

# Design Configuration in Industrialized House Building

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## INTRODUCTION

Industrialized house-building refers to an efficiently managed construction process based in technical platforms, using highly developed off-site manufactured, modularized, technical-functional house-building components or modules (Lessing, 2006). Project design in this context is seen as a process of configuration where variable or interchangeable parts of the technical platform are determined (Hvam et al., 2008).

Architectural design deals with complex problems that, aside from technical aspects, also concern user functionality and aesthetics. During the traditional design process, architects have a central role in coordinating different requirements concerning use and construction. This is often done in an iterative manner, defining problems and solutions in parallel. This approach is, however, unsuited for the industrialized house-building design process, where platform development is separated from project design.

In design practice, the configuration system for a technical platform contains information about the platform's technical parts and restrictions in design (Olofsson et al., 2004). This means that the configuration system normally does not include information about user functionality and aesthetics, i.e. if the platform can fulfill the client's expectations concerning spatial use or aesthetics from a comprehensive architectural view.

This information is still supposed to be managed independently by the architect, prior to configuration, in what could be considered a traditional early design process. If information about user activities and aesthetics could be included and managed in a transparent way by the configuration system, early design could be fully integrated in an industrialized design process.

This chapter presents the results of research with the aim of investigating premises for architectural design as part of an industrialized house-building design process, focusing on three areas of importance: (1) support for architectural design in platform development and modularization; (2) support for architectural design in product configuration; and (3) organization of design information to support architectural design. The implication of the results of this research is a better understanding of how to use technical platforms as a viable business alternative for a broader spectrum of construction projects, including enhanced knowledge of how to manage and overcome the perceived constraints concerning architectural freedom in the design process when using technical platforms.

## THEORETICAL FRAMEWORK

Architectural design does not only affect the built environment, but also intentionally affects the

humans who use and experience it (Steadman, 1979; Hillier, 1996). The built environment sets conditions and offers possibilities for human activity; therefore, it is appropriate to conclude that architectural design is about the relationship between humans and buildings as a socio-technical system (Ekholm, 1987).

The environmental psychologist, Roger Barker, has introduced the concept of behavior setting to refer to a concrete unit of behavior and milieu, with the milieu circumjacent to behavior (Barker, 1968). According to Amos Rapoport, the environment can be conceptualized as a system of settings within which a system of activities takes place (Rapoport, 1997). Christopher Alexander's similar concept pattern is described as a design unit with a strong emotional content referring to concrete systems of place and human activities and experience (Alexander et al., 1977). The inseparable unit of social activity and built environment is named fabric by John Habraken in a similar attempt to capture the essence of the built environment, in use, as a living organism (Habraken, 2005).

The built environment is generally thought of as organized in different levels of design or intervention (Habraken, 1982; Habraken, 1998; Ekholm, 1987). The level order reflects both the artefacts' size and other aspects, and how they are controlled in different levels of social systems. Based on this insight, the Swedish National Board of Public Building identified three levels of building parts: society-related, building-related and organization- or activity-related - (Ahrbom, 1980). Four levels of control actors can be envisioned in the socio-technical system regarding control of the built environment (see Table 1).

The ideas of behavior setting (Barker, 1968), pattern (Alexander et al., 1977) and fabric (Habraken, 2005) comprise the background of the situation concept, which refers to units of people, behavior, experience and built environment. In the context of object-oriented architectural design, it is here proposed that a situation can be represented as an architectural object. Phenomenal properties must be attached to this context (see Figure 1).

Our primary intent is that the concept of architectural object could support architectural design in industrialized house-building within, for example, different software applications or configurator solutions. An architectural object may be modularized and parametric and part of a configuration system based on a basically spatial view. The objects are composed of parts of the building system and user activity which in turn generate a phenomenal (architectural) property (see Figure 1). An anticipated platform of architectural objects may also be organized in design levels reflecting the control levels that were earlier observed in relation to the built environment.

## Product Views

All systems can be observed from a functional or compositional aspect, where the compositional parts can be members of several functional systems (Ekholm, 1987). This feature is also acknowledged in the international standard, ISO 12006-2 Building construction - Organization of information about construction works - Part 2: Framework for classification of information. For platform development where it is argued that a generic part of structure could support different

Table 1. Levels of control, built element, and actors in the socio-technical system man-built environment

Control Actor	Controlled Built Environment	Control Level
City authority	Infrastructure (streets, sewer etc)	City, neighborhood
Building management	Building related building elements	Building
Building user organization	Organization related building elements	User organization space, e.g. apartments, staircase
Building user	Activity related building elements	Activity space, e.g. rooms or subdivisions

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