Mediating Artifacts in Architectural Design: A non-Visual Exploration

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Abstract. This paper reports on a study of a design meeting between two architects and a blind user/expert. To make the design process more inclusive, and not have to rely solely on verbal descriptions, we created some visuo-haptic representational artifacts of the proposed design. The design process is studied in real time through an ethnography in combination with the use of video. Our analysis, following Interaction Analysis, focuses on the mediating aspects of objects in the actions, related interests mainly pay attention to sight and visually discernable interactions. However, similar processes occur in haptic explorations of a design proposal. The detailed analysis of the minute interactions between the actors in the situation reveals practices such as knowing and indicating to others where design elements are on the site, knowing what design element is being talked about, and holding the element and its environment "in place". They could be said to be the haptic equivalents to visual cognitive actions like deictic gestures and different practices of highlighting. The analysis further shows that the presence of visuo-haptic representations allows the blind user/expert to explore the spatial configuration of the design, designating with her hands her own parcours. A shift in agency from the architects and a verbal description towards the blind user/expert and a visuo-haptic representation enable the latter to enact a more autonomous participation in the design meeting. As such, our study shows that exploring inclusivity "upstream", i.e. in the design process, may contribute not only to inclusive design, but also to a more articulate understanding of the working of mediating objects and their use in architects’ design processes in general, e.g. a better understanding of non-visual processes of action, perception and cognition.
1. Introduction

Through their daily interactions with the built environment, people with disabilities become able to appreciate spatial qualities or detect obstacles that architects—and other designers—may not be attuned to. People born blind, for instance, do not have a visual reference system and are more attentive to hearing and touch [1]. As such, they strongly differ from architects, who—like other designers—tend to know and work in a visual way [2]. This observation forms the basis for exploring whether and how design processes in architecture can be enriched by establishing a dialogue between architects and disabled people [3].

As part of this exploration, the study reported in this paper investigates scenarios for involving people with sensory disabilities as experts in the design team. To this end, it relies on a team ethnography in the context of a real-world competition design. A young architecture office, selected to participate in the competition, is teamed up with two so-called user/experts, i.e. "anyone who has developed natural experience in dealing with the challenges of our built environment" [4]. The user/experts in our study are both blind. The competition involves the design for the extension of a town hall into an Administrative Centre and Social House, gathering all local services.

Fig. 1. Plan view of existing situation (top left). Plan view (top right) and elevation (bottom) of newly designed situation (© ONO-architectuur).
The design proposed by the architecture office aims to maximally preserve the green space on site by inserting multiple smaller volumes and arranging them in a U-shape (Figure 1). In order to safeguard the open space and perspectives as much as possible, the volumes are lifted from the ground, allowing the green space to run on underneath. The centre’s main functions are situated on the first floor, resulting in a "bel-etage" town hall with a view on the green. On the first floor, the different volumes are linked through "passerelles" (covered footbridges) forming one public circulation connecting all public desks.

2. Mediation of action, perception and cognition through objects

Rather than an individual mental activity, designing is increasingly understood as distributed collaborative work. Designers often work in teams of people with different expertise. Representational artifacts used in such collaborative work settings (i.e. models, drawings, sketches, photographs, CAD-models) play an important part [5-7]. During design meetings, they mediate processes of cognition, action and perception in terms of the design [8, 9]. Increasingly, studies take into consideration the role the environment, and the objects present, play in design meetings as researchers acknowledge their importance. How we act in a certain situation is mediated through the socio-material setting in which we act. Humans delegate certain actions to an object through inscription [8, 10]. As such, objects can mediate our actions, or put differently, make us do things we would not be able to do without them. For instance, different representational artifacts allow architects to take the building site with them into their office and make it possible to discuss the design around a more stable representation than through talk alone. In short, they make collective designing possible.

In addition to how these representational artifacts mediate our actions during collaboration, Peter Paul Verbeek [8] also describes how they mediate perception in terms of "reduction" and "amplification". Objects transform our perception in a particular way as "mediation always strengthens specific aspects of the reality perceived and weakens others". Objects provide new modes of access to reality, other than naked perception. A scaled reduction of the site as in, e.g. a site plan, allows for an overview of the totality of the site and for sharing with a number of people. The site can be perceived from a bird’s eye view, but in the process loses some of its details.

Verbeek considers action and perception extensively, but does not treat cognition explicitly. Therefore, we turn to cognitive science, and more precisely to the theory of distributed cognition [9, 11]: "The theory of distributed cognition, like any cognitive theory, seeks to understand the organization of cognitive systems. Unlike traditional theories, however, it extends the reach of
what is considered cognitive beyond the individual to encompass interactions between people and with resources and materials in the environment". [11] Architectural design as collaborative work is no exception to this. Representational artifacts help in reducing the computational load of spatial transformations. A collaborative design meeting allows for cognitive alignment of the different persons present through collective active sharing, for instance, through verbal communication and deictic and representational gestures in relation to the artifacts present in the meeting [12].

However, the representational artifacts architects use are scripted for visual use—and consequently—interaction. Even if alternative uses or alternative representations are possible [3]. To put it in the words of Verbeek [8], most of these representations invite a visual interpretation, while discouraging e.g. haptic exploration. In research too, the focus lays mainly on visual aspects in collaborative work.

Our study involves blind people who rely on non-visual perception to make sense of their world and act accordingly. Therefore, we provided some visuo-haptic representations of the design in order to allow the blind persons to participate in a design discussion that conventionally involves more than verbal communication. Considering then processes of cognition, action and perception, our question is how the persons involved interact with each other and the specific artifacts present? And what use do these artifacts allow in a design meeting?

3. Data gathering and analysis

Our focus on the use of objects during a design meeting has implications for the way our data are gathered and analyzed. The data used for this paper come from a three-month ethnographic study in an architecture office by two researchers (author 1 & 2). Recent calls by e.g. [13, 16] summon researchers to study architectural and other design practices through ethnography. Still others summon to combine ethnography with the use of video [16, 17]. Much like Jordan & Henderson [17], we use ethnography in conjunction with video. As they explain, "[w]e rely on participant observation, in situ interviewing, historical reconstruction, and the analysis of artifacts, documents, and networks for providing the framing context. In the course of this ethnographic work, we attempt to identify interactional "hot spot"—sites of activity for which videotaping promises to be productive". In our study, one researcher, with a background in anthropology/sociology ® observes the design process "from outside", using video and audio recording and inventorying all documents and artifacts processed and produced. Another researcher, with a background in architecture (RA) acts as member of the design team, so as to follow the design process from "an insider’s perspective".
This paper focuses on one particular design meeting in which a blind user/expert (UE) is consulted by one of the two senior partners of the office (A), and the participating researchers (R & RA). Such a design meeting is one of the interactional hot spots during the design process where videotaping holds the promise of disclosing minute information that can inform the ethnography at large.

After the multi-modal transcription of the whole design meeting, the two researchers identified the most relevant "ethnographic chunks" [17] for further analysis in a group viewing session. The analysis of the selected material and the analytic foci under consideration, are informed by the research question and corresponding theoretical framework (Section 2).

In this meeting we selected two vignettes to further analyze in more detail. In the first one, more towards the start of the meeting, architects A & RA explain the site layout and immediate surroundings to UE. In the second vignette, half an hour later, UE asks the architects to clarify the dimensions of the buildings they are designing.

4. Empirical examples

4.1. Setup of the design meeting

In order to enable the users/experts involved in the design process to perceive the designed situation, but also to allow relieving some of the computational load in cognitive tasks when desired, providing representations that could be read in a non-visual (c.q. haptic) way seemed necessary. Otherwise, trying to comprehend the whole design by following the architects’ wordy description would be too arduous of a task (for anyone). For this specific meeting between the architects and one blind user/expert, we presented the design as it was at that point in the design process by three models that could be read haptically. We started from insights gained in studying an architect who had to develop ways of designing more haptically after losing his sight [18]. We made visuo-haptic models of different scales (1:1000, 1:500, 1:200); individually each presents either more detail, or more context—in line with what Verbeek [8] calls "reduction" and "amplification"—but when used together, they make for a more complete understanding of the design. The scale was also informed by the need for a haptic "overview", in the sense that these models can be encompassed with both hands, so that the overall situation could be explored very quickly.

A first model (scale 1:1000) gives an "overview" of the building site, its immediate surroundings and the different volumes on site (both existing and newly designed). Starting from an aerial photograph (used extensively in the design process up until then), we modified it such that it could be read haptically.
too. Dented lines in the cardboard base mark the streets’ edges and the site itself is another cardboard layer on top, so that its edges are perceivable as well. The buildings on site are scaled volumes (cardboard for the existing buildings, layers of foam board for the newly designed), which can be removed, repositioned and (temporarily) fixed again by using semi-adhesive double sided tape instead of glue to fix them. The second model (scale 1:500) is similar to the first, but the buildings are represented as cardboard layers instead of volumes. This model gives more information about the buildings’ internal configuration, e.g. by openings cut out in the layers. A third model (scale 1:200) allows for haptic exploration of the three-dimensional spatial configuration of one newly designed wing, especially the horizontal and vertical circulation. This larger scale allows to go inside the model with the hands, rather than encompass it like the previous two. The two vignettes selected will further demonstrate how the second, more plan-like model was used during the design meeting.

4.2. Knowing where, knowing what, and holding things in place

Throughout the meeting, there are numerous instances during which the participants situate aspects they are talking about on the site. In the next vignette, architects A & RA give the blind UE an exposition of the site and the different volumes it contains.

Still 1: Architect RA wants to start "showing" UE the site on the model. However, some initial hesitation occurs, to which UE immediately responds with "you can take my hand". When involving a blind person, architects cannot make use of the "usual" ways of showing, i.e. through verbal and non-verbal indexical cues. Together with verbal indexical cues—"this", "that", "next to", "in front of", "behind", etc.—pointing as non-verbal indexical cue has been identified as an important means for (sighted) people "to establish a particular space as a shared focus for the organization of cognition and action" [19]. That in this case it is useless to do so by pointing, does not mean it is impossible tout court. A common practice among blind people is to take one’s hand or finger and feel or trace what is to be singled out, resulting in a co-produced indexical gesture. While it would be less interesting a technique to use in real-world situations (scale 1:1) that are "out of reach", most scale models used during a design process allow for co-produced gestures. In a sense, then, much like the scale model allows for a visual overview in which elements can be easily pointed out (an action that would be equally impossible on site), the visuo-haptic scale model allows for a similar collaborative practice in which elements are "within reach" for co-produced gesture.
Still 2: RA and UE have traced one outer limit of the site together, which covers the full width of the site. After tracing this line, RA lets go of UE’s hand. The baseline now serves as a reference line. What can be noted is that UE’s left hand stays put. It stays at the initial starting point. As such, UE has a reference point that is "pinning down" both the beginning of the story (adhering to the narrative sequentiality of the exposition), and a strategic topological reference point. It is UE, now, who is creating a situationally constructed phenomenal field by "fixing" this point with her hand, in combining it with the baseline she just traced. The field she establishes comprises the current selection (cf. [20]) of the subject under discussion with the architects, namely the "whole" site. This current
selection, it can be suggested, is literally held in place by UE’s left hand, her "reference hand".

The fixing of the point, it must be added, is also afforded by the specific design of the visuo-haptic model: the site outline on the model being put in relief, a so-called figure-ground relationship between the site and its wider environment has been inscribed in the model. As Goodwin suggests, "human cognitive activity characteristically occurs in environments that provide a complicated perceptual field. A quite general class of cognitive practices consists of methods used to divide a domain of scrutiny into a figure and a ground, so that events relevant to the activity of the moment stand out" [21]. The latter is often done by highlighting. In visual practices, highlighting is done, for example, by the superposition of different layers, such as placing grids or colored and numerically labeled sectors on plans. Although Goodwin’s attention goes to visual perception, and visual techniques of highlighting, the visuo-haptic model suggests that practices of highlighting for perception do not necessarily have to be visual in nature.

Still 3: With the baseline "in place", and the reference point pinned down, UE can now begin to explore the site haptically by herself. For now she knows where she is. While moving her fingertips over the model, and each time she comes across a "new" volume (i.e., one she did not touch yet), RA identifies which volume it is. "That’s the first volume at the street side", he says. Two things come to the fore with this small sequence. First, exploring the site "by hand" has a certain advantage for sharing information. Unlike the scanning gaze, which is relatively untraceable for other participants in a discussion, the haptic exploration of the model allows the other participants present to follow the hand. The haptic exploration thus serves both as exploration of the model, as well as deictic practice for the others. Second, by referring to the street side, RA verbally narrows down the phenomenal field (of possibilities). The street side is not only an "obvious" cultural feature for orientation, it also constitutes a boundary in this design. In other words, RA’s use of language here is indexical and situational; he is trying to clarify the location by referring to elements within the context of the model. As such, his talk helps to support UE’s haptic exploration.

Besides knowing where the different elements are, UE now knows what the elements stand for. It should be stressed, however, that she occasionally asks to reconfirm what corresponds to what. It is tempting to ascribe this to UE being blind; yet asking clarifications about what is what on a model is something we encountered quite often during other design sessions among sighted participants.

Stills 4, 5, 6: After having located and identified the first two volumes, part of the "existing" buildings, UE goes on to find the first of the newly designed buildings with her right hand. Both topologically and narratively there is a cut; the two existing buildings are situated "elsewhere" on the site, and they differ—by function and form—from the newly designed buildings. Within the site, then,
subsets of grouped volumes can be discerned; **subsets of local narrative relevance** (i.e. following the architects’ design proposal).

The topological and narrative cuts coincide with shifts in UE’s haptic exploration. The first shift seems to follow fluently from the left to right stroke UE makes, discovering the first newly designed building after she passed the last existing building (still 4). The difference is that she "comes back" to the gap between both with her right hand, and spreads her fingers over the volumes. The initial exploration of the "whole" site is temporarily interrupted, but what for? Architect A specifies "[that's] the new construction". The cut is marked. UE takes notice of it by scrutinizing the physical space between the existing and the new part on the site.

The next shift **marking the cut** is UE moving her left hand from the initial reference point to the gap between both parts. After checking out the zone with her (more active) right hand, the left hand comes to stabilize the situation by again pinning down a new strategic point (still 5). With this shift, there is also a shift in the figure-ground relationship: it moves from the "whole" site in relation to its wider environment, to the newly designed part of the site in relation to both the "whole" site and the wider environment. After the **recalibration move**, UE starts to explore the newly designed part and the "existing" part, holding it in place again with her left hand (still 6). Besides the highlighting for perception that is inscribed in the artifact (as discussed above), smaller zones for perceptual scrutiny can also be situationally demarcated by the same practice of holding a reference point in place on the model. As Suchman notes: "That engineering objects mediate embodied practices of engineering is clear. By looking more closely, we can see as well how bodies mediate engineering objects" [22].

### 4.3. Taking voice in the spatial exploration of the design

At the start of the design meeting, UE follows the architects’ explanation with her hands on the visuo-haptic models. Or sometimes she is lead through them (as described above), occasionally resulting in one of the architects repositioning her hand in the model when she is no longer following his narrative. But at a certain point in the discussion, UE goes back to the 1:500 model (right in front of her at that time) to ask a question about the dimensions of the design, and relate the answers back to the scaled spatial configuration of the model.

She first looks for the side of the building she wants to know the length of. One hand finds the corner, while the other moves along the mentioned side. Concurrently, she asks about its dimension. By this action, A’s and RA’s gaze are guided to that specific line in the model, so all three know what part of the design they are talking about. RA answers her question about the building’s length and adds that its width is 13 meters. UE responds by sliding her finger along the width of the building in the model. With this information, she moves further in the
model to a "passerelle" connecting two wings. She states that it is quite long too. RA confirms this after which UE again moves further to a second "passerelle" to confirm it has the same length.

UE: Yes, and what are the dimensions again, so this is 10 meters?
RA: 27 meters.
UE: 27 meters.
RA: and 13 meters wide.
UE: So this is long too, he.
RA: That's 10 meters.
UE: Yes, and that.
A: That as well.
UE: Ah yes, yes and this is a longer building.
A: And this is a longer volume.

Fig. 3. Video stills and audio transcript [minutes : seconds : frames] – UE asking about the dimensions of the design.
She finishes her stroke through the model with sliding her hand along a third wing in the model, noticing that it is longer than the previous two, which is indeed so. She also quickly checks this by briefly moving her hands back to the first wing (where she started her exploration). Again, she follows a certain logic in the exploration of the building’s dimensions. She starts at the front of the site with the wing housing the main entrance and moves along the U-shape of the plan towards the back, finishing with a quick motion back and forth to the front again.

At this point in the discussion, UE is not guided any longer by the architects’ explanation. Instead, her actions are mediated (partly) through the model as she brings the discussion to the dimensions of the different design elements. It allows her to explore the spatial configuration of the model. It thus mediates her participation in the design meeting. She is no longer following, but actively engaging in the discussion about lengths, proportions and configurations. That is, she actively engages in cognitive tasks of measuring and comparing volumes. The model’s presence in the discussion allows UE to get a different kind of understanding of the dimensions of the design. In Verbeek’s [8] terms, the model “invites” UE to explore the spatial configuration of the design in a spatial way. It invites her to touch and move her hands in two dimensions, building a different spatial relation with the design than a mere wordy description of a plan could do. It also allows her to explore a spatial configuration at her own pace and course through the model, rather than being taken through the design in just one way, that of the architects.

By exploring the side in the model she is asking about, UE not only gets an understanding of the length of that side. In addition, her gestures allow for the architects to see her hand movements and thus know what side UE is asking about. For her it is a way of relating the answer of “27 meters” with the actual dimensions of the model she is feeling; for the architects, her action is much like someone fixing their gaze by pointing at an element in the model. We could speak of hand designation instead of glance designation. This example thus illustrates how a model can be experienced in multiple ways, or what Verbeek [8] referred to as "multi-stability" in the relation between persons and objects (or, more specifically, technologies). "[Technologies] are only technologies in their concrete uses, and this means that one and the same artifact can have different identities in different use contexts". In this specific situation the use context clearly depends on the setup of the discussion (as a meeting about a design proposal), but also on the persons who are involved. For UE the model at hand is used haptically, but the architects interpret her haptic exploration of the model in a mainly visual way.

By making these representations of the design haptically readable in the task of exploring the spatial relations in the design, the agency shifts from the architects towards UE and the different models. UE is able to explore the spatial configuration by herself, and is less dependent on a wordy description of a visual
representation. At the start of the meeting, she still follows more or less the architects’ explanation, and when she wanders off too much they relocate her hands in the model. Yet, in this part of the discussion, she takes the model in order to facilitate her question, without anyone suggesting her to use the model. Moreover, the architects follow her path and tempo through the model. Besides the newly inscribed perceptual inclusivity – i.e. both visual and haptic – giving voice to a disabled community, the UE can actively take voice, thereby asserting her right to participate in a design meeting.

The use of spatial representations in design meetings is widespread in architectural practice. Providing representations that are equally interpretable haptically in a design meeting between architects and a blind user/expert proves to be fruitful. The blind person makes use of these visuo-haptic models to explore the spatial configuration of the design in a way that is closer to architecture (as organizing space) than mere talk.

5. Discussion and conclusion

How representational artifacts are used in the collaborative practice of designers is mostly studied with attention for visually discernable interactions. This results in the development of ocularcentric theories. However, in our observation of a design meeting between two architects and a blind user/expert we found other ways of engaging in interaction that are possible. What’s more, processes of action, perception and cognition turn out to occur in a haptic exploration of a design proposal similar to sighted practice.

The work of indicating to others where one is in the model and where the others need to look/feel makes up for a large part of a design meeting. In order for the different participants to be able to “follow” the discussion, they need to know where things are on the site, and what specific element it is they are talking about. Moreover, when talking about specific elements on the model, the element and its immediate environment need to be "held in place". During the design meeting and throughout the multi-modal interactions (e.g. verbal, gestural, sighted, haptic, around design artifacts), practices like co-produced gestures, use of a reference hand and recalibrations to establish a situated phenomenal field adhering to the narrative at hand make this possible in a haptic way. They could be said to be the haptic equivalents to visual cognitive actions like deictic gestures and different practices of highlighting. At the beginning of the meeting the narrative of the exploration is still guided by the architects. Further along in the discussion, the blind user/expert herself goes back to the visuo-haptic representations to inquire into spatial questions. The possibility to go back to certain elements in the representational artifacts makes cognitive tasks relating to spatial problems easier.
to perform in comparison to a strictly verbal account of the design under discussion.

The representational artifacts enable her to explore the spatial configuration of the design in a spatial way, but still allow the sighted architects to follow her actions, as her gestures are explorative as well as indexical.

That she spontaneously uses one of the models at a given moment to clarify a question relating to the spatial configuration leads us to consider that the agency is distributed differently over the people and artifacts involved. Together with the model she is able to enact a more autonomous participation in the design discussion.

Across the board, attempts to design inclusively tend to focus on what is being designed. Judging from our study, inclusivity can be explored in another way as well, by trying to make (parts of) the design process more inclusive. This means trying to explore inclusivity "upstream", in the design process itself. We have tried to make aspects of the design process more inclusive by making representational artifacts extensively used by the architects haptically readable.

Studying inclusivity "upstream" does not only benefit the domain of inclusive design, however. Judging from our study, it may also contribute to a better understanding of the working of representational artifacts and their use in design processes in general, e.g. a better understanding of non-visual processes of action, perception and cognition.

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References