

ARCHITECTURAL INTENTION AS THE MEDIATOR OF LEAN HOUSING CONSTRUCTION

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ABSTRACT

In recent years a number of companies have taken up the challenge of producing prefabricated houses using *lean* principles, hereby incorporating *value* driven production theory as the means to optimize construction processes. However, the *value* of home is dependent on architectural qualities and interior spatial experiences difficult to operationalize as production objectives. As stated by Sven Bertelsen a home should be more than the sum of the parts; the home constitutes our physical and metaphysical being and there is *deep feelings* connected to this phenomenon (Bertelsen, 2005).

Modularization and prefabricated production as *lean construction* strategies hold obvious potentials in the development of an effective building envelope with regards to indoor climate, assembly etc. However, the discussion of lean construction, future working conditions and processes, often avoid an actual positioning regarding the *values*, which were originally the main focus of *lean construction philosophy* (Howell, 1999). Through the development of a particular interior architectural focus this paper suggests a method for reintroducing customer *value*; architectural quality, as the outset for making housing construction lean.

KEY WORDS

prefabrication, architectural values, construction strategies, theory and application

INTRODUCTION

With the automotive industry as a role model prefabrication is generally considered to improve *value*, by reducing complexity of construction, minimizing errors and lowering production expenses (Lessing, Stehn and Ekholm, 2005). Since Le Corbusier introduced his 'machine for living' a century ago architects and companies have pursued the idea of developing good quality low cost industrialized houses. However, instead of unfolding increased

architectural values the industrialized house has remained architecturally uniform and poor in spatial and material detailing. The units set into production have continuously become only a shadow of the many architecturally iconic and expensive prototypes developed (Davies, 2005:11). The matrix of uniting potentials of lean construction theory and interests of different parties in developing architecturally stimulating *homes* is though practically difficult to solve. This is reflected in the current discussion of prefabrication as a lean

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construction method. Here focus is often on the measurable aspects of construction rather than the complexity of *home* as a phenomenon; ensuring value through process management and evaluation in (Ballard, 2000), customization/standardization, product and process complexity in (Höök and Stehn, 2005) and management approaches and quality assessment approaches in (Beim and Jensen, 2005). Thus the establishment of prefabrication as a lean construction method is a complex concept which Björnfot and Sarden have been trying to clarify, concluding that there is still a need to precisely specify customer value in lean construction (Björnfot and Sarden, 2006: 275). In continuation hereof workflow, and the role of different parties is a heavily debated area of lean theory treated by Koskela, Ballard and Tanhuanpää, 1997 amongst others. But how can value be defined with regards to the house and who is responsible for developing these values?

In the house, the experienced *value* is dependent on spatial articulation. The experiences which we cherish and which become lasting memories often occur in the specific *interior* treatment and detailing of architecture. This could be for example a window which is not just a window but also a place to sit, read and enjoy the view. Thus, when reconsidering *value* for the customer as suggested by Björnfot and Sarden, the intangible concept of *architectural quality* must necessarily be part of such reconsideration. This paper takes its starting point in architecture and how a positioning of architectural qualities within the technical framework of prefabrication can contribute to the values of lean housing construction. Through a

specific case study, an ongoing research project carried out in co-operation with the Danish housing manufacturer Boel Living, the paper explores the potentials of using architectural intention as the theoretical and practical mediator for transforming production, constructions and *values*. Hereby an increased involvement of the architect in the formulation of specific endeavored architectural values and in the actual development of modules, joints, tolerances and spatial details is suggested.

LEAN CONSTRUCTION AND INDUSTRIALISED HOUSING PRODUCTION

When Engineer Ohno began developing lean strategies it was with the intention to reduce the time to develop and deliver a new model, why the production processes was considered along with the design of the car. In opposition to Henry Ford's 'flow based' strategy Ohno started focusing on customer orders; a '*value based*' strategy (Howell, 1999). Thus '*Value can only be defined for the critical customer and is only meaningful when expressed in connection with a specific product.*' (Bejder, 2005:34). Theoretically Ohno wanted to be able to adjust each car according to customer needs.

With prefabrication the house is adopting some of the characteristics of the car, especially in volume element production, which is the subject of this paper. Here production is systematized into elements of a high level of prefabrication. However, fitting the home into an industrialised production causes complexities in terms of both technique and architectural qualities. In the following a number of these

complexities are listed and formulated on the basis of a study of the ongoing production at Boel Living. The purpose of the study has been to expose streamlining potentials both with regards to construction techniques and architectural qualities. Boel Living, established in 2007, is producing timber frame volume elements, aiming to offer a series of fully detailed single family housing typologies of high *quality* (Boel Living, 2008).

Technically new joint principles are required to achieve a tight building envelope meeting the increasing building code requirements. Material tolerances need to be considered and modes of assembly are to be integrated into the construction system and logistics. Architecturally, volume element production results in a number of limiting conditions regarding dimensions, shape which is conditioned by the chosen construction system (in this case timber frame construction), and adaptation to site which is in the case of Boel Living limited to orientation. These conditions are similar to the ones of the car; roadwidth, joints, safety etc. Still though we do not think of the industrialised house as we think of the car, especially the users are often sceptical of buying a “ready to wear” house. What differentiates house and car?

The car is a highly specific product, expressing an identity; a SMART, a Volvo or a BMW (Björnfot and Sarden, 2006). Consequently the design qualities of the car, are consistent regardless of the individual choices made by the customers. The customisation level does not disturb the overall architecture of the car or, one might say the identity and design

intent; it is limited to changes of colour, interior fabric, motor specifications etc. If looked at as architecture the car would be considered a “gesamtkunstwerk” (Frampton, 2001:59.); a total work of art where every design detail has been determined as part of the whole; a whole which is the responsibility of the designer. With reference to Bejder, cited at the beginning of this section the specific shape and detailed design of the car is the foundation for making its production lean as well as for the appreciation of its design; its *values*. In case of the house in contrast, we are discussing and expecting a completely different level of customization, a flexible system of walls allowing the user to design freely, leaving manufacturer and architect without responsibility for the actual qualities of the house. Hereby the house is loses its specific shape and if following the above; its *value* and the motivation for lean production. Consequently there is a need to reconsider the parallel between car and house; does flexibility equal architectural quality of the house and what are the actual *values* of home; the values which according to Greg Howell should be considered the outset construction philosophy? (Howell, 1999)

AN INTERIOR APPROACH TO ARCHITECTURAL QUALITY AND VALUE

In its origin architecture is a multidisciplinary profession which requires the skills to balance technical-scientific, experiential-artistic and societal-contextual aspects. Therefore the question of the architectural quality of the house is closely related to the question of the architect’s role, -how we approach the field of architecture.

When Le Corbusier formulated his architectural vision for the 20th century ‘machine for living’, it was highly motivated by technological breakthroughs (Corbusier, 1923:137). But despite his proclaimed goal to develop a replicable model, he did not evade to develop this model from a specific interior spatial intent. His Unité apartment is a characteristic inhabitable interior, almost a piece of furniture offering different specifically designed spatial experiences of home to the customer. Today one parameter seems to dominate most discussions on the subject of desired qualities of the industrialized house: flexibility.

However, often the users actually have difficulties managing the choices provided by the resulting open plan solutions (Mortensen et. al, 2005:12). Instead of experienced value the spaces are without characteristics, spaces which the users do not identify with as dwellings. When held together with the actual circumstances of lean construction treated above, the strive for flexibility has resulted in a lack of development of the actual spatial possibilities of volume-elements. In prefabricated houses the plan often follows the module lines, resulting in interior uniformity (Frier, 2007:38). In this way especially interior qualities are ignored; contents and hereby values are left out even though with volume elements there is evidently an unexplored potential for the architect to address the interior beyond the standard insertion of the toilet core and slavish interior accept of the boxed framework. In addition the prefabricated house is without context. Identical houses are reproduced on different locations and thus cannot gain their value from a specific

relation to site; so what is the possible value of the industrialized house?

“We give shape to the house and the house gives shape to us” one can read from Andrew Ballantyne’s ‘What is Architecture?’ (Ballantyne, 2002:2). Following this line of thought the house whether industrial or not, has to be approached with the immediate relationship between architecture, user, and architect as the starting point. Consequently, the value of home is dependent on specific intended interior experiences. According to American architect and theoretician Marie-Ange Brayer, a chair, a carpet, a bed etc. are immediately inhabitable due to their proximity to the human body (Brayer & Simonet, 2002:42). Following this line of thought one could say that furnishing; the points were architecture twist, folds, or bends to create specific experiences signify our experience of home. The ability of architecture to furnish a place simultaneously defines the area of contact between the architect’s spatial intentions and the identity of the inhabitant. Herein the experienced value of the house is revealed: the interior defines home. Inspired by the classical conception of architecture understood as furniture, proposed by Le Corbusier among others, a novel design strategy, for the future industrialized house is hereby suggested. But what are the conditions of this necessary interior empathy governing house in the context of lean construction? In the following the conception of architecture understood as furniture is sought adopted as a perspective through which to challenge construction strategies and the role of the architects in lean construction processes.

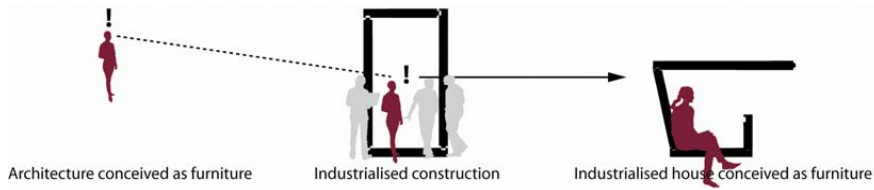


Figure 1: Architectural intention as mediator of construction- and value development.

APPLICATION, ARCHITECTURAL INTENTION AS MEDIATOR

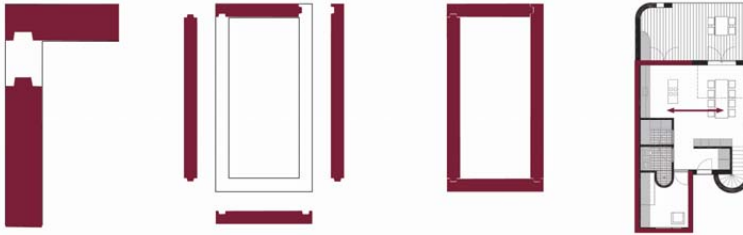
Often communication between engineers, architects and manufacturer is broken off when production is initiated. At Boel Living this has been the case and the first houses are being produced from drawings made in the planning stages, in need of further development in order to streamline production. In continuation hereof and in line with the above theoretical study, the research project has methodologically developed into an action-oriented experiment, investigating whether an architectural involvement in the product optimization process can help increase the architectural *value* potential of future housing series. Thus the mentioned production research has been followed up by research concerning development of details and assembly systems which are naturally of the greatest challenges for a new company. Here the intention has been to use the conception of interior and furniture as a *value* generating perspective in the development of construction details.

The quality of furniture with regards to both perception and production flow is the detail; the detail is decisive for the flow of production and for the *feel* of the chair. At Boel Living the greatest challenge so far has

been related to the tolerances and assembly problems concerning the flow from planar elements into volume-elements. With the detail as the focus point the action based research has taken its starting point in participation of the architect as the means to familiarize with construction, production and the problems at hand. This field study and the theoretical idea of the connection between architecture and furniture have resulted in the development of a proposal for a new assembly system incorporating a groove system securing precise assembly and adjustment of tolerances. With the groove system all planar elements can be raised, pulled together and fixed with screws with no further adjustments needed, securing a better production flow. An optimization of detail and assembly simultaneously holds a potential for a higher degree of architectural freedom. In line with the intention of developing a furnishing architecture and improvement of assembly technique opens up for the development of interior and exterior furnishing contents within the volume elements. With an optimized basic envelope system a more free approach can be adopted in the interior independent of exterior walls and module lines offering articulated kitchens, intimate baths and enjoyable embracing window corners adding to the *value* of the house, like the detailed interior of a car. Hereby novel interior

qualities are suggested in the industrialized house through the utilization of technologies and production methods attributing to form and decoration and

hereby to our sensuous experience of *home* as illustrated below.



Groove joints allowing easy module-assembly and hereby a more free interior detailing; embracing corners and open sequences

Figure 2: Architecture conceived as furniture in detail and entirety.

CONCLUSIONS

This paper has outlined that a strong connection between theory (of architecture and of construction strategies) and practice is needed in order to improve the value of the industrialized house and make it suitable for lean construction. In line with working-constellations in the automotive industry, the research suggests that an architect working in-house now more than ever has the opportunity of becoming an advocate for *value* and for performing a quick adaption of the product for different sites and user-groups. Hereby a potential to develop specifically designed furnishing architectural elements within the technical and economic framework of volume element production; a kitchen which extends onto an outdoor kitchen furnishing the terrace, a window-seat, or a bath with a view etc.

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Simultaneously this approach offers a potential for reinforcing the exterior site-relation of the industrialized house by using furnishing elements to establish a dialogue between house and surroundings.

Through a re-evaluation of the origins of lean production; the car, and the concept of value in the context of home, a method for reintroducing customer value; architectural quality, at the center of lean construction strategies has developed. This reevaluation has been strongly motivated by a specific positioning regarding architectural quality rooted in an interior furnishing conception of architecture. Hereby it is suggested that architectural intention can become a mediator for uniting different perspectives among lean parties into a joint venture pursuing the values of constructing and living in industrialized homes.

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