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Developing Perception-Based Criteria of Inclusive (Architectural) Design

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Abstract. Inclusive design outcomes in architecture rely on valid and reliable information about user experiences. The way users perceive and experience the built environment contains the clues for the optimal facilitation of their needs and expectations. However, their perceptions of aspects of the built environment and their needs and expectations are not easily accessed for incorporation into the design work of professional architects and architecture students. This paper identifies how this need may be addressed and outlines methods of making such knowledge more accessible and in a form that facilitates ease of incorporation of user perceptions and expectations into design. Specifically, this paper details approaches whereby user perceptions are transformed into design tools that can be used by architects for applying inclusive design. Several approaches that are described in this paper can be applied and combined by architects and students to obtain information regarding user perception of the built environment and subsequently converting the information into the tools or criteria for designing inclusive buildings and facilities. The approaches and the tools are expected to support the incorporation of inclusive design into the architecture profession and education.

Keywords. architecture, built environment, criteria, inclusive design, perception

Introduction

The concept of "inclusive design" or "universal design" has become topical in the world of architecture. Application of inclusive or universal design principles within the process of creating a building is aimed at the inclusion of all people's functional needs without discrimination. The original notion that underpins more inclusive design practices stems from the recognition that traditional design often unintentionally excludes people with disabilities. In this sense, disability can be defined as the effect of reduced functional performance of a person's organs on his/her abilities [1]. The

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original work on 'design for the disabled' [2] was intended to serve people with particular mobility and/or reaching limitations that impede their access to buildings and associated fixtures and fittings. Inclusive design or universal design addresses an even wider range of people, with an emphasis on reducing the stigmatisation of people with disabilities by following the principal that disability is an element of normal life rather than a descriptor for a specific group of people who require special or different treatment compared with other individuals [3, 4].

Even though inclusive design has been commonly applied in the most of design discipline, professional architects and architecture students have not been sufficiently driven to incorporate it in their work [5]. The issues that influence the reluctance of architects or students to apply inclusive design are discussed in this paper. This paper addresses what approaches might be used to improve understanding and uptake by architects and how user perception of the built environment should be involved in resolving design issues. For example, user perception is considered important for the application of inclusive design due to its usefulness in determining the degree of safety and comfort in performing activities in the built environment and providing guidance for architects, designers and students concerning how to design safe and comfortable settings, facilities and buildings for all kind of people. However, acquiring human perception and utilising it for design process is not a simple task; it involves a dynamic process and it must address complex and variously interconnected elements.

The descriptions in this paper are based on these questions:

a) What approach(es) are available to be utilised in order to acquire information regarding user perception of the built environment?
b) What can the information regarding user perception of the built environment provide for the application of inclusive design?

The process of answering these questions is used to structure the arguments outlined in this paper. The first part of the paper identifies the aspects that are needed to be taken into account in analysing or measuring perception. The second part discusses issues that are related to the application of inclusive design. The third part discusses how user perception can be acquired and be used for coping with the issues and applying inclusive design in architecture. The last part contains conclusion and recommendation for further research.

1. Perception and its aspects

Perception, in general, can be explained as the conscious experience involving various senses that is stimulated by the surroundings [6, 7]. The things or events in the environment that provoke the stimulation are termed stimuli [8]. The recent theories regarding perception emphasise multisensory experiences. Previous perspectives, which distinguished the perceptual elements into: sight, sound, touch, smell and taste, regarded each sense as an autonomous component that could act and be analysed separately from other senses. The contemporary research on perception instead, focuses on dynamic and complex systems involving the interaction of multiple senses

simultaneously [8, 9]. Thus we can view perception as an interaction that consists of the prioritisation of one sense over the others, otherwise termed 'hierarchical interaction' or the equal cooperation of several senses, which is called 'lateral interaction' [10]. Lateral interaction may be a cross-modal process that involves senses that do not only collaborate but, nevertheless, impact each another [10]. The perceptual process contains the interaction of five systems [9]: the basic orienting system, which is connected to how the body achieves balance and reacts to the gravitational force; the haptic system, which deals with touch, movement and temperature; the visual system, which is concerned with the sensing of light, colour, forms, depth, distance, and movement; the auditory system, which identifies sounds; and the olfactory-gustatory systems, which detects flavour and odour.

Discussions and theoretical explorations of perception in architecture have previously highlighted the importance of the whole body experience and comfort within the built environment, which are closely connected to the multi-sensory perceptual processes. Experiencing architecture is concerned not only with looking at space and/or its elements but also with how our bodies react to spatial objects [11]. Therefore, it makes sense in an architectural design context that assessing spatial quality should involve multisensory-based approaches [12].

Nevertheless, measuring perception is problematic as it is complicated by the fact that the built environment is experienced dynamically and therefore the interactions between perceiver and the environment are complex. The dynamic complex nature of perception may be challenging for the architects and/or architecture students who want to comprehend and utilise perceptual experience as design materials. However, there are scientific methods that can support architects and/or architecture students to analyse user's experience in the built environment scientifically and reliably. For instance, examining how people perceive visual cues can be performed in the controlled settings (such as laboratory or virtual space) or in the real and uncontrolled environments, by measuring the variety of the participant's responses to recurrences of stimuli, not only through the visual system but also via the auditory system [13, 14].

2. Issues in Applying Inclusive Design

Inclusive design does not limit its scope by dealing with people with impairment or disability only; it addresses each and every individual with his/her unique characteristics through elements that provide similar usability and comfort for people with various places of origin, cultures, ages and physical conditions. Inclusive design must be accessible, adaptable and transgenerational [3]. Inclusive design serves people with normal vision as well as individuals with visual impairment. Inclusive design also can accommodate children, adults and elderly equally.

Inclusive (architectural) design is centred on a sustainable and reciprocal relationship between humans and their built environment. Inclusive design processes require a high level of users' involvement to provide human-oriented design outcomes that have long-term functionality. For instance, when designing specifically for a particular user group such as people with low vision, due to a wide variety of backgrounds, conditions and behaviours of the users; acoustics, lighting and glare,

textual and auditory clues will are all important but to various degrees. Those with wet macula degeneration may prefer glare minimisation while those with dry macula degeneration may prefer greater luminance. Achieving both is a design challenge. Thus identifying the similarities and differences in the way people perceive built environment assists architects to define the design solution most likely to satisfice both types of user experiences.

Inclusive design has been described as belonging to the users and thus not exclusively being located within the domain of designers such as architects [15]. Thus the competencies regarding the application and the evaluation of inclusive design is a collaborative processes between architects, the users and other related contributors [16] and, as such, demands the shifting of mindsets from designer-centred to user-centred solutions. In an inclusive design approach, architects should position users as the members of the design team rather than as "the others". People and users should be regarded as partners of the architects rather than as the design evaluators [16]. In other words, inclusive design should be considered as design that is performed by all and aimed for all.

Even though inclusive design contains these high ideal values, by aiming to provide the optimal built environment for everyone, its application in the professional practice and educational activities is still problematic. The application of inclusive design in architecture must deal with at least four issues.

The first issue in the application of inclusive design is related to the critics who claim the impossibility of providing comprehensive facilities for all people [15]. They claim that inclusive design, which offers certain general principles for implementation to achieve ideal condition, is considered as a concept that is closely related to design philosophy rather than to easily interpretable guidelines or techniques [15]. Principles enable the application of inclusive design in the different contexts or situations, but the lack of detailed descriptions as to how to make the built environment inclusive compels the architects / designers to fall on their own resources, to search for themselves what they regard to be potentially the most useful approaches in facilitating inclusive design, which, in practice, means referring to their own experience and knowledge. Considering that architects / designers have different experiences, knowledge and perspectives, their design will have various types and degrees of facilitation as well; therefore the current practice of architecture and lack any robust evidence–base for more specific and contextual solutions may result in architectural products that continue to be unintentionally exclusive rather than inclusive. For instance, the combination of stairs and ramps in Museum M located in the Louvain, Belgium demonstrates the architect's aim to provide inclusive circulation path that accommodate not only people with and without wheel-chair but also individuals with and without visual impairment [17]. However, due to the architect's unfamiliarity of the way people with visual impairment perceive spatial elements, white colour applied on combined stairs and ramps has caused difficulty for visitors with vision loss in distinguishing the variety of height and inclination of the circulation path in a sunny condition [17].

The second issue is connected to the dominant attitudes within architecture profession and education toward the application of inclusive design. For instance, some have noted that the critical opinion of professional peers is frequently more valued than the needs of users. Unfortunately, the supremacy of architectural styles in design preferences and prioritisation of the aesthetics of visual form; lead to a gap between the intended and the real experience of the built environments [12, 5]. Further, some architects perceive compliance with accessibility regulations as a barrier to making

"beautiful" buildings [5]. One example are the large glass vertical planes that are applied to enhance aesthetics aspects and to establish strong connection between interior and exterior spaces, may be inaccessible and hazardous if they do not provide informative spatial elements such as glazing strips/markings that can be used by people with visual impairment for distinguishing transparent walls from glass doors. The colours that are preferred by architects may be different from colours that are considered as providing high visibility for detecting spatial elements according to people with visual impairment, such as: yellow and white [13, 19].

The third issue deals with transforming 'knowing how (to do or to use things)', which is located in the domain of the users, into 'knowing what (makes the things work)', which belongs to the architects [16]. Knowing how to ride the bicycle, which is possessed by cyclists, is different from knowing the principles of physics, which should be mastered by the engineers or designers, that enable a bicycle to be designed and used appropriately [16]. This issue indicates that user experience and perception cannot be easily and directly applied as parameters for professional designers. Bridging that gap requires shared elements of communication [20].

The fourth issue concerns the scarcity of suitable analytical tools and methods that should be utilised to develop and evaluate the applications of inclusive design both in architectural profession and education [5, 21]. There are only a few guidelines that have been developed and applied to accommodate individuals with various backgrounds, conditions and limitations in the built environment, such as Housing Enabler that connects individual limitations with the required settings [4, 22]. However, the majority of current tools are mostly related to accessible design standards and focus on capability or disability and are limited to dimensions, forms and arrangements of spatial elements or provide recommendations with little evidence-base. The standards should include all aspects that are not only related to physical capabilities or limitations, but also to perception. This paper not only describes approaches that can be applied for acquiring perception but also displays an example of formulating design tools based on perception. Another example of the inclusive design criteria that incorporate perception can be viewed in guidelines for interior spaces that take perception of people with visual impairment into account for accommodating various visual conditions, proposed by Bright and Cook [23].

3. Approaches involving User Perception

As a response to the issues described in the previous part, especially to the first issue, the supporters of inclusive design suggest that facilitating users with particular impairments or limitations will automatically encompass greater number of people [15]. The roles of inclusive design are not limited to accommodation of persons with impairments or specific needs only; they should be beneficial for all people. Another response is the internalisation of inclusive/universal design. This internalisation can be achieved by integrating the related aspects and values in activities of architecture profession and education, so that the application is expected to be accomplished more naturally and sustainably [5]. The architects and students who possess the internalised values will regard the principles of inclusive design not as obstacles but as catalyst for

making innovation that can serve various abilities as well as disabilities. In certain conditions, the restrictions, constraints or instructions will stimulate the creativity needed to provide the appropriate solutions [24]. The approaches using user perception, which are described in this paper, incorporate a blend of these two responses.

The process of analysing user perception involves multisensory experience and entails dynamic relationships of the visual system, the haptic system, the auditory system, the basic orienting system and the olfactory-gustatory system [10]. Analysing the perceptual process by isolating one sense from other senses or one system from other systems and separating the sensory information from the cognitive information is nearly impossible; therefore the approaches of studying perception of the built environment are needed to involve both hierarchical and lateral interaction of senses [10]. Theoretical exploration regarding the perception of built environment can be considered as having strong connection to environmental psychology, which deals with the study of interrelation between humans and their physical surroundings [25].

The approaches utilised for studying the relationship of human perception and the built environment may be distinguished into place-based and human/observer-based approaches [25]. Place-based approaches usually utilise mechanical or other physical devices for analysing and measuring the quality of the environment objectively. Human/observer-based approaches aim to address these subjective aspects [25]:

- description, which focuses on how people think and perceive the environment in their daily lives;
- evaluation, which measures the positive and negative judgment from the user/people;
- aesthetics, which deals with to what extent people perceive the beauty of a place / object;
- emotion, which is concerned with what people feel about a place/object;
- meaning, which is related to engagement, communication and purpose; and
- risk, which emphasises safety and security.

Considering that examining perception cannot be performed by excluding human as the perceiver, the approaches that are outlined in this paper emphasise observer based methods for acquiring perceptual data [25] without eliminating the possibility of combining them with place-based methods. These observer based methods are:

- Self-report method, which is conducted by asking what the person perceives through interviews, questionnaires, checklists, documentations, recordings, models, virtual environment or open descriptions;
- Time sampling method, which requires the person to move within an environment and to report what he/she perceives at certain intervals of their movement;
- Behaviour-inference method, which uses behaviour of a person as the signifier of his/her perception;
- Psychophysical method, which measures the intensity of occurrence of the stimuli in the environment;
- Phenomenological method, which provides direct information about perception because the researcher can position him/herself as the perceiver.

The methods of data collection that are described above can provide materials for analysing different aspects in the built environment in relation to each perceptual system: the basic orienting system, the haptic system, the visual system, the auditory system and the olfactory-gustatory systems.

Comprehending the environment in the inclusive design framework demands the involvement of as many groups of people as possible. The approaches, which are applied in the study of inclusive design in architecture, usually require intensive and effective communication among architects, users and other related experts [16]; and/or the empathy of the architects regarding perception and experience of the users [5]. These approaches can be used for addressing user perception and distinguished into several types based on the roles of the user:

- Participatory approach that positions users as information providers. The users describe their perception, experience and expectation concerning the built environment to the architects/ designers and/or other related experts. The information will then be filtered, measured, analysed and formulated by the architects and/or other experts as guidelines for the design process [16]. Self-report, time sampling, behaviour-inference and psychophysical methods may be relevant for this approach and applied repeatedly by other architects, designers, researchers and students in other environments, especially in the settings that have similar conditions and backgrounds.
- Participatory approach that positions users as members of design team. Intensive discussions between users and architects apply the shared communicative elements to achieve the mutual understanding to establish design guidelines or criteria [16]. Users not only supply information, but also perform the process of design development with the architects. Self-report, time sampling, behaviour-inference, psychophysical and phenomenological methods can be appropriate for this approach. This approach enables the architects and users to develop and share their perception concerning the built environment. It also provides an opportunity to obtain deeper understandings of user perception and update the information continuously.
- Empathic approach, which involves architects / designers that position themselves as users, such as: role playing. This approach aims to raise and develop the empathy and understandings of architects /designers regarding limitations encountered by certain groups of people so that the design outcomes will be in accordance with the various kinds of user capabilities, disabilities and expectation [5]. As well as the participatory approach that position users as the members of the design team, this approach may utilise all methods: self-report, time sampling, behaviour-inference, psychophysical and phenomenological methods.
- Combination of approaches. Considering that each approach may have certain limitations in addressing all aspects contained in complex and dynamic process of perception; combining two or three approaches is suggested to provide a more valid and reliable results. The approaches described above can be triangulated to ensure the comprehensiveness of the results.

As well as other studies related to human or social aspects, the appropriate number of participants, or sample size, must be considered. This will depend on the chosen methods, selection criteria and the availability of time, funding and workforce. Although studies concerning perception and design are closely related to a wide variety of subjective or personal interpretations that are determined by different contexts and/or cultures, they require several aspects that can be generalised, so that the outcomes can be applied within various settings. Therefore, the studies of perception demand representative samples to ensure both the validity and comprehensiveness of the results. A larger sample size may increase the precision [26]. Nevertheless, it is a reality that many studies are hampered by the issues of limited time and/or support; so stratified, purposive or convenience sampling is a common approach, in which targeted groups of people are recruited in numbers of participants ranging from 30 to 100 [26].

Whatever the method of collecting data employed in grasping perceptual phenomena, it must provide the opportunity for free descriptions or personal interpretations from the users or participants; combination of observation with semi-structured interviews or questionnaires containing both determined and open questions can be applied as an alternative. The process of analysing and synthetising must be able to deal with both qualitative descriptions and quantifiable data. Coding and content analysis that are usually applied for categorising and interpreting qualitative data can be proposed as alternatives; which consist of these stages [27]:

1. Extracting interpretive comments
2. Determining headings/ areas based on extracted data
3. Putting the topics based on the extracted data within headings and displaying the frequencies of each topic
4. Making sub categories within headings to signify more specific issues
5. Reviewing and summarising the results of previous phases.

Considering that inclusive design must address the needs of various kinds of users, comparative studies to identify similarities and differences among characteristics of representative users, categorised by using one or several of different classifications (such as physical conditions, ethnic groups, regions, cultures, ages and educations) are also helpful. A multiplicity of approaches enables all relevant strategies to occur, whether they are predicted or not, in order to obtain more comprehensive outcomes.

The proposed approaches can be applied in various design contexts to establish inclusive design criteria, although the criteria's contents in one context can be different from those of other contexts; which may be influenced by diverse aspects such as cultures, locations and natural conditions. The materials described in this paper aim to produce standardised approaches rather than standardised criteria. The approaches are not expected to deliver uniform guidelines, but to provide design tools that can be adjusted with conditions and requirements of each context.

An example of criteria is displayed on Table 1. The criteria presented address visual perception of people, with and without visual impairment, concerning spatial elements (such as the appearances of Tactile Ground Indicators/TGSIs and step nosing) and their relation to the surroundings (such as the colours and textures of floor surfaces). Each blank box can be filled with descriptions based on what people with and without visual impairment perceive visually and/or expect from TGSIs and step nosing. These descriptions can then be applied by architects and students to assess and

guide the application of TGSIs and step nosing. For instance, the descriptions on these boxes may inform architects regarding the combination(s) of colours or materials that should be applied on TGSIs, step nosings and floor surfaces in order to provide sufficient luminance contrast or what kind of combinations may cause visual discomfort such as glare. The descriptions also can indicate what arrangements of TGSIs and step nosings that ensure visibility for people with various visual conditions. In addition to assessment of the elements on the horizontal planes such as TGSIs and step nosing, the criteria may also be applied to examine the elements located on vertical planes such as door frames and handles, and their relations to the adjacent wall surfaces.

Table 1. The Example of Design Criteria

Background/ Floor Surfaces	**Tactile Ground Surface Indicators (TGSIs)**				**Step Nosing**		
	Black	**Grey**	**Ivory**	**Yellow**	**Black**	**Grey**	**Yellow**
Black-Matt Surfaces							
Black-Glossy Surfaces							
Grey-Matt Surfaces							
Grey-Glossy Surfaces							
Brown-Matt Surfaces							
Brown-Glossy Surfaces							

4. Conclusion

Each approach proposed above may be autonomously and adequately utilised for understanding the user perception of the built environment and establishing the criteria of inclusive (architectural) design based on their perception, which is useful for design and evaluation process. Nevertheless, combined approaches, especially if they are conducted in both uncontrolled and controlled settings, may provide more holistic criteria; even though availability of time, resources and labour may significantly influence the selection of approaches. The criteria should provide measurable, transferable and testable guidelines for architects and students to design a perceivably safe and comfortable built environment according to various kinds of users.

The materials described in this paper are intended to strengthen the dialogue between architects and the users that enables the application of inclusive design; to establish more accessible / inclusive architectural practice and education; and to promote the safer, more comfortable and more secure built environment for the variety of people. Materials that are presented in this paper are composed based on literature review. Future research should focus on using the described approaches in the field in order to discover the kinds of built environments yielded by inclusive design practised in such a way. Each of the described methods or approaches may have different efficiencies and effectiveness in translating perceptions to solid criteria and guidelines and further research is required to identify the relative advantages and disadvantages of each approach in the field. Further research may also explore to what extent various settings and backgrounds influence human perception concerning the built environment.

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