Journal of Research Practice
Volume 11, Issue 2, Article M3, 2015

ISSN: 1712-851X

Main Article:

Mobilizing Disability Experience to Inform Architectural Practice: Lessons Learned from a Field Study

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Abstract

Through their bodily interaction with the designed environment, disabled people can detect obstacles and appreciate spatial qualities architects may not be attuned to. While designers in several disciplines acknowledge disabled people as lead or critical users, in architectural practice their embodied experience is hardly recognized as a valuable resource for design. In this article, we therefore investigate what professional architects could learn from disabled people. To this end, the article reports on a field study, set up to explore ways of mobilizing disabled people's embodied experience to inform architectural practice. Analysis of the field study's outcome suggests that mobilizing this experience does not only add nuance to the existing accessibility standards, but also offers architects rich insights into building qualities that surpass these standards.

Index Terms: architectural practice; disability; embodied experience; situation of use; spatial experience; spatial quality; actor of innovation

Suggested Citation: Vermeersch, P.-W., & Heylighen, A. (2015). Mobilizing disability experience to inform architectural practice: Lessons learned from a field study. *Journal of Research Practice*, *11*(2), Article M3. Retrieved from http://jrp.icaap.org/index.php/jrp/article/view/495/419

1. Introduction

In this article we use the term *disabled people* to refer to those whose particular experiences become disabilities when encountering an unaccommodating built environment. In line with the WHO (2002), we thus distinguish between having an impairment (a problem in a body function or structure) and being disabled (a complex phenomenon reflecting an interplay between features of a person's body and features of the environment and society in which that person lives).

Through their bodily interaction with the designed environment, disabled people are able to appreciate qualities designers may not be attuned to (Cassim & Dong, 2003; Fitzsimons, 2012; Pullin, 2009). This observation was the basis of a field study conducted on the premises of the University of Leuven (KU Leuven, Belgium) that mobilized the embodied experience of disabled students and staff to inform the redesign of university buildings (Heylighen, 2012).

The study was set up at a point when the University decided to obtain expert advice from an accessibility office regarding the inclusivity of its buildings. To complement this advice based on legal norms, we set up a field study based on disability experience of users. According to Ostroff (1997), "a user/expert can be anyone who has developed natural experience in dealing with the challenges of our built environment," including people with an impairment who gain experience in dealing with disabling situations. For example, a blind person who has to navigate an environment designed with vision in mind develops a natural experience in relying on auditory cues.

In this study, pairs of students in engineering-architecture were teamed up with a so-called user/expert—in this case, a student or staff member with a sensory impairment, mobility impairment, or a diagnosis on the autism spectrum. Each team visited and analyzed a university building for which works were planned in the near future. The architecture students documented the visit in the form of an analysis report that is descriptive, narrative, and illustrated with pictures and graphic material. Findings were discussed with architects and other built environment professionals of the University's technical services.

As has been reported elsewhere (Heylighen, 2012; Heylighen & Vermeersch, 2015), the study was a learning experience for all parties involved. Through the building visit with a user/expert, the architecture students became more reflexive about design practice; the user/experts became more reflexive about their own spatial experience; and the architects of the technical services especially appreciated the nuanced approach to accessibility.

In this article, we aim to study in more detail what lessons professional architects could learn from building visits with user/experts, in other words, what exactly the added value could be of mobilizing disabled people's embodied experience to inform architectural practice. After presenting the background for and set-up of the field study, we address this question by relying on the analysis reports produced by architecture students who participated in the study. We conclude with the most important lessons learned and directions for future research.

2. Background

2.1. Architecture and (Disabled) Bodies

Throughout history the human body has been used in architecture as source of proportion and measurement; it has been used to derive divine proportions in classicist anthropomorphism, discover organic-physical laws in functionalist organicism, and elicit mathematical principles in modernism (Van Herck & de Cauter, 2004). Today the human body is still mainly applied by architects to derive numerical proportions or functional dimensions. However, the earlier functionalism has led to contemporary ergonomics moving away from the organicism towards a focus on the fragmented body (de Solà-Morales, 1997). By using sources like the *Metric Handbook* (Adler, 1999) or *Architects' Data* (Neufert & Neufert, 2000), designers introduce alleged ideal measurements in architecture (Imrie, 2003), which objectify the body but say little about how a building is experienced.

This numerical and objectifying approach also characterizes the way in which architects consider and relate to disability. In architecture and beyond, conceptions of disability tend to be dominated by a medical discourse, which considers disability as an individual, physiological disorder to be treated or cured. The disorder is thought to be situated in the person and the solution to the problem caused by the disorder lies in treatment or cure to restore the body's function. In this view, disability is defined by means of measurable criteria and statistically derived thresholds. In *International Statistical Classification of Diseases, Injuries and Causes of Death*, the World Health Organization (WHO, 1993) defines when a person is disabled based on measurable aspects of the human body. Once measured, a threshold can be chosen when this specific aspect contributes to the person being disabled. Visual impairment, for instance, is defined as having a visual acuity of less than 3/10, and blindness as having a visual acuity of less than 1/20 and/or a field of vision of less than 10°. Accordingly, accessibility norms or guidelines translate accessibility into measurable facts (or indicators and averages) by fixing minimum levels of colour or luminance contrast, minimum widths of doors, or maximum heights of thresholds.

Critiques of such medical conceptions of disability place the body in its socio-material context and stress the role of environmental determinants in performing day-to-day activities and fulfilling social roles (Fogeyrollas, 1995). The social model of disability therefore distinguishes conceptually between impairment and disability. It sees disability as socially constructed on top of impairment (Corker & Shakespeare, 2002), and places the explanation of disability's changing character in the organization of the society in which it is found (Butler & Bowlby, 1997). Referring to the definition of blindness, for instance, Butler and Bowlby (1997) argue that the threshold at which a person considers oneself visually disabled varies across individuals and may also differ from how others perceive them.

This move to embrace disability as a social issue can be traced in the *International Classification of Functioning, Disability and Health* (ICF) (WHO, 2001). It recognizes disability as a complex phenomenon reflecting interplay between features of a person's body and features of the environment he or she lives in. It states: "Disability is not something that only happens to a minority of humanity. The ICF thus 'mainstreams' the experience of disability and recognizes it as a universal human experience" (WHO, 2001). The ICF's assessment of this experience, however, is based on a checklist with an ambition to quantify and set boundaries to bodily and environmental factors of disability (Üstün, Chatterji, Bickenbach, Kostanjsek, & Schneider, 2003).

In the context of architecture and other design domains, this recognition of the two-way relationship between a disabled person and their environment has led to the development of design approaches like *universal design* (Connell et al., 1997), *inclusive design* (Clarkson, Coleman, Keates, & Lebbon, 2003), and *design for all* (Bendixen & Benktzon, 2013). These approaches focus on issues of social inclusion in that they aim at "designing environments that facilitate people's emancipation from artefacts that restrict or prevent their ease of mobility and access" (Imrie, 2012, p. 876). Despite their appearance, these design approaches have "vestiges of a medical model underpinning its value-base, and clinical and physiological rather than cultural (social) criteria appear to be defining, and shaping, its design mentalities and approaches" (Imrie, 2012, 874). In line with D'Souza (2004) and Tobias (2003), Imrie (2012) points at the positivist predisposal of these approaches towards the propagation of universal principles, their normative prescription of rules defining what good design is or ought to be, and their instrumental and pragmatic character in seeking to influence the usefulness of designed artefacts. As such, they seem to fit into a "problem-solving paradigm," whereby the design problem is posited as an objective entity that, through the development of applications and standards, will result in the correct outcomes (Imrie, 2012, 874).

A notable exception is the work of those who adopt a broader view on universal or inclusive design, such as Pedersen and Crouch (2002) and Cassim (2007). The latter in particular acknowledges the added value of people's embodied experience, which is at the centre of the field study reported here.

2.2. Disabled People's Embodied Experience

In reality, design outcomes are interpreted and experienced by people in ways that may considerably differ from the designers' intentions (Crilly, Maier, & Clarkson, 2008). This holds in particular for disabled people. Through their bodily interaction with the designed environment, disabled people can detect obstacles or appreciate qualities that designers may have ignored (Cassim & Dong, 2003; Pullin, 2009). This tends to be neglected by discourses focusing on functional aspects of disability experience (Fitzsimons, 2012).

A case in point concerns people with vision impairment—blindness or low vision. Through their body, perception, and activities, vision-impaired people have more nuanced knowledge of non-visual qualities of the built environment than sighted people (Dischinger, 2006). For a person who is blind, for instance, a room that seems coherent from a visual perspective may be experienced as multiple spaces. In the absence of sight, the part of the room that is lit by direct sunlight is an entirely different space than the part in the shadow, because of the difference in temperature (Vermeersch & Heylighen, 2012). Unlike what is often assumed, blind people's other senses are not better developed than that of sighted people: they do not have better ears, skin, muscles, or joints (Hollins, 1989). As they have to rely on senses other than sight, they learn to be more attentive to these (Cox & Dykes, 2001; Hollins, 1989; Lowenfeld, 1983; Warren, 1978). "Sighted people," by contrast, "feel themselves to be dependent on sight for many of the simplest everyday tasks that an independent life [without sight] demands of an individual. It is, therefore, easy for them to become blind (sic) to the wealth of information that their other senses provide." Butler and Bowlby (1997, p. 423) point out.

While vision-impaired people remind us that sight is a facilitating assumption in much design discourse, mobility-impaired people draw attention to how the senses connect with another corporal experience: motion (Fitzsimons, 2012). Whether having difficulty in walking or using a wheelchair, mobility-impaired people view space from a viewpoint atypical for designers. Their viewing angle differs from that of an able-bodied pedestrian (Annemans, Van Audenhove, & Vermolen, in press). They are more attentive to the texture of floors or pavement and they highlight the role of other people in how space is experienced (Annemans, Van Audenhove, & Vermolen, in press; Nijs & Daems, 2012; Winance, 2006). Their perspective challenges the distinction between functional and circulation space or, as Fitzsimons (2012) calls it, between "experience-substance-meaning" and "access-circulation-functionality" (p. 251).

Besides sensory or mobility impairments, particular cognitive conditions may lead to experience of disability that designers could learn from. Think for instance of people with a diagnosis on the autism spectrum. Although they are diagnosed based on their particular behaviour, this behaviour results from a particular cognitive style, a difference in information processing with a neurobiological cause (Rajendran & Mitchell, 2007).

Some autistic people have difficulties in visually distinguishing between foreground and background. Dominique Dumortier (2002), an author with a diagnosis on the autism spectrum, describes this phenomenon as follows: when a drawing board with white drawing paper is standing in front of a green door, she tends to see only a white surface on the door and not something standing there, and she wonders how the white surface ended up on the door. Similarly, autistic people may struggle to distinguish between foreground sounds and background noise. As a student, Dumortier (2002) had difficulties in following the teacher when the tube lamps in the classroom started buzzing. While her fellow students hardly heard this buzz, for her it was so loud that it became impossible to hear the teacher's voice clearly.

Because of this cognitive style, some autistic people can distinguish details that remain unnoticed by other people (Schiltmans, 2002). Moreover, as some with the condition have difficulty in drawing together diverse information to construct higher-level meaning in context (Frith & Happé, 1994), they try to find logic behind everything (Baumers & Heylighen, 2010; Kinnaer, Baumers, & Heylighen, 2015).

Disabled people's knowledge comes from their own experiences, but may also be reinforced by the specific training they receive. Teaching people who have lost their sight to perform daily activities is an established rehabilitative profession that typically deals with "low vision skills, communication, personal management, orientation and movement, home management, and leisure time activities" (Ponchillia & Ponchillia, 1996, p. 4). Similarly, wheelchair users are taught strategies to transfer from bed to wheelchair, wheelchair to car, and so forth.

2.3. Disability Experience and Design

Because of these particular embodied experiences, disabled people are increasingly acknowledged as lead or critical users in product and service design (Conradie, de Couvreur, Saldien, & de Marez, 2014). They experience a need that is not yet experienced by the rest of the market and attach high importance to obtaining a solution that addresses this need (Hannukainen & Hölttä-Otto, 2006). Disabled people also may interpret and use existing products in radically new ways (Cassim & Dong, 2003).

In architectural practice, disability experience is rarely recognized as a valuable resource for design. Accessibility of the built environment is often considered as a matter of fact (Latour, 2005) and something taken care of by professional experts (Simons & Masschelein, 2009). In line with a medical conception of disability, building codes translate accessibility into facts which can be objectively measured. Designers feel that these restrict their creativity and prevent intelligent design solutions (Gray, Gould, & Bickenbach, 2003), while offering little insight as to why a building feature may be problematic or appreciated. Moreover, rendering accessibility to the realm of facts leaves those affected by it—disabled people themselves—incapable of joining the design debate because they are supposedly not experts in the field.

This suggests a need for treating disability experience as a potential resource for design in order to enhance architectural practice. The study discussed in this article was set up to explore how the disabled person's embodied experience of the designed environment can be mobilized to inform architectural practice.

3. Methodology

In this section, we first describe the field study. We then describe how we analyzed its results to discuss the value of mobilizing disability experience to inform architectural practice.

3.1. Set-Up of the Field Study

3.1.1. Context

The University of Leuven decided to obtain advice from an official accessibility expert. One protected building was subjected to an accessibility audit first. The audit was performed by a professional accessibility advisor—a specialized architect. The advisor assessed the building and wrote a report. The report was based on an analysis of measurable elements which were already pre-identified in a checklist (i.e., elements such as height of steps, width of doors, etc.).

3.1.2. Rationale

The approach adopted in the field study was intended not as an alternative, but rather as complementary to professional approaches like the accessibility audit. First,our approach acknowledged forms of cognition that are embodied (Lakoff & Johnson, 1999) and situated (Osbeck, 2009; Suchman, 2006). These forms of cognition extend the location of knowledge from the individual brain to the body and its surrounding environment. Second, the measures in the abovementioned checklist are often determined based on the perspectives and needs of one user group (say, wheelchair users). Our field study sought to involve multiple perspectives. Moreover, rather than imposing certain solutions upon architects, we aimed to inform them or at most make suggestions to them, while leaving the actual design to them.

3.1.3. Buildings

The buildings considered in the field study were protected buildings on campus. Buildings were selected in consultation with architects of the University's technical services. Preference went to buildings for which works are planned in the near future. At the time of the study, seven buildings had been addressed—one building per academic year (between 2008 and 2015). Of these, five are discussed in this article (the remaining two are excluded because those two involved a slightly different approach). The five buildings were the following:

(a) *Van Dalecollege*, a sixteenth-century college accommodating the University's student services and student housing;
(b) *Arenbergcastle*, a sixteenth-century building housing the architecture department;
(c) *Popecollege*, a late eighteenth-century college used as a dorm for 180 students plus a branch of the University restaurant;
(d) *Leo XIII seminar*, a nineteenth-century building complex currently also used as student dorm; and
(e) *Dutch college*, a seventeenth-century college that has been preserved exceptionally well and is currently used as a meeting point for the academic community.

3.1.4. Participants

Each of the five buildings included in the analysis was visited by multiple teams (see Table 1). Every team was composed of one user/expert and two Master's students in architecture (or, in some cases, one Master's student and one PhD student). User/experts included students, staff, and visitors with mobility impairment (using a wheelchair, having difficulty in walking), sensory impairment (blindness, low vision), or a diagnosis on the autism spectrum. They were recruited through the university's Service for Students with Disabilities and the network of the Research[x]Design group. The architecture students attended an elective course on inclusive design. The number of teams per building varied across academic years, depending on the number of students enrolled for the elective course. Teams visited the building considered and identified *in situ* its qualities and weaknesses as experienced by the user/expert in the team.

Table 1. Composition of the Teams

Building	Team	User/Expert (M: Male; F: Female)	Student Researchers
1. Van Dalecollege	V1	UE1. Vision impaired: central black spot (8% vision) (M)	1 Master's + 1 PhD
	V2	UE2. Vision impaired: blindness (F)	1 Master's + 1 PhD
	V3	UE3. Mobility impaired: using tricycle (M)	2 Master's
	V4	UE4. Mobility impaired: using manual wheelchair (M)	2 Master's
	V5	UE5. Mobility impaired: using electrical wheelchair (F)	
	V6	UE6. Developmental condition: diagnosis on the autism spectrum (M)	1 Master's + 1 PhD
2. Arenbergcastle	A1	UE7. Vision impaired: sight reduction to light and darkness (F)	2 Master's
	A2	UE8. Vision impaired: congenital blindness and hearing impaired (M)	2 Master's + 1 PhD
	A3	UE9. Mobility impaired: using trolley or manual wheelchair (M)	2 Master's
	A4	UE10. Mobility impaired: using electrical wheelchair (F)	2 Master's
	A5	UE11. Developmental condition: diagnosis on the autism spectrum (M)	1 Master's + 1 PhD
3. Popecollege	P1	UE7. Vision impaired: sight reduction to light and darkness (F)	2 Master's
	P2	UE12. Vision impaired: blindness (F)	1 Master's + 1 PhD
	P3	UE9. Mobility impaired: using trolley or manual wheelchair (M)	2 Master's
	P4	UE13. Mobility impaired: using electrical wheelchair (F)	2 Master's
	P5	UE11. Developmental condition: diagnosis on the autism spectrum (M)	1 Master's + 1 PhD

Building	Team	User/Expert (M: Male; F: Female)	Student Researchers
4. Leo XIII seminar	L1	UE14. Vision impaired: blurred far sight (F)	2 Master's
	L2	UE1. Vision impaired: central black spot (8% vision) (M)	2 Master's
	L3	UE12. Vision impaired: blindness (F)	2 Master's
	L4	UE15. Mobility impaired: having difficulty walking (Ff)	2 Master's
	L5	UE16. Mobility impaired: using cane or manual wheelchair (M)	2 Master's
	L6	UE9. Mobility impaired: using trolley or manual wheelchair (M)	2 Master's
	L7	UE17. Mobility impaired: electrical wheelchair (F)	2 Master's
	L8	UE18. Developmental condition: diagnosis on the autism spectrum (M)	2 Master's
	L9	UE11. Developmental condition: diagnosis on the autism spectrum (M)	2 Master's + 1 PhD
5. Dutch college	D1	UE12. Vision impaired: blindness (F)	2 Master's
	D2	UE19 Mobility impaired: using manual wheelchair (F)	2 Master's
	D3	UE20. Developmental condition: diagnosis on the autism spectrum (M)	2 Master's

3.1.5. Output

The architecture students in each team wrote an analysis report summarizing the insights gained during the visit by the team. The report was documented with photos and graphical material that resonated with architects' visual way of working (Cross, 1982; Goldschmidt, 1994) (Figure 1 and Figure 2). Each academic year, all reports about the building analyzed were shared and discussed with the other teams analyzing the same building, thus augmenting their validity, and with architects and other built environment professionals of the technical services. Altogether, 28 analysis reports were written by the student researchers.

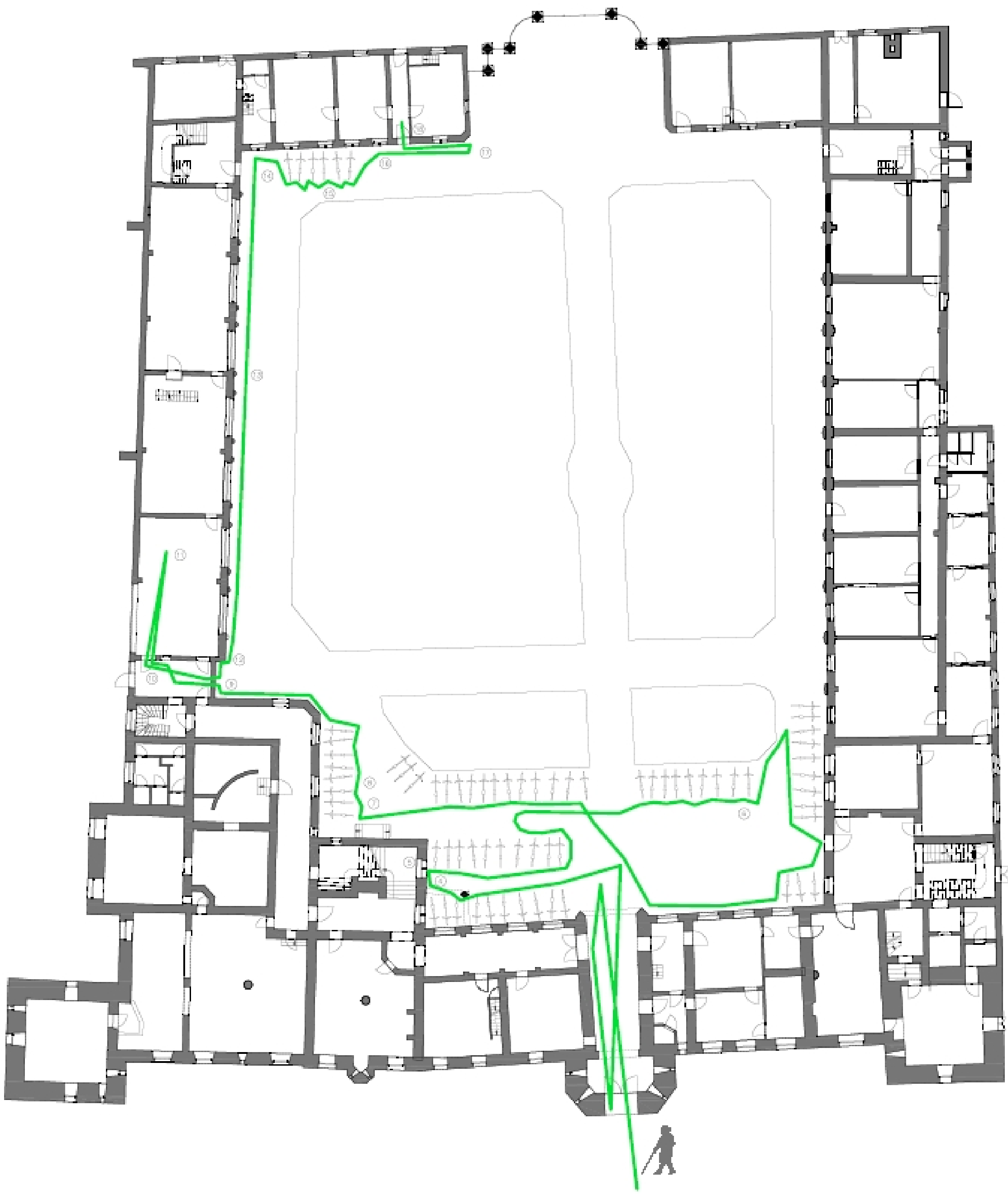

Figure 1. Graphical illustration of how a blind user/expert searches his way in the courtyard of a university building, and gets lost in between the bikes that are parked there. (© P. W. Vermeersch based on J. Claeys & K. Happaerts)

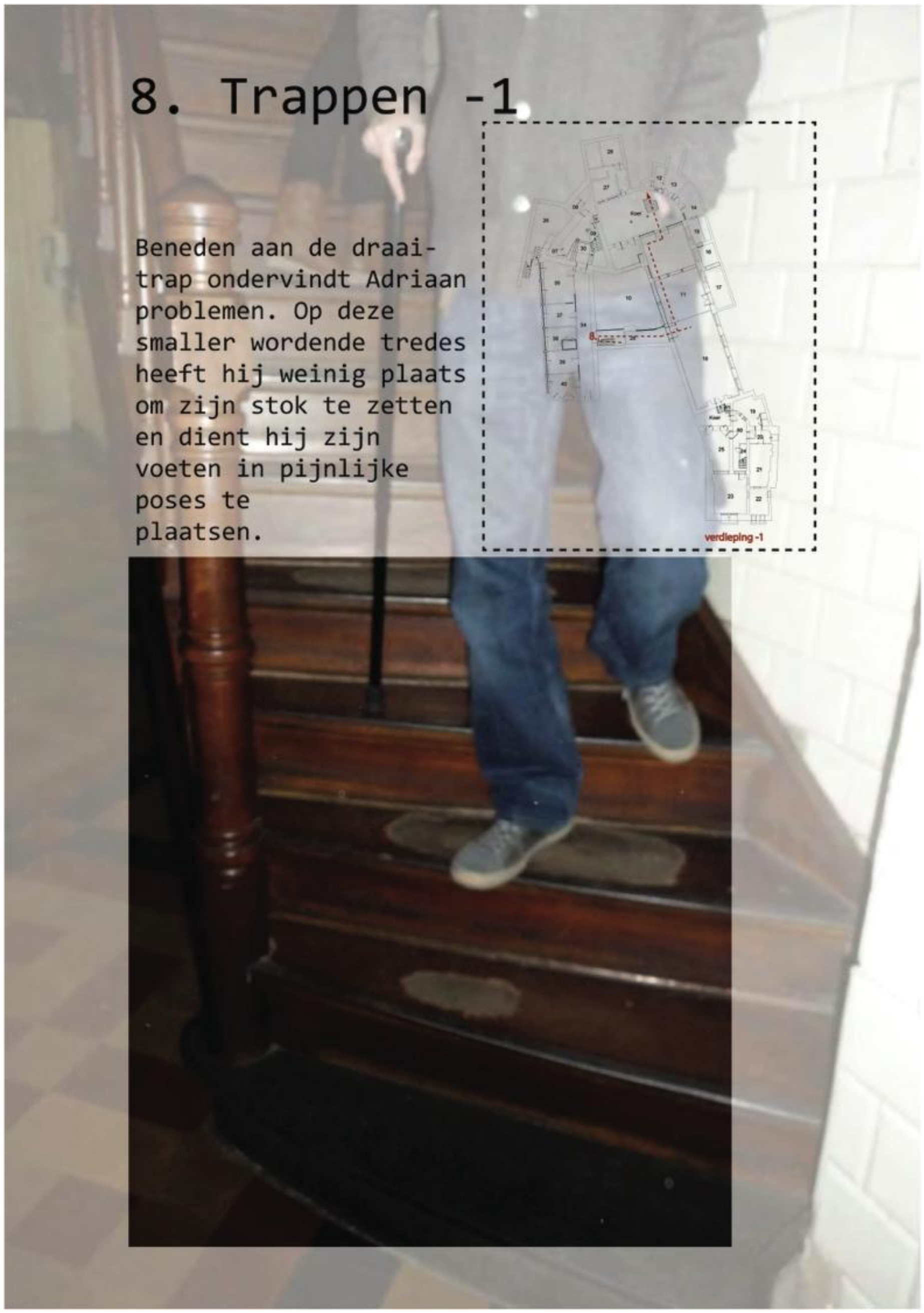

Figure 2. Illustration combining text, photo and graphic material explaining how a person using a cane experiences difficulties going down a winding stair. (©Annemie Poortmans & Lore Tonnet)

3.2. Analysis

In order to pinpoint the added value that disability experience could bring to architectural practice, we conducted a document analysis (Creswell, 2003; Mortelmans, 2013) of the reports produced by the student researchers who participated in the field study. We conducted a qualitative thematic analysis (Braun & Clarke 2006) on the 28 reports. The goal of this analysis was to gain insight into the experiences of the user/experts. Themes were therefore sought across the entire data set. We started from the dichotomy between disability experience and disability representation in architectural design processes, trying to find alternatives that would provide more richness to the design process. In the first iteration of the analysis, the data within the reports (including both text and images) were structured according to four questions:

(a) How was the building visit approached?
(b) Which kind of disability did the user/expert experience?
(c) What information was exchanged during the visit?
(d) How was this information presented in the report?

These questions were chosen such that we could encompass aspects of disability experience and architectural design, namely the embodied action, perception, and cognition of the user/experts and the representational media to report on this. These structured data were coded, which led to a table of codes ordered under the four questions.

The next iteration was the interpretative step of defining themes by sorting and grouping codes under more encompassing themes. On the one hand, this iteration was data-driven as we worked with emergent codes. On the other hand, this iteration was also guided by our original interest in exploring how disability experience may contribute in architects' design process.

4. Findings

Analysis of the reports suggests that the information gathered from the building visits with user/experts provides rich and nuanced insights into the buildings' qualities: insights into aspects of the buildings' functionality as well as insights into their sensory qualities. The insights on functionality complement the analysis based on accessibility standards as performed in professional accessibility audits. However, the knowledge gained from the building visits appear to surpass functionality, as the user/experts tend to sense spatial qualities that are less obvious to architects.

4.1. Beyond Functionality

Comparing the students' reports with the report made by the professional accessibility advisor indicates the extent to which the visits with user/experts could add to established approaches. While the professional accessibility advisor's report privileges the needs of one user group (c.q., wheelchair users), the students' reports offer insights into a building's usability from the standpoint of other possible user groups. Furthermore, spatial qualities that are not dividable into elements, nor measurable, but nonetheless crucial to certain groups, are easily omitted in the quantitatively oriented accessibility standards.

4.1.1. Accessibility Standards Versus Situations of Use

During the building visits with user/experts, adaptations that had been made to the building according to accessibility standards were put to the test. For instance, while approaching the Arenbergcastle, a blind user/expert (UE8, see Table 1) explained that a road paved with tactile tiles which line up insufficiently with the actual building entrance can be confusing. “[Guideline tiles] often lead to nowhere: they are meant to lead to an entrance, but as functions change or buildings are refurbished, they can even lead straight to a blind wall” (User/expert UE8). In situations where an accessibility standard could not be applied, for example, due to lack of space, the user/experts came up with feasible solutions in the situation. In the same example, the user/expert had to rely on the students’ help and her own ability to find other (natural) guidelines in the environment. The architecture students report: “The lanes in front of the Arenbergcastle are for [the user/expert] easy to follow, the hedges and trees at both sides give a clear direction.”

Adaptations made for one user group were tested by multiple user/experts with different impairments. This revealed neutralities, synergies, and contrasts between different needs, surpassing the checks based on information derived from one user group. Accessibility standards applied for one user group are not always helpful for others and can even become an obstacle for some. Visiting a building with people from multiple user groups allowed architecture students to identify these possible gaps that are present in a checklist approach as adopted in the professional audit. For example, two entrances of the Arenbergcastle were adapted to wheelchair use: a concrete and stainless steel platform integrating ramps and steps replaced the blue stone steps at the door. A user/expert with low vision (UE7) identified this as an obstacle as the steps showed no contrast, had no railing and were located away from the door where she would have expected them to be.

At another place in the Arenbergcastle, the architecture students’ reports suggest that different user/experts experienced similar needs. Referring to one particular staircase, a participant with low vision (UE7) mentioned that “at a certain point there is a ‘hole’ in the wall because of a window. At that point, a person with low vision has no ‘support’ [i.e., guideline].” A mobility-impaired participant (UE9) pointed out that a handrail in a corner should be continuous, which was not the case for this staircase. For one participant, the handrail is a guideline, for the other a support, but both benefit from a continuous handrail. Such examples give a better understanding of how different user groups can be supported by the same building element.

The building visits with user/experts provided insights into actual use situations that are linked to accessibility standards. By allowing the user/experts to explain the why and how of their needs, the visits offered a translation of the numerical values at the core of accessibility standards to their impact on users’ actions. Throughout the visits with the above-mentioned mobility-impaired person (UE9), for example, an important element was the handrails. Although subject to standards of presence and dimensions, some situations required a handrail, others did not. During the visit to the Arenbergcastle, the user/expert could demonstrate and explain how he used the handrail differently in different situations: sometimes for support (to prevent falling), sometimes for grip (to pull himself forward), and sometimes a handrail was not necessary since a nearby wall provided sufficient support to descend a ramp.

As one place can be “visited” multiple times over, during the visits some places or situations were altered slightly on the spot to analyse multiple (hypothetical) situations of use. For example, UE9 who has difficulty in walking and sometimes uses a wheelchair visited two buildings (the Arenbergcastle and Popecollege) partially on foot. During these visits, he sometimes pointed at aspects that did not raise a problem at this point, but would if he were using his wheelchair, or vice versa. Slopes were very handy when in the wheelchair, but on foot he preferred a well-dimensioned staircase because on a slope he had more difficulty keeping balance. Whether or not he used a wheelchair changed his body configuration and, by consequence, the building features he appreciated or found problematic. During the visit to the Dutch college, a wheelchair user (UE19) highlighted the distinction between how she experienced the situation being pushed by one of the accompanying architecture students, and how she would experience it when being alone: "Some obstacles are not visible for the person who assists, but they can harm a person in a wheelchair by bumping into them. An obstacle like that was the plinth from the kitchen which was much larger than normal and was in the way of the wheelchair."

4.1.2. User Group Strategies and Personal Tactics

An important nuance in the user/experts' explanations of the how and why of (in)accessible situations is the difference between how they have been taught to deal with such situations and how they act in the moment. During the visits, the user/experts made a distinction in their explanation between user group strategies and personal tactics in dealing with the built environment and its obstacles. User group strategies refer to what user/experts have learned from others with similar impairments through schooling. An example of a strategy taught to blind people is shore-lining: identifying and following continuous lines in the environment to reach a destination. With personal tactics we mean *in situ* adaptations of strategies to the situation at hand.

When user/experts encountered obstacles during the building visit, they demonstrated how they dealt with them, enabling the architecture students to observe their tactics. Furthermore, the user/experts could describe verbally how these tactics followed or diverged from their general strategies. During the visit to the Arenbergcastle, a vision-impaired user/expert (UE8) imparted both his personal experiences and generalities in the experience of other people with similar impairments to the architecture students. From a student's report we take that "a person with a visual impairment often uses his memory. If he took a staircase at the entrance, he will expect one at the exit. Since the stairs do not continue over the width of the entrance, he could fall if he exited at the other half." One example that came back in multiple visits was how blind people relying on shore-lining had to adapt to the situation at points where tactile tiles were not present. Tactics demonstrated in such situations ranging from trying to find natural guidelines following the general direction or asking for help.

4.1.3. Gradient in Obstacles

Visiting buildings with user/experts led to the identification of a larger variety of situations in which obstacles were encountered than a checklist approach with its presence/absence evaluation would. In the analysis reports, the following gradient in obstacles came to the fore (see Figure 3):

(a) situations that are impossible to overcome;
(b) situations that require assistance;
(c) situations that require personal tactics;
(d) situations that can be dealt with independently;
(e) and situations that are comfortable.

Figure 3. Gradient in obstacles:
(a) Impossible: electric wheelchair versus stairs without alternative entrance (©Nele Byns & Marjon Marx)
(b) Accessible with help: someone opening door which is too heavy to open by a wheelchair user herself (©Hilde Bockx & Nathalie Boudin)
(c) Accessible with personal tactics: using trolley for support on slope (©Arne Frederix & Kirsten Cornelissen)
(d) Accessible independently: finding a clear natural guideline in the right direction (©Joke Claeys & Karen Happaerts)
(e) Comfortable: handrail that follows the stairs and offers good grip and guidance (©Joke Claeys & Karen Happaerts)

This gradient was revealed as a result of teaming up the user/experts with architecture students during the visits, which made it possible to tackle obstacles in different ways. If one obstacle turned out impossible to overcome independently, the user/expert first tried another method. If this failed too, the architecture students could help to continue the visit. For instance, in the Popecollege where a mobility-impaired participant (UE9) encountered a flight of stairs, he could not continue with his wheelchair. The absence of a handrail meant that he could not use that as support either. Another strategy where he used a trolley for support (something that helped him overcome smaller height differences) failed too in this particular case of stairs. The strategy that worked was to ask and rely on the architecture students to support him while descending the stairs. The students' report describes: "this staircase has no handrail. [The user/expert] asks here the help of a person for support. If he can lean on a shoulder it is possible to take the stairs. . . . Luckily, [the students] were present to carry his trolley and wheelchair down the stairs."

This possibility to identify obstacles of different degrees allows for a building analysis that takes into account more factors than only the abstracted impaired person and the building. These factors would include the person's own creativity or help from others. The gradient also surpasses minimal requirements of functionality when user/experts talk about comfort in situations they identify as potential obstacles.

4.1.4. Scaling Up Accessibility

Visiting a building is more than using its elements; it entails the whole building. This became apparent when the user/experts evaluated the ease of wayfinding in the buildings visited. At this point, building elements and the general layout of the building were analysed together.

When visiting the Van Dalecollege, two vision-impaired participants (UE1, UE2) pointed at the lack of clear organization. According to the architecture students' report, the participant with low vision (UE1) had the impression that the building complex was "not designed as a whole. . . . Also the constant search for rooms he found user-unfriendly." The blind participant (UE2), for her part, found the building inconveniently arranged. For her to use it independently would require a clear explanation of its appearance, location, orientation, and structure. Nevertheless, she was able to find the reception by herself because it was near to the entrance which she would seek intuitively (because of its smell, as explained below). The architecture students' report mentions: "The ground floor, apart from the cobblestone courtyard was easy. . . . The first floor, on the other hand, was chaotic with too much nooks and crannies and she would lose her way easily." An autistic user/expert (UE6) also had trouble with the lack of clear organization. Except in places he was familiar with (because he had been there before), it was difficult for him to figure out his exact location within the building.

In the Arenbergcastle, a blind participant (UE8) pointed out that the secretariat of the department accommodated by the building was located in an illogical spot: while he would expect it close to the main entrance but it was actually located in a side wing. Moreover, the path that he followed to navigate the courtyard (see Figure 1) made clear how the placement of bicycle racks complicated an otherwise convenient building layout. A participant having difficulty in walking (UE9) also suggested changes to the building's organization. The entrance to the porter's lodge would be much more accessible to him when using the back door instead of the door going on to the courtyard. The same applied for the seminar rooms. By considering the entrance via the current secretariat as a full entrance to the seminar rooms, people would not be obliged to cross the bumpy cobblestones in the courtyard.

These examples illustrate that the extent to which a building was experienced as accessible was a matter not only of the building's physical fabric but also of how it was used. The latter seemed to play an important role also in the experience of an autistic participant (UE11). In the Popecollege, the architecture student's report mentions that the entrance hall was "an unpleasant place to wait, as the noise of the vending machine and of the people passing is too disturbing." Similarly, the big spaces in the Arenbergcastle used by architecture students as design studios may not be a suitable place for him to work. These spaces would be very busy, with students and staff running in and out. When entering the room you were directly confronted with the people present. For the autistic participant (UE11), the design studios perhaps would be better subdivided in smaller, structured spaces that were more or less separated from each other in terms of view and sound.

4.2. Beyond Accessibility: Identifying Sensory Qualities

We have compared the insights gained through building visits by user/experts with insights gained through the accessibility audit performed by a professional accessibility advisor. However, the visits offered a much more nuanced appreciation of the situation in and around a building and revealed issues that may be easily overlooked when focusing on accessibility only.

Besides identifying obstacles in the buildings visited, the user/experts also described their general experiences of the building and its spaces. Unlike building codes or standardized checklists, the approach adopted in the field study allowed the user/experts to express their experiences in their own words. For instance, a blind participant (UE12) found the Popecollege "not cosy at all." It is "way too big" and there is "not much order." An autistic participant (UE11) had the impression that "lumber is lying everywhere" which he found disturbing. After the visit, the architecture student wrote:

> [The autistic participant] was happy to be outside again because he dislikes the building's interior and has an oppressive feeling inside. . . . Asked what he finds unpleasant, he refers to "the prison corridor." This specific corridor is more spacious than the other ones at the north side, but because the prison feeling prevails, he finds it particularly unpleasant. In relation to this, he mentions the lack of sufficient natural daylight, which is problematic to him in many places.

The analysis reports of the building visits included not only building aspects that users/experts experience as problematic but also aspects that they valued, in particular its sensory qualities. The reports highlight the key role played by the senses in how a building or site is appreciated. Through smell, vision, hearing, and touch, the user/experts discovered distinctive features that not only offered clues to understand and navigate a building or site, but also affected how it was experienced.

Smell. When visiting the Van Dalecollege, a blind participant (UE2) managed to locate the reception in part through its smell: when passing by the door to the reception, the architecture student's report mentions, she noticed "a smell that reminded her of libraries and journals." Once inside the building, it struck her that the spaces smelt unpleasant which she ascribed to poor ventilation. Similarly, in the Dutch college, a blind woman (UE12) and a man with autism (UE20) both pointed at specific smells, which they found disturbing.

Vision. In the Popecollege, several user/experts complained about the lack of light (see Figure 4). The architecture students visiting the building with a participant having low vision (UE7) noticed that the transition from dark to bright(er) spaces, and vice versa, constituted a considerable threshold for her. The students' report pointed out:

> [T]here is no continuous lighting and [the user/expert] has trouble with this: "this is very troubling, each time I have to adapt to the light and back to the dark and back to the light . . . That is really difficult."

In dark spaces, the recognizability of building elements diminishes considerably. For the architecture students, it did not make a difference in which corridor they were walking yet they sensed that the user/expert walked more cautiously through the darker corridors.

An autistic participant (UE11) also mentioned the lack of sufficient natural light in the Popecollege, which he considered especially problematic in the long windowless corridors along the student rooms. Deprived of contact with outside, he did not know on which side of the building he was. Interestingly, the only corridor he found beautiful had sufficient light (Figure 5). This enabled him to better see how the space was finished. Another space he found beautiful was the hall with the old staircase. The hall was well-lit and spacious, and the rustic wood offered a beautiful contrast with the white painted walls.

Figure 4. In the Popecollege, several user/experts complain about the lack of light. (©Adelheid De Muynck)

Figure 5. In the Popecollege, UE11 found one corridor beautiful: material finishes were similar to the other corridors, but more natural light entered the corridor. (©Adelheid De Muynck)

The amount of light and especially the kind of light also seemed to play an important part in the appreciation of the Dutch college. Based on their visit with an autistic participant (UE20), two architecture students distinguished three different types of rooms in terms of lighting (see Figure 6). The first type included rooms with authentic interiors (e.g., the salons and the library), each illuminated by an old crystal chandelier—a single direct light source which reflected the light multiple times. These reflections and the glimmering might result in an overload of stimuli. In the second type of rooms (the garden room and the canteen), the lighting was better for the user/expert because different ways of illuminating the room were available. These rooms had different contemporary light sources that each could function separately: indirect light, direct light, and spots. By choosing the desired amount and position of artificial light, a different atmosphere could be created in the room. Several ways of lighting were possible also in the chapel, but here the luminaires were of an older type. The third type of lighting was found in the hallways, which are illuminated indirectly. This offered enough light without too many stimuli.

Figure 6. In the Dutch college, three different types of rooms can be distinguished in terms of lighting. (©Jonathan Denoiseux & Eline Rens)

Hearing. When entering the main entrance of the Arenbergcastle, a blind participant (UE8) was relatively quick to realize that the building was structured around a courtyard (see Figure 1). He derived this from what he was hearing. The architecture students reported how "he described the covered entrance as a passageway in between two buildings (he noticed an echo), which is followed by an open space." The rectangular shape of the courtyard made it easy for him to become orientated. When leaving the Van Dalecollege, another blind participant (UE2) managed to find the entrance gate because of the traffic noise on the street. Inside the building, she noticed that the rooms did not sound pleasantly: there was way too much resonance. We already referred to the fact that an autistic participant (UE11) did not like the entrance hall of the Popecollege, in part because of the sound of the vending machine.

Touch. Besides smell, vision, and hearing, touch also played a role in the user/experts' understanding and appreciation of the buildings visited. In the Van Dalecollege the blind participant (UE2) immediately noticed that she entered the courtyard, since the air displacement changed when leaving the arched doorway. The Van Dalecollege, Arenbergcastle, and Popecollegeeach has a courtyard covered with cobblestones. Their unevenness caused a number of problems for several user/experts: (a) for those having difficulty in walking, it made using a cane more difficult and increased the risk of stumbling; (b) for wheelchair users, it provided a bumpy ride; and (c) for blind participants, it made walking with a white cane difficult—cobblestones lying in the same direction could not be felt as a guiding line.

By contrast, positive elements found in several of the buildings visited were old staircases. In the Arenbergcastle, for instance, a staircase in the porter's lodge was praised for its comfortable dimensions and its handrail. The handrail did not only offer good grip, its banisters made the staircase clearly recognizable as such to a blind participant (UE8). Also in the Popecollege, one particular staircase was described as very comfortable and its handrail as offering good grip.

Embodied knowledge about the built environment involves multiple sensory modalities. The different senses do not operate in isolation, however. The building and site visits with user/experts also showed that these sensory modalities overlapped with and connected to the bodily interaction with the environment. The entrance hall in the Popecollege, for example, had large windows, which let in a lot of light. Yet, for an autistic participant (UE11), these visual qualities seemed to disappear to the background because of the disturbing noise of the vending machine.

5. Discussion and Conclusion

Disabled people are able to appreciate spatial qualities that designers may not be attuned to. In architectural practice, this ability is not fully acknowledged as a valuable resource for design. In this article, we have reported on a field study in which disabled people visited university buildings accompanied by architecture students. The reports of these visits were analysed to explore how mobilizing disability experience may inform architectural practice.

Analysis of the reports suggests that the major added value of mobilizing disability experience for architectural practice is that it provides rich and nuanced insights into a building's functionality. These insights not only surpass accessibility standards but also assist architects in applying those standards. When the user/experts encountered obstacles and presented solutions to overcome them, they did so in the situation. This means that apart from the how, they could explain the why, which enables architects to understand a given solution rather than merely apply it. These insights are important to architects who need to integrate accessibility solutions into the complexity of a building design. Accessibility standards lack this quality for architects to be able to adapt and integrate those standards in a design. Without such quality, standards may be added to a design but may not become a part of it.

The building visits with user/experts focus less on solutions but rather on explaining situations of use and identifying spatial qualities. Therefore, they do not impose a de facto solution but allow architects to come up with their own solutions that provide the desired functionality or spatial quality. The blind participants' actions demonstrated where the environment provided natural guidelines; what elements they were made of; and how the user/experts could find them. This is potentially interesting information as it allows architects to implement the environment needed for shore-lining by using elements that are part of that environment (e.g., curb stones, gutters, floor joints, etc.) rather than adding an extra layer of tactile tiles.

Analysing buildings *in situ* offers insights into the differences between strategies and tactics and demonstrates the limits of the former. Strategies could also be taught to non-disabled people such as architects, but the nuances of the tactics emerge from actual use situations and require embodiment—or at least observation in the situation. Indeed, as Ingold (2000, p. 349ff) points out, learning a skill may be effectuated by a cultural practice of handing over instructions (e.g., strategies), but happens eventually in the perceptions and actions in context, which might lead to personal tactics in the long run. Understanding the relation between both is possible through observation of actions *in situ*. Passing on strategies only does not offer architects insight into tactics, because they did not undergo the same learning process.

Moreover, visiting buildings with user/experts allowed architecture students to identify a larger variety of situations in which obstacles were encountered than the presence/absence evaluation of a checklist approach, ranging from situations that were impossible to overcome to situations that were comfortable. Extending the focus towards comfort is potentially important. Being comfortable frees up more resources of disabled people to spend on other activities, such as conversing with others.

Analysis of the reports suggests that mobilizing disability experience offers an added value beyond accessibility: the multiple user/experts together provide insights into the buildings' spatial, sensory qualities. Because of their abilities, they have specific experiences that can differ from those of most architects. People in a wheelchair are more attuned to visual qualities from a different (lower) perspective. Vision-impaired participants described acoustic and haptic qualities. Those who have some remaining sight are able to pinpoint difficult lighting conditions. Autistic people were strong in identifying the general atmosphere of spaces, providing insight into a building's legibility, for example, whether a public passage is also experienced as public.

These qualities play a role in the building's functionality (e.g., in wayfinding), and beyond, in experiencing comfort and well-being. As such, disabled people's involvement allows architects to bridge the two concepts of accessibility and spatial experience that tend to be considered as unrelated in design practice. Moreover, extending the focus towards spatial qualities enables architects designing inclusive solutions to build on a building's strengths instead of focusing on its faults and weaknesses only.

Impact. The outcomes of the field study have had a major impact on local decision-making. The insights gained through the visits have motivated and informed the technical services to implement alterations in some of the buildings visited. The Big Auditorium (in Dutch: *Grote Aula*) has undergone several interventions to improve its acoustic comfort which are directly motivated by insights gained through the analyses with user/experts. The outcome of these has also played a crucial role in the negotiations with and convincing of the conservation authorities to approve these interventions. The lack of organization in the Van Dalecollege pointed out by several user/experts has inspired major organizational interventions to rearrange the student services more logically in the available space such that all students can consult them, while limiting interventions which require touching the historic fabric. Moreover, the numerous complaints about the cobblestones has inspired the University's technical services to set up another field study. On one of its sites, they have implemented a test strip, by breaking out cobblestones, sorting them, and grouping the flattest stones.

This impact has triggered the idea to explore the feasibility of extrapolating the approach adopted in the field study to existing buildings beyond the premises of our University. In line with practices of *co-design* (Sanders & Stappers, 2008, Steen, Manschot, & de Koning, 2011), we are currently investigating to what extent and in what format disabled people could partake as actors of innovation in architectural practice (Schijlen, Van der Linden, Meulenijzer, Vermeersch, & Heylighen, 2015). This may be particularly relevant for the way in which established cities with historical stocks of buildings are to be developed in the future. Given disabled people's vulnerable position on the job market, it is crucial that the embodied experience they can bring to the table is not only acknowledged, but also rewarded accordingly. Moreover, since few architects seem to link disability with spatial experience (Schijlen et al., 2015), efforts are needed to sensitize architectural practice on this matter.

Acknowledgements

This research has received funding from the European Research Council under the European Community's Seventh Framework Programme (FP7/2007- 2013)/ERC grant agreement No. 335002 and from the KU Leuven Industrial Research Fund. The authors thank all who contributed to the field study, in particular the user/experts, the architecture students, and the staff of the technical services for their participation in the field study, and Stijn Baumers, Francesca Bozza, and Jasmien Herssens for assisting students during the building visits. *Conflict of Interest*. The authors declare that there is no conflict of interest.

References

Adler, D. (1999). *Metric handbook: Planning and design data*. Oxford, United Kingdom: Architectural Press.

Annemans, M., Van Audenhove, C., Vermolen, H., & Heylighen, A. (in press). In-patients' spatial experience: Interactions between material, social and time-related aspects. *Space and Culture*.

Baumers, S., & Heylighen, A. (2010). Harnessing different dimensions of space. In P. Langdon, J. Clarkson, & P. Robinson (Eds.), *Designing inclusive interactions* (pp. 13-23). London, United Kingdom: Springer-Verlag.

Bendixen, K., & Benktzon, M. (2013). Design for all in Scandinavia—A strong concept. *Applied Ergonomics*, *46*(B), 248-257.

Braun, V., & Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101.

Butler, R., & Bowlby, S. (1997). Bodies and spaces: An exploration of disabled people's experiences of public space. *Environmental and planning D: Society and Space*, *15*, 441-433.

Cassim, J. (2007). 'It's not what you do, it's the way that you do it': The challenge workshop—A designer-centred inclusive design knowledge transfer mechanism for different contexts. In C. Stephanidis (Ed.), *Universal access in human-computer interaction: Coping with diversity* (Series: Lecture Notes in Computer Science, Vol. 4554, pp. 36-45). Heidelberg, Germany: Springer.

Cassim, J., & Dong, H. (2003). Critical users in design innovation. In J. Clarkson, R. Coleman, S. Keates, & C. Lebbon (Eds.), *Inclusive design: Design for the whole population* (pp. 532–553). London, United Kingdom: Springer.

Clarkson, J., Coleman, R., Keates, S., & Lebbon, C. (Eds.). (2003). *Inclusive design: Design for the whole population*. London, United Kingdom: Springer.

Connell, B. R., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., . . . Vanderheiden, G. (1997). *The principles of universal design*. Raleigh, NC: North Carolina State University, Center for Universal Design, College of Design. Retrieved September 27, 2015, from http://www.ncsu.edu/ncsu/design/cud/about_ud/udprinciplestext.htm

Conradie, P., de Couvreur, L., Saldien, J., & de Marez, L. (2014). Disabled persons as lead users in product innovation. In *10th biannual NordDesign conference proceedings* (pp. 284-293). Espoo, Finland: Design Society.

Corker, M., & Shakespeare, T. (2002). Mapping the terrain. In M. Corker, & T. Shakespeare (Eds.), *Disability/postmodernity: Embodying disability theory* (pp. 1-17). London, United Kingdom: Bloomsbury.

Cox, P. R., & Dykes, M. K. (2001). Effective classroom adaptations for students with visual impairments. *Teaching Exceptional Children*, *33*(6), 68-74. Retrieved from https://truddentechnology.wikispaces.hcpss.org/file/view/Effective+Classroom+Adaptations.pdf/34305783/Effective%20Classroom%20Adaptations.pdf

Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approaches*. London, United Kingdom: Sage.

Crilly, N., Maier, A., & Clarkson, P. J. (2008). Representing artefacts as media. *International Journal of Design*, *2*(3), 15-27.

Cross, N. (1982). Designerly ways of knowing. *Design Studies*, *3*(4), 221-227.

de Solà-Morales, I. (1997). Absent bodies. In C. C. David (Ed.), *Anybody* (pp. 18-24). Cambridge, MA: MIT Press.

Dischinger, M. (2006). The non-careful sight. In P. Devlieger, F. Renders, H. Froyen, & K. Wildiers (Eds.), *Blindness and the multi-sensorial city* (pp. 143-176). Antwerp, Belgium: Garant.

D'Souza, N. (2004). Is universal design a critical theory? In S. Keates, J. Clarkson, P. Langdon, & P. Robinson (Eds.), *Designing a more inclusive world* (pp. 3-10). Berlin, Germany: Springer-Verlag.

Dumortier, D. (2002). *Van een andere planeet: Autisme van binnenuit* [From a different planet: Autism from within]. Antwerp, Belgium: Houtekiet.

Fitzsimons, J. K. (2012) Seeing motion otherwise. *Space and Culture*, *15*, 239-257.

Fogeyrollas, P. (1995). Documenting environmental factors for preventing the handicap creation process. *Disability & Rehabilitation*, *17*(3-4), 145-153.

Goldschmidt, G. (1994). On visual design thinking. *Design Studies*, *15*(2), 158-174.

Gray, D. B., Gould, M., & Bickenbach, J. E. (2003). Environmental barriers and disability.*Journal of Architectural and Planning Research*, *20*(1), 29-37.

Hannukainen, P., & Hölttä-Otto, K. (2006). Identifying customer needs: Disabled persons as lead users. In *Proceedings of IDETC/CIE 2006, ASME 2006 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference* (p. 9). Philadelphia, PA: ASME.

Heylighen, A. (2012). Inclusive Built Heritage as a Matter of Concern: A Field Experiment. In P. Langdon, P. J. Clarkson, P. Robinson, J. Lazar, & A. Heylighen

(Eds.), *Designing inclusive systems* (pp. 207-216). London, United Kingdom: Springer-Verlag.

Heylighen, A., & Vermeersch, P. (2015). Mobilizing disability experience to inform architectural education. Lessons learned from a field experiment. In *Raising awareness for the societal and environmental role of engineering and (re)training engineers for participatory design (Engineering4Society)* (pp. 51-58). IEEE.

Hollins, M. (1989). *Understanding blindness*. Hillsdale, MI: Erlbaum.

Imrie, R. (2003). Architects' conceptions of the human body. *Environment and Planning D*,*21*, 47-65.

Imrie, R. (2012). Universalism, universal design and equitable access to the built environment. *Disability & Rehabilitation*, *34*(10), 873-882.

Ingold, T. (2000). *The perception of the environment: Essays on livelihood, dwelling and skill*. London, United Kingdom: Routledge.

Kinnaer, M., Baumers, S., & Heylighen, A. (2015). Autism-friendly architecture from the outside in and the inside out: An explorative study based on autobiographies of autistic people. *Journal of Housing and the Built Environment* (First online: May 10, 2015).

Latour, B. (2005). From realpolitik to dingpolitik or how to make things public. In B. Latour, & P. Weibel (Eds.), *Making things public* (pp. 14-41). Cambridge, MA: MIT Press.

Lowenfeld, B. (1973). *The visually handicapped child in school*. New York, NY: Day.

Mortelmans, D. (2013). *Handboek Kwalitatieve Onderzoeksmethoden* [Handbook of qualitative research methods]. Leuven, Belgium: Acco.

Neufert, E., & Neufert, P. (2000). *Architects' data*. Hoboken, NJ: Wiley-Blackwell.

Nijs, G., & Daems, A. (2012). And what if the tangible were not? And vice versa. *Space & Culture*, *15*, 186-197.

Ostroff, E. (1997). Mining our natural resources: The user as expert. *Innovation*, *16*(1), 33-35.

Pedersen, A., & Crouch, C. (2002). Introducing universal design to a colonial context. In J. Christophersen (Ed.), *Universal design* (pp. 289-314). Drammen, Norway: Norwegian State Housing Bank.

Ponchillia, P. E., & Ponchillia, S. V. (1996). *Foundations of rehabilitation teaching with persons who are blind or visually impaired.* New York, NY: AFB.

Pullin, G. (2009). *Design meets disability*. Cambridge, MA: MIT Press.

Rajendran, G., & Mitchell, P. (2007). Cognitive theories of autism. *Developmental Review*,*27*(2), 224–260.

Sanders E. B.-N., & Stappers P.-J. (2008). Co-creation and the new landscapes of design. *CoDesign*, *4*(1), 5-18.

Schijlen, J., Van der Linden, V., Meulenijzer, D., Vermeersch, P., & Heylighen, A. (2015). Exploring the potential of disability experience as consultancy in architectural design practice. In R. Valkenburg, C. Dekkers, & J. Sluijs (Eds), *PIN-C 2015 Reframing Design. Proceedings of the 4th Participatory Innovation Conference 2015* (pp. 124-131). The Hague, The Netherlands: PIN-C.

Schiltmans, C. (2002). *Autisme verteld* [Autism narrated]. Gent, Belgium: Vlaamse Vereniging Autisme & uitgeverij EPO vzw.

Simons, M., & Masschelein, J. (2009). The public and its university: Beyond learning for civic employability? *European Educational Research Journal*, *8*(2): 204-217.

Steen, M., Manschot, M. A. J., & de Koning, N. (2011). Benefits of co-design in service design projects. *International Journal of Design*, *5*(2), 53–60.

Tobias, J. (2003). Universal design: Is it really about design? *Information Technology and Disabilities*, *9*(2).

Üstün T. B., Chatterji, S., Bickenbach, J., Kostanjsek, N., & Schneider, M. (2003). The international classification of functioning, disability and health: A new tool for understanding disability and health. *Disability and Rehabilitation*, *25*(11-12), 565-571.

Van Herck, K., & de Cauter, L. (2004). Het lichaam van de architectuur [The body of architecture]. In H. Heynen, A. Loeckx, L. de Cauter, & K. Van Herck (Eds.), *Dat is architectuur* [This is architecture] (pp. 736-746). Rotterdam, The Netherlands: 010.

Vermeersch, P., & Heylighen, A. (2012). Blindness and multi-sensoriality in architecture. The case of Carlos Mourão Pereira. In R. Hayes, & V. Ebbert (Eds), *The Place of Research, the Research of Place*. ARCC/EAAE 2010 International Conference on Architectural Research (pp. 393-400) Washington DC: Architectural Research Centers Consortium (ARCC).

Warren, D. H. (1978). Perception by the blind. In E. C. Carterette, & M.P. Friedman (Eds.),*Handbook of perception* (Vol. 10). New York, NY: Academic.

WHO. (1993). *International statistical classification of diseases, injuries and causes of death, tenth revision*. Geneva, Switzerland: World Health Organization.

WHO. (2001). *International classification of functioning, disability and health*. Geneva, Switzerland: World Health Organization.

WHO. (2002). *Towards a common language for functioning, disability and health: ICF*. Geneva, Switzerland: World Health Organization.

Winance, M., (2006). Trying out the wheelchair: The mutual shaping of people and devices through adjustment. *Science, Technology, and Human Values*, *31*(1), 55–72.

Received 29 May 2015 | Accepted 26 October 2015 | Published 1 December 2015