation to the affordance and movement. Therefore, the ideal is a balanced and countable number of stimuli. We observed that the more planes that needed to be explored in one go, the more complex it was for them. If the number is too high, the configuration is probably too complicated like for example the hexagonal space that one of the participants of the home visits referred to [M009].

**Connection**

A connection of a plane involves a corner, an opening or a moveable connection. Corners may not be too sharp and are preferably straight or obtuse angles (90° ≤) for safety reasons. Openings are clearly marked and support the body’s ergonomics and movements. Repeated openings in a certain rhythm are appreciated when predictable. If openings are unpredictable or not felt at touchable height, (for example an opening between a wall and a floor that is not felt at the height of the touching hands), this can be very dangerous. Moveable connections are always challenging points for haptic perception. Well known moveable connections are for example doors, shutters, moveable panels, treadmills,... Important for moveable connections is that these do not have openings between the plane that moves and other planes. For the ideal direction of movement we refer to the parameter ‘orientation’.

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\(^{93}\) Personal comment to us of a person born blind on “Ontmoeting in het Donker”, October 7th 2010, Antwerp by B.V.
Edges

Edges can be straight, curved, round or oblique. Straight edges are always very easy to recognise and predictable in relation to the body’s egocentric reference frame. If the edges are straight and perpendicular to the body, this supports comfort as well as safety. Curved and round edges are safe as well but not designated in an unprecedented context where one has to orient. Different it is for curved or round edges in relaxing situations and for sensitive body parts where edges comply with the body’s ergonomics. Oblique edges are unsafe when not predictable, like in the case of the chamfered staircase. They are considered to be uncomfortable when not following the direction of movement or the body’s ergonomics.

Rhythm and Frequency

The rhythm or frequency that is experienced, is preferably predictable and recognisable and in accordance to the body’s ergonomics. If certain rhythms repeat, this repetition can be considered as comfortable. In some situations predictable rhythms even support safety like for example for a staircase.

Examples

A good example of rhythm is the corridor of Portland College in Mansfield, Nottinghamshire (U.K.). Portland College is a single storey learning centre for people with varying degrees of disability, designed by Patel Taylor. Different doors in one corridor are placed with a small twist, which makes it easy to count the doors based on the number of corners felt in the wall (Fig. 5.24).

Size

Definition

Size is the information about the dimensions of a plane, and also its length. By length we mean the distance between the perceiving body (part) and the perceived plane. Length is measured in relation to the body.

Cross Analysis and Triangulation of the Findings on the Expertise of User/Experts Born Blind

One major difference between visual and haptic perception, resulting from the proximal nature of the haptic sense in terms of discerning space, is accessibility of scale. Haptic exploration limits the vantage point, whilst merely turning one’s head immediately expands visual access. Consequently, nearby stimuli are appreciated, as are the stimuli whose size corresponds to the size of the body surface (or body part) that is doing the touching. For example, hands are perfectly suited to feeling small details and patterns.

The home visits revealed that small planes, small spaces and low ceilings contribute to a pleasant atmosphere and, in most situations, also to comfort. The participants define ‘small spaces’ based on the width of the passage between planes [M001, M005, F002, F004, F005, M008, M009, M011, M012, M014]. This space is ideal in terms of feeling guide planes on both sides, parallel to the direction of movement. One participant literally shows us the ideal dimensions by keeping her arms at an angle of 120° in relation to her body [F005]. Others affirm that the width of the body, multiplied by two, is preferable [M005, F004, F005, M014]. However, places that are too small are not good either, nor are huge spaces in which it is not possible to find reference points to help with orientation. In other words, a room can be very large so long as the

guiding planes support the user, and the planes are placed at an ideal distance from the body. However, the caregivers referred to large spaces in which no clues can be found. These are classified as obstacles because it is very difficult to find your way in a large space without reference points in non-visual conditions. However, this does not mean that the distance needs to be marked by the structure of the planes alone. Material properties can also mark differences in paths, provide clues that haptically offer a landmark, or indicate a node and an edge.

The plan annotations and the explanations of the caregivers suggest that there is no difference between distances inside or outside a building. This is because the body favours proximity in relation to haptic perception and proximity is considered to be a system of measurement. When designing size, it is crucial to take this in mind. Sizes are mostly estimated via active or dynamic touch and body contact is required. This is also the reason why many pictures taken by the children represent details, or close ups of elements, as the children take pictures while actively or dynamically touching the object. Pictures that show an overview are always based on memories about the space, like the picture of the big hall, the shelter or the judo room. Caregivers explicitly stress the proximal character of haptic perception by explaining that their students always rely on the nearest stimuli and that it is difficult for them to estimate distance. Passive touch, in the form of facial vision, occurs when participants are conscious of it.

In general, size is measured in relation to the body, the movement of the body and time.

The fact that the body is a measure in itself makes it much harder to generalise an ideal size. Each body is characterised by different dimensions. Therefore, the measure of distances is always slightly different and very personal. The caregivers explain that, depending on the user’s body, proportions can be perceived very differently.

Because so much is measured in relation to the body, it is logical that the small details that are much easier to perceive can form huge landmarks. The caregivers explain this, and it is also evident during the video tour when several participants refer to small details in their furniture or the buildings.

A good example of measurement through physical movement is when the participants in the home visits explain that they prefer rectangular forms. The caregivers also affirm this. In the context of the exploration techniques described in Chapter 3, this is not surprising. If participants walk the perimeter of a room and the room is square, it is much harder to remember which side of the room they are on. But if there is a difference in length between two sides, as in a rectangular room, it is much easier to locate oneself. This rectangular form is felt by counting the number of steps taken to walk along the wall. Counting architectural elements, or steps, is something that is also noticed during the photo tour. SPE F003 took pictures of the corridor in which she always counts the windows when passing by. She also counts her steps when crossing a (familiar) street. The mobility instructors taught her to do this and they tend to teach the children to cross the street next to the school by counting their steps. Instead of counting steps, people can also rely on the time needed to move from one point to another. Time also enables people to discern, and estimate, the distance of planes. Thus time can be seen as a conscious barometer that informs people about the distances they have travelled.

Values

As revealed in Chapter 3, the metric system used to estimate size in haptic conditions relates to movement, the perception of time and the body of the perceiver. The body is the measure of size, or the metric system to which the perceiver relates the information. By means of muscle memory, the information is stored. Time can give additional information about the size of a plane, or a room in general.

In haptic conditions, certain aspects relating to size disappear - like depth. On the other hand, huge distances can be estimated simply by travelling the distance. Exceptionally, some people can tell the size of a room based on facial vision or passive touch. The minimum distance between two points, or lines, is 3 mm. According to Maarten Wijk, the size of a clear structure ideally consists out of short routes between interrelating functions.97
Examples

Jamie Hamilton, an architect, designed a beautiful day care centre for sensory impaired war veterans in Wilkieston, Kirknewton (U.K) (Fig. 5.25). Embedded within a sensory garden, this beautiful building also shows that the architect kept the size in mind. The size of his building is on a very human scale. The corridor, for example, provides enough space for three people to walk side by side. The architects state: “Inside the building, the primary circulation route is a generous width and has a continuous handrail down one side to provide support where required in addition to acting as a guide to the visually impaired. Where access to rooms occur off this corridor, bold gestures have been made at these locations both in the layout and in terms of the colours used on the walls.” This explanation is given in the context of inclusive design. The corridor has enough space to allow easy passage, but is not so large that people cannot haptically perceive the nearby planes (Fig. 5.26). A handrail, for example, follows the line of the corridor along the different windows and acts as a guide plane.

Fig. 5.25 Daycare centre for sensory impaired veterans, Jamie Hamilton Kirknewton (UK)

Fig. 5.26 Corridor in daycare centre for sensory impaired veterans, Jamie Hamilton, Kirknewton (UK)

5.4 Building the Framework of Haptic Design Parameters

The framework of the haptic design parameters is built up in such a way that the parameters can be consulted and assessed at any point in the design process. It is based on the main outlines that we described in the foregoing sections: the conditions for the context, the haptic experience and the design itself. We will summarize these ideas in order to build up the design framework.

The context of the design will influence ‘how’, ‘when’ and ‘where’ we touch. What we touch is described in terms of surfaces or planes. The values of each parameter can apply to each surface separately. These planes can afford certain actions in the built environment and, based on our empirical findings, we distinguish three kinds of affordances regarding haptic experience in the built environment: moving, guiding and resting. These three uses will form the first range of possibilities in the context of the design and result in the corresponding planes: movement plane, guide plane and rest plane (Fig. 5.27). Whereas these three kinds of planes represent the different affordances that a user can recognize, the movement of the body itself will also contribute to the context of a haptic experience. How movement occurs makes a great difference to the haptic experience. It can occur through the body alone, tools might be used to support the exploration, or the body might be static. Based on the different kinds of body movements and the level of control a user has, we add a classification in terms of active, dynamic and passive touch (Fig. 5.28). Finally, the impact of a sensitive or insensitive body part will also determine the preferred values.

Although a movement plane will most often be actively touched, it can also be useful in terms of passive touch. The same is true of guide planes, which can support users in terms of orientation in the built environment. Rest planes, on the other hand, are

<table>
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<tr>
<th>modes of touch</th>
<th>active touch</th>
<th>dynamic touch</th>
<th>passive touch</th>
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<tr>
<td>movement planes</td>
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<tr>
<td>guide planes</td>
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<tr>
<td>rest planes</td>
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Fig. 5.27 Planes resulting out of affordances

Fig. 5.28 Contextual classification based on modes of touch and kinds of planes
primarily perceived through passive touch, although active and dynamic touch is also possible. The values of the parameters that relate to movement planes focus on structure and try to support orientation and balance in movement. The values of the parameters related to guide planes primarily provide information about the direction of the surfaces. The values of the parameters for the rest plane, on the other hand, relate to the support of the body when in a static position and are primarily concerned with passive touch. With regard to the latter, information about which materials can heat or radiate warmth or cold, and the effect of materials when rubbed against the skin, is for example important.

The information regarding use, the sensitivity of body parts and the movements of the body all relate to the context. They are placed on the main orthogonal 3D grid that outlines the framework. The three categories are placed on three axes (Fig. 5.29).

The values of the parameter can differ according to all the possible combinations between the kind of touch being considered by the designer, the use afforded and the sensitivity that will be applied. During the design process, the designer can start from a certain context, or he/she can work towards a certain context.

The haptic experience is the effect that results from the design in relation to the context and it is determined by the different levels of mental processes: the level of perception, the level of memory and the level of meaning. The interaction between these levels will form the final value of the haptic experience. The experiential variables are placed on an octant, of which the three axes represent the three levels of mental processes (Fig. 5.30).

The level of perception tells us about the predictability (or unpredictability) of stimuli, whilst the level of memory represents the values in relation to the aspect of comfort-discomfort. The level of meaning, on the other hand, focuses on general knowledge and provides information about the safety (or hazards) within a design. Our empirical research affirms that it is possible to determine three different axes on which the different values can be set. These values will contribute to the final experience.

For each possible combination within the context, we can form the octant with similar extremes but changeable values. In our approach, this octant will form the basic framework for each haptic design parameter. Based on these axes we can assign values to the variables of each experiential parameter. These three axes are placed in an octant and each value can change depending on the different choice within the context. Consequently, each parameter may vary in value depending on the kind of touch, the use of the plane and the sensitivity (Fig. 5.31). To this octant of experience we place the values of the haptic design parameters. The haptic design parameters relate to the
material and geometrical properties of the built environment. Each haptic design parameter may offer several possible variants of haptic experience in relation to the context. Designers can be inspired by the values of the parameters, or they can start from the context or the experience itself. This means that designers can use the framework from the bottom up, as well as from the top down.
5.5 Applying the Haptic Design Framework to the Design Process

So far, we have explained the framework of haptic design parameters, the parameters and their values, but how can we assess these parameters within the design process? As previously explained, the framework is designed to inform and inspire, as well as to offer feedback on existing designs. A designer has the freedom to choose which parameters she/he applies and to accept the challenge to implement these parameters in the creation of a well-balanced environment. As in visual design, haptic design receives meaning through the carefully chosen creation of diversity. The concepts of landmarks, paths, nodes, edges and boundaries may be supporting elements in terms of building up a design. In the context of planes, boundaries will create these concepts. Mary Ann Lang conducted studies with children born blind and revealed that: "An important difference between the children with full vision and those with impaired vision was the frequency of their use of physical boundaries. The children with full vision infrequently used or organized their play around these markers. The children who were blind or partially sighted, however, used them often as equipment and as orientation guides. This may point to a major difference between the way in which these two groups regard objects and boundaries. Individuals without visual impairments generally treat objects and boundaries as obstacles to be avoided. People with impaired vision use them as landmarks to be encountered and to assist in way finding."99

The parameters are defined in such a way that they can be consulted and assessed at any point in the design process in order to support the main concepts.

In order to assess the performance of the design in terms of haptic experience, after the haptic design parameters had been implemented into the design process, we made use of drawings. This might sound paradoxical, since drawing is a visual representation technique. However, strictly speaking, the drawing is an act that connects visual language with the haptic. The act of drawing is a haptic skill of a hand that is able to translate the visual ideas of the mind. Sketches, in particular, are also drawn in a sequential way, step by step. This is comparable to the process of haptic perception. Similarly, the person drawing is forced to pay attention to details, and she/he will certainly perceive more whilst sketching. Besides the strong link between haptic and visual language, we recognize the importance of drawings in the design process. As Brian Lawson points out: "The design drawing seems to be so central for many designers that they are almost unable to think without a pencil in their hand."100 Drawings also form the basis for evaluating a design proposal because they allow designers to adjust things over and over again.101

Thus the assessment relies on well-known skills and design practices in architecture and focuses on accentuating and clarifying the purpose of an environment. To assess the performance, we focus on the three different uses that a plane can afford: moving, guiding and resting.

To assess the extent to which haptic orientation and movement is included, designers are advised to check whether the space in which people move is conveniently arranged. We were inspired by one of the explanations given by a participant in the home visits. She pointed out that she could easily analyse a well-structured space that supports movement by vacuum cleaning [F005]. When she is vacuum cleaning, she bumps into furniture and walls and she can clearly feel the movement in space. As explained in Chapter 4, we analysed the plans of the home visits by means of plan annotations and we also drew the inverted space of all the houses. The inverted space refers to the places in which people can move through a room. Sometimes, designers also identify this map as the ‘figure-ground’ or the space represented as the ‘negative’ space, meaning that the walls and furniture represent the positive space. It reveals the relationship between building mass and open space (Fig. 5.32). Consequently, by means of drawing the inverted space, structure becomes clearer.

Interestingly, the participants disliked those rooms and places in the houses, that appeared to have very complicated inverted spaces. The inverted space allowed us to check the curvature of movement planes, the configuration of the structure and the size of the planes and the whole room. For orientation, we required an inverted drawing of the plan section.

Drawing the inverted space in architecture is nothing new. One of the oldest drawings known is the city map of Rome drawn by Giambattista Nolli (Fig. 5.33). The mass is coloured black and the free space is white.

Guide planes on the other hand can be assessed by drawing the run lines onto the plans (Fig. 5.34). If run lines...
are supported by architectural elements, especially on decision points, guidance is probably well supported. This became very clear in the plan annotations. The trailing along certain planes confirms their usability as a guide plane. Ching explained the importance of guiding in architecture: “The path of our movement can be conceived as the perceptual thread that links the spaces of a building or any series of interior or exterior spaces together. Since we move in time, through a sequence of spaces we experience a space in relation to where we have been and where we anticipate going.”

Using routing, or paths, to analyse space is also a technique that is frequently used in architecture. Ben Van Berkel also explains the phenomenological value of drawing the paths. He states that the usability of a place is evaluated by the way in which you approach the objects you live with: “You approach a table and the bathroom and you move towards objects that you live with. But the most beautiful aspect is that these elements of life are connected to architecture.”

Moreover, Van Berkel states that the different elements may afford several uses - as in the Möbius house, in which the Möbius ring represents the daily routing and a concrete wall also acts as a staircase. Besides the use of run lines in almost every design (Fig. 5.35), Van Berkel also makes use of the inverted space to analyse his creations (Fig. 5.36).

Rest planes are more difficult to represent. Nevertheless designers can encircle the fields meant to be rest places and check that passageways do not diagonally crossed them (Fig. 5.37). If they are crossed too often, this means that their rest function will likely be disturbed.

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103 Ben Van Berkel on youtube: www.youtube.com/watch?v:F4kavwFhwwQ on October 5th 2011
104 Ben Van Berkel on youtube: www.youtube.com/watch?v:F4kavwFhwwQ on October 5th 2011
5.6 Discussion

If architects paid more attention to non-visual senses in their designs they could contribute to the creation of more inclusive environments. Indeed, if an environment offers a range of sensory triggers, people with different sensory capacities can navigate and enjoy it. Rather than trying to implement as many sensory triggers as possible, the intention should be to make buildings and spaces as accessible and enjoyable as possible for the greatest number of people, in line with the objectives of Designing for More. Interestingly, this approach gives the architect the freedom to stress what she/he considers to be the most important aspect of the design. Based on the characteristics of haptic perception, this study lays the foundations for a framework of haptic design parameters. These are defined as limits, between which architects can make choices as to how to design the appropriate experience. Architecture creates opportunities for perceptions, experiences, meeting and living and designers need to realize the vital role that they play in the process of creation.

To evaluate whether these parameters meet the needs of architects, and the diverse users of the built environment, the proposed framework of haptic design parameters is tested with a group of professional architects and a group of possible end users of the built environment, as will be explained in the following Chapter.
Chapter 6: Evaluation Track

6. Evaluating the Framework of Haptic Design Parameters
6.1 Introduction

Having designed a framework of haptic design parameters based on the expertise of people who are blind, the following question needs to be addressed: “To what extent can the framework be applied so that all users, regardless of their abilities, gain maximum benefit from them?”

The evaluation of the framework provides an opportunity to adjust and refine our research results, which is in line with the ‘user orientation’ of Design for More. Evaluation thus completes the design process (often characterised by ideas going back and forth) and finally affirms the cyclical nature of the DfM process, as each evaluation encourages improvements. Designing for More is a never ending process based on knowledge gained through user involvement.

According to Goodman and Waller, the involvement of real end-users at any - or all - stages of the design process can provide insights into what design solutions can and cannot be used for, and what goals may be achieved.1 To some extent the framework of haptic design parameters can be considered to be a product of DfM. The end-users are situated on two levels. Indeed, the end-users of the framework are, on the one hand, architects—the designers of the built environment—and, on the other hand, any users of the built environment. The assessment focuses on the content of the parameters, and their interpretation. Besides the content of the parameters, the extent to which they can support architects in addressing haptic experiences during the design process is evaluated.

In order to evaluate the framework from the architects’ point of view, a design process was simulated as accurately as possible within an architecture firm.2 Evaluating the usability of the parameters’ content for other users of the built environment was more complicated.

As explained in Chapter 2, we decided to evaluate the validity of the framework’s content for different end-users of the built environment via a focus group interview with a diversity of users. Prior to this evaluation, we report how the framework for the haptic design parameters was evaluated by architects.

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6.2 Architects: Future Users of the Framework of Haptic Design Parameters?

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 (Fig. 6.1).

6.2.1 Set-Up and Approach

The workshop takes place on February 16th 2010 after work in a meeting room at the firm’s headquarters.

The workshop consists of three parts: an introduction to the framework of haptic design parameters, 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 participants 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 the participants 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
<table>
<thead>
<tr>
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<th>gender</th>
<th>birthdate</th>
<th>profession in office</th>
<th>working @ office since</th>
<th>education</th>
<th>function within the design team for the psychiatric centre</th>
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<td>researcher R&amp;D team</td>
<td>2003</td>
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<td>M</td>
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<td>architect</td>
<td>2007</td>
<td>Architecture</td>
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<td>1973</td>
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<td>2000</td>
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</tbody>
</table>

Fig. 6.1 List of participants in the workshop and focus group interview for architects

Fig. 6.2 Concept model (top left & bottom left) and detail (top right & bottom right) of the project (© osar architects)
intertwined roller coasters embedded in the surrounding undulating hills (Fig. 6.2). 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, 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.

Participants had the opportunity to discuss the parameters and their implementation within the context of the psychiatric centre design project for 45 minutes. We originally proposed working in teams of two to three people, but in the end the meeting space did not facilitate groups sitting separately. Participants started talking in groups of two but, eventually, the discussion encompassed the whole group.

Lawson argues that conducting empirical work on the design process is notoriously difficult because the design process, by definition, takes place inside the mind. In order to avoid misinterpretation, and to stimulate the participants to engage in designing as much as possible, a post-workshop focus group interview is planned. The aim is to allow participants to describe how they work under regular conditions.

After a short break the moderator starts the focus group interview and questions 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 analysed together with the folders and floor plans used by the architects.

The reactions during the focus group interview suggest that the participating architects immediately picked up the underlying idea of the framework, and recognized its relevance in relation to the design project at stake, but that its representation confronts us with a sensory paradox: although the framework questions the impact of the visual in architectural design, it is meant to be used by designers, who are trained to think, understand and work in a visual way.

6.2.2 Findings

6.2.2.1 Haptics and the Relationship between Experience and Knowledge

Most participants find the research on haptics useful and everybody agrees that certain buildings need to be more user friendly and include haptic qualities, e.g. public buildings or buildings for a particular group (schools, homes for the elderly, homes for people with dementia, dwelling places for children, hospitals and libraries) [ARCHI 5, ARCHI 4, ARCHI 3, ARCHI 1]. However, some participants find that these properties cannot be implemented within all buildings. For example, in a museum: “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, you really want huge spaces... that breathe air and light...” [ARCHI 6]

This reaction 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 therefore suggests that some of the participants regard the parameters as restrictions rather than sources of information that offer opportunities and possibilities. Only two participants are certainly convinced about all the opportunities of the parameters. According to one participant, inserting a path-routing system (run lines) representing the guide planes encourages one to think in different ‘motion’ steps and can thus help to clarify a design [ARCHI 5].

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5 ARCHI 6 (Dutch excerpt): “Ja bij een museum zou je dan eerder zo iets hebben van een rondgang waardat je tot rust komt en dan ga je niet beginnen met smallere ruimtes van twee keer hé armbreedte gaan ontwerpen hé... die die...licht en ruimte uitdelen dan...”
participants had previously heard about haptic experiences in architecture. In fact, during their studies, two participants conducted a case study of a building by pretending to be blind and filming the result [ARCHI 1, ARCHI 6]. However, the integration of this knowledge into the design process is still difficult - as the results of the design workshop show.

6.2.2.2 Parameters: A Different and Difficult Approach

The workshop reveals that the participants find it hard to think in a different, non-visual way. While only few participants recognise 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 had made the effort to go through the information, one person immediately asked whether we could help to get her started [ARCHI 7]. She finds it difficult: “... as the parameters make you check the design in terms of what I need to do where, and if it is still relevant to do that there... and... and... yes it becomes a difficult mental exercise.” When asked if she can explain the difficulty, she responds that the framework of haptic design parameters is a very extreme way of thinking as it does not fit an exact science: “…yes, I say yes... It’s harder because you ... you know ... there’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 for what and when ... because eventually you want to use different qualities which make your work unruly. So what do you use where and when?... Is there a form of guidance or some kind of theory?” [ARCHI 7]

Other participants immediately question this opinion and confirm that they actually appreciate the fact that the parameters do not form prescriptive guidelines [ARCHI 1, ARCHI 3, ARCHI 5].

6.2.2.3 The Content of the Framework

All participants agree that there are some inspiring elements within the parameters in terms of the design process: for example, the different planes (movement, guide and rest plane) are found to be usable and effective. The entire group agrees that the knowledge of the parameters improved the design of the psychiatric centre for children and encouraged them to change certain things. When implementing the parameters as an instrument with inverted space and the path-routing system, the participants realise that the entrance, entrance hall and connecting circulation show considerable room for improvement [ARCHI 5]. The corridors became the focus of attention and the entrance hall was perceived to lack a sense of ‘place’ and orientation. It also contained a lot of unused space. The staircase, for example, seems to be put in the middle of the hall for no particular reason and is set at an oblique angle. When the participants analyse the inverted space, it becomes clear that orientation on the first level is very poor and this part needs to be redesigned. The elevator leads nowhere and is integrated into a round form because, one participant explains, round forms are inserted as landmarks within the design [ARCHI 5]. In this configuration, however, the elevator cannot possibly be a landmark.

An idea develops which calls for an extension of the parapets to encourage movement within the entrance hall. However, the whole structure or configuration of the building needs a review (Fig.6.3).

6 ARCHI 7 (Dutch excerpt): “Allez dat wordt zo moeilijker als ontwerper hé...dan moet ge gaan checken van wat moet ik waar doen en is dat dan wel relevant dat ik dat daar doe...en en... Ja het wordt wel een moeilijke denkoefening.”

7 ARCHI 7 (Dutch excerpt): “Ja ik zeg maar...het is moeilijker omdat het eigenlijk niet zo iets als exacte wetenschap ... en ja architectuur is dat sowieso niet maar wel heel...dit is wel héé... ik vind het extreem omdat jullie daarstraks ook zeiden: ge hebt daar verschillende haptische kwaliteiten en misschien kunt ge daar wel die gebruiken en daar die ik ga der iets...niet dat je een exactheid moet hebben moh ge moet wel een voeling hebben van ...want op den duur gade misschien wilde wel verschillende kwaliteiten doorheen gebruiken waardoor dat het just wel tegendraads ga werken hé. Dus wat gebruikt ge waar en wanneer dat...is daar een soort leidraad of is daar een soort theorie over of is dat...”
Analysing their own design project makes the participants think. One of them 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 forces you to read it consciously” [ARCHI 5]. The keyword that most participants picked up on is ‘movement’; when thinking about movement, they would organise the plan differently: “...and yes...then we look (at the plan) and

8 ARCHI 5 (Dutch excerpt): “Ik denk dat er wel zo’n aantal hoofddingen zijn wel die ge ...als ge nu enkel dat plan zou lezen dat je dat dwingt ons wel om nu aandachtig te lezen.”

Fig. 6.3 Inverted space of the entrance hall (© plan osar architects): 1. corners and edges without function; 2. entrance unclear; 3. elevator: no landmark; 4. reception: round form; 5. staircase: unclear direction; 6. obstacle.
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... but, indeed, if you have to think more in terms of extending lines and... movement...”[ARCHI 1]9 Besides changing the entrance hall and corridors, the participants all agree that they would connect the interior more to the exterior spaces. They recognise that the choice of materials is important. One participant explains that she always looks at a plan in a visual manner and now she also really thinks about the materials: “and materials as well because everything in here is [concrete]...in fact we have to know by now in which materials this will be built. I think that if we look at the plans now, we are all thinking, what is it really going to look like?”[ARCHI 5]10

One participant remarks that many haptic design parameters are already integrated intuitively during the design process [ARCHI 7]. When they analyse the psychiatric centre for children, however, the visual dominance of the plan is striking. Interestingly, not one single line has been drawn during the whole workshop. A few participants point at the plans when talking, whereas others stare at them. This might suggest that there is knowledge about haptics present but that its integration within the design process is yet something else. Although participants are convinced that they didn’t learn anything new, the analysis of their design process shows that they are now thinking in a different way. Regarding the content of the framework, most of the participants agreed that the parameters do not limit their creativity and are, in fact, very useful.

6.2.2.4 Sensory Paradox between Content and Representation

During the presentation, we consciously chose to use different methods of representation to illustrate the framework and the parameters. All participants agree that the examples were very easy to understand, but concurred that few contemporary buildings integrate all the aspects described. One participant remarks that: “Yes, well, it is not that we see many innovative projects, I think. Well... for blind people I mean. Like the example with the sliding walls11, I had never seen that before and so...well, most offices are not dealing with this and sometimes, I think, you pick things up more easily because you see them...”[ARCHI 6]12 (Fig. 6.4) The images were not considered prescriptive but more like sources of inspiration; not as an enumeration, but more as a way in which designers can give their own interpretation to the parameters. The importance of the fact that these illustrations are visual is repeatedly stressed. A table explained the variables and different uses of the parameters but was used by only a few participants. One participant explicitly argues that there is too much text in the scheme [ARCHI 1]. The rest of the participants support her opinion. The table does convey a lot of information but it is too theoretical and too full of text. At the time of the workshop, the firm had just begun to work with technical building specifications that were visual [ARCHI 2]. The participants propose working with symbols and to look for a narrative, so that working with the parameters is not too prescriptive.

One participant says, “I think that the more you can apply these parameters, the more you will take them into account unconsciously.”[ARCHI 6]13 None of the participants had ever worked with this kind of design approach before. It may therefore require training before a designer can apply this framework of haptic design parameters swiftly.

The participants cannot immediately answer the following question: at what point in the design process do the parameters need to be implemented? The discussion suggests that parameters can be used throughout the design process and that, depending on the concept of the design, different parameters might appear sooner than others.

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9 ARCHI 1 (Dutch excerpt): “en ja dan zien we heeft dat wel een leuke vorm en misschien moeten we dit zo plaatsen, maar dat is dan puur vanuit het visuele hé vanuit...vanuit... maar inderdaad als je meer moet denken in in...lijnen doortrekken en en...beweging en...”

10 ARCHI 5 (Dutch excerpt): “en materialen want dat is hier allemaal in...eigenlijk moeten wij nu al weten in welke materialen dat allemaal is. Ik denk dat als wij nu naar dat plan zijn aan het kijken dat wij allemaal den hele tijd zijn aan het denken, hoe dat dat er... écht gaat uitzien.”

11 This person refers to the Hazelwood School for the Blind in Glasgow, more precisely its ‘Backbone wall’.

12 ARCHI 6 (Dutch excerpt): “ja het is ook niet dat we heel veel vernieuwende projecten zien, vind ik. Euh...voor blinden bijvoorbeeld. Gelijk dat voorbeeld dat je aangehaald hebt met die wanden, dat had ik nog nooit gezien allez dus euhm allez veel bureaus zijn daar ook niet mee bezig en soms vind ik dan pik je daar ook wel rapper op in omdat je ziet van ooh ja dat kan ook weet je...”

13 ARCHI 6 (Dutch excerpt): “ik denk dat hoe meer dat je dat probeert toe te passen, denk ik hoe meer dat je daar onbewust ook rekening mee gaat houden hé.”
6.2.3 Discussion

In order to assess the extent to which the framework of haptic design parameters can support architects during the design process, we conducted a workshop and focus group interview with architects. Although most buildings are being investigated after their construction, rather than in the process of planning and design, interesting insights are obtained through the evaluation and analysis of the haptic design parameters within a project that is still on the drawing board.

The findings suggest that architects acknowledge the importance of haptics in the built environment and the usability of the proposed framework. Moreover, our analysis indicates that when architects possess knowledge of haptics they generally analyse and design a building plan with more attention to movement and the haptic experience.

Regarding representation and methodology, it still requires some degree of adaptation to be able to pay attention to haptics during the design process. If application of the framework seems to be unclear, a narrative may help people to imagine realistic experiences. Pallasmaa states that a single sentence by his professor, Aulis Blomstedt, proved to be the most significant thought he encountered during his architectural education: “For an architect, more important than the skill of fantasizing space, is the capacity of envisioning situations of human life”. A narrative might well facilitate the process of envisioning haptic experiences in the built environment.

Whereas the framework of haptic design parameters aims to support the design process in accordance with the principles of Universal Design (UD), its assessment by architects reveals that the parameters themselves lack cognitive accessibility for designers. Interestingly, the participating architects demand a more visual representation of the parameters, meaning that they need to be translated in a more visual language. According to the participants a visual scheme, complemented by symbols, would make it more applicable for ‘simple and intuitive use’ (UD principle 3). Providing choices and being non-prescriptive (UD principle 2) is another necessary condition. In general, the architects agree that the parameters have a descriptive form, but that they lack accuracy and precision in terms of their application (UD principle 2). When transforming the framework for the haptic design parameters into a visual scheme, attention needs to be paid to the legibility of the perceptual information (UD principle 4). The parameters’ tolerance for error (UD principle 5) might be intercepted, in terms of geometric properties, by drawing the inverted

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17 The seven UD principles are: 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 (see Chapter 1 for a more extensive explanation).
space and path-routing system for example, or by encircling these places. On the other hand, a different form of evaluation needs to be applied to the material properties during the design process. In order to do this, materials need to be thought about very early on in the design process. Applying the haptic design parameters should be easy and require no physical effort (UD principle 6). Architects complain about the difficulty of reading the table explaining the parameters. If reading text is too strenuous, a visual representation of the parameters might help designers feel more comfortable when using them. The actual scheme itself needs to be the correct size in terms of approach and use (UD principle 7). Last but not least, the framework of haptic design parameters needs to fulfil the needs of as many architects as possible.
6.3 User/Experts: Users of the Built Environment

Although people who are blind are said to be the ultimate user/experts when it comes to non-visual experiences, the framework of haptic design parameters aims to support the design of environments with better haptic qualities for everyone. It is therefore appropriate to evaluate the content of the framework, and its parameters, using an additional group of diverse end-users.

Goodman and Waller state that different stages in the design process require different kinds of information, so the most appropriate users to involve (and how to involve them) may vary from stage to stage. As this research aims to understand the role of haptics within people’s experience of the built environment, a group of users with very mixed experiences is appropriate.

6.3.1 Set Up and Approach

In autumn 2010, a focus group interview takes place with such a group. Based on a preliminary brainstorming session regarding possible candidates, a list of 20 potential participants is compiled. During the brainstorm, age diversity was also a topic of discussion. Although the aim was to find an equal number of participants for each age group, it proved very difficult to find potential participants between the ages of 45 and 60 and 60+. A call is made on a website for older people. Eventually enough representatives are found for each age group. The list strives to achieve a balance between men and women, as well as diversity in terms of background and age. Everybody is contacted by email. Eight women and five men agree to participate. A well-balanced number since it is known that the majority of problems can be identified within a group of 10 users. The average age of the participant is 46 years, with the youngest being 26 years old and the oldest 68 years.

Most participants live in Leuven, or the surrounding villages. Four live further away and come from Brussels, Sint-Niklaas, Merchtem or Herzele. Three participants are retired. Two people have chosen to take a sabbatical from work and seven are working full time.

The expertise of the participants is very diverse. Two participants live with motor impairments and one of them uses a wheelchair. One participant is an experienced mother and is seven months pregnant at the time of the interview. Another participant has a diagnosis on the autism spectrum, whereas another is highly sensitive and has suffered psycho-traumatic experiences. Three participants provide the focus group with experiences of retirement. One of them even mentions her osteoarthritis. Finally, the group comprises people with no particular abilities (Fig. 6.5).
The interview takes place in the county hall of the province of Flemish Brabant (Fig. 6.6), next to the railway station, more precisely in one of the meeting rooms on the ground floor (Fig. 6.7). The location is easily accessible as parking is provided underneath the building and public transport is nearby.

As explained in Chapter 2, focus group interviews stimulate a group people to discuss a specific topic. The aim of this interview is to assess whether the experiences of the general group of users correspond with the results relating to haptics that were found with the help of people born blind. Prior to the actual interview, participants receive a folder in which they find an informed consent.

### List of participants in the focus group interview for user/experts of the built environment

<table>
<thead>
<tr>
<th>Code</th>
<th>Gender</th>
<th>Age</th>
<th>Expertise</th>
<th>Profession</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER F01 F 28</td>
<td>psychology / sociology</td>
<td>Consultant Psychologist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER M01 M 26</td>
<td>history</td>
<td>PHD researcher</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER F02 F 42</td>
<td>communication</td>
<td>PR manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER M02 M 36</td>
<td>wheelchair users/motor impairments</td>
<td>Post Doc IT Researcher</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER F03 F 43</td>
<td>highly sensitive &amp; gifted</td>
<td>Sabbatical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER F04 F 41</td>
<td>7 months pregnant / experienced mother</td>
<td>Administration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER M03 M 40</td>
<td>motor impairments</td>
<td>Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER M04 M 42</td>
<td>autism</td>
<td>Coordinator &amp; Tax Officer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER F05 F 57</td>
<td>practical / good at working with her hands</td>
<td>Sabbatical (IT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER F06 F 51</td>
<td>experience of related projects</td>
<td>Cultural Officer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER F07 F 67</td>
<td>retirement</td>
<td>Retired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER M05 M 63</td>
<td>retirement/carer</td>
<td>Retired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER F08 F 68</td>
<td>osteoarthritis</td>
<td>Librarian (Retired)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
background information on the research and a small compensation (voucher).

The interview relies on a structured list of questions. Instead of informing the participants about the framework of haptic design parameters and explaining the results, the interview begins with an exploration of what haptic perception means. The first seven questions gather information about why, what and how the participants touch. For example: “Why do you touch in the built environment?” After a short break, the second part of the interview focuses upon architectural properties (material and geometrical) in relation to the haptic sense. The questions follow the structure of the framework and begin by addressing material properties (8) followed by questions about geometric properties (10) in relation to haptics. The questionnaire also partially covers the subcategories of the parameters. For example, the aspect of direction: “What do you think about spaces in which the walls follow the direction of your movement?” An overview of the questionnaire can be found in Appendix 10.4.

During the interview, the questions are simultaneously projected onto a screen. As a result, people can read as well as hear the questions, which supports those participants who might have problems understanding. A video camera and digital dictation machine recorded the interview in its entirety. The interview is transcribed word for word and a written analysis is conducted.

6.3.2 Findings

6.3.2.1 Haptic Perception and Experience

The opening question addresses the way people touch within the built environment and whether they mainly touch in an active, dynamic or passive way. All participants agree that the three ways of touching are always present but, because it happens consciously, active touch is mentioned more frequently (whereas passive touch is, for the most part, subconscious). However, there is a slight difference in frequency between the different users depending on personal interest or abilities. For example, the wheelchair user explains that he dynamically touches the floor by means of his wheelchair because his wheelchair informs him about the roughness or softness of the floor - for example, asphalt [USER M02]. The person with autism points out that his condition often results in highly sensitised or desensitised experiences [USER M04]. For example, most autistic people find it very hard to feel differences in temperature, which explains why some people with autism still may wear a t-shirt in winter. Their elevated sensitivity may result in a strong awareness of clothes. The participant explains that: “It always feels strange because… it (clothing) is a stimulus …but sometimes when I dress… it is as if the clothes are rubbing like rough gloves… yes, then you feel uncertain. I will also feel it when I wear something with long sleeves, but I would rather roll them up.” [USER M04]

Another participant refers to her interest in wool because she knits a great deal. If she enters a yarn shop
she always touches the wool [USER F05]. The whole group agrees that in some shops, you almost have to touch - like in a clothes shop where you can distinguish natural wool from synthetic [USER F08]. But in a grocery shop, on the other hand, it is culturally unacceptable to touch, except perhaps to check if fruit is ripe.

One participant contends that this is the first time that she has thought about different ways of touching. She remarks that passive touch is something that happens to you, without you realizing it, while you are obliged to make choices when it comes to active touch [USER F07]. Similarly, pregnancy could also be described as involving a form of passive touch. A baby touches the mother without a conscious act on the part of the mother. The participant who is seven months pregnant describes this as a “new tactile experience”. She states that a pregnancy results in a different way of being. In a way, you pay much more attention to haptic stimuli that come your way. On the one hand, this is because of safety concerns but, on the other hand, because you are generally much more aware of haptic stimuli.

Besides the culture, interests, personality and ability of the participants, one member of the group stresses that the professional background is important as well [USER M03]. As a staff member of the accessibility committee in the province, he often screens buildings for accessibility. For him, active touch is part of his work - checking whether a door handle is easy to use, or not, for example. Passive touch is less verifiable but the participant explains that he always has very strong feelings when he enters a building for the first time: “The passive feeling of cold and warmth instantly gives me an impression of that building. If I enter a place that feels cold, cool and if air conditioning is used, I don’t feel ‘welcome’.” [USER M03]

The highly sensitivity participant agrees and states that she immediately feels, passively, whether a space is pleasant or not [USER F03].

A similar feeling overwhels the wheelchair user when he enters a building or ‘walks’ on a square: “(...) depending on the ground or floor tiles, I will feel comfortable - or not. I will explain. If I’m not in my wheelchair I can still walk, but it is difficult and then I’ll stumble and fall. And I can assure you, if you fall on the asphalt or fall on a ‘clinker’ floor it hurts a lot more than falling on linoleum or parquet. So if I enter my office, then I am sure that I will fall gently on the linoleum without hurting myself. But there are ‘clinkers’ on the car park and there I can assure you, from experience, it really is damn painful. So I much prefer linoleum ... However, this has nothing to do with active touching, of course, because I won’t immediately touch everything. But I do notice the materials and what it would feel like if I might fall. This has impact on whether I feel at ease in that space. (...) It is why the floors at home are parquet.” [USER M02]

The retired participant with osteoarthritis argues that, to feel at ease, she needs doors (and door handles) that she can use with the least amount of effort [USER F08].

6.3.2.2 Haptics: What Matters?

One participant states that active touch affirms that things are real [USER F06]. The group agrees and the historian explains that his research on an old cabinet of the 16th and 17th century was very enjoyable because it brought the past alive [USER M01]. The participant with a background in psychology and sociology confirms that you create a link with an object through touch [USER F01]. But preference goes to things that are pleasant to touch, or that stimulate touch in the first place [USER F02]. For example, nature invites to touch. However, for cultural, safety or hygienic reasons people might hold back from touching. In public toilets, for example, people avoid touching anything – simply because so many different people use the toilets and they are often very unhygienic. Other participants argue that you touch things to stop others from hurting themselves - protecting children, for example. The pregnant
mother states that: “everything that is touched by my children goes first through my hands. Before it even comes close to them, I have already touched it: it has to be soft, round, pleasant, safe, a thing that can be trusted.” People with autism have to feel safe in order to feel comfortable. The participant with autism explains that he once climbed the church tower using the spiral staircase and that he immediately used the handrail [USER M04], whereas other people only started to use the handrail after a few steps. When no handrails are available, it is very different. For example, when climbing a mountain he finds the use of poles very disturbing. The poles require a physical coordination that disturbs his concentration. In this case, the poles do not form part of the environment but are a dynamic extension of his body. All the participants agree that people want to touch when in extreme situations - for both orientation and safety reasons.

Besides these supporting functions, one participant remarks that touch is an exquisite sense for the expression of personal affection [USER F04]. Personal affection for objects is expressed by touching - for example, books, papers and wooden boxes. People search for enjoyable haptic experiences like the warmth of the sun’s rays, the freshness of water or the brightness of the light. It all encourages positive feelings. Besides touching both the environment and objects, human beings might touch each other. Cuddling, embracing or kissing is a way of showing affection for a loved one.

They all agree that the context in which the user’s body is situated contributes to this positive feeling. In the summer, a fresh cold surface or the breeze produced by a fan might offer a lovely experience, whereas a warm carpet next to a sheltered fireplace is more welcome in winter. Depending on the user’s preferences, contextual parameters may dominate. One of the participants loves hospitals because the environment is always very well lit [USER F08]. The illumination overrules any negative feelings.

6.3.2.3 Impact of the User’s Body

The experience of the latter participant reveals that in addition to the context of the environment, the user’s preferences also come into play. For example, some people like to garden with gloves whereas others prefer to feel the soil between their fingers.

Regarding texture, most participants agree that they prefer smooth materials. However one participant argues that for her, roughness can be very pleasant as well, as she really likes to touch sandpaper: “I really like rough sandpaper. I like to touch it. It is something like…yes it is just that structure, yes, that is…something very rough is not something that is soft or smooth. Those are just the opposite and yes, the rough, rough finish. And when I come across something that is very roughly finished, I always have to touch it...yes...If I notice that, then I place my hand on the walls and so on.”

Thus the personality of users and the context may yield different preferences. However, the physical condition of the body might also result in different haptic experiences. For example, a foot that is very calloused as a result of old age might be less sensitive than, say, a baby’s. A pair of lips, in general, is more sensitive than most other body parts. Consequently, the physical differences between human bodies can account for different types of haptic experiences.

Participants agree that there is a difference between hands and feet. Feet - and many other parts of the body - are often covered; but hands are usually bare [USER F02]. This makes one participant conclude that the hands are better trained and therefore the parts of the body that have the most ‘experience’ [USER F06]. However calloused palms may interfere with the natural ability of the hands. This is illustrated by one of the retired participants who gave massages with her hands for over 20 years. Recently, she followed a training course so that she could give massages with her feet. She discovered that her feet are much more sensitive [USER F07].
Another participant points out that although the lips are the most sensitive part of our bodies, we mostly touch with our hands because it is more culturally appropriate [USER F01]. The back is also very sensitive and needs a solid support, argues the manager [USER M03]. On the other hand, the participant with autism explains he walks barefoot at home because it makes it easier for him to recognize the temperature difference between summer and winter [USER M04].

6.3.2.4 Context of the Body

Besides the abilities and sensitivities of different parts of the body, people may prefer to use a certain part of the body depending upon what it is that has to be touched: “I do think...well for me it is, that it depends on what I prefer to touch, what it is that I have in my hands or my feet. For example I prefer to feel the water with my back, nothing is more wonderful than sun on my back...”[USER F06] This also illustrates the role of the context in which the body finds itself. Taking a shower can either be a functional or a relaxing experience. The participant with osteoarthritis agrees that when moving around, she immediately feels when something is made badly [USER F08]. All participants agree that whilst movement generates a more conscious haptic experience, it is relaxation that is experienced more subconsciously.

6.3.2.5 Architectural Elements that support Haptic Experiences

Material Properties

The second part of the interview focuses on the material properties that support - or trigger - haptic experiences. As we have seen in previous chapters, the impact of material properties on haptic experience is considerable.

The participants tend to prefer natural materials, like wood and bricks, and materials that generate a feeling of warmth. One participant, for example, remembers the extreme haptic and other sensory qualities of a wellness environment designed by Peter Zumthor in Vals, Switzerland [USER F01] (Fig. 6.8). A leather component in the design of the changing rooms was robust and smelled wonderful.

Other factors, however, such as functionality might overrule a person’s personal preferences. A carpet, for example, might feel very soft, warm and nice but, from a hygienic point of view, is not ideal [USER F04]. Another participant agrees that if there is something between the actual floor and her body, unattached to anything else, she feels less safe [USER F04].

The mass, or density, of elements is important in relation to haptic experiences. One participant explains that a “rich” material is much denser and feels less hollow [USER F01]. For example, a brick wall offers a different haptic and auditory experience than a prefabricated metal wall finished with gypsum board. The wheelchair user prefers natural wood to laminate floors for the same reason [USER M02]. Moreover, one of the participants states that materials have to look like they are: a cork floor has to look like cork [USER F08].

When asked about her favourite temperature, one participant immediately mentions her preferred room temperature: 23°C [USER F03]. However, although a material may be situated in a room where the temperature is 23°C, it still might feel cold. All sorts of materials can affect our sense of temperature, but their conductivity may differ. One participant states that her body temperature, 37°C, is her preferred temperature, meaning that

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31 USER F06 Dutch excerpt: “ik denk ook dat het …allez voor mij is het toch zo, dat het een beetje afhangt van wat het is, wat ik het liefst aanraak, wat heb ik in mijn handen of mijn voeten. Bijvoorbeeld water voel ik liefst met mijn rug aan, niets is zo heerlijk als die stralen op mijn rug...dat is eigenlijk een...”

32 USER F04 Dutch excerpt: “ja ik heb het gevoel dat ik minder contact heb met de vloer als daar iets tussenzit, (bijvoorbeeld een tapijtlaaper)”
the material’s temperature has to approach her body temperature [USER F06]. The preferred temperature also depends on the context and situation of the body. Climatic conditions (which will be discussed later), or whether a body is in movement (or not), make a difference: a moving body produces warmth and sweat and thus the room, or materials, feel warmer. Consequently, the permeability of a material might influence the experience of temperature. All participants immediately agree upon the importance of permeability. If materials breathe and are permeable, they are likely to feel pleasant [USER M04]. Air, in general, is important and fresh air is preferred to air-conditioning. One participant refers to a meeting room in the office where he works, designed as a glass box in the middle of a large space. Unfortunately, the architects forgot to provide air to the box - there is no natural ventilation or air-conditioning. This means that meetings have to be held with the doors open or people end up with headaches due to the poor air quality in the box [USER M03]. The participant with autism agrees that air quality contributes to the whole body experience. He once worked in an office building without natural ventilation and the air-conditioning made him drink a lot more water each day [USER M04].

The texture of materials should fit the environmental context in the first place. In a bathroom, smooth tiles are preferred; in a public environment, pavements require a rough structure - yet not so rough that it frightens people who might fall. Climatic conditions may influence the actual experience of texture, as smooth surfaces may sometimes become slippery. One of the retired participants explains that the stone floor in front of the new museum ‘M’ in Leuven is a real danger for visitors as it is too polished – people might fall [USER F08]. A different participant suggests that cork flooring is perfect for houses: it neither smooth nor rough, but soft and warm, resilient, air permeable and slightly insulating. All in all, it is a very pleasant material [USER M05].

**Geometric Properties**

In terms of geometry, most participants prefer symmetrical, structured, clear spaces within the built environment because these give a clear overview [USER F03, USER F04, USER F08, USER M03]. One participant explains: “... I strongly dislike buildings in which I have to look behind every corner to see what could possibly be behind that door. It is very pleasant in a building where you can immediately see aah ... that’s there, that’s there ….“[USER M03]

Some participants find that spaces have to meet their expectations in terms of recognition and orientation [USER F01]. However, one participant also refers to the likeability of unpredictability in some situations. She refers to a building designed by Tadao Ando in Wheil am Rhein, Switzerland (Fig. 6.9). The building is implanted within a grass environment, with only one path leading to the smallest front door. As a result, some people chose to cross the lawn and walk to the largest door which is not actually open to the public. These people are misled by the environment, which makes them think about what they do. Nevertheless, such an architectural statement invites people to devote time to it and according to all participants it is therefore probably better suited to a relaxing atmosphere. USER F02 explains that the aspect of unpredictability is sometimes less problematic in a home environment, because in relaxing situations people like to search.[USER F02, USER F04] One participant refers to the Atomium in Brussels (Fig. 6.10), one of Belgium’s most iconic monuments - a metaphorical representation of the nine provinces that represented Belgium in the World Fair of 1958: “or a museum, like the Atomium for example, is a real atypical building and yet I find it a pleasant building to walk around. With its balls and pipes and the levels and...you never know where you are....“[USER M03] Although this building has a structure it is difficult to maintain an overview of it.

In terms of geometry, participants dislike oblique spaces. The exception were spaces under roofs because they were perceived as acceptable, and cosy even, by some people [USER F04, USER F05]. However, other participants find such spaces oppressive and claustrophobic [USER M01]. Round forms are more appreciated in environments that are used for relaxation. For example, one participant prefers rounded borders in the garden; in a zoo people like to follow a path that twists and turns between the animal.

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33 USER F01, USER M03 Dutch excerpt: “ik heb een grote hekel als ik in een gebouw achter elk hoekje moet gaan kijken van wat zou eventueel achter die deur zitten. Het is heel aangenaam in een gebouw op het moment dat je ergens staat je onmiddellijk weet aah...dat is daar dat is daar...”

34 USER F02: “of een museum...allez het atomium bijvoorbeeld is een een atypisch gebouw en en toch vind ik dat een heel aangenaam gebouw om daar rond te wandelen. Met die bollen en de pijpen en en ...de niveaus en ge weet nooit waardat je zit...”
The forms upon which the movement, guide and rest planes depend are, in the first place, related to the function of the plane and the intended experience. For orientation and walking, participants prefer flat and straight surfaces and avoid oblique planes. A path on an incline is very difficult to walk on with a pram. Furniture, on the other hand, permits wavy or oblique planes and they invite you to lie down and rest.

Interestingly, one of the participants mentions that he prefers fixed materials: “Yes fixed. I absolutely hate mats, as soon as you step on them you get the feeling that you want to push it out the way” [USER M03].

The size of the planes, and spaces in general, are also important. Whereas some people dislike huge spaces, others dislike spaces that are too small. One participant relates his measure of spaces to the use of his wheelchair [USER M02]. If he uses his wheelchair, he requires enough space to turn and move around. But he can still walk, so he needs points upon which he can lean in order to move on. He therefore finds a staircase next to a lift very dangerous, and the stairwell offers no support to keep him balanced. Another participant argues that being inside or outside makes a difference. This relates to the difference between public and private spaces, as you are more familiar with the environment in your own home [USER M01]. Participants mention that, again, a lot depends on the context and the way people move around. With movement, the user’s ability and personality certainly play an important role.

All participants find it helpful if guide planes are available in the environment, especially when orientation is lacking. One participant remarks that time is important.
when you navigate the environment. If there is no time limit, than it is ‘fun’ to explore [USER F06]. The participant with autism states that it can be helpful to find guides on the floor, as well as on the walls, so that you have an option as to ‘how’ you move and behave [USER M04]. Corners are very useful if you need to orientate yourself in space. Asked whether participants touch corners while moving in space, most say they do. There are different reasons for this. For example, someone may want to avoid knocking against a corner, so there is a personal safety issue, or they might touch a corner because it is different from other corners. Corners function as a hold for the wheelchair user, which might make him decide which direction to take. He defines it as a ‘help point to switch direction’ [USER M02]. Many participants contend that they start touching more frequently when moving in the dark or orientating themselves. This suggests that the time of the day, season or year might influence our haptic experience. Besides the influence of time on the context, it can also influence one’s mood. As one participant points out: "The time factor also plays in terms of fatigue, I think. If you spend a whole day, you have less well ... how shall I say, you have less need for some things and vice versa - if you are physically tired and you still have things to do, then it is very heavy and it seems at that stage, although the stairs are the same, you are almost back in a manner of speaking, and it seems that stairway is suddenly much more unpleasant, much steeper than that it really is.” [USER M03]36 One participant states that speed at which people move on a staircase is always determined by the slowest user: a lady of 80 years old also has to be able to use the staircase [USER F04].

All participants agree that an environment in which you can, and are allowed, to touch is both important and necessary.

6.3.3 Discussion

By evaluating the framework of haptic design parameters and its content with users of the built environment, we demonstrated that they might result in an environment with haptic qualities for a diversity of users. All participants of the focus group agree upon the fact that all three ways of touching – active, dynamic and passive - are present in their daily activities. However, the focus might vary depending upon people’s interests, abilities, profession and culture. Pregnant women, or people living with autism, are much more sensitive to passive touch. Whilst the group considers active touch to be a conscious act linked to orientation and safety, passive touch is viewed as more subconscious and less verifiable. However, passive touch does in fact contribute to a person’s first impression of a building or environment and also contributes to a person’s sense of comfort, or discomfort, in any given place. Participants recognize all three modes of touch.

The results of the focus group interview suggest that people touch for different reasons: to check whether something is real, to create a bond between user and environment, to feel safe, to orientate yourself, to show personal affection or to look for additional information. Haptic experiences are influenced by the conditions and context of the person’s body. The condition of the person’s body is characterized by physical as well as mental characteristics. Both might be influenced by nature, culture and nurture. Whereas the mental state of a person involves memories and knowledge, physical conditions primarily arise from nature and might change over the course of a lifetime due to the ageing process, disease or accident. Participants of the focus group interview explain that parts of the body may experience different haptic sensations depending upon the amount of clothes being worn. A naked body is much more sensitive than a fully clothed one. When skin ages, parts of the body may become less sensitive; people touch differently when they are tired. Different climatic conditions, or the time of day, can make a difference to the act of touch. Participants recognize the importance of haptics

36 USER M03 Dutch excerpt: “de tijdsfactor speelt ook mee op vlak van vermoeidheid, denk ik. Als ge nog een hele dag bezig geweest zijt, dan heb je minder... alles hoe zal ik dat zeggen, dan heb je minder behoefte voor een aantal zaken en omgekeerd als je lichamelijk vermoeid bent en je moet dan nog allemaal dingen doen, dan is dat enorm zwaar en dan lijkt die trap, hoewel dat dezelfde trap is, dan wil je bijna terug bij manier van spreken dan lijkt die trap plotseling veel onaangename, veel steiler dan dat die eigenlijk is.”
when experiencing the built environment. There is a preference for fixed materials over those that move. In general, most participants prefer soft textures; the exception, however, confirms the rule. At best, the ideal temperature for materials is that of the human body.

Air is an important haptic stimulus in the context of geometry, as it is for materials. Participants still prefer natural ventilation. Spaces should ideally take the form of a structured shape that allows a user to obtain an overview of the layout. Corners give direction and are therefore helpful instruments in terms of orientation – they can, provide support, or a point at which to rest. Nevertheless, to maintain an overview of a space the number of corners has to be limited. Most participants prefer straight and orthogonal shapes. People only find round, oblique or complex spaces interesting to explore when they have enough time. However, the exploratory space must not be too large or too small. Remarkably, participants primarily link space to their movement within it. Clearly, the more options that are made available for haptic experiences, the better. This means that if people have a choice as to whether to orientate themselves via the floor or the wall, this results in a better understanding of the environment. Finally, the results show that all participants understand the idea of unfolding the built environment in movement, guide or rest planes. Moreover, some argue that if designers took this into account, some spaces would be different in a very positive way. Consequently, the findings of the focus group interview suggest that the content of the framework is not restricted to users without vision and that the haptic design parameters can support the design of environments that offer haptic qualities to more users of the built environment.
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Problem Definition

Chapter 2
Road Map
PHD

Chapter 3
Theoretical Track

Chapter 4
Empirical Track

Chapter 5
Design Parameters

Chapter 6
Evaluation

Chapter 7
Conclusion

State of the Art | Research Track | Design Track | Evaluation Track
Chapter 7: Evaluation Track

7. Conclusion
7.1 Epilogue

People experience the built environment in a multisensory way. Nevertheless, designers of the built environment mainly focus on visual experiences and use a visual language in their design process. Three possible underlying reasons were put forward which correspond with theoretical movements in different disciplines:

1. The neurological characteristics of humanity give priority to visual information.
2. Western culture gave primary attention to visual art.
3. The design language of architects and designers of the built environment is primarily visual.

The introduction supplied interesting information, but taking a position on this was not the general aim of this thesis. Instead, it was our objective to offer insights in the perceptual process of experiencing architecture, more precisely the haptic experiences in the built environment. The insights on haptic perception and experience can offer usable information for designers to implement in the design process and it may enable them to design ‘for more’ people in the built environment. Designing for more people is our general objective that builds further on the idea of UD, ID and DfA. Whereas these three postmodern approaches join in with the social model of disability, this research follows a cultural model of disability that includes disability as a form of expertise in the design process. We use ‘Designing for More’ as the umbrella term for this design approach.

Five key questions in our research led us to the actual design of the framework. In this Section we summarize our main findings based on these five main questions.

1. What does ‘blindness’ and ‘haptic’ mean in the context of the built environment?

Our research considered blindness as a form of expertise in the built environment. Rather than restricting the design to one group of users with a disability we insert the expertise of people born blind to learn more about the multisensory qualities in the built environment. As explained before, this idea fits in with a cultural model approach of disability. Through history we recognise an evolution in the approach of researchers in relation to people born blind. Fletcher categorises the deficiency, inefficiency and difference theory. Each of these theories takes a specific position on the spatial knowledge of people born blind. Fletcher categorises the deficiency, inefficiency and difference theory. Each of these theories takes a specific position on the spatial knowledge of people born blind. In our research, the spatial capacities of people born blind are not questioned. But more important is their spatial expertise that can create opportunities for designers. Therefore we would like to add the opportunity theory to Fletcher’s classification as a category that involves researchers who look at disabilities as forms of expertise.

Literature study revealed that the term ‘haptic’ has different connotations in different disciplines and even within certain research domains. Some use the term only in relation to active touch, when kinaesthetic movements are required, while others consider it as the science of
touch in general. In relation to architecture and the built environment, we consider ‘haptic’ as the cover all term for all touch related experiences in the built environment. Consequently, haptics involves active, dynamic as well as passive touch. The literature study also revealed that the haptic system largely contributes to architectural experiences. Haptic space is the basic source for information on the built environment. Moreover, by means of haptic perception we are able to change the built environment. This makes the haptic sense unique compared to other senses.

2. What constitutes a haptic experience in the built environment?

Whereas the theoretical track mainly focussed on ‘how’ haptic perception takes place in the built environment and how these experiences come into being, the empirical track investigated why, when, where and how exactly people touch. For this empirical investigation, we adopted the principles of Grounded Theory and combined different qualitative studies that could enrich each other. Three main studies have been set up: home visits with adults born blind, a photo tour with children born blind and focus group interviews with caregivers. The home visits consisted out of in-depth interviews followed by guided tours through the house. Whereas the in-depth interviews are cross-analysed by means of codes, the video-ethnographic study is complemented with plan annotations. During the photo tour, the children took pictures of elements in their daily environment that gave them a pleasant or unpleasant feeling. The pictures themselves were categorized in different libraries or groups of pictures illustrating different parameters or haptic experiences and even the process of haptic perception. Finally, we interviewed caregivers with many years of experience in teaching and supervising people born blind. This experience made them second best experts in haptic experiences.

Movement is an essential element in haptic experiences in the built environment. In haptic conditions, people show to literally walk the place to receive haptic experiences: walking as place making. In this way the movement of the body is considered as a stimulus itself. Muscle memory can store these movements. Besides the movement of the body, movements in the environment can also induce haptic experiences.

A cross analysis through the theoretical and empirical track revealed that in haptically experiencing the built environment, people rely on materials, geometric properties (forming structure) and the context.

Diversity is a keyword for haptic experiences. Through diversity in materials or geometric characteristics designers can inform on landmarks, paths, nodes, edges and boundaries in the environment. These cognitive elements, important in visual perception, show to be relevant in haptic conditions as well. Nevertheless, it must be remarked that the characteristics for landmarks in haptic conditions differ from the visual.

In terms of haptic perception there is no difference between touching outside or inside the built environment. This is a result of the proximal characteristic of haptics because the stimuli are always near to the body. Another result of this proximity is the fact that preference goes out to details in architectural elements.

Regarding haptic characteristics it is generally considered that qualities are appreciated in relation to the primary needs in the first place. Predictability, safety and comfort are indispensable and have priority over all other requirements. Remarkably all studies reveal the importance of the impact of haptics as a proximity sense. Haptic information is gathered through sequential exploration. Time has a different dimension in haptic conditions, because due to the sequential characteristic of perception, haptic requires more time to perceive than visual perception.

As haptic perception is most frequent at decision points, these points require special attention in design. For example, haptic stimuli are important as people need to rely on an ‘invitation’ to touch when vision is absent. In familiar environments, on the other hand, blind people tend to use a ‘control touch’ at each decision point.

3. What is the expertise by experience of people born blind regarding non-visual sensory experiences in the built environment?

The theoretical as well as the empirical studies show that people born blind are the ideal user/experts for research into multisensoriality in the built environment. Blind people have learned to be more attentive to non-visual senses. Their attentiveness becomes clear through exploration as well in terms of their interpretation of the built environment. Our studies confirm that some blind people give preference to auditory information while others prefer haptic
stimuli. Nevertheless, they all prove to be experts in haptic perceptions.

In terms of exploration, people born blind show to have acquired haptic exploration strategies and they follow patterns in the built environment. These patterns offer them structure in their environmental experiences. Materiality is very important in haptic experiences and blind people give a lot of attention to materials.

The empirical studies acknowledge the impact and importance of educational training provided by the caregivers.

4. How can we design a framework of haptic design parameters and what do we mean by haptic design parameters?

Based on the triangulation and a cross analysis of the theoretical and empirical track, we found concepts that gave us a starting point for our design of the framework of haptic design parameters.

If designers want to take haptic qualities and constraints into account, they have to reckon with context and experience. The context determines the modes of touch (active, dynamic, passive), the perceived affordances of the planes (movement, guide, rest plane) and the sensitivity of the body (sensitive-insensitive). The experience is based on the levels of mental processes and influenced by perception, memory and knowledge. Without memories or knowledge we are not able to give meaning or interpretation to our experiences (think of the Escher sketch). Empirical results have clarified that participants’ judgement on safety, comfort and predictability contributes to their general haptic experience in the built environment. The haptic design parameters are values that are put into the octant of experience, which in their turn depends on the combination and position in the grid representing the context.

The framework aspires equitable use and the provision of accessible information for all users, designers as well as the end users of the built environment. In addition to the support for building, the framework might offer a language for end users to talk about haptic experiences.

In addition to our findings on haptic perception and experience in the built environment, some research methodologies proved to be very useful in sensory research. With regard to the research methodology the general outcome reveals that photo- and video-ethnography can help bridge the language gap to communicate about the haptic sense. More important these methods allow to investigate sensory perception. The fact that our participants are blind increases the reliability as they are less aware of the video camera. The photo camera, on the other hand, gives self-confidence to the participants. Participants literally feel the camera as an extension of their own body. The camera becomes a tool to perceive in a haptic way. Besides the actual pictures, the acts of taking pictures showed to be very interesting as well. Therefore, in relation to future sensory research, we would recommend to additionally video record the whole photo-ethnographic study.

The plan annotations show to be a good summary to bridge the gap between sensory research and design research.

5. How do users of the framework of haptic design parameters assess its design and content?

Because the development of the framework is a design in itself, it was but logical to evaluate its usability as well as its content. In the evaluation track, we conducted two focus group interviews with the users of the framework of haptic design parameters (architects) and the end users of the built environment. The reactions of the participating architects suggested 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.

The users of the built environment pointed out that they had never thought about different modes of touch before our focus group interview, but they agreed that they use all three kinds of touch on a daily basis. Their answers confirmed the importance of contextual parameters as participants describe that touching could differ depending on the performed actions. It was also clear that participants could easily link their preferences for certain values of the parameters to contextual and experiential situations, but that further research is required to have a more detailed insight into all the specific values.
7.2 Future Research

Future research could investigate the parameters more in detail. Moreover, a longer-term evaluation of the framework and its parameters in the design process would help to refine its representation as well as its content. For example, the actual values of the parameters could be studied and given the complexity, each parameter could form a research topic in itself. In this kind of research, we see opportunities for interdisciplinary research between designers of the built environment, neurologists, psychologists and user/experts. We agree with Sarah McGann that it is time for partnerships to be built between innovative architectural practitioners, academics and the community. In this way, the practice of architecture can work alongside research to serve an important community need.1

Whereas the parameters are based on the experiences of Flemish citizens, they could be refined by means of conducting research with participants who are living in regions different from Flanders. This could enable researchers to investigate whether there are additional or different parameters (or values) depending on the culture participants live in. As the framework of haptic design parameters is a design in itself that is meant to support architects, additional research on the representation of the framework could help to make it more accessible and useable for designers.

Based on the findings of the evaluation track it became clear that adding visual information would be supportive for designers in understanding the framework. How these parameters could be best represented can be a topic for future research. 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.2 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 could trigger them to 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’. 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. The structure 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 with focus on haptic experiences, 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. Consequently, the framework of haptic design parameters could be worked out as a specific interactive tool as well as a mixed media tool.4

The framework has the ambition to serve as many users as possible. It would be interesting to verify whether the haptic design parameters lead to designing environments that also support people with other impairments. For example, research points out that for people with autism the sense of touch is often compromised by excessive sensitivity, but it can sometimes provide the most reliable information about the environment.5

At the level of methodology, our research made clear that visual studies can be supportive in sensory research and haptics in particular. As visual technology improves very rapidly, this might perhaps open up new methods for sensory research in architecture or in other domains.

Besides the directions for future research that were directly derived from our findings, we also hope that this research may be a trigger for others to conduct more research on haptic perception and experiences in architecture. Although the impact of multisensory experiences in the built environment is still an underexplored research topic, it may offer many valuable findings for designing for more, in general.

In addition, the cooperation with blind people turned out to be very valuable in the research design and is highly recommended. Their interpretation and approach can offer opportunities for researchers to learn more about multisensory experiences. We believe that participatory designing together with blind people can be a very large value for a designer.

Although some researchers question research on, with and for people born blind and we did not conduct this research ‘for’ people born blind but called in their expertise from a cultural model approach, it is good to know that the number of people with low vision is growing very rapidly and could double by the year 2020 because of the aging of the global population and the increased prevalence of vision impairment among the older adult population.6 For these people haptic qualities and experiences in the built environment could be a major improvement for their daily life.

While looking forward to these future excursions, we hope that this thesis has clarified the opportunities and possibilities of implementing haptic experiences in the built environment and the advantages of a Design for More attitude. To conclude in O’Neill’s words: “By cultivating awareness of a range of haptic sensibilities and placing appropriate emphasis upon them, designers can more appropriately consider how insiders really experience places. Through a widening of disciplinary boundaries, perhaps we will come to a richer understanding of place identity in the contested terrain of development.”7

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5. Table with information about the participants of the focus group interview for the end users of the built environment, Jasmien Herssens
7. Set up for the focus group interview, Jasmien Herssens
9. Vitra conference pavilion, Weil am Rhein, Tadao Ando, Nick Van Eekhout
10. Appendices
### 10.1.1 Drop-off

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10.1.2 Questions In-Depth Interview June 2006

**English**
- Since when do you live here?
- Was your home your own choice?
- Based on what?
- What do you like about your home?
  - Why?
  - Which aspects contribute to this cosiness according to you?
  - What would you like to change?
- How do you define cosiness?
- How do you feel at home?
- Which room do you prefer to stay?
- If we talk about circulation room, what does that mean to you?
- Are circulation spaces as important to you as other spaces?
- Are circulation spaces cosy? Do they have to be?
- What would you like to change?
- How do you define cosiness?
- How do you feel at home?
- Which room do you prefer to stay?
- If we talk about circulation room, what does that mean to you?
- Are circulation spaces as important to you as other spaces?
- Are circulation spaces cosy? Do they have to be?
- Will you stay living here?
  - Yes: what would you change?
  - No: what would you choose or opt as an improvement?
- How do you move through space?
  - During day time?
  - During night
- If you were able to link cosiness to one of the following words (freedom, security, viability, order), what would you choose?

**Nederlands**
- Sinds wanneer woon je hier?
- Was jouw woning je eigen keuze?
- Op basis van wat?
- Wat vind je gezellig aan je woning?
  - Waarom?
  - Aan welke factoren ligt dit volgens jou?
  - Wat zou je willen veranderen?
- Wat versta je zelf onder ‘gezellig’?
- Hoe voel je je in de woning?
- In welke kamer vertoeft je het liefst?
- Als we spreken over circulatieruimtes, waarvoor staat dat dan voor jou?
- Zijn circulatieruimtes even belangrijk als andere ruimtes voor jou?
- Zijn deze circulatieruimtes even gezellig? Zouden ze even gezellig moeten zijn?
- Blijf je hier wonen?
- Ja: wat zou je veranderen
- Neen: wat zou je kiezen of opteren als verbetering?
- Hoe verplaats je je in de ruimte?
10.1.3 Questions In-Depth Interview July 2007

**English**

**General questions**
- Since when do you live here?
- Was this home your own choice?
- Based on what? [what made you decide to live in this house?]
- What does dwelling mean to you?
- Can you describe your own dwelling using the haptic sense and literally talking about what you feel in your own words?
- Do you feel good in this dwelling?
- What feels good about your dwelling? In which room or place do you feel good?

**Circulation elements**

**Approach**
- Do you feel it when you are approaching the dwelling?
- Is that for you an excellent way? Why? Why not?
- What is according to you the best way to come home?

**Entrance**
- Do you feel that you enter your dwelling? How?
- What helps you to orientate yourself at the entrance?
- What do you think is necessary at the entrance of a dwelling?
- Is form at the entrance important to you? Why? In which sense?
- What do you think is a nice entrance hall?
- Which room in your dwelling do you feel is the most pleasant to enter? Why?

**Configuration of the path**
- How do you move through your dwelling?
- What is annoying when you move through space?
- Have you noticed the circulation path when you purchased the house? Do you prefer a way of moving through space: (through spaces, through a corridor or a corridor that ends in a space)?

**Path-space relationship**
If you move through space, are there things on which you can orientate yourself?

When is a circulation space good for you and when do you feel at home?

Can you estimate the size of the room?

Do you feel if a transition or node approaches?

Do you feel the height of a ceiling? What is the most pleasant?

Imagine that you walk somewhere and suddenly the ceiling goes one floor up. Do you feel that? Do you think that is pleasant?

Is the size of the room for movement important to you?

Do you sometimes count certain things when you walk around to recognize things?

Form of circulations space

Circulation spaces can assume different forms (galleries, halls, staircases and rooms), what do you think is the most pleasant experience? Is the form of a circulation space important to you?

How do you move through space?

Is symmetry important to you?

Staircase

Is the staircase good for you?

Would you change something to the staircase?

Do you think the direction of the staircase is important to you?

Do you prefer a certain type of staircase? (straight staircase, L-staircase, spiral staircase)

Is the material of the staircase important to you?

Light

Is light important to you? Do you think this is pleasant?

Do you feel where the windows are?

Does light contribute to a pleasant spatial feeling?

Materials

Are materials important to you in space? (If they are: why? Measure distance, echo,...)

What do you think are pleasant materials in your dwelling?

If you are touching, which materials you prefer?

If you are walking on a floor, which materials do feel most pleasant?

Final questions

Will you stay here for living? Why?

Can you describe the circulation spaces in your own dwelling according to what you feel and in your own words?

If you think about your haptic sense, which information related to dwelling gives that to you?

What is according to you the most important in a circulation space?
Achtergrond

Sinds wanneer woon je hier?
What was jouw woning je eigen keuze?
Op basis van wat?
Wat is voor jou belangrijk bij wonen?
Kan je je huidige woning beschrijven aan de hand van wat jij voelt en in je eigen woorden?
Voel je je goed in je huidige woning?
Wat voelt goed aan in je woning? In welke ruimte of plaats voel je je goed?

Circulatie elementen

Benadering
Voel je het als je aan je woning aankomt?
Is dat voor jou een ideale manier? Waarom wel? Niet?
Wat kan er volgens jou beter?
Wat is voor jou de beste manier om ergens thuis te komen?

Ingang
Voel je dat je je woning binnenkomt? Hoe?
Op wat oriënteer je je bij de inkompartij?
Wat vind je noodzakelijk aan de inkom van een woning?
Is de vorm van de inkompartij belangrijk voor je? Zo ja, in welke zin?
Wat vind je een aangename inkompartij?
Welke ruimte in je woning voelt het meest aangenaam aan om binnen te komen? Waarom?

Configuratie van het pad
Hoe beweeg je je door de woning?
Wat voelt er hinderlijk aan als je beweegt door de ruimte?
Als je je woning koos, heb je dan gelet op de wijze van circuleren doorheen de woning? Geef je een voorkeur aan de wijze van lopen (doorheen ruimtes, via een gang of een gang die eindigt in een ruimte)?

Pad-ruimte-relatie
Als je doorheen je woning loopt, zijn er dan bepaalde dingen waarop je je oriënteert?
Wanneer is een bewegingsruimte voor jou goed en voel je je thuis?
Kan je de grootte van ruimtes inschatten?
Voel je het wanneer je een overgang of knooppunt nadert?
Voel je de hoogte van een plafond? Wat is het meest aangenaam?
Als je ergens loopt en plotseling wordt het plafond een verdieping hoger, voel je dat dan? Vind je dat aangenaam?
Meet je de afstand tot bepaalde ruimtes? Op welke manier?
Is de grootte van de ruimte die je hebt bij het bewegen belangrijk voor jou?
Tel je soms bepaalde dingen als je rondloopt om iets te herkennen?
Vorm van circulatieruimte
◦ Bewegingsruimtes kunnen verschillende vormen aannemen (gaanderijen, hallen, gallerijen, trappen en ruimtes), wat voelt het meest aangenaam aan? Is de vorm van een bewegingsruimte belangrijk voor jou?
◦ Hoe beweeg je je door de ruimte?
◦ Is symmetrie belangrijk voor jou?

Trap
◦ Is de trap goed voor jou?
◦ Zou je iets veranderen aan de trap?
◦ Vind je de richting van een trap belangrijk?
◦ Geef je voorkeur aan een bepaald soort trap? (Rechte trap, L-trap, U-trap, spiltrap, spiraaltrap)
◦ Is het materiaal van een trap belangrijk of zijn afwerking?

Licht
◦ Is licht belangrijk voor jou? Voel je dit als aangenaam?
◦ Voel je de plaatsing van de ramen?
◦ Draagt licht bij tot het aangenaam aanvoelen van de ruimte?

Materialen
◦ Zijn materialen belangrijk voor jou in een ruimte? (zo ja, waarom> afstand meten, echo, …)
◦ Wat vind je aangename materialen in je woning?
◦ Als je tast, naar welke materialen of soort materialen gaat dan je voorkeur uit?
◦ Als je over een vloer loopt, welke materialen voelen dan het meest aangenaam aan?

Slotvragen
◦ Blijf je hier wonen? Waarom?
◦ Kan je je bewegingsruimtes in je huidige woning beschrijven aan de hand van wat jij voelt en in je eigen woorden?
◦ Als je denkt aan je eigen tastzin, welke informatie met betrekking tot wonen vertelt dat jou?
◦ Wat is het meest belangrijk bij een bewegingsruimte voor jou?

10.1.4 Questions In-Depth Interview December 2008

English

General questions
◦ Since when do you live here?
Was this home your own choice?
Based on what? [what made you decide to live in this house?]
What does dwelling mean to you?
Can you describe your own dwelling using the haptic sense and literally talking about what you feel in your own words?
Do you feel good in this dwelling?

**Circulation elements**

**Approach**
- Do you follow a path when you are approaching the dwelling?
- What do you feel when you are approaching the dwelling?
- Is that for you an excellent way? Why? Why not?
- What is according to you the best way to come home?

**Entrance**
- What do you feel when you enter your dwelling? How?
- What helps you to orientate yourself at the entrance?
- What do you think is necessary at the entrance of a dwelling?
- What is the form of the entrance? Is it important to you? Why? In which sense?
- What do you think is a nice entrance hall?

**Configuration of the path**
- What is important when you move through your dwelling? How do you move through your dwelling (which tool do you use)?
- What is annoying when you move through space?
- Did you give attention to the way you were feeling when you purchased the house? Do you prefer a way of moving through space: (through spaces, through a corridor or a corridor that ends in a space)?

**Path-space relationship**
- If you move through space, are there things on which you can orientate yourself? What is good for you concerning circulation spaces?
- When is a circulation space good for?
- Can you estimate the size of the room? What do you prefer big or small places? When is a space big and when small?
- Do you feel if a transition or node approaches?
- Do you feel the height of a ceiling? What is the most pleasant? High or low ceilings? Why?
- Imagine that you walk somewhere and suddenly the ceiling goes one floor up. Do you feel that? Do you think that is pleasant?
- Is the size of the room for movement important to you?
- Do you sometimes count certain things when you walk around to recognize things?

**Form of circulations space**
- Circulation spaces can assume different forms (galleries, halls, staircases and rooms), what do you think is the most pleasant experience? Is the form of a circulation space important to you?
- Is symmetry important to you?
Staircase
◦ Is the staircase good for you? What is the best staircase?
◦ Would you change something to the staircase?
◦ Do you think the direction of the staircase is important to you?
◦ Do you prefer a certain type of staircase? (straight staircase, L-staircase, spiral staircase)
◦ Is the material of the staircase important to you?

Light
◦ is light important to you? Do you think this is pleasant?
◦ Do you feel light? Gives light information to you?
◦ Does light contribute to a pleasant spatial feeling?

Materials
◦ Are materials important to you in space? (If they are: why? Measure distance, echo,...)
◦ What do you think are pleasant materials in your dwelling?
◦ If you are touching, which materials you prefer?
◦ If you are walking on a floor, which materials do feel most pleasant?

Final questions
◦ Which room in your dwelling is the most pleasant to enter?
◦ Will you stay here for living? Why?
◦ Can you describe the circulation spaces in your own dwelling according to what you feel and in your own words?
◦ If you think about your haptic sense, which information related to dwelling gives that to you?
◦ What is according to you the most important in a circulation space?
◦ If you approach a building, which direction of the path do you prefer: curves, right, oblique, spiral?
◦ What do you think is the most ideal width of a path? Can you describe this using your body as an instrument?

Nederlands

Algemene vragen
◦ Sinds wanneer woon je hier?
◦ Was jouw woning je eigen keuze?
◦ Op basis van wat? [Wat deed jou beslissen om in deze woning te gaan wonen?]
◦ Wat is voor jou belangrijk bij wonen?
◦ Kan je je huidige woning beschrijven aan de hand van wat jij voelt en in je eigen woorden?
◦ Voel je je goed in je huidige woning?
Circulatie elementen

Benadering
◦ Volg je een pad wanneer je naar de woning komt?
◦ Wat voel je als je de woning nadert?
◦ Is dat voor jou een ideale manier? Waarom wel? Niet?
◦ Wat is voor jou de beste manier om ergens thuis te komen?

Ingang
◦ Wat voel je als je de woning binnenkomt? Hoe?
◦ Wat helpt u om u te oriënteren aan de inkompartij?
◦ Wat vind je noodzakelijk aan de inkom van een woning?
◦ Wat is de vorm van de inkompartij? Is dit belangrijk voor je? Zo ja, in welke zin?
◦ Wat vind je een aangename inkompartij?

Configuratie van het pad
◦ Wat is belangrijk wanneer je door de woning beweegt? Hoe beweeg je je door de woning? Welk hulpmiddel gebruik je?
◦ Wat voelt er hinderlijk aan als je beweegt door de ruimte?
◦ Als je je woning koos, heb je dan gelet op de wijze van circuleren doorheen de woning? Geef je een voorkeur aan de wijze van lopen (doorheen ruimtes, via een gang of een gang die eindigt in een ruimte)?

Pad-ruimte-relatie
◦ Als je doorheen je woning loopt, zijn er dan bepaalde dingen waarop je je oriënteert? Wat is goed voor jou in relatie tot circulatie?
◦ Wanneer is een bewegingsruimte voor jou goed en voel je je thuis?
◦ Kan je de grootte van ruimtes inschatten?
◦ Voel je het wanneer je een overgang of knooppunt nadert?
◦ Voel je de hoogte van een plafond? Wat is het meest aangenaam?
◦ Als je ergens loopt en plotseling wordt het plafond een verdieping hoger, voel je dat dan? Vind je dat aangenaam?
◦ Meet je de afstand tot bepaalde ruimtes? Op welke manier?
◦ Is de grootte van de ruimte die je hebt bij het bewegen belangrijk voor jou?
◦ Tel je soms bepaalde dingen als je rondloopt om iets te herkennen?

Vorm van circulatieruimte
◦ Bewegingsruimtes kunnen verschillende vormen aannemen (gaanderijen, hallen, gallerijen, trappen en ruimtes), wat voelt het meest aangenaam aan? Is de vorm van een bewegingsruimte belangrijk voor jou?
◦ Hoe beweeg je je door de ruimte?
◦ Is symmetrie belangrijk voor jou?

Trap
◦ Is de trap goed voor jou?
◦ Zou je iets veranderen aan de trap?
◦ Vind je de richting van een trap belangrijk?
◦ Geef je voorkeur aan een bepaald soort trap? (Rechte trap, L-trap, U-trap, spiltrap, spiraaltrap)
◦ Is het materiaal van een trap belangrijk of zijn afwerking?
Licht
- Is licht belangrijk voor jou? Voel je dit als aangenaam?
- Voel je de plaatsing van de ramen?
- Draagt licht bij tot het aangenaam aanvoelen van de ruimte?

Materialen
- Zijn materialen belangrijk voor jou in een ruimte? (zo ja, waarom≥ afstand meten, echo, ...)
- Wat vind je aangename materialen in je woning?
- Als je tast, naar welke materialen of soort materialen gaat dan je voorkeur uit?
- Als je over een vloer loopt, welke materialen voelen dan het meest aangenaam aan?

Slotvragen
- Blijf je hier wonen? Waarom?
- Kan je je bewegingsruimtes in je huidige woning beschrijven aan de hand van wat jij voelt en in je eigen woorden?
- Als je denkt aan je eigen tastzin, welke informatie met betrekking tot wonen vertelt dat jou?
- Wat is het meest belangrijk bij een bewegingsruimte voor jou?
- Als je een gebouw nadert, welke richting verkies je dan: curve, recht, schuin of spiraalvormig?
- Wat is denk je de meest ideale breedte van een pad? Kan je dit beschrijven door het lichaam als een instrument te gebruiken?
10.2 Appendix 2: Photo-Ethnographic Study with Children Born Blind

10.2.1 Questions Photo Interview

*English*

- What is the place you first think about in Spermalie?
- Why do you immediately think of this place?
- How do you remember this place? (describe)
- If you move through Spermalie on which elements do you orient yourself?
- Why?
- How do you orient in this place at this element or object?
- What do you think is the most pleasant space in Spermalie? Why?
- How does the space feel?
- Which space do you most dislike in Spermalie?
- Why do you dislike this space the most?
- How does that space feel?
- Which places give you a special feeling?
- Which feeling do you get at these places?
- Why?
- Where do you make use of your sense of touch?
- Why do you make use of the sense of touch at this place?
- How do you make use of the sense of touch?
- What are the most pleasant materials in Spermalie?
- Why do you think these are the most pleasant materials?
- How do these materials feel like?
Nederlands

◦ Wat is de plek die je je het snelst kan herinneren in Spermalie?
◦ Waarom kan je je die plek het best herinneren?
◦ Hoe herinner je je die plek? (beschrijven)
◦ Als je je moet verplaatsen in Spermalie op wat oriënteer je je dan?
◦ Waarom oriënteer je je dan op dat?
◦ Hoe oriënteer je je op die ruimte/plek/object?
◦ Wat vind je de meest aangename ruimte in Spermalie? Waarom?
◦ Hoe voelt deze ruimte aan?
◦ Wat vind je de minst aangename ruimte in Spermalie? Waarom?
◦ Hoe voelt deze ruimte aan?
◦ Welke plaatsen geven jou een speciaal gevoel?
◦ Welk gevoel krijg je op die plaatsen?
◦ Waarom heb je dat gevoel?
◦ Hoe voelt die ruimte dan aan?
◦ Op welke plaatsen maak je gebruik van de tastzin?
◦ Waarom maak je daar gebruik van de tastzin?
◦ Hoe maak je gebruik van je tastzin?
◦ Wat vind je de meest aangename materialen in Spermalie?
◦ Waarom vind je dat de meest aangename materialen?
◦ Hoe voelen die materialen aan?
10.3 Appendix 3: Focus Group Interviews With Caregivers

10.3.1 Drop-off

FOCUSGESPREK Spermalie
Datum: 25-02-2008
Uur:
Naam:
Voornaam:
Geboortedatum:
Opleiding (hoogste diploma):
Beroep:
Functie op KPMI Spermalie
voltijds / deeltijds
10.3.2 Topic List (Dutch)

- Mensen met congenitale blindheid zonder visus (lichtperceptie toegestaan)
- Ruimte:
  - Omschrijving: Wat?
  - Beleving?
  - Representering?
  - Vorm? (observatie / impressie)
  - Situatie: invloed omgeving op emoties
  - Oriëntatie
  - Tijd: lengte
- Mis[fits] in gebouwde omgeving
  - Fits gebouwde omgeving
  - Misfits gebouwde omgeving
  - Haptische [mis]fits
- Tastzin
  - Wat?
  - Hoe?
- Oriëntering
  - Hoe?
  - Structuur? [grenzen, paden, knooppunten, gebieden, landmarks]
- Materialen? (textuur, densiteit, temperatuur)

10.3.3 Questions Focus Group Interview

**English**

Opening question

- Write down three for you important aspects of ‘how’ people who are congenitally blind without vision perceive space in a haptic way?

Introductory question: haptic constraints

- What are the most remarkable obstacles in the environment? Why?
- What are the most remarkable positive aspects in the built environment? Why?

Transition question: Space

- Do you think a certain structure or pattern exists in their pattern of orientation?
- How would you describe this structure?
Do you perceive certain haptic orientation points in space?
- Which?
- Why?
- How?

**Key questions: experience**
- What are according to you pleasant spaces for people with visual impairments?
- How do people with a visual impairment experience these spaces?
- What is important in space towards the experience of space? Why?
- What are materials with a positive haptic experience?

**Key questions: the haptic sense**
- When do people with visual impairments use their haptic sense in relation to their experience?
- How do people with visual impairments use their haptic sense?

**Concluding questions: responding conclusions focus interview?**
- Are there topics left who didn’t came up during this interview but you think they are important?
- Words of thank + offering final report

---

**Nederlands**

**Openingsvraag**
- Schrijf drie voor jou opvallende aspecten op van hoe mensen met aangeboren blindheid zonder visus tactiel met ruimte omgaan.

**Inleidingsvragen**
- Wat zijn opmerkelijke hindernissen in de gebouwde omgeving? Waarom?
- Wat zijn opmerkelijke positieve aspecten in de gebouwde omgeving? Waarom?

**Overgangscragen: Ruimte**
- Merk je dat er een bepaalde structuur of patroon terug te vinden is in hun oriënteringspatroon?
- Hoe zou je deze structuur omschrijven?
- Merk je bepaalde tactiele oriënteringspunten in de ruimte?
  - Welke?
  - Waarom?
  - Hoe?
Kernvragen: Ervaring
◦ Wat zijn volgens jou aangename ruimtes voor MZV?
◦ Hoe beleven MZV deze ruimtes?
◦ Wat is er belangrijk in de ruimte naar beleving van de ruimte? Waarom?
◦ Wat zijn materialen die positief onthaald worden voor beleving van de ruimte?

Kernvragen: Haptische gevoel
◦ Wanneer gebruiken MZV hun tastzin met betrekking tot beleving?
◦ Hoe gebruiken MZV hun tastzin dan?

Concluderende vragen: samenvatting van gesprek en vragen of er nog bijkomende opmerkingen zijn?
◦ Zijn onderwerpen die niet aan bod kwamen tijdens het interview maar die volgens u wel belangrijk zijn?
◦ Dankwoord en aankondiging eindrapport

10.3.4 Key Words & Sentences

English
◦ structure ground: orientation
◦ acoustics + sound = point of orientation
◦ scent
◦ sensory (in general)
◦ shuffling with feet
◦ scanning the wall
◦ safe distance
◦ search for landmarks
◦ search for other tactile landmarks
◦ attention for detail
◦ new space: do nothing
◦ building up landmarks in imaging
◦ difference between new & well known area
◦ age is important
◦ being passively present to creatively discovering
◦ verbal
◦ afraid of huge spaces
◦ air displacement: the space inside or outside?
◦ real tactile exploration = concrete feeling
◦ the more complex the space: the harder
complex structures are ok
never spontaneously exploring complex environments
capacities are involved
pleasant materials
things that don’t frighten
pleasant materials: good stimuli have to be felt for example corner > rough materials and not refined materials
smooth materials do not endure
rough materials: more appropriate> encourage haptic
square rooms are much harder than rectangular
strong stimuli
security and protective attitude> stimuli
all sensory stimuli
predictability: consistency> support what is to come
smoothly through space: space to imagine> great work item> apparently have no spatial representation> no spatial representation
scale models are used for presentation to learn
spatial relationships are very different> one small obstacle course is hard right
different scale
avoid rounded corners = confusing both outside and inside
oblique edges
spatial imagery: perception of distance?
difficult to estimate> for example cleaning cart in Spermalie> no overview
always shared information
crossing hallway
drawing what they walk> from own experience
consciously count footsteps, for example five to the left my bed
focus on objects: children who have a
trampoline in the room, for example next to trampoline is linen bag. Objects can be interior or furniture products
perceive sounds: eg. heels in motion clock ticking
perceive sounds for example clicking of heels in hallway
sounds = auditory but both are intertwined for example footsteps and hearing
first auditory phase and afterwards adding tactile information for example too dark> no residual vision> no noise: then touching
some children: use little tactile information> less feeling but strong focus on auditory. Why? Useful or convenient.
tactile: often taught> as soon as knowledge is used
some children often touch you: it is a habit
If something is known: more useful> recognizable
big difference in the ability of orientation > for example some are excellent others aren’t > like the seeing
auditory stimulus is more spontaneous rather than haptic stimulus that truly must be looked for> taught
much depends on personality
hesitation in new surroundings> new ‘search’ for the ‘unexpected’
the tactile is less direct
- Some children are scared of noises
- Materials: sometimes large aversion towards materials, but taught to touch it can happen that people spontaneous touch or the other way around that they keep their aversion
- Mental imaging is generally slower compared to other children
- Construction / intelligence determine knowledge on the haptic sense
- Orientation
- Locomotive impairment
- Some ask a lot of support
- Stimulation is necessary depending on stimulation given by educator
- For example, 2 holes in the sink
- Noise should also be taught, but
- Sound approaches you as well, gives difference in experience
- Blind children: passive
- 2 things at once = difficult for example eating a meal and following a conversation

Nederlands
- Structuur grond: oriëntatie
- Akoestiek + geluiden = oriëntatiepunt
- Reuk
- Sensorisch algemeen
- Schuifelen, vooruitgaan met voeten
- Aftasten tegen een wand
- Veilige afstand
- Zoeken naar herkenningspunten
- Zoeken naar andere tactiele herkenningspunten
- Aandacht voor details
- Nieuwe ruimte: niets doen
- Herkenningspunten opbouwen
- Onderscheid nieuwe & gekende ruimte
- Leeftijd is belangrijk
- Passief aanwezig zijn tot creatief ontdekend
- Verbaal
- Benauwd van grote ruimte
- Luchtverplaatsing: welke ruimte binnen of buiten?
- Echte verkenning = tastzin = concreet voelen
- Hoe complexer de ruimte: hoe moeilijker
- Ingewikkelde constructies zijn niet aangewezen
- Nooit spontaan complexiteit verkennen
- Capaciteiten spelen mee
- Aangename materialen
- Dingen die hen schrik aanjagen niet
- Aangename materialen: grote prikkels moeten voelen vb. hoekje > ruwe materialen en niet de fijne materialen
○ gladde materialen beklappen niet
○ ruwere materialen: meer aangewezen > tactiele aanwakkeren
○ vierkante ruimte is veel moeilijker dan lange ruimte
○ sterke prikkels
○ veiligheid en beschermende houding > prikkels
○ alle sensorische prikkels
○ voorspelbaarheid: consistentie > ondersteunen van wat gaat komen
○ vlot door een ruimte: zich ruimte kunnen voorstellen > groot werkpunkt > hebben blijkbaar geen ruimtelijke representatie > geen ruimtelijke voorstelling
○ maquettes worden gebruikt voor voorstelling aan te leren
○ ruimtelijke verhoudingen zijn heel verschillend> een kleine hindernis in recht parcours is moeilijk
○ andere schaal
○ afgeronde hoeken vermijden = verwarrend zowel buiten als binnen
○ afgeschuinde hoeken
○ ruimtevoorstelling: afstandsbeleving?
○ moeilijk in te schatten > vb. kuiskar in Spermalie > geen overzicht
○ altijd deelinformatie
○ oversteken in een gang
○ tekenen wat ze stappen > uit eigen ervaring
○ bewust stappen tellen vb. 5 stappen naar zijkant bed
○ focus op voorwerpen: kinderen die trampoline in kamer hebben vb. naast trampoline ligt linnenzak. Voorwerpen kunnen interieurmuebelen of producten zijn
○ geluiden waarnemen: vb. hakken in gang, tikken uurwerk
○ geluiden = auditief maar beide geven elkaar de hand = onlosmakelijk verbonden
○ vb. voetstappen voelen + horen
○ eerst auditieve fase en nadien aanvullen met tactiele vb. te donker > geen restvisus > geen lawaai en dan tastzin
○ Tactiele: vaak aanleren > zodra kennis: wordt gebruikt
○ Sommige kinderen voelen vaak aan jou: gewoontevoorming
○ Indien iets gekend is: bruikbaarder > herkenbaarheid!
○ Groot verschil in oriëntatievermogen vb. sommigen die hen heel goed kunnen oriënteren en anderen minder > zoals bij zienden
○ Auditieve = prikkel die spontaner is ipv tactiele prikkel die echt moet gezocht worden > aanleren
○ Veel = afhankelijk van persoonlijkheid
○ Aarzelen in nieuwe omgeving > nieuw is ‘zoeken’, ‘onverwachte’
○ Het tactiele is minder direct
○ Sommige kinderen ook bang van geluiden
○ Materialen: soms grote afweer van materialen, maar zodra je het aanleert kan het spontaan ontstaan om zelf het materiaal te betasten of omgekeerd aversie blijft
○ Opbouw is globaal trager tov andere kinderen
○ bepalend om met de dingen om te gaan
  ○ Aanleg / intelligentie
- Oriëntatie
- Motorische beperking
- sommigen vragen veel ondersteuning
- stimulatie is noodzakelijk > afhankelijk van stimulatie door begeleider
- vb. 2 gaatjes in de lavabo
- geluid moet ook aangeleerd worden, maar geluid komt ook op je af > geeft verschil in ervaring
- blinde kinderen > passief
- 2 dingen tegelijk = moeilijk vb. maaltijd: tasten en gesprek volgen
10.4 Appendix 4: Focus Group Interviews with User/Experts Of The Built Environment

10.4.1 Drop-off

FOCUSGESPREK Provinciehuis Leuven

Datum: 01.10.2010
Uur: 13u30.
Naam:
Voornaam:
Geboortedatum:
Contactgegevens:
Adres:
Telefoon:
Opleiding (hoogste diploma):
Beroep:
10.4.2 Questions Focus Group Interview

**English**

**Haptic perception**
- How do you touch? (active, passive, dynamic? sequential?)
- What primarily affects you? (which body part?, do you make use of movement?)
- What do you touch in the built environment? (> surfaces, openings, barriers, corners)
- Why do you touch in the built environment? (invitation, support, memory, exploration)
- Which incentives are you looking for? (active, passive, dynamic)
- Is there a difference for you to touch with hands, feet, back,...?
- Is there a difference for you when you touch to get around or when you touch during relaxation?

**Material**
- Do you prefer certain materials while using the haptic sense?
- What temperature do you prefer when you touch a material?
- [Does your preference for temperature differs when you slide your hands, when you moves them very fast or when the hands are in a rest position?]
- Does the air permeability of a material plays a role while sensing? Why?
- Do you prefer a smooth texture or a rough texture? Why?
- Is there a difference depending the location?
- Do you prefer hard or soft materials? Why?
- Does context plays a role in the experience of a material?

**Space**
- Do yo prefer certain spaces when you move yourself? (Is structure of a building important for the support of movement?)
- While you are relaxing?
- When you are looking for something? Why?
- Is there a difference for you between exterior and interior in relation to the sense of touch?
- Do you prefer orthogonal spaces, round spaces? Spaces with sloping walls?
- What do you think about spaces in which the walls follow the direction of your movement?
- What is for you the most ideal form of a surface when touching it?
  - Straight/flat
  - Wavy
  - Oblique
  - Why?
- Do you sometimes touch a corner in your environment? Why?
- Does time play a role in the experience of the sense of touch for you? Why?
- Do you orientate yourself using the sense of touch? Why?
• Is context important to you when you feel something?
• Is there a difference for you between the experience of the sense of touch in the city or at home? (scale, do you prefer large or small spaces > circulation space need to be large enough) Why?

Nederlands

Haptische perceptie
• Hoe tast u? (actief, passief, dynamisch? sequentieel?)
• Hoe tast u voornamelijk? (met welk lichaamsdeel?, maakt u gebruik van beweging?)
• Wat betast u in de gebouwde omgeving? (> vraag naar vlakken, openingen, grenzen?, hoeken?)
• Waarom tast u in de gebouwde omgeving? (uitnodigend, bewegingondersteunend, herinnering? Verkennend rondlopen?)
• Naar welke prikkels gaat u op zoek? (actief, passief, dynamisch?) (belangrijk dat het voorspelbaar is? Zoek je stimulatie op bijvoorbeeld voor ondersteuning?)
• Bestaat er voor u een verschil voor tasten met handen, voeten, rug,...?
• Bestaat er voor u een verschil wanneer u tast om u te verplaatsen of wanneer u tast tijdens ontspanning?

Materiaal
• Hebt u voorkeur voor bepaalde materialen bij het tasten?
• Welke temperatuur verkiest u bij het voelen van materialen?
• [Verschilt uw temperatuursvoorkeur wanneer u de handen laat glijden, ze snel beweegt of ze laat rusten?]
• Speelt de luchtdoorlatendheid van een materiaal een rol bij het voelen? Waarom?
• Verkiest u een gladde textuur of een ruwe textuur? Waarom?
• Is er een verschil naargelang de locatie?
• Verkiest u harde of zachte materialen? Waarom?
• Hangt dit af van de context waarin het materiaal zich bevindt?

Ruimte
• Hebt u een voorkeur voor bepaalde ruimtes wanneer u zich beweegt? (is de structuur van een gebouw belangrijk voor de ondersteuning van uw beweging?)
• Wanneer u ergens rust?
• Wanneer u iets zoekt? Waarom?
• Is er een verschil voor u tussen binnen en buiten tasten?
• Verkiest u rechte ruimtes, ronde ruimtes? ruimtes met schuine wanden?
• Wat denkt u van ruimtes waarin de wanden de richting volgen van je beweging?
• Wat is voor u de meest ideale vorm van een vlak dat je zou betasten?
  ◦ Recht/vlak
  ◦ Golvend
  ◦ Schuin?
  ◦ Waarom?
• Raakt u soms een hoek in de omgeving aan?
• Waarom doet u dit dan?
10.4.3 Questionnaire Focus Group Interviews with User/Experts

**English**

**Haptic perception**
- How do you touch? (active, passive, dynamic, sequential?)
- How do you mostly touch? (using which body part?, Do you make use of movement?)
- What do you touch in the built environment? (> question for surfaces, openings, boundaries?, corners?)
- Why do you touch in the built environment? (inviting, support for movement, memory, exploring)
- Which stimuli are you looking for? (active, passive, dynamic) (Is it important that it is predictable? Do you look for stimulation as support?)
- Do you find a difference between touching with hands, feet, back,...?
- Is there a difference for you between touching in order to move or touching while relaxing?

**Architectural elements**

**Material**
- Do you prefer certain materials when touching?
- Which temperature do you prefer when touching materials?
- [Is there a difference in when sliding your hand, when moving or resting?]
- Does air permeability plays a role in the haptic sense? Why?
- Do you prefer a smooth texture or a rough texture? Why?
- Is there a difference according location?
- Do you prefer hard or soft materials? Why?
- Is this context related?

**Space**
- Do you have a preference for certain spaces when you move yourself? Is structure of a building important for the support of your movement?
- When you rest?
- When you are looking for something? Why?
- Is there a difference for you between interior and exterior while touching?
° Do you prefer straight spaces, round spaces? Or spaces with sloping walls?
° What do you think about spaces in which the walls follow the direction of your movement?
° What is for you the most ideal form of a surface while touching it? (straight, wavy, diagonal) Why?
° Do you sometimes touch corners in your environment? Why?
° Does time play a role in the experience of touch for you? Why?
° Do you orientate yourself through the sense of touch? Why?
° Is context important for you when you feel something?
° Is there a difference for you between the experience of the sense of touch in a city or at home? (Scale, do you prefer large spaces or small spaces > passage ways need to be large enough) Why?

Nederlands

Haptische perceptie

° Hoe tast u? (actief, passief, dynamisch? sequenteel?)
° Hoe tast u voornamelijk? (met welk lichaamsteil?, maakt u gebruik van beweging?)
° Wat betast u in de gebouwde omgeving? (> vraag naar vlakken, openingen, grenzen?, hoeken?)
° Waarom tast u in de gebouwde omgeving? (uitnodigend, bewegingondersteunend, herinnering? Verkennend rondlopen?)
° Naar welke prikkels gaat u op zoek? (actief, passief, dynamisch?) (belangrijk dat het voorspelbaar is? Zoek je stimulatie op bijvoorbeeld voor ondersteuning?)
° Bestaat er voor u een verschil voor tasten met handen, voeten, rug,...?
° Bestaat er voor u een verschil wanneer u tast om u te verplaatsen of wanneer u tast tijdens ontspanning?

Architecturale elementen

Materiaal

° Hebt u voorkeur voor bepaalde materialen bij het tasten?
° Welke temperatuur verkiest u bij het voelen van materialen?
° [Verschilt uw temperatuursvoorkeur wanneer u de handen laat glijden, ze snel beweegt of ze laat rusten?]
° Speelt de luchtdoorlatendheid van een materiaal een rol bij het voelen? Waarom?
° Verkiest u een gladde textuur of een ruwe textuur? Waarom?
° Is er een verschil naargelang de locatie?
° Verkiest u harde of zachte materialen? Waarom?
° Hangt dit af van de context waarin het materiaal zich bevindt?

Ruimte

° Hebt u een voorkeur voor bepaalde ruimtes wanneer u zich beweegt? (is de structuur van een gebouw belangrijk voor de ondersteuning van uw beweging?)
° Wanneer u ergens rust?
° Wanneer u iets zoekt? Waarom?
° Is er een verschil voor u tussen binnen en buiten tasten?
° Verkiest u rechte ruimtes, ronde ruimtes? ruimtes met schuine wanden?
° Wat denkt u van ruimtes waarin de wanden de richting volgen van je beweging?
Wat is voor u de meest ideale vorm van een vlak dat je zou betasten? (recht / vlak; golvend; schuin; waarom?)

Raakt u soms een hoek in de omgeving aan? Waarom doet u dit dan?

Speelt tijd een rol in de ervaring van de tastzin voor u? Waarom?

Oriënteer je je door middel van de tastzin? Waarom?

Is de context belangrijk wanneer je iets voelt?

Is er een verschil voor u tussen de ervaring van de tastzin in een stad of bij jou thuis? (schaal heb je voorkeur voor grote ruimtes of kleine ruimtes > doorgangsruimtes moeten voldoende groot zijn)

Waarom? (vb. verkies je eerder grote ruimtes of kleine ruimtes.)

10.4.4 Presentation Focus Group Interviews with User/Experts
focusgesprek met gebruikers van de gebouwde omgeving

Provinciehuis Vlaams Brabant
1 oktober 2010
Jasmien Herssens & Prof. Ann Heylighen

onderzoekers

- Wie?
- Wat?
- Hoe?

ann & jasmiën

agenda

- korte voorstelling onderzoek (ers)
- doel gesprek & mapje toelichten
- discussie
- pauze 15 min
- discussie

onderzoek

- Wie?
- Wat?
- Hoe?

betere gebouwde omgeving voor iedereen

agenda

- korte voorstelling onderzoek (ers)
- doel gesprek & mapje toelichten
- discussie
- pauze 15 min
- discussie

onderzoek

- Wie?
- Wat?
- Hoe?

focus op het gebrek aan multisensorialiteit
Zoeken naar kwaliteiten & beperkingen voor de tastzin in gebouwde omgeving

omzetting van waarden naar bruikbare info voor architecten
Hoe tast u?
voornamelijk

Wat betast u?
in de gebouwde omgeving

Waarom tast u?
in de gebouwde omgeving

Naar welke prikkels gaat u op zoek?
in de gebouwde omgeving

Bestaat er voor u verschil tussen tasten met handen, voeten, rug,…?

Bestaat er voor u verschil wanneer u tast om u te verplaatsen of wanneer u tast tijdens ontspanning?
Stel dat we onze omgeving beschouwen op vlak van materiaal en ruimte?

materiaal

ruimte

materiaal

Hebt u een voorkeur voor bepaalde materialen bij het tasten?

Waarom?

Pauze 15’

materiaal temperatuur

Welke temperatuur verkiest u bij het voelen van materialen?

Waarom?

MATERIAAL

materiaal temperatuur

Verschilt uw temperatuursvoorkeur wanneer u de handen snel beweegt, ze laat glijden of ze laat rusten?
**materiaal**

**luchtdoorlatendheid**

Speelt de luchtdoorlatendheid van een materiaal een rol bij het voelen?

Waarom?

---

**materiaal**

**textuur**

Verkiest u een gladde textuur of een ruwe textuur? Waarom?

Is er een verschil naargelang de locatie?

---

**materiaal**

**elasticiteit**

Verkiest u een harde of zachte materialen? Waarom?

Hangt dit af van de context waarin het materiaal zich bevindt?

---

**ruimte**

Hebt u een voorkeur voor bepaalde ruimtes wanneer u zich beweegt? Wanneer u ergens rust? Wanneer iets zoekt?

Waarom?

---

**ruimte**

Is er een verschil voor u tussen binnen en buiten tasten?

Waarom?
ruimte
Is er een verschil voor u tussen binnen en buiten tasten?
Waarom?

ruimte
Wat is voor u de meest ideale vorm van een vlak dat je zou betasten?
recht / vlak
golvend
schuin?
waarom?

ruimte
Verkiest u rechte ruimtes, ronde ruimtes? ruimtes met schuine wanden?

ruimte
Wat denkt u van ruimtes waarin de wanden de richting volgen van je beweging?

ruimte
Raakt u soms een hoek in de omgeving aan?
Waarom doet u dit dan?

ruimte
Speelt tijd een rol in de ervaring van de tastzin voor u?
Waarom?
ruimte
Configuratie
schaal

Is er een verschil voor u tussen de ervaring van de tastzin in een stad of bij u thuis?

Waarom?

DANK U WEL😊!
## 10.5 Appendix 5: Workshop with Architects

### 10.5.1 Drop-off

<table>
<thead>
<tr>
<th>drop off &gt; osar workshop</th>
<th>kinderpsychiatrisch centrum Genk</th>
</tr>
</thead>
<tbody>
<tr>
<td>info participant</td>
<td></td>
</tr>
<tr>
<td>naam</td>
<td></td>
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<tr>
<td>voornaam</td>
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<tr>
<td>geslacht</td>
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<tr>
<td>geboortedatum</td>
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<tr>
<td>woonplaats (stad of gemeente)</td>
<td></td>
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<tr>
<td>functie binnen osar</td>
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<tr>
<td>werkzaam bij osar sinds (jaartal)</td>
<td></td>
</tr>
<tr>
<td>werkt u voltijs of deeltijds bij OSAR?</td>
<td>voltijs -----deeltijds: (% of /5)</td>
</tr>
<tr>
<td>statuut? (zelfstandig, bediende, andere?)</td>
<td></td>
</tr>
<tr>
<td>Welke hogere opleiding(en) hebt u genoten?</td>
<td></td>
</tr>
</tbody>
</table>

Hebt u op een of andere wijze reeds gecombineerd aan het project "Kinderpsychiatrisch centrum Genk" indien ja sinds wanneer? in de hoedanigheid van workshop in het kader van het doctoraatsonderzoek van Jasmien Herssens

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10.5.2 Questions Focus Group Interview

English

Introductory questions
◦ Did you previously heard about haptics?
◦ How did you start with the parameters?
◦ Do you find it a useful idea?

Transition questions
◦ Did this change your opinion on the design process?
◦ Does this influence the design process?
◦ Did you design something?
◦ Would you change your design or concept after hearing the information about the parameters?
◦ What results did you become?
◦ Do you think it is possible to integrate this within other architectural restrictions?
◦ How would you like to see the parameters represented?
◦ Was the presentation clear enough? Which examples did you find the most meaningful?

Key questions
◦ In which part of the design process would you integrate the parameters?
◦ Do you think it is usable throughout the whole design process?
◦ To what extent do you think that the parameters can contribute to the design?
◦ Do these parameters restrict your creativity?

Final questions
◦ Would you do this in a different way?
◦ Are there gaps?
◦ What could be better or improved?

Nederlands

Inleidingsvraag
◦ Hadden jullie voorheen al gehoord over haptiek?
◦ Hoe zijn jullie gestart met de parameters?
◦ Vinden jullie het een zinvol idee?
Transitievragen: van algemeen niveau naar meer specifiek niveau
◦ Heeft dit jullie blik op het ontwerpproces veranderd?
◦ Heeft dit naar uw mening invloed op het ontwerpproces?
◦ Hebben jullie iets ontworpen? Heeft dit resultaat kenmerken als een gevolg van de workshop?
◦ Zouden jullie het ontwerp aanpassen, met de kennis van nu of zouden jullie het concept aanpassen?
◦ Tot welk resultaat zijn jullie gekomen?
◦ Denk je dat dit duidelijk te integreren valt binnen andere architectuurrestricties?
◦ Op welke wijze zou jij deze parameters geregineerd willen zien?
◦ Was deze representatie voldoende? Welke voorbeelden vonden jullie het meest zinvol?

Sleutelvragen: kern van het onderzoek
◦ Waar in het ontwerpproces zouden jullie de parameters integreren?
◦ Denk je dat dit doorheen het gehele ontwerpproces bruikbaar is?
◦ In welke mate kunnen de parameters volgens jou bijdragen tot het ontwerpproces?
◦ Beperken de parameters jouw creativiteit?

Besluitende vragen
◦ Zou je het anders aanpakken?
◦ Zijn er nog hielen?
◦ Wat zou volgens jullie nog beter zijn?

10.5.3 Presentation Focus Group Interview
workshop @ SAR

onderzoekers

- wie
- wat
- onderzoek

agenda

- korte voorstelling onderzoek (ers)
- drop off invullen
- voorstelling haptische parameters
- vragen
- duodesign i.f.v. kinderpsychiatrisch centrum Genk
- gezamenlijke groepsbespreking
- eindevaluatie

agenda

- korte voorstelling onderzoek (ers)
- drop off invullen
- voorstelling haptische parameters
- vragen
- duodesign i.f.v. kinderpsychiatrisch centrum Genk
- gezamenlijke groepsbespreking
- eindevaluatie

agenda

- korte voorstelling onderzoek (ers)
- drop off invullen
- voorstelling haptische parameters
- vragen
- duodesign i.f.v. kinderpsychiatrisch centrum Genk
- gezamenlijke groepsbespreking
- eindevaluatie

agenda

- korte voorstelling onderzoek (ers)
- drop off invullen
- voorstelling haptische parameters
- vragen
- duodesign i.f.v. kinderpsychiatrisch centrum Genk
- gezamenlijke groepsbespreking
- eindevaluatie

drop off
agenda

- korte voorstelling onderzoek (ers)
- drop off invullen
- voorstelling haptische parameters
- vragen
- duodesign i.f.v. kinderpsychiatrisch centrum Genk
- gezamenlijke groepsbespreking
- eindevaluatie

haptische parameters

- doel?
- algemene architecturale visie
- haptisch?
- parameters?
In most cases, in order to apprehend the whole object, voluntary movements must be made in order to compensate for the smallness of the tactile perceptual field. The size of this field thus varies according to the body parts which are mobilized (a finger, the whole hand, both hands associated to movements of the arms, etc.). The kinesthetic perceptions resulting from these movements are necessarily linked to the purely cutaneous perceptions generated by skin contact, and they form an indissociable whole labeled 'haptic' (or tactilo-kinesthetic or active touch) perception. As a result, object perception is initially incomplete, it may lack coherence and it is highly sequential. This latter property increases the load on working memory and requires, at the end of exploration, a mental integration and synthesis in order to obtain a unified representation of the object.

(Révész, 1950)
haptische parameters

actief dynamisch passief
bewegingsvlak geleidingsvlak rustvlak

actief tasten is het tasten waarbij handen, voeten ... alle lichaamsdelen kunnen bewegen van een object of ruimte te manipuleren en/of te exploreren en om zijn eigenschappen te determineren. Daarbij gebruiken we zowel de huid zelf als onze gewrichten en spieren. Door middel van een actieve exploratie en beweging van het lichaam krijgen we feedback. Beweging is hierbij essentieel en hierdoor kunnen we ook onze plaatsbepaling meer definiëren.

dynamisch tasten is het tasten waarbij een extern object of ruimtelijk element wordt ingezet om de wereld te exploreren. Dynamisch tasten vertelt ons dus informatie over de omgeving door middel van de prikkels die we ontvangen van een extern object of element. Dynamisch tasten bevindt zich letterlijk tussen het actief en passief tasten. Je exploreert en ervoer de indirecte prikkels doorheen een bijkomend element.

passief tasten is het tasten waarbij handen en voeten ... alle lichaamsdelen kunnen bewegen van een object of ruimte te manipuleren en/of te exploreren en om zijn eigenschappen te determineren. De huid is aangeraakt door een extern object of wezen. Het is dus tactiel informatie die een resultaat is van huidprikkels.

ARCHITECTURALE REPRESENTATIE
Is de bewegingsruimte structureel overzichtelijk?
**Haptische parameters**

**Actief**

- Bewegingsvlak
- Geleidingsvlak
- Rustvlak

**Dynamisch**

**Passief**

- Bewegingsvlak
- Geleidingsvlak
- Rustvlak

**ARCHITECTURALE REPRESENTATIE**

*Zijn de looplijnen efficiënt en duidelijk?*  
*Zijn er geleidingsmogelijkheden gecreëerd?*

---

**Materiaal**

- Temperatuur
- Lichtdoorlatendheid
- Luchtdoorlatendheid
- Textuur
- Elastiteit

**Ruimte**

- Richting
- Configuratie
- Vorm

---

**Materiaal**

- Temperatuur

---
### Workshop @ OSAAR

**Haptische parameters**

<table>
<thead>
<tr>
<th></th>
<th>Actief</th>
<th>Dynamisch</th>
<th>Passief</th>
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<tbody>
<tr>
<td>Bewegingsvlak</td>
<td></td>
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<tr>
<td>Geleidingsvlak</td>
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<td></td>
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<tr>
<td>Rustvlak</td>
<td></td>
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</tbody>
</table>

**Materiaal**

- Lichtdoorlatendheid
  - Textuur
- Textuur

---

**Materiaal**

- Lichtdoorlatendheid
- Textuur

---

**Materiaal**

- Ruimte
  - Richting
- Richting

---

**Materiaal**

- Ruimte
  - Richting
- Richting
“Euhm maar het grote voordeel hiervan is voor mij dat dat allemaal vrij klein is en dat alles euhm dat ge eigenlijk u heel makkelijk van het ene tactiele punt naar het andere kunt verplaatsen in uw huis. Dat ge nooit op een plaats komt, waar ge niet binnen de ene stap weer waar ge precies maar dan ook precies gaat staan in uw huis.”

agenda

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• eindevaluatie

parameters

ACTIEF

bewegingsvlak

ruimte

vorm

configuratie

bewegingsvlak
geleidingsvlak
rustvlak

ruimte
categorische

vorm

recht ok ok
golvend ok mits voorwaarden hoek t.o.v. voetvlak ok ok maar amplitude max. helft gemiddelde armlengte

schaal overzichtelijk met oriëntatiepunten binnen menselijke schaal overzichtelijk + ergo-oriëntatiepunten

2x breedte gemiddelde gebruiker voldoende voelbaar met hand/vinger

open-gesloten oriëntatiepunt

vorm rechthoek rechthoek
parameters

DYNAMISCH

- geleidingsvlak
- voet
- hand e.a.
- lichaamstemperatuur 20°<x<lichaamstemp
- glad & in looprichting
- hard / beloopbaar
- < >
- neen ok voor oriëntatie

BEWEGINGSRICHTING
- richting van verplaatsing
- ondersteuning
- verplaatsingsrichting
- onder-zijde
- in looprichting
- of ongehinderd van looplijn
- 0°-3° t.o.v. hor. voetvlak bij voorkeur >= 90° (liefst 90°)
- aanpasbaar volgens richting en tempo
- sequentieel ifv geleidingsrichting
- binnen één voetpas
- voelbaar binnen handbereik
- consequent materiaal
- indien voldoende groot: oriëntatiepunt
- kadans met looppas
- met looprichting
- met voelrichting
- overzichtelijk
- wandelbaar

PASSIEF

- rustvlak
- voet
- hand e.a.
- 20°<X<42°
- lichaamstemperatuur
- zacht
- evenwichtsstabiele densiteit
- zacht
- ~ ~
- zie temperatuur
- i.f.v. ruimte

STRALING & WRIJVING
- recht
- eerder rond
- onder-zijde-boven
- n.v.t.
- los van eigen voet of looplijn
- los van eigen lichaam(sbeweging)
- bij voorkeur 1 vlak
- verschillende vlakken ifv ergonomisch
- rustend lichaam
- naast/ zonder doorgang
- steunvlak voor lichaam en bij voorkeur geen geleidingsvlak of bewegingsvlak
- "warm" materiaal
- i.f.v. ruimte
- ritme
eritme niet van toepassing
- plekken creëren

ERVARING

- eerder klein
- ergonomische schaal
- van rustplaats voet
- ergonomische schaal menselijk lichaam
- voelbare luchtdruk
- ifv lay out
- ok

ok indien aansluiting op overzichtelijk
- niet schuin vlak
- ok indien r>10 m

ERVARING

- ok
- indien wand plafond: voorrang aan oriëntatie & veiligheid
- ok maar indien wand plafond: voorrang aan oriëntatie & veiligheid

vragen?

workshop @ osar

workshop @ osar
11. Biography
Jasmien Herssens (1978, Dendermonde, Belgium) studied architecture at the Sint-Lucas Institute in Ghent, part of the University College for Science and the Arts (Hogeschool voor Wetenschap en Kunst - WENK), where she graduated cum laude as a Master in Architecture in 2001. Afterwards she studied at the University of Leuven (K.U.Leuven) and completed a postgraduate degree in Architectural Science, graduating cum laude with the thesis Virtuality in Architectural (Re)Presentations - an Ambiguity of Symbolism and Technique.

In 2002, Jasmien began a six-month internship at Ante architects in Sint-Niklaas after which she continued and finished her internship at Wim Goes architects in Ghent, where she worked for three years. She was involved in the design and construction of De Schuur in Wortegem-Petegem and the project ‘L’ in Kortrijk, a home for an art collector, both of which were nominated for the Belgian Awards in 2005. She also worked on the competition design for the extension of the Dhondt-Dhaenens museum in Deurle, which was won by Wim Goes architects, and the design of the museum square between the museums of contemporary and fine arts in Ghent (Stedelijk Museum voor Actuele Kunst - SMAK and Museum voor Schone Kunsten - MSK). Her last project was the design and follow up of the Video Biennial Contour in Mechelen.

In 2005, she became an assistant in the Department of Universal Design at the PHL University College in Hasselt (Provincie Hogeschool Limburg) under the supervision of Professor Hubert Froyen. In addition to research activities such as the writing and making of the Flemish Universal Design Toolkit, she taught architectural design and architectural practice with a special focus on Universal Design.

In 2007, Jasmien obtained a Ph.D grant from the Institute for the Promotion of Innovation through Science and Technology in Flanders (IWT-Vlaanderen) to undertake research into the development of a framework for new haptic design parameters using the expertise of people who are congenitally blind. Her Ph.D is a collaboration between PHL University College, the University of Hasselt and the University of Leuven under the supervision of Professor Ann Heylighen and Professor Bert Willems. Her research is conducted through the ArcK-research group (Department of Architecture, Interior Architecture and the Visual Arts) at the PHL University College and CAAD, Design and Building methodology research (CBDM) group (Department of Architecture, Urbanism & Planning -ASRO) K.U.Leuven. She is also a thesis
supervisor at the PHL University College and K.U.Leuven, holds seminars on Universal Design for the Masters degree students and supervises the studio work of third year undergraduates. Jasmien represents the ArcK PhD students at the Research Council of the PHL University College. At K.U.Leuven she represents the CBDM PhD students at the Architecture Research Commission (OnderzoeksCommissie Architectuur - OCA) and is the coordinator of YASRO (the group for young researchers in the Department of Architecture, Urbanism and Planning - ASRO).

She is currently a researcher for the AIDA project (Architectural design In Dialogue with dis-Ability), part of the ASRO Department, Faculty of Engineering K.U.Leuven, Belgium, where her current research is supported by the European Research Council under the European Community’s Seventh Framework Programme (FP7/2007-2013) / ERC grant agreement n°201673.

Peer Reviewed Contributions to International Publications


Publications with Colleagues


Lectures at International Conferences

• Through the Ears of People Born Blind. Include 2011: London Helen Hamlyn Research Centre, April 20th 2011.
• Haptic design research. EAAE/ARCC: The Place of Research, The Research of Place: Washington DC, June 24th 2010.
• A Lens into the Haptic World. Include 2009: London Helen Hamlyn Research Centre, 5th-8th April 2009.

Seminars and Lectures at National Conferences (and others).


• 2005-2009 assistant in the Design Studio: 3rd Bachelor Architecture PHL University College (Dept. of Architecture and Arts)

### Supporting Academic Activities

**2009-2011**

• CBDM PhD student representative in the Research Commission for Architecture (OnderzoeksCommissie Architectuur - OCA), K.U.Leuven

• Coordinator for the CBDM research group in YASRO (Young ASRO Researchers)

**2006-2009**

• ArcK PhD student representative to the Research Council of the PHL University College

### Funding & Awards

• 2010 Best doctoral paper presentation at CWUAAT 2010, Cambridge: Fitzwilliam College

• 2007 PhD grant from the Institute for the Promotion of Innovation through Science and Technology in Flanders (IWT-Vlaanderen)

• 2007-2008 Support of the Flemish Government for Buildings Revis(it)ed, workshop series for professional architects (supervision: Prof. Hubert Froyen & Prof.dr. ir.-arch. Ann Heylighen)

• 2005-2006 Support of the Flemish Government for the booklet Equal Chances and Opportunities for the UD-toolkit, written as an inspirational guide for architects and designers (supervision: Prof. Hubert Froyen)

### Teaching

• 2007-2011 assistant in the department of Universal Design: weekly seminar on Universal Design at PHL University College (Dept. of Architecture and Arts)

• 2007-2011 supervision Master theses at K.U.Leuven (ASRO) and PHL University College (Dept. of Architecture and Arts)

• 2008-2010 optional course: Qualitative Research Methodology: coding strategies.