

CINARK RESEARCH

Three Ways of Assembling a House

Elaborated at CINARK –

Centre for Industrialised Architecture by

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PREFACE

This report is the final result of the research project Architectural Quality, User Requirements and Mass Customisation in Industrialised Building Systems. The research was carried out by CINARK – Centre for Industrialised Architecture at the Royal Danish Academy of Fine Arts, School of Architecture in Copenhagen.

Preliminary studies and data collection were started in spring 2007 and the project was finished by the end of 2008. The research was funded by the French governmental secretariat for Planning, Urbanism, Construction and Architecture (PUCA) within the framework of the inter-European ERABUILD research programme. The task was at first to provide knowledge and an assessment of Scandinavian industrialised and prefabricated building systems applicable for multi-storey housing developments.

The report consists of two main parts. Part 1 is a preliminary State-of-the-art discussing the three main themes, Architectural Quality, User Involvement and Mass Customisation. This part

was originally presented in November 2007. Part 2 is the main report *Three Ways of Assembling a House*. This part focuses attention on specific industrialised building systems and subassemblies and uses these examples as a framework for a conceptual discussion of industrialised building systems and assemblies.

Through the ERABUILD research programme, the present research has been connected to parallel projects carried out by The Technical University of Chalmers, Department of Architecture in Sweden and by the IPRAUS research unit at the Ecole Nationale Supérieure d'Architecture de Paris-Belleville in France. The exchange between the projects was realised through meetings, common excursions and company visits.

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Main contributions to the data collection – primarily through interviews concerning the specific cases – were made by Gert Jespersen, Design Manager at NCC Construction, Keld Kielstrup, Danish Sales Representative at Willa Nordic, Mattias Hjalmeby, sales director at the Willa Nordic main office in Sweden, Mikkel Kragh, Associate at Arup, part of Arup’s Environmental Physics team in London, Nils Fredriksen, System Manager at Altan.dk, John Sommer, Section Manager at MTHøjgaard, Søren Rasmussen, Owner of ONV-Arkitekter, Niels Sandahl, former CEO and present Director of Development at EJ Badekabiner. Supplementary comments were provided by Dan Engström, Adjunct Professor and former Senior Project Manager at NCC Construction Sweden AB, NCC Technology, Søren Daugbjerg, CEO at Vilhelm Lauritzen, Sverker Andreasson former Manager of Product Development at NCC Komponent AB, Fredrik Anheim, CEO at NCC Industrial Construction, and Åsa Bronge, Architect at NCC Construction Sweden.

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EXECUTIVE SUMMARY

The report points at several critical questions when looking across the Danish construction industry from an architectural point of view. The following chapter forms an executive summary of the main observations, analyses and conclusions. Further discussions supplied with numerous examples from extensive interviews with significant stakeholders can be found in the full report. They underline the many different positions in the construction industry concerning the questions of: organisation and production systems, user aspects and quality.

Organisation and production systems

- **The limitation of the production system solved by multiple suppliers**

In turnkey projects, the general focus is primarily directed towards the production system of the main contractor when developing the project. If the traditional supply strategy (traditionally held by architects) is all about finding processes that spoil the architectural vision as little as possible, then the turnkey supply strategy (promoted by contractors) is all about finding a vision within the production system that reduces its capabilities as little as possible.

The architectural flexibility, as well as the transparency of the pricing structures of the turnkey projects are very limited. A healthy market structure based on such contractors can only exist,

if there is a wide range of suppliers who cover a variety of qualities and designs. Optimising the various production systems to build anything can be one strategy, but it is neither technologically feasible nor very economical.

An architectural ideal, within the turnkey supply strategy, points at offering a wide range of systems, so the architectural schemes can vary from project to project and the investor can choose the right system optimised for his/her needs and preferences and for the end-users.

- **Integrated product deliveries**

Project based development is not efficient if know-how is not systematically collected and implemented in future projects. Part of the explanation for this is an outdated tender system that excludes the manufacturer from participation in the preliminary phases of a project where specific choices determine the final result. Fixed business partners on both sides in the value chain would be beneficial to the development of integrated product deliveries – an explicit strategy of *Altan.dk*.

Working with fixed partners who know what they want ensures stability in the production flow and allows room for innovation. One way of solving this dilemma is to split the design process into pre-contract and post-contract phases. The pre-contract work is mainly concerned with outline design, scheme design and detail design necessary

to determine the nature and position of all contractual interfaces and the product performance, but only the desired appearance of the visual ones.

Not all building projects can be based on integrated product deliveries. Also there might be a problem of possible overlap between them (no clear interfaces). A method of resolving this issue may be not to lock conventions on details – but to leave space for redefinition/reformulation of new interfaces and for future changes.

- **Configuration management**

The industrialised building composed by subassemblies can perhaps bridge the gap between the traditional project orientation and the industry's production orientation, thus resulting in unique projects based on composition and configuration of systemised products.

Given enough choices, the task of 'configuration management' could turn out to be one of endless opportunities.

User aspects

In what way and how far into the design processes are the users going to be involved? These are central and repeated questions throughout the interviews. Splitting up the building into different building assemblies that are manufactured and put on a market as products may seem over the top. However,

it is not always completely clear how the product is defined and how the connection between product, production, technology and user should be understood. In the cases discussed, at least three quite different conceptions are expressed. What is actually the product? What do people buy? Who are the users/clients? It is therefore important to clarify aspects such as: Are the users to be involved at a general level in order to define a concept of living? Or are the users to be involved to specify materials and product qualities? In other words, are they to be regarded as visionary collaborators for mutual inspiration and specification of the projects? Or are they to be regarded as consumers being offered what they expect? A question left open for discussion is: Does having the choice give more value than the (high quality) standard solution? The answer might depend on what is left open and what is standardised.

Some aspects are important for the end-user, some for the client and others again for e.g. the architect, and often it is the financial and organisational setup rather than architectural experience that determines whether choices are left open for different stakeholders - and which ones.

Quality

Looking across the cases, architects are strikingly absent from industrial product development except

SCOPE OF THE RESEARCH

in one case (NCC-shaft). However, when focusing on e.g. integrated product delivery it also has obvious weaknesses. Strict definitions of qualitative properties of subassemblies cannot secure cohesion with the actual context. This will require products that have a certain openness and adaptability towards the context in a broad sense thus including the actual interface as well as technical aspects, aesthetics, functional schemes, economy, ecology, time, place and other values,¹ which all influence what we term the architectural quality.²

An important challenge for the architect – as an in-house or external consultant – will be to clarify the demands concerning quality performance openly defined, as well as pointing out relevant contextual aspects in order to provide the necessary coherence of subassemblies used in construction.

This research focuses on residential architecture. In the ongoing industrialisation of construction, many stakeholders are looking for ways to simplify, standardise and rationalise the processes by means of systems at both product and process level. However, potential house buyers and users still want individually customised homes of architectural quality. These different attitudes are not always compatible. There is a risk that future housing will be cheap and unattractive at the expense of both architectural quality and sustainability. The present report aims at shedding light on highly industrialised Scandinavian building systems and concepts. By looking at the system itself, the way it is produced and the business model behind, the intention is to assess these systems and concepts in their broader organisational context and not just as physical manifestations of original clear-cut design intentions. Industrialisation is mainly about process – it is a means to an end, not a goal in itself.

¹ Beim, Anne and Jensen, Kasper Vibæk (2007); *Forming Core Elements for Strategic Design Management*.

Article in: *Architectural Engineering and Design Management*. CIB

² The term, Architectural Quality, is discussed in, *State of the Art*, Part I of this project.

Acknowledging that there is more than one possible way of enhancing the application of industrialised solutions in construction and architecture, the present report introduces a framework of several different strategies for industrialisation. The strategies are not to be understood as scenarios where one excludes another. Rather, the framework can be seen as our interpretation of parallel tendencies found in contemporary Scandinavian practice – a way to conceptualise a motley or scattered reality in order to better understand the dynamics behind. Through case analyses focusing on both technological aspects and applied business models, the specific characteristics of different industrial *deliveries*, within construction, are sought clarified. A subsequent general discussion focuses on the constraints and potentials of the different systems and strategies reflected in the cases. It is our hope that this will help inspire the development of new industrialised solutions that go hand in hand with architectural ingenuity.

But why should we industrialise construction and the (process of) creation in architecture? From the point of view of an architect, this question may seem difficult to answer. With a huge collection of mostly bad references from the first wave of industrialisation in the 1960's and 1970's, such as monotonous building (systems), widespread and serious building defects and economical failure of all encompassing building systems, there are many reasons *not* to return to this path. However, the present scenario of not using industrialisation, or only using it sparsely is perhaps even worse: While the basic architectural challenge in construction remains rather constant, construction as a whole is getting ever more complex in order to comply with current legislation demands on e.g. safety, energy consumption, indoor environment and material recycling. This fact makes it ever more difficult to control the process and achieve the necessary architectural *coherence*.³ But is it then simply a question of choosing the least mediocre among various poor alternatives? We think not: Used wisely, industrialisation can – through better control – perhaps become the essential tool in true architectural creation.

³ For an explanation of the coherence concept see Beim, Vibæk & Jørgensen (2007)