

## THE LOAD-BEARING STRUCTURE AS VISUAL STIMULUS: COMPLEXITY OF THE SCENE

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### ABSTRACT

Sustainable spatial design necessitates a systemic analysis of environmental, economic, and social factors. Within this integrated approach, structural design aims to enhance the overall performance of built environments. In this process, the load-bearing structure is developed based on a set of parameters concerning social sustainability, particularly focusing on the health and wellbeing of users. Given that load-bearing structures are often exposed in sustainability-focused projects, their visual properties must be carefully considered. Through critical content analysis, this paper examines load-bearing structures as an important element of the users' visual experience, analyzing them at three levels of visual stimulation: presentational, representational, and symbolic. The goal is to identify the key factors influencing the visual complexity of the scene, as well as to point out their possible effects on the user aesthetic experience. The findings provide insights for future research aimed at improving the design of load-bearing structures to enhance users' wellbeing.

**KEYWORDS** \_ *structural design, visual stimulation, complexity, users' wellbeing*

## INTRODUCTION

In the process of integrated building design based on sustainability principles, structural design aims to improve the overall performances of a building as a whole (Kestner, 2010). The building structure is viewed as a functional unit, that is, understood and thus evaluated through its relation to a specific function of architectural space (Nenadović, 2014). Structural design is based on a set of parameters related to environmental, economic, and social wellbeing (Birkeland, 2002; Nenadović and Milošević, 2022). When it comes to social sustainability, a special focus is placed on the health and wellbeing of users (Woodcraft et al., 2012; Shirazi and Keivani, 2017; European Commission, 2020). The wellbeing of building users is largely determined by information from the environment in terms of their effect on current needs, preferences, and activities (Božović-Stamenović, 1997). The focus is on what architectural spaces "do" within the experience (Dewey, 1934). The perceptual properties of architectural space become aesthetically relevant in the context of expressive qualities that relate to the user's emotional states in response to the space (Berleant, 1997; Sinico, 2015). When it comes to user wellbeing, in addition to the quantitative aspects, which are a necessary but not sufficient condition for the realization of the basic role of space, it is necessary to achieve quality in the visual sphere. The level and patterns of visual stimulation should be consistent with the intended role of architectural space. Given that load-bearing structures are often exposed in sustainability-focused projects, their visual properties must be carefully considered during design. In the context of the above, through critical content analysis, this paper examines load-bearing structures as an important element of the users' visual experience, analyzing them at three levels of visual stimulation: presentational (Goldman, 1990; Lynch, 1960; Weisman, 1981), representational (Hagerhall, 2001; Božović-Stamenović, 1997; Fleming and Singh, 2010; Adelson, 2001), and symbolic (Williams et al., 1992; Karana, 2010). The goal is to identify the key factors influencing the visual complexity of the scene (Berlyne, 1963, 1968, 1970), as well as to point out their possible effects on the user experience. The findings provide insights for future research aimed at improving the design of load-bearing structures to enhance users' well-being.

## THE PERCEPTUAL QUALITIES OF ARCHITECTURAL SPACE

Architectural spaces and their elements represent a set of facts available to perception. Perception is defined as the process of acquiring information from and about the environment, actively and purposefully (Lang, 1987). In this process, humans select, organize, and interpret sensory data to guide their behavior (Cook and Hunsaker, 2001). Information from the environment is interpreted in terms of its effect on immediate needs, preferences, and activities (Canter, 1983), while also triggering various emotional states (Berleant, 1997). In this sense, aesthetic experience is interpreted as a positive emotional response to sensory stimuli from the environment (Dewey, 1934). Aesthetic experience is more closely related to self-fulfillment than to self-preservation (Porteous, 1996). The perceptual qualities of architectural space, or its expressive qualities, should evoke pleasant emotional states, thereby contributing to the primary function of the space, which is to stimulate users activity (Mehrabian and Russell, 1974; Božović-Stamenović, 1997). And indeed, thanks to their ambient qualities, architectural spaces can enhance the productivity of employees (CABE, 2005), improve the learning process (Kjærvang, 2003), or contribute to the faster healing of patients (Ulrich et al. 2004; Malkin, 1992). In the process of users bonding with architectural space, two key aspects of its quality are highlighted: functional and symbolic (Giuliani, 1993; Williams et al., 1992). These aspects relate to the ability of a space to stimulate desired experiences (Kyle and Chick, 2007; Williams et al., 1992). Considering the above, social sustainability, which concerns creation of "places that promote wellbeing, by understanding what people need from the places" is recognized as a fundamental component of sustainability (Shirazi and Keivani, 2017). The key objectives relate to the achievement the specific outcomes for building users in terms of functionality, comfort, convenience, accessibility, health and wellbeing (European Commission, 2020). In that sense, architecture that aims to enhance the quality

of life must address to all senses simultaneously (Berleant, 1997). In existing building evaluation systems within the context of sustainability, the primary focus has been on the quantitative aspects of architectural space quality. While these aspects define necessary conditions, they are not sufficient to fulfil the fundamental role of space. Achieving quality in the visual dimension is of equal importance.

### **A VISUAL STIMULUS: THE COMPLEXITY OF THE SCENE**

Architectural spaces can be understood as communication portals that visually stimulate users. Architectural spaces can be more or less complex visual stimuli. Complexity is directly linked to the stimulating qualities of space, referring to the scene's capacity to capture and sustain an individual's attention (Kaplan, 1987). The process of translating complexity into simplicity is an integral part of the aesthetic experience (Arnheim, 1972). In fact, order and complexity together contribute to the perception of beauty (Eysenck, 1942). To fully experience the complex order of architectural spaces, individual elements must be perceived in relation to their role within a larger, integrated whole (Kyle-Davidson, 2023). This involves an emotional and intuitive fusion of different spatial elements, or rather, the recognition of their relations (Mako, 2012). The aesthetic experience is interpreted as a perception of harmony, that is, the recognition of harmonious relationships within space. "Humans perceive spatial harmonies even at high levels of complexity. This ability can be further developed through experience and learning" (Božović-Stamenović, 1997). This is a dynamic process in which a sequential series of aesthetic experiences unfolds one after another through movement and interaction within the space (Mako, 2009).

### **THE LOAD-BEARING STRUCTURE AS VISUAL STIMULUS: COMPLEXITY OF THE SCENE**

The level and patterns of visual stimulation, which includes the exposed load-bearing structure, should align with the intended function of the architectural space. Three levels of visual stimulation should be considered.

#### **Visual stimulation on presentational level**

The first level of visual stimulation is presentational and relates to the visual perception of spatial configuration and materials under specific lighting conditions (Fleming, 2019). At this level users process and organize spatial visual information. The goal is to achieve spatial legibility and coherence, enabling users to better understand and navigate the space (Lynch, 1960; Kaplan S. and Kaplan R., 1982). The legibility enables users to easily organize spatial elements into a coherent pattern (Lynch, 1960; Weisman, 1981; Coburn et al., 2019), that is, to perceive different elements as a unified whole (Berlyne, 1963). The concept of coherence is related to stability and predictability. The spatial arrangement and materialisation of visible structural elements can contribute to both the legibility and coherence of space (Hadid, 2008). The key factors influencing the visual complexity of the scene at this level include the number of structural elements, their heterogeneity in shape and material (i.e., colour and texture), as well as the irregularity of their forms and their arrangement. Principles such as symmetry, a clear hierarchy of elements, and rhythmic repeating patterns, facilitate easier cognitive processing (Arnheim, 1972), contributing to calmness (Coburn et al., 2019). In contrast, chaotic or overly complex layouts may lead to anxiety (Kawshalya et al., 2022). It should be borne in mind that structural materials do not inherently possess aesthetic properties (Marciano, 2008; Nakanishi, et. al. 2024). The visual experience will be influenced by the interrelationships of all materials used. Research shows that users prefer contrasting combinations of materials, colours, and textures (Muezzinoglu, 2020; Thundathil et. al., 2023). Contrast enhances spatial legibility and coherence, by highlighting specific areas and establishing spatial hierarchy, which all enhance user activity (Kamaruzzaman, 2010). Also, the structure, colour, and texture of structural materials, as well as their transparency and

reflectivity, affect the level of illumination, the distribution of light, and its intensity and colour, all of which influence the visual experience of space (Howarth, 2005; Ishikawa, 2023).

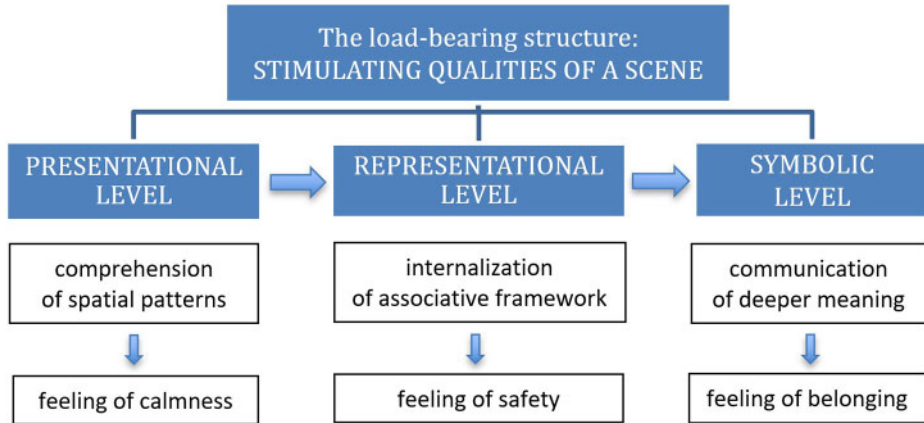
### **Visual stimulation on representational level**

The second level of visual stimulation is representational and pertains to users' understanding of the use value of architectural space and its elements. At this level, the complexity of the scene relates to how closely the visual stimulus aligns with the observer's idealized image - a mental representation shaped by cultural and personal experiences (Hagerhall, 2001). When the associative framework is unclear, users may experience frustration, negatively impacting the intended activity (Norman, 1988). When assessing the use value of a building structure, users evaluate their safety and security. The perception of strength, stiffness, and stability - i.e., structural logic - stems from an ecologically significant innate ability to predict the physical behavior of objects and adjust motor actions accordingly (Fleming & Singh, 2010; Cholewiak et al., 2012). This intuitive process also considers material properties, their physical and chemical composition (Adelson, 2001; Fleming, 2014), and the way they change over time (Strappini, 2024). Users primarily process material strength and, consequently, the load-bearing capacity of elements and assemblies (Jones et al., 2001). In that sense, material properties contribute to emotional responses (Adelson, 2001; Strappini, 2024). Strong, durable materials such as stone, concrete, and steel are typically associated with safety, evoking feelings of security, while lighter materials may be perceived as less secure, even if structurally sound (Fleming, 2014). Understanding structural logic is simplified when the structure is exposed, that is, where structural elements like beams and columns are visible (Alexander, 1977). "A building will seem alien if it does not give its users a direct and intuitive sense of its structure. Buildings where the structure is hidden leave another gap in human understanding of the environment" (Alexander, 1977). When users cannot intuitively predict an object's physical behavior, it can create discomfort. This undermines the sense of safety in a space, which is essential for the process of 'dwelling' (Heidegger, 1971).

### **Visual stimulation on symbolic level**

The third level of visual stimulation is symbolic and concerns the symbolic meaning that users assign to architectural spaces and their parts (Williams et al., 1992). These meanings develop in the context of personal experience with architectural spaces i.e., cultural and personal symbolic system (Hershberger, 1970; Giuliani, 1993). At this level, the complexity of the scene relates to symbolic forms that communicate attitudes about life, by resonating with individual and collective memories, values, and beliefs, that is, encoding existential reflections (Norberg-Schulz, 1979; Ortner, 1993). These forms, as carriers of identity, reinforce a sense of belonging (Williams et al., 1992; Ortner, 1993). "The architectural representation transcends visual spatial expression by offering deeper feelings and cognitions related to man and his place in the universe, which is essentially a symbolic expression" (Mako, 2009). These symbolic forms include materials that "have a history that helps us assign meaning" (Karana, 2010). During and after World War II in Europe, many people were temporarily housed in wooden barracks (Bajford, 2011). Light concepts communicate attitudes about changeability and transience. However, people tend to prefer permanence, seeking stability and continuity in the spaces they inhabit (Institut für Marketing & Innovation, 2011). Yet, permanence itself can evoke a range of different feelings. "Concrete can be sublime. It can also inspire fear" (Ricciotti, 2008). In the film "Concrete Stories" by Lorenzo Findisan (Google, 2015), people talk about their lives in buildings made of prefabricated reinforced concrete slabs. Their stories about industrial housing evoke the European story of standardization that ruled the lives of entire generations, in a time of clashing ideologies of East and West. On the other hand, transparent glass panels offer deeper feelings of freedom and inclusivity (Sadeghi, 2015). In the sense of the above, architectural spaces should function as carriers of identity, where symbolic elements reinforce a sense of belonging and cultural continuity.

Based on the above findings, the key factors influencing the stimulating qualities of a scene, in relation to the load-bearing structure, include the appropriateness of its spatial patterns, associative framework, and the meaning it conveys. The level and patterns of visual stimulation, shaped by structural configuration and applied materials, should be evaluated based on their impact on the user's visual experience, particularly their emotional response (Figure 1).



**Figure 1:** The load-bearing structure: stimulating qualities of a scene (Source: Author's own work).

## CONCLUSIONS

The exposed load-bearing structures, which are increasingly common in sustainability-driven projects, are an important element in shaping the user's visual experience. The visual complexity of a scene is perceived across three levels: presentational, representational, and symbolic, where users engage with spatial patterns, associative frameworks, and meanings. The findings of this paper highlight the need for a more holistic approach to structural design, integrating the visual properties of building structures into sustainable, user-centered architectural practices - ensuring that they contribute to users' well-being by fostering feelings of calmness, safety, and belonging. This implies that structural design concepts should no longer focus solely on technical aspects, but also on aesthetics, thereby broadening the scope of structural design. In this context, future research should explore the interdisciplinary intersections between structural design, cognitive science, and environmental psychology to optimize the built environment for users' psychological well-being. Additionally, the focus should also be on education of architects and structural engineers, particularly in understanding users' well-being, as incorporating these considerations into architectural practice require informed judgment.

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