

# Building Analysis from a Spatial Cognition Perspective

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*This short paper focuses on the application of concepts and methods of Spatial Cognition to building analysis. We investigate the close relationship between spatial knowledge and built environment by combining theoretical analysis with user comments and behavioral data. Based on an empirical study in a complex multi-level-building two main aspects of navigational space are considered: architectural features of the building and cognitive processes of the user. Seven possible causes for navigation problems are discussed; especially the staircase design is identified as a major wayfinding obstacle. Finally we address further benefits of cognitive approaches for the architectural design process.*

**Keywords:** *spatial cognition, multi-level building, spatial knowledge, usability*

## 1. INTRODUCTION

Architecture is both process and product: it deals with design, construction, organization and conceptualization of space (Freksa, Vrachliotis & Bertel, 2004). All these aspects have great influence on the comprehension and knowledge of orientation and navigation systems. More than 40 years ago, Le Corbusier (1962) emphasized the idea of movement as a central theme in the theory of architectural design. The perception of a built environment must be described as a dynamic process of movement because we do not experience the spatial layout of a building as a static structure. Thus, from a user's perspective several points of environmental ability, legibility (Lynch, 1960), imageability (Passini, 1992), and intelligibility (Hillier, 1996) are essential to understand and interpret building layouts.

### 1.1. ARCHITECTURAL USABILITY

In *Space is the machine*, Hillier (1996, p. 129) clarifies that 'the property of intelligibility [...] means the degree to which what we can see from the space that make up the system [...].' And further on 'an unintelligible system is one where well-connected spaces are not well integrated [...].' With this in mind, configurations of building layouts have great impact on the users' behavior. But only few researchers have explicitly discussed usability issues of buildings (i.e. Werner and Long, 2003; Butler et al., 1993). Superseding often loosely formulated conceptions of layout complexity in Environmental Psychology (Weisman, 1981), the Space Syntax movement has introduced formalized, graph-based accounts of complexity and visibility (e.g., Peponis et al., 1990). Haq and Zimring (2003) recently reported strong correlations between topological connectedness of locations in a hospital building with route choices of visitors both in unguided exploration and in directed search tasks.

## **2.1 THE CONFERENCE CENTER**

The common layout of the conference center (built in 1970) consists of various simple geometrical elements that are arranged in a complex and multi-faceted architectural setting (Figure 1). Consequently, this building is subdivided into a well-designed group of solids with void space between them. The building can be architecturally categorized as an “indoor city” (Uzzell, 1995) as it is composed of a small ensemble of units and a large public circulation area. The main path of walking through the building is an axial one rather than a cyclical one, which means one has to pass the central point frequently when traveling between areas. Changing floors in the building exemplifies its spatial complexity and vertical impenetrability.

## **2.2 THE EMPIRICAL CASE STUDY**

The analysis of the building is supported by experimental data from a wayfinding experiment in which the 12 participants had to find six target locations. One half was familiar with the building, while the other half was novices. Both task-concurrent verbal data and behavioural measures were collected and analysed with respect to cognitive aspects including familiarity, survey knowledge and strategies. Participants’ observations of wayfinding deficits in the building were gathered in post-experiment interviews. The experiment is more fully described elsewhere (Hölscher et al., submitted) and for the current purpose we concentrate on those observations that can be clearly linked to specific building properties.

*Insert Figure 1 about here.*

## **3. COGNITIVE-ARCHITECTURAL ANALYSIS OF THE CONFERENCE CENTER**

Overall, we believe, the functional dilemma of the building for wayfinding is prominently caused by the problematic arrangement of complex decision points, their linking paths, the position and design of stairways, vertical incongruence of floors, incomprehensible signage, and too few possibilities for monitoring interior and exterior landmarks. Consequently, the building as a whole gives the impression of a three-dimensional maze. In the following, we focus on seven “regions of interest” (ROI) of the building and describe their problems from a cognitive-architectural point of view.

### **3.1 ROI 1: *Entrance hall***

*The entrance hall is indiscernible.* For public buildings the entrance hall constitutes a most important point in the layout. The public entrance as well as the large entrance hall (Fig. 2) is comparatively indiscernible, despite their central position in the building. The entrance hall immensely lacks visual access to areas relevant for the legibility of the spatial situation (see Fig. 2). It doesn’t make the navigation choices visible to the user; especially the stairways are invisible from the entrance hall.

*Insert Figure 2 about here.*

### **3.2 ROI 1: Survey places**

*The building lacks survey places.* Within complex spatial settings architects and designers have to create places of survey and overview to allow users to build well-integrated spatial knowledge. A striking example for this is the basement with its leisure facilities: Far from giving a good overview, the entrance hall is still better than the basement. And indeed comparing this two areas, there were significantly more stops in the basement (16 vs. 6: t-test,  $t=3.079$ ,  $p=.01$ ), yet no differences in the frequency of getting lost.

### **3.3 ROI 3: Floors**

*The layout of the floors is incongruent.* In the planning of complex buildings architects have to pay attention to the insightful organization of floors. The floors of the conference center give the impression of matching one another, but in fact they are considerably different (see Fig. 1). From wayfinding research and a building usability point of view, this a) prompts improper assumptions in the users about the route networks and b) hampers the mental alignment of levels.

### **3.4 ROI 4: Dead ends**

*Dead ends make wayfinding difficult.* It is essential, particularly for public buildings such as hospitals or conference centers, to pay attention to always provide an alternative route to any navigational decision. Dead ends block the user's exploration activity and are difficult to handle within the mental representation of the building. We observed a total of 17 episodes of getting lost in our experiment. 5 of these episodes (29%) were directly caused by the fact that the participant was stuck in one of the two dead-ends in the basement (Fig. 1).

### **3.5 ROI 5: Interior building structure**

*The interior building structure is not distinguishable.* Both the exterior and the interior structure of a public building should to be understood effortlessly. Looking at the floor plan, the dissimilarity of geometrical shapes and architectural forms would appear to be helpful for the users to orientate themselves. But in fact, when actually navigating in the building, the different subsections are no longer readily recognizable, leading to a lack of visual differentiation.

### **3.6 ROI 6: Public and private space**

*There is too little differentiation of public and private space.* Separating private or personal from public space allows the designer to integrate two distinct spatial systems within one building. There are a lot of mistaken public and private areas within the conference center, disorientating the user and producing unnecessary dead ends. Therefore public spaces have to be clearly indicated both by architectural layout and signage.

### **3.7 ROI 7: Stairways – Vertical motion in multi-level buildings**

*Here lies the main disadvantage of this building.* In architecture, a stairway should serve as visual focus and spatial connector. In the conference center this criterion is not met. During vertical motion well designed stairways can provide access to various perspectives of the interior organization of the building and thus facilitate its legibility. But the positions of the five small stairways in the conference center are not evenly dispersed and not perceptively placed (Fig. 2). Furthermore, there is no main stairway which would provide visual focus while exploring the building. The frequently used stairway near the entrance hall is particularly counter-intuitively located. Consequently, not only the impractical location of the entrance hall but also the stairway has a negative effect on the building's usability.

*Insert Figure 3 about here.*

Using the foremost stairway (near the entrance hall), there are a lot of spatial twists and turns without an opportunity for controlling one's location. This deficit is at least partly due to the complete lack of visual access to the outside, which would help to improve spatial updating. Additionally, the number of rotations within the stairway plays a great role for the user's stability of his cognitive map of the building. As this staircase is offset from the main axis and not directly accessible from the entrance hall, a total of 7 turns is necessary when moving between the main corridors of two levels. Frequently, users reported being very disoriented after using this stairway. 6 of the 17 episodes of getting lost (35%) are identified as disorientation observed directly after leaving the stairway, sometimes even before reaching the proper destination level. Figure 3 illustrates a typical episode of getting lost due to the stairway. Taken together, the analyses revealed that – except for global building characteristics – the staircases are the single most clearly identified cause of wayfinding usability in our setting.

#### **4. OUTLOOK**

Providing guidelines for improving wayfinding friendliness and usability is clearly a practical goal of our research. Based on the present study we hope to intensify the cooperation of cognitive scientists and architectural designers, ideally from early planning stages on. The building deficits described in this paper need to be related to Space Syntax analysis in subsequent analyses. We are especially interested in working on an even better understanding of the stairways problems, which requires the use Space Syntax extensions to vertical movement.

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## FIGURE CAPTIONS

*Figure 1:* The multi-level conference centre. Public hallway space is indicated in red

*Figure 2:* Location of stairways (blue boxes) and visual access area from the main entrances hall (light blue shaded area in center). Main visual axis in red.

*Figure 3:* Close up of the most central staircase, located closest to the entrance hall. The white line illustrates a participant's movement from level +1 to the basement, including path deviations related to disorientating properties of the stairways.

FIGURE 1

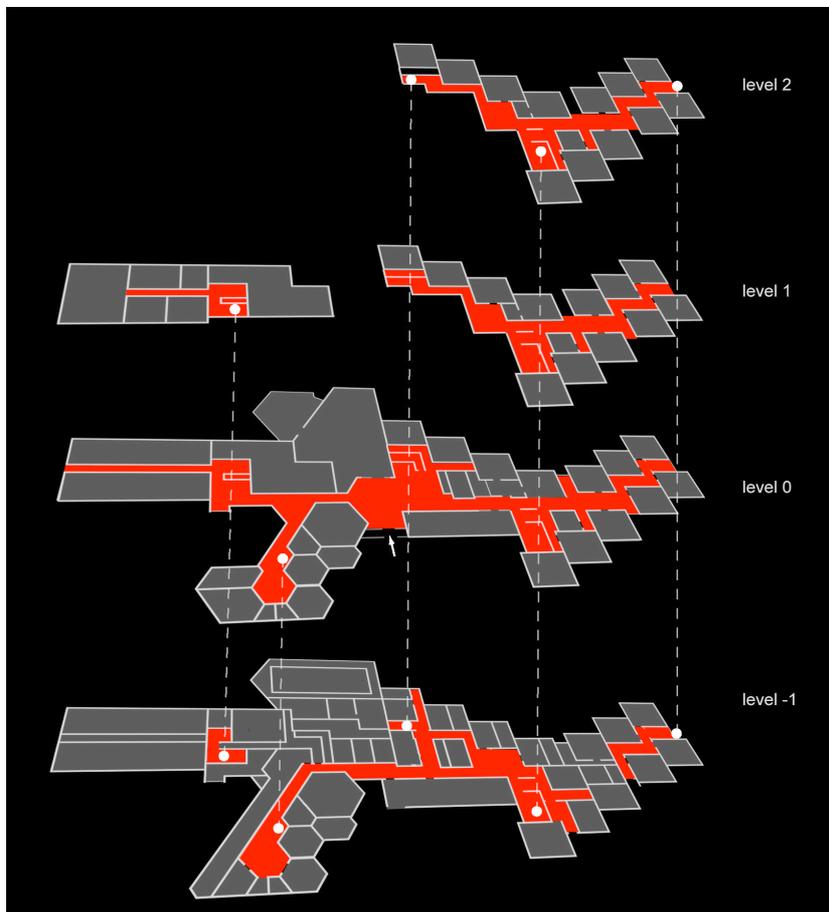


FIGURE 2



FIGURE 3

