"Design, Cognition & Behaviour: Usability in the Built Environment"

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Editorial

Ideally, legibility of the built environment is an issue where the interests of users and designers coincide: designers should care about users' positive experiences, and users' experiences are influenced by spatial stimuli. This Special Issue examines the spatial cognition of the built environment from the perspective of the user and the designer. It showcases current research examining how people behave in the built environment.

The design and cognition of the built environment is an area that spans a number of disciplines, including architecture, psychology, geography, computer science, linguistics, complexity, and artificial intelligence. The interchange between these different domains of knowledge has led to the rise of various techniques, methodologies and tools; a key cross-over point is between architecture and psychology (Dalton et al., 2012). This Issue examines approaches dedicated to the analysis and simulation of how individuals interact with their environment, through linking the structure of the environment with user behaviour.

This Special Issue was born out of the "Design Cognition and Behavior: Usability in the Built Environment" workshop (Emo et al, 2014) hosted during the Spatial Cognition 2014 conference in Bremen, Germany. Forty scientists and practitioners including architects, psychologists, cognitive scientists, and computer scientists came together to discuss the latest research on the behavioural aspects of human spatial cognition. The workshop highlighted the need for spatial cognition research to address its potential for innovation in the design of the built environment.

One way of approaching this is through evidence-based design, which brings together the standpoint of the designer and the end-user. A designer is trained to anticipate the usage of a building or urban space, by considering how the end user will perceive and behave in the environment. Thus perceptual, cognitive and behavioural processes come together in the proposed design. The analysis of how individuals and groups interact with the built environment feeds directly into evidence-based design. The use of virtual experiments has been used extensively in the context of built environment modelling (see for example an early study by Dalton, 2001), and in the context of design using agent-based models (Maher and Gero, 2002), but there remains the need to extend the scope of these experiments and explore the use of hybrid worlds, where elements of both real and virtual worlds might be combined.

Innovation in the design of the built environment can be supported with technical tools, analyses, and empirical models. These should not be alienated from users' experiences; the interaction between people and the built environment should be at the very essence of any modelling or design approach. Such an approach was theoretically articulated in the man-environment paradigm (Hillier and Leaman, 1973), and is embedded in the representational schemes and theoretical propositions of space syntax (Hillier, 1996; Hillier, 2012). The contribution of space syntax to "a comprehensive theory of environmental psychology" was proclaimed by Montello (2007). An explicit link between space syntax and wayfinding and cognition was established in the early work of Peponis et al (1990), followed by a more comprehensive investigation into spatial cognition by Kim (1999) and Dalton (2001). At the fundamental level, it is thought that the relationship between movement and the syntactic representation has cognitive meaning (Penn, 2003); an example of empirical evidence supporting this hypothesis comes from a real-world navigation study using eye tracking

(Emo, 2014). The cognitive correlates of the syntactic form of representation are-also thought to be inherently linked to mental representations of the environment (Haq 2003; Kim and Penn, 2004). The inclusion of angular distance in the syntactic representation of the street network simulates the human preference for near-continuous paths in the urban settings (Turner and Dalton, 2005; Hillier and Iida, 2005). The person-space interaction was also re-established in the dynamic modelling description of Turner's cognitive agents (Turner and Penn, 2002; Turner, 2003), and its applications in ecomorphic design (Turner, Mottram and Penn, 2004). Taken together, space syntax methods present a toolkit which can be used to explore the users' experience in built spaces (see for example Carlson et al., 2010) and to motivate design interventions at building (e.g. Sailer et al., 2008) and urban scales (Karimi, 2012). However, in order to establish a theoretical and empirical framework for the applications of cognitive psychology in architectural and urban design, there is a need to bridge the link with neurosciences (Dalton et al, 2015) and complexity sciences (Portugali, 2011).

The papers included in this issue build on the wealth of research in this area and address the cognitive basis of movement in the built environment from different angles. Each paper is the result of research led by architects on how people interact with built spaces. To reflect the applicability of such research, the selected papers span both indoor and outdoor spaces.

The paper "Pedestrian route choice by elementary school students: the role of street network configuration and pedestrian quality attributes in walking to school" by Ozbil, Argın and Yesiltepe, explores how the design of urban spaces might be improved to meet the navigational choices of pedestrians. The authors' analysis of school children's route selections walking to and from school, shows a strong influence of measures of spatial configuration on route choice. Through the syntactic analysis of actual path preferences, the paper recommends solutions for optimal street design, street network configuration, and school location.

The paper "Visuospatial search in urban environment simulated by random walks" by Natapov, Czamanski and Fisher-Gewirtzman, connects the design of urban spaces with spatial behaviour, by examining pedestrian visibility patterns. The paper uses several types of visibility models for an in-depth analysis of visibility patterns during random walks. The findings show a strong connection between local and global visibility properties during pedestrian navigation, a key property for the design of intelligible public spaces and street networks.

The impact of behavioural research on the design of the built environment is shown in the paper "Human navigation inside complex buildings: Using instructions and maps to reach an area of refuge" by Carattin, Meneghetti, Pazzaglia, and Tatano. The authors examine a critical navigation scenario: emergency exit routes for disabled people. The study evaluates the effectiveness of different instruction types (verbal versus maps) and the placement of areas of refuge. The paper is the result of a collaboration between architects and psychologists; by bringing together behavioural and cognitive aspects, the paper makes recommendations for the design of wayfinding systems.

The small selection of papers included in this issue is part of a larger body of research that addresses the design, creativity and innovation of the built environment. It is hoped that this initiative will trigger new insights into the relationship between people and the built environment on both building and urban scales, and trigger new methods addressing how this relationship might be modelled as a tool to support design and planning approaches.

The major challenge that research relating to the design, cognition and behaviour of the built environment faces, is translating research findings into design interventions. Successful initiatives to date are the result of intense dialogue between researchers and practitioners; more platforms are needed to ensure the cross-breeding between the two groups. One area where research studies can be especially valuable is the direct analysis of the experience of the user. Whereas in the past this was often achieved through observation, new mobile technologies (such as eye tracking, recording of biometric data) allow for the accurate first-person recording of a user's experience. This has the

potential to revolutionise the nature of post-occupancy evaluation studies, an area where research and practice converge. Furthermore, rapid advances in virtual-world modelling make it possible to test design interventions in a controlled set-up. The number and nature of the interventions can be varied systematically, given the absence of the usual constraints (such as budget). An area that still has scope for development is the use of cognitively-infused agents in virtual models, as a means of analysing how people might move around such a space in the real world. The level and nature of the cognitive input that such agents might have is still a matter of debate (compare for example Turner and Penn, 2002; Becker-Asano et al., 2014).

The next generation of research should seek to combine the empirical and analytical tools into a single platform, so as to facilitate the implementation of the research findings in actual design projects. As a result, the breadth of research currently being undertaken by researchers across the globe will have a discernible impact on the usability of the built environment.

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