

TRANS-USERS

Transforming construction by user-driven innovation

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TRANS-USERS

Transforming construction by user-driven innovation



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Preface

This report summarises the results from the work undertaken in the international collaborative project 'TRANS-USERS – transforming the construction sector through user-driven innovation'.

TRANS-USERS was carried out in 2007-2009. The project was executed in collaboration between CSTB (Centre Scientifique et Technique du Bâtiment) and SBI/AAU (the Danish Building Research Institute/Aalborg University).

The editors wish to thank the contributors to the project as well as our interview persons in the industry. In particular, the editors wish to thank the funding agencies that sponsored the project as part of the ERABUILD collaborative research funding scheme: the Danish Agency for Enterprise and Construction (Erhvervs- og Byggestyrelsen) in Denmark and PUCA (Plan, Urbanisme, Construction et Architecture) in France.

Danish Building Research Institute, Aalborg University
September 2009

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Research Director
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Introduction: The turn towards consumption

By Kim Haugbølle, Marianne Forman & Frédéric Bougrain

Reading instructions

This report contains three main parts. In the first part, we introduce the subject of user-oriented industrialisation strategies for building and construction. The first part includes the objectives of the study along with the theoretical framework and the research design of the study.

The second part of this report contains the five case studies conducted in Denmark, Sweden and France. The five case studies included are:

- BoKlok – a strategic partnership between the industrial manufacturer of furniture IKEA and the contractor SKANSKA, who jointly developed an industrialised home building concept for low-budget housing based on market surveys of user preferences, IKEAs overall design strategy etc.
- HTH – the largest manufacturer of kitchen solutions in the Nordic region developed a web based product configurator for end users to individually configure kitchen solutions for their private homes.
- Rockwool – explored the potential of utilising the dual role of employees as both employee and user for product, process and marketing innovations at a large manufacturer related to air tightness and low-energy housing.
- Maisons MACCHI – a local French manufacturer of low-energy individual homes has redesigned its production and business processes to accommodate user requirements by implementing a quality management system based on ISO 9001: 2000.
- ACCOR Hotels – the client as driver of innovation on the construction and renovation of the low budget hotel brand Formule 1 through long-term contracting, client coordination of construction sites and learning tools.

The third part covers the discussion and conclusion of lessons learned from the case studies. The report will address three interrelated issues related to the role of users, the construction business system and the reconfiguration of the boundaries between companies, concepts and users.

Background: Innovation and industrialisation

Innovation is generally considered to be the key driver of improved wealth and welfare. Several definitions of innovation, technological change, technical development etc. can be found in the literature. One authorised definition is provided by OECD in its Oslo Manual (OECD & Eurostat 2005). The third edition of the Oslo Manual on collecting and interpreting innovation data defines innovation as (OECD & Eurostat 2005: 46):

*'An **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.'* (original emphasis)

The most interesting news in the third edition compared to the previous editions in 1992 and 1997 is the recognition of two new types of innovations –

marketing and organisational innovations – to accommodate for innovation in service industries. Thus, the Oslo Manual (OECD & Eurostat 2005) defines four types of innovations:

- A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
- A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

Historically, a major bulk of innovation activities has aimed at industrialising the construction industry in a rather traditional sense of product and process development. Industrialisation has for decades been viewed as the prime way to increase productivity and improve quality in the construction sector. In a historical perspective, industrialisation has progressed through three waves. At the beginning of the 20th century, the first wave took the form of a change from single building materials to composite materials, namely reinforced concrete. After WWII, the second wave of industrialisation introduced prefabrication off-site at designated factories, in particular prefabricated concrete panels, beams, columns etc. The third wave started off in the late 1980s when new types of collaborative forms of work or integration of design and construction gained increasing attention in the construction sector e.g. witnessed by the Danish PPB development program in 1994-2002 (Process and Product Development in Building). At the turn of the 20th century, we are now facing several different trends. One trend is towards systems delivery and mass-customisation of products. Another trend is towards digitalisation of the information flows through the use of building information modelling. Further, we may be witnessing a new orientation towards servicesation focusing less on production and more on the customer and services. The main question is now, where do we go from here?

In recent years, the policy and research efforts in both Denmark and abroad e.g. the Danish policy on governmental building projects, the proactive strategy of CIB on revaluing construction and the establishment of an International Construction Clients Forum (ICCF) has emphasised the role of the client as a driver for change in the construction sector. This has primarily its roots in the understanding of the market as an incentive factor for technology development and changing processes in the society. Furthermore new forms of cooperation have been tried where the client, the consultant and the building contractor form a partnership from the beginning of the project as a way to optimise the planning process and to increase the quality. However, little effort has been put into understanding if and/or how clients have in fact been a valuable contributor to reforms in the construction sector. At the same time user-driven innovation has been introduced as a new source for the companies' innovation. In the strategy of user-driven innovation, there is focus on the need for development of competence among the actors in the construction sector in order to capture the inspiration etc from the users. It is the hypothesis of this project that to realise user-driven innovation you have to understand the production and consumption symmetrically. This implies an understanding of who are the users, how do user requirements meet the technical and functional development of the products, and how do user strategies fit the business strategies. In that sense user re-

sources and competence are just as important as the companies. Or in other words the companies have to go beyond the mechanisms of the market to see who the users are and how they can meet them.

This turn from production towards consumption of the built environment (and its associated products and facilities) is likely to manifest itself in various forms. It is these manifestations that we will explore in this study.

Objectives

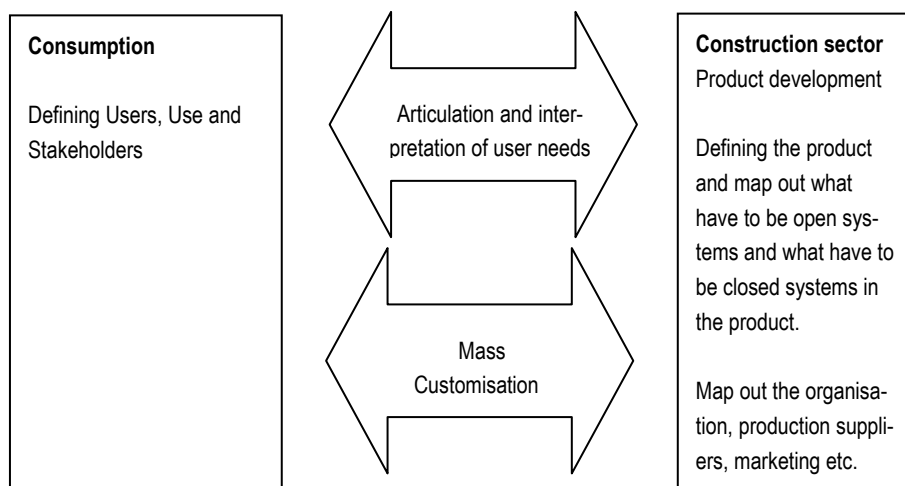
The aim of the project is to examine the interplay between user-driven innovation and industrialisation in the construction sector. By focusing on cases in the construction sector, where development has taken place as systems delivery of kitchens, standardised refurbishment of hotel rooms, production of family dwellings etc. it is possible to identify central preconditions and mechanisms that have worked in the transformation process. The project aims to transfer the identified experiences and mechanisms into strategic aspects so that they can be taken into account in the decision-making process in companies and in developing public policies for industrialising the construction sector.

The objectives of 'TRANS-USERS – transforming the construction sector through user-driven innovation' are:

- To analyse how users are shaping and are being shaped by a reconfiguration of industrialised design and production methods in the construction industry.
- To analyse how the construction business systems is being reshaped due to the interplay between production and consumption in the built environment.
- To develop strategic recommendations for policy-makers and decision-makers in firms on reconceptualising industrialisation and applying user-driven innovation.

The hypothesis in the project is that the interplay between new industrialisation and user-driven innovation is as shown in Figure 1 below.

Figure 1: The interplay between user-driven innovation and strategies of new industrialisation.



The upper arrow shows the interaction between the consumption and the production with relevance for the unfinished products. Schot & de la Bruheze (2003) focus on the mediation process between production and consumption and characterise this mediation process as a process of mutual articulation and alignment of product characteristics and user requirements. They involve not only the user but also spokespersons for the users in the articula-

tion of user requirements. In the mediation process, the user demands can be expressed by real users, projected users and represented users. The box on the right shows the processes in the construction sector or the single company where development and adaptation are central processes. The lower arrow shows the interaction between consumption and production with relevance for the finished product. This interaction will be characterised by being a market situation with a sales person and a purchaser/customer.

Theoretical framework

What does theory tell us of the mutual shaping of production and consumption in the built environment with respect to industrialisation and innovation? The first group of theories we visit are rather production-oriented in their nature and include concepts like complex product systems, construction business systems and construction economic sector system. While the first group of theoretical positions help us explore how industrialisation and innovation will re-position or re-locate the boundaries of production between e.g. manufacturing industry and construction industry, these theories do not provide us with a thorough understanding of the use and consumption of buildings. Instead will need to turn our attention to a different strain of theories and concepts. These include concepts like lead users from the innovation management literature, co-construction from science and technology studies and domestication from everyday life studies.

Framing production of the built environment

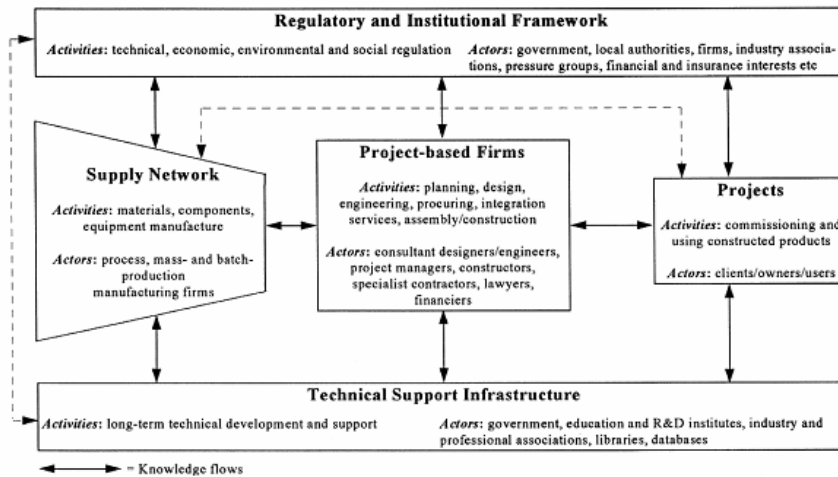
Complex product systems

Gann & Salter (2000) provide an analytical framework for understanding the construction industry. First, every construction organisation is embedded in a context of not only markets but also politics and technical support infrastructure. Both shape the boundaries of possible action of the firm in important ways.

Second, construction in general operates in a context of project-based services. As noted by Gann & Salter (2000), a major impediment for innovation in project-based service firms is the gap between the project-based processes and the business processes of the firm. The project-based nature of construction implies that the interdependencies are primarily linked to the rather fluently, changing and ad-hoc patterns of cooperation with a rather great number of external firms.

Gann & Salter (2000) provide an analytical framework that can situate change agents of construction in a context of the regulatory and institutional framework on one hand and the technical support infrastructure on the other hand. Further, Gann & Salter (2000) offer a framework that explicitly addresses the linking of business processes of the firm with project-based processes (see Figure 2).

Figure 2. Knowledge, information flows and actors in project-based processes.



Source: Gann & Salter (2000: 960).

The strength of this framework of Gann & Salter (2000) is its strong emphasis on putting construction into context – a context of both knowledge and policy-making. Another attraction of the model is its recognition of not only actors but also activities taking place. Further, the model acknowledges not only the construction industry in a traditional sense – namely contractors and consultants – but it also includes the manufacturing industry delivering most of its output to the construction industry. In adopting this view, Gann & Salter (2000) are setting themselves alongside the resource area policy analyses conducted by the Danish Agency of Enterprise (Erhvervsfremme Styrelsen 1993 & 2000) inspired by the work of Porter (1990).

The weaknesses of this approach are twofold. First, couplings between the individual elements are primarily framed in terms of knowledge flows. Thus, issues of power as well as the mechanisms through which the interaction takes place are less well-developed. Second, the model squeezes together clients, owners and users into one group. As pointed out by Haugbølle & Forman (2006), these actors are not necessarily one but may rather be seen either individually or as multi-centred users. In many respects the roles of users and owners/clients are operating in the context of a property market, and not a construction market. Add to this the importance of insurance, finance and real estate agents, then an elaboration of the consumption would be needed.

Construction business system

In a previous editorial, Winch (2000) developed an overall conceptual framework for understanding construction business systems. Based on Winch & Campagnac (1995), Winch (2000: 90-91) argued that although the organisation of construction projects varies considerably from one project to another within a single country, nationally distinctive patterns in the organisation of those projects can be identified and summarized in the following terms:

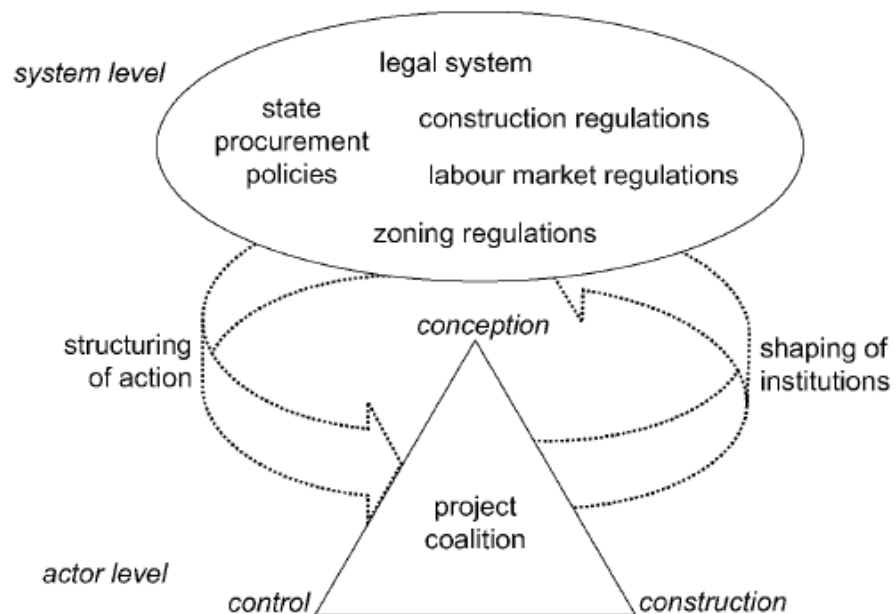
- Conception refers to the organisation of the process of design on behalf of the client.
- Construction refers to the organisation of the process of execution on behalf of the client.
- Control refers to the organisation of third party actors ensuring that the client's requirements are met.

Failing to distinguish clearly between the institutional level and the governance level of national business systems, he later revised the conceptual framework (Winch 2002: 390-391, original emphasis):

'At the system level are all the elements of the regulatory context of construction project management discussed in the earlier Editorial. This regulatory context structures the range of actions that participants on projects can take — while certain actions are standard practice, others are excluded from the business recipe. In turn, practice on projects at the actor level shapes the institutions of the regulatory context, pushing them to allow the actors on the project to innovate and deliver value for clients more effectively. The regulatory context thereby provides both constraints and opportunities. This is shown in Figure 1, which lays a system or institutional level over the actor level of the 3Cs from Figure 1 of Winch (2000).

The relationships between the actors in the system can be seen as one of competitive collaboration. They must all collaborate together in coalitions on particular projects mobilized by clients in order to achieve their aim as firms of staying in business; at the same time they compete with each other for influence at the system as a whole. These types of dynamics are found in a number of industrial sectors that rely on highly skilled professionals.'

Figure 3. National construction business systems: a conceptual framework. Source: Winch (2002)



In this revised version of the construction business system (see Figure 3), Winch (2002) has included both a system level focusing on policy-making and an actor level focusing on the construction project. However, the analytical framework does not include knowledge institutions except indirectly through their contributions to construction regulation etc. Further, the interaction between the actor level and the system level is only characterised in the very broadest terms as 'structuring of action' and 'shaping of institutions'. Finally, the analytical framework tends to focus too narrowly on the production chain of value, reducing the input and pull from consumption to a marginal role. Thus, issues of use, finance, insurance and sale (real estate agents) can hardly be contained within this analytical understanding of construction business systems.

Construction economic sector system approach

In 2004, the CIB Working Commissions W055 on 'Building Economics' and W065 on 'Organisation and Management of Construction' issued a report describing a new approach to studying the construction industry. Carussus

(eds. 2004: 10, original emphasis) defines the construction economic sector system as follows:

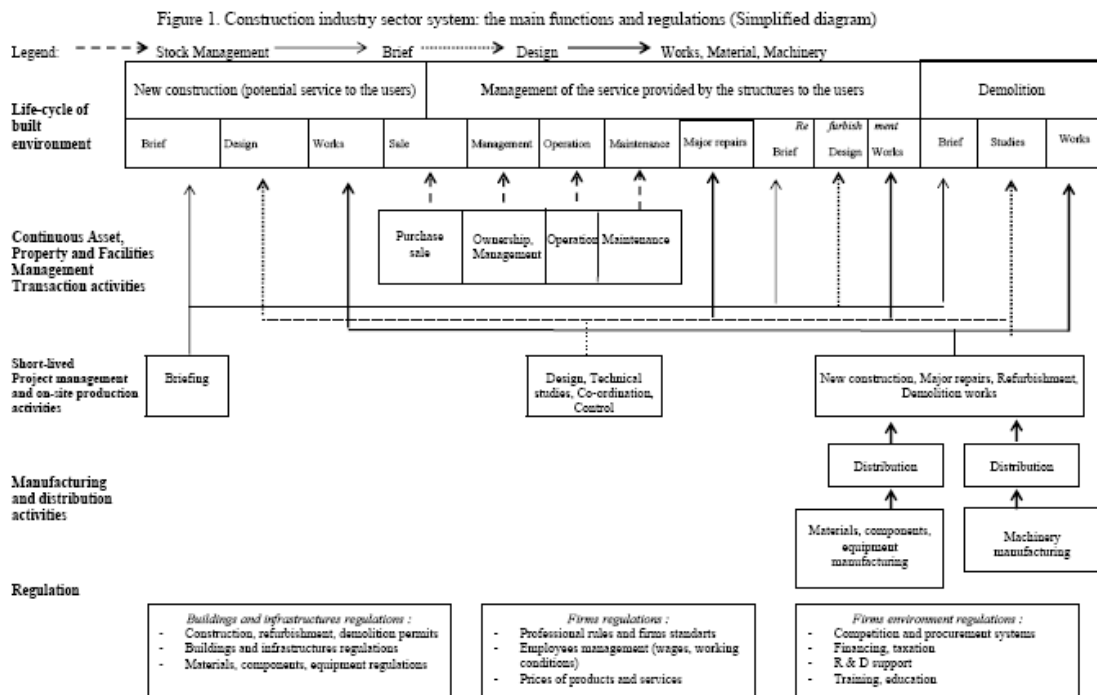
The construction economic sector system can be defined as *the organised complex of commercial and non-commercial relationships, between productive and institutional actors, taking part in the production and the management of services provided by the structures used, throughout their life cycle, as the living and working environment of a population.*'

Construction is defined to consist of three main groups of activities:

- The first group of activities concerns the continuous management of the existing stock of structures.
- The second group of activities concerns the short-lived design and complex production assembly on itinerant sites.
- The third group of activities is focused around the industrial production and distribution of materials, components, equipment and plant implemented, assembled, installed by construction firms on worksites.

Below, Figure 4 gives an overview of the construction industry sector system.

Figure 4. Construction industry sector system.



Source: Carussus (eds. 2004: 13).

According to Carussus (eds. 2004: 190):

'This new approach takes into account the "tertiarisation" of the economy. It takes into consideration the recent development of Public Private Partnership and Facilities management. It is clearly focused on the service provided by buildings and infrastructures to the users. It highlights the new part of construction in the economy: to build and to manage built facilities to provide services for an efficient and sustainable economy. It underlines the end of the boundaries between construction, manufacturing and services. Companies and government are asking for a package of a better service, coming from buildings and infrastructures, services activities and industrial utilities.'

The testing of the approach in nine countries has clearly illustrated its strength by highlighting differences related to institutional contexts, clients'

procurement and actors. Further, the approach has identified significant similarities about the emergence of services, the decreasing of construction industry weight, the heaviness of the construction sector system, the significance of the stock and of its maintenance, and the coexistence of big companies with a very fragmented system.

Although, the approach emphasises the emergence of servicesation the analytical focus is more on the production of these services than the consumption of these services or the emergence of the need for them. Despite the strengths of the approach, the deep rooting of it in an economic or business perspective blurs its analytical capacity to understand consumption when it comes to users and their use of the built environment.

Framing consumption of the built environment

While the different theories and concepts described above include consumption to various extents, there does seem to be a need to include use and users more explicitly in the analysis. Thus, we will turn our attention towards more consumption-oriented approaches in the following.

In the study we use three main strains of theoretical perspectives on users, which contribute to a better understanding of the user as a driver for change:

- *Construction procurement* dealing with issues related to e.g. theoretical foundations; development and privatisation; the role of culture: trust and institutions; procurement systems: classification and choice; contractual arrangements and forms of contract; procurement: culture and conflict; environmental sustainability and procurement (see e.g. Rowlinson & McDermott eds. 1999).
- *Innovation management* dealing with issues related to the nature of innovations, drivers of innovation, innovation process and innovation systems. Within the demand-pull model, von Hippel (1986) has been highly influential in showing the importance of lead users in the development of new technologies.
- *Science and technology studies (STS)* that emphasise the mutual shaping of users and technologies. The point of departure is that technical objects and social relations are bound together and that actors and technology are co-constructed (see e.g. Bijker, Hughes & Pinch eds. 1987; Bijker & Law eds. 1992 & Oudshoorn & Pinch eds. 2003). Focus is on how users and technologies interact. Thus, the field of STS is dealing with the issue of 'agency', that is the dualism of actors and structures in relation to the roles of users, clients and stakeholders.

Consequently, the analysis will draw on a combination of insights from these three specialised fields of inquiry. More specifically, the analysis will draw on a combination of innovation theories dealing with the role of users most notably the concept of lead users, various constructivist approaches on the co-construction of users and technologies, and the role of clients in changing the construction industry as dealt with by the CIB Task Group 58 and the literature on construction procurement.

Construction procurement: the role of the client

For the past 20 years or so, the Working Commission W092 on Procurement Systems within the International Council for Research and Innovation in Building and Construction (CIB) has discussed the issue of construction procurement. The focus of W092 has largely been on the proper design of procurement systems so as to ensure the best performance of the building. In 1999, the present coordinators of W092 (Rowlinson & McDermott eds. 1999) edited a thorough overview of procurement systems. First, the collection describes the background of W092 and introduces the key issues, which have emerged over time like procurement strategies and systems, contractual arrangements, forms of contract and the nature of the construction

process. The second part deals with organisational issues of procurement systems with a focus on e.g. the client organisation, strategic briefing, value management, organisational design and project success factors and organisational learning. In the third section, emergent issues in procurement systems are approached like the importance of culture, sustainability and the use of new web-based technologies. Finally, the anthology deals with procurement systems in practice in relation to partnering as well as methods and criteria for evaluating and selecting contractors.

While W092 has largely focused on the proper design of procurement systems so as to ensure the best performance of the building, attention has increasingly been turned towards using procurement to stimulate innovation for example as an element in a public demand-oriented innovation policy (see e.g. Edler & Georghiou 2007). Manseau & Seaden (eds. 2001) sampled an international collection of papers and studies from CIB Task Group 35 focusing on how public policies can stimulate and support innovation in construction. Most notable internationally is the establishment of the CIB Task Group 58 on client and construction innovation and the 'clients driving construction innovation' conferences in Australia (see e.g. Brown et al. 2005 & 2006). Despite the quality of the individual papers, most of the contributions tend to focus on the subject matter e.g. information and communication technologies, sustainability or performance assessment rather than discussing the concept of the client and how clients act as change agents.

Behind the strategy of client as change agent, lies the belief that the client through the choice of procurement methods, targeted goal setting, acting as a lead user etc. can have a decisive impact on the products and services from the building industry on behalf of the owner/end-user.

However, the client as change agent requires a closer definition of the role of the client. It is clear that construction projects – whether procured through traditional systems or through long-term 'service contracts' – have to meet the needs of stakeholders and in particular the needs of users and clients as expressed by the representatives of users and owners.

In Sweden, the Swedish Association of Construction Clients has been highly engaged in developing projects and programmes to gain experiences with the client as a change agent. In 1997, the Swedish Academy of Engineering Science in collaboration with leading building owners and clients published a highly influential study on organisational competences for clients. The report (IVA 1997) suggests that the client must maintain a broad spectrum of competences in order to manage planning, execution and operation of a building. The report (IVA 1997) goes on to identify the competences needed by a client in order to handle the relationship with the owner, the customer, society and the building sector.

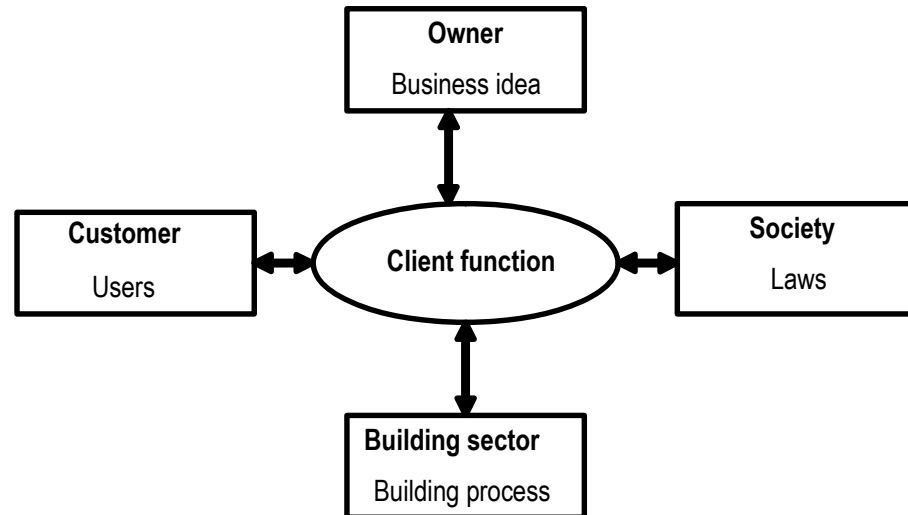
According to the Swedish regulatory code for construction (the Planning and Building Act or PBL) the construction client is 'the person carrying out or having carried out building, construction, demolition or other site works, on his own account'. The Swedish Construction Clients Forum has expanded this to include a wider range of responsibilities, thus 'The construction client is also the person who interprets and translates the needs, expectations and desires of the end-user into requirements and conditions for building and construction projects'.

According to the Swedish Academy of Engineering Science, the client must maintain a broad spectrum of competences in order to manage planning, execution and operation of a building. The client role is defined through its relationship between supply chain (production) and the various stakeholders who have an interest in the final output whether this is a building or a network. These include the potential owner, the occupiers and the users as well as society in general. The client has the responsibility to identify requirements in particular those of the users, communicate these to the potential suppliers and selecting appropriate procurement framework. During the process it is the client responsibility to interact with supply side and stake-

holders when necessary and finally take deliverable of the completed project, oversees its commissioning and its acceptance by users, and arranges for evaluations of performance in order to inform future projects.

Thus, focus must be on the client's ability to handle the relationship with all stakeholders of the building, be it the owner, the customer, society or the building industry (see Figure 5). As the interface between users and supply side, the clients have a central role in developing the construction sector in to a demand-driven sector and providing a better user/client satisfaction.

Figure 5. The client's relations to the stakeholders



Innovation management: lead users

According to Dodgson, Gann & Salter (2002), the literature on innovation management has dealt with four questions. First, researchers have analysed the nature of innovation activities by asking questions on whether innovations are radical/incremental, continuous/discontinuous, has transience in its effects on existing ways of doing things, changes over life-cycles, are modular/architectural (systemic), results in dominant designs, or is sustaining/disruptive. Second, other approaches consider the sources of innovation which can broadly be grouped in the science-push model, the demand-pull model, and the coupling model. Third, approaches related to analysis of the innovation process include the chain-linked model, the innovation journey, and various innovation management approaches focusing on organisational integration, technology strategies and knowledge management. Fourth, approaches concerned with innovation systems has focused on systems of innovation on a national, regional, sector and technological level, analyses of networks to which firms belong, and the integration of complex product systems.

Within the demand-pull model, von Hippel (1986) has been highly influential in showing the importance of users in the development of new technologies. Von Hippel (1986: 791) has in particular introduced the concept of lead users:

'Accurate marketing research depends on accurate user judgments regarding their needs. However, for very novel products or in product categories characterized by rapid change – such as "high technology" products – most potential users will not have the real-world experience needed to problem solve and provide accurate data to inquiring market researchers. In this paper I explore the problem and propose a solution: Marketing research analyses which focus on what I term the "lead users" of a product or process.

Lead users are users whose present strong needs will become general in a marketplace months or years in the future. Since lead users are familiar with conditions which lie in the future for most others, they can serve as a need-forecasting laboratory for marketing research. Moreover, since lead users often attempt to fill the need they experience, they can provide new product concept and design data as well.

In this paper I explore how lead users can be systematically identified, and how lead user perceptions and preferences can be incorporated into industrial and consumer marketing research analyses of emerging needs for new products, processes and services.'

Another important concept introduced by von Hippel & Katz (2002) is toolkits for user-centred innovation. Von Hippel & Katz (2002) stress that traditional product development, where manufacturers first uncover users' needs and then develop responsive products, is insufficient, because the users needs change rapidly. By using toolkits the manufacturers have given up the idea, that they can understand the users need in detail. To illustrate the toolkits they use the pizza as an example, where many aspects of the design such as the dough and the sauce have been made standard, and the user choice has been restricted to the single task of designing the topping. Von Hippel & Katz (2002) found that toolkits for user innovation are applicable to essentially all types of products and services with many different user demands. Von Hippel & Katz (2002) stress some conditions that influence the use of the toolkit: It is important that the toolkit is designed in a way that leaves room for "learning by doing via trial and error", there has to be an appropriate "solution space", the toolkit should be "user-friendly", there may be module libraries, and lastly there may be a problem in translating user designs into production specifications, because of difference in language, context, elements etc. so the toolkits have to be convertible between user and production.

Franke & Shah (2003) has studied how user-innovators outside firms obtain innovation-related resources and assistance to develop their ideas and how they share and diffuse the resulting innovations. Based on studies of individuals belonging to voluntary special-interest communities like windsurfers, Franke & Shah (2003: 157) states that:

We find that these individuals often prototype novel sports-related products and that they receive assistance in developing their innovations from fellow community members. We find that innovation-related information and assistance, as well as the innovations themselves, are freely shared within these communities.

In a similar vein, Jeppesen & Molin (2004) has studied how the development of online computer games relies on an external consumer community for innovation. Jeppesen & Molin (2004) suggest that learning and innovation efforts from which a firm may benefit need not necessarily be located within the organisation, but may well reside in the consumer environment. Based on an explorative case study, Jeppesen & Molin (2004: 363) shows:

'...that consumer innovation can be structured, motivated, and partly organised by a commercial firm that organises the infrastructure for consumers' interactive learning in a public online domain.'

The theoretical contribution of innovation management, in particular the concept of lead users, is the emphasis on change and the role certain groups of users may play. However, the emphasis on lead users somewhat eschew the focus from users and use situations in general. Important questions like how do users generally adopt innovations and why do some users reject an innovation is not adequately addressed. A second contribution is the strong analytical focus on the processes taking place at the micro level of firms and

users. But this micro level approach does not in any significant way include a systemic perspective, thus structural issues are largely left at the margins with an inherent risk of ending up in a rather voluntaristic perspective on the role of users in innovation. Thirdly, the approach has been applied in industry in general, and not in construction or similar project-based service-enhanced firms. The adequateness in relation to this type of business still remains to be fully tested.

Agency and structure: mutual shaping of clients/users and technologies

Since the 1980s it has been argued within science and technology studies (STS), that technology is socially shaped and designed. The point of departure in STS is that technical objects and social relations are bound together and that actors and technology are co-constructed. The distinction between the social and the technical is not given beforehand, but is the result of a mutual shaping process (Bijker et al. 1987; Bijker & Law eds. 1992). Various sociologists and historians of technology have put the image of a modern society created and built by experts, scientist and engineers under pressure. By emphasising the developments in daily life and the use of new products, the users have been made visible as co-constructors of the modern technology society. In the following some of the different perspectives of the role of the users are described.

Based on a collection of papers from various theoretical starting points, Oudshoorn & Pinch (eds. 2003) attempt to bridge various approaches to the co-construction of users and technology. The approaches on the studies can be grouped in four:

- The SCOT approach focusing on users as agents of technological change.
- Feminist approaches focusing on diversity and power.
- Semiotic approaches to users focusing on configuration and script.
- Cultural and media studies focusing on consumption and domestication.

Pinch & Bijker (1984) were some of the first to include the users in technology development by introducing the concepts of interpretative flexibility and relevant social groups in their SCOT approach. In the now classical study of the birth of the bicycle, Pinch & Bijker (1984) illustrate how other perspectives and groups than engineers, designers and scientists enter into the design process by defining problems and develop solutions interpreted through respective technological frames of the groups. The technological frame guides thinking and interaction within and between the different relevant social groups.

Feminist approaches have played a leading role in drawing attention to users and use rather than on engineers and design. Cowan's (1987: 263) work on the 'consumption junction' as *'the place and time at which the consumer makes choices between competing technologies'* has been seminal in drawing attention to understanding the unintended consequences of technologies for users, in particular women. According to Oudshoorn & Pinch (eds. 2003), feminist approaches have been instrumental in addressing issues of the diversity of users and the power relations between users and other actors in socio-technical change. Addressing not the use but rather the non-use of technologies, Wyatt (2003) in her study of the internet develops a taxonomy of four types of non-users: 'resistors', 'rejectors', 'the excluded' and 'the expelled'.

The semiotic approaches to users focus on two concepts: configuration and script. The concept of configuration was introduced by Woolgar (1991: 59) as the process of *'defining the identity of putative users, and setting constraints upon their likely future actions'*. According to Oudshoorn & Pinch (eds. 2003: 8), the inherent focus on the designers' conception of the user and its locus in the design/test phases has called for criticism. This in turn has led to an extended approach to the relations between designers and us-

ers. Another important concept is 'script' inspired by the term manuscript from the movie industry. The concept was introduced by the actor-network theorist Akrich (1992) to describe the obduracy of objects. To avoid falling into the same trap as Woolgar (1991), Akrich (1992: 207) explicitly addresses the agency of users and emphasises the dualism between objects and subjects in order to conceptualise both designers and users as active agents of socio-technical change.

Lastly, cultural and media studies have highlighted consumption and domestication as key concepts to understand the role of users and consumers in socio-technical development. The point of departure is the dynamics of the world of users and consumption, rather than the designers, because technologies must be culturally appropriated in order to become functional. According to Oudshoorn & Pinch (eds. 2003: 13-14):

Cultural and media studies thus articulate a perspective on user-technology relations that emphasizes the role of technological objects in creating and shaping social identities, social life, and culture at large.'

Another important concept is 'domestication' to describe how objects become integrated in daily life. Domestication involves symbolic work to create symbolic meaning of objects, practical work to integrate objects in daily life and cognitive work to learn about the artefacts. Domestication involves four processes (Oudshoorn & Pinch (eds.) 2003: 14 referring Silverstone et al. 1992):

- Appropriation is when a product or service is acquired by a household or individual.
- Objectification is the process of display, which reveals norms and principles of the household.
- Incorporation is when objects are used in and incorporated into daily routines.
- Conversion describes the processes in which the use of objects shape the relationship between users and people outside the household.

In their summary of the approaches and studies, Oudshoorn & Pinch (eds. 2003) identifies three main conclusions. First, the collection of papers addresses the active role of users as well as resistance and non-use in shaping socio-technical change. Second, focus is on the multiple collectives like advocacy groups and experts who attempt to speak on behalf of the users and the ways in which they represent the diversity of users. Third, focus is turned towards the multiple locations where the configuring of users in the development of technology is taking place. These locations include the design phase of a new technology, testing by clinical trials of drugs and the mediation process between production and consumption, in which mutual articulation and alignment of product characteristics and user requirements is taking place. In sum, although the collection of papers show the creative agency of users in shaping socio-technical change, the studies also show how agency is constrained by government regulations, gender relations etc.

In a previous paper on industrialised detached house building, Haugbølle & Forman (2006) has shown just how relevant this perspective is for a renewed understanding of the role of the client/user/owner/facility manager etc. as multi-centred. That is, users of detached houses hold multiple perspectives or focal points which are time-dependent in two ways since they are coupled to the life-cycle of the building as well as the life-cycle of the actor. Further, the different positions will interact with each other.

Hopefully, the strengths of the approaches presented above are evident. An explicit focus on users and the context of use or consumption add significantly to our understanding of how the built environment is being constructed. In various ways, the different approaches struggle with the dualisms of actors/structures and objects/subjects. Although the approaches and

studies may in various ways inform an analysis on the users' role in industrialisation in construction, it is also apparent that the bulk of studies do not explicitly address construction or the built environment.

Research design: Case studies

Different institutional contexts

This study involves case studies from three different countries: Denmark, Sweden and France. Although a number of similarities exist between the countries, there are also a number of important differences in institutional contexts. Previous studies of the institutional context (see e.g. Manseau & Seaden 2001; Winch 2000 & Carussus eds. 2004) have identified five main institutional contexts:

- The '*anglo-saxon*' context of UK, Canada and Australia is characterised by a reliance on liberal market values, relatively weak state regulation, reliance on the stock market for industrial finance and relatively low levels of worker protection.
- The '*social-democrat*' context of Denmark and Sweden is characterised by the reliance on tripartite agreements between state-employers-unions, the reliance on strong labour unions and high levels of worker protection and relatively strong state regulation and financing.
- The '*corporatist*' context of Germany and Japan with negotiated coordination between the 'social partners' of commerce and government, greater willingness to intervene in the market to protect social values, greater reliance on banks for industrial finance and relatively high levels of worker protection.
- The '*public*' institutional context of France and Portugal is characterised by a significant role of the government in coordinating and financing the economy and a relatively high protection of worker condition.
- The '*transitional*' institutional context of the Eastern European countries like Lithuania, where the economy is transcending from a planned economy to a market economy. Public firms are massively privatised and a new public regulation has to be set up.

In spite of marked differences among the five institutional contexts, the significance of the government regulation in the construction sector system is a common characteristic. Regarding international regulation, the European Union countries are very different compared with other countries. The European Union role in regulating construction sector system is increasing. This role is especially important when it concerns materials regulation, competition and procurement systems, financing and R & D (Carussus eds. 2004).

Although the construction sector system functions are the same in the studied countries, the actors performing those functions may be different. For instance, general contracting has been the dominant business system in UK since the beginning of the 19th century (Winch, 2000b), while separated trades contracting are common on the European continent. Certain professions like quantity surveyors only exist in the anglo-saxon countries. Similar, the French 'Bureaux de contrôle' are private building controllers, but usually public entities in other countries. In Denmark, Sweden and Germany cooperatives for building and managing built facilities are strong, but they are weak or absent in many other countries. Even when an actor has the same name in the different countries, his/her role may be different. The role of the architect is stronger in UK, Germany and Denmark than in France or Sweden (Haugbølle 2002; Carussus eds. 2004).

Selection of cases

This research is based on a case study design. Case studies are relevant in situations where there is a need for exploring phenomena as they appear in reality. The case study is a research method where we go in depth with a single or few cases, and draw out the specifics, which can have a more general character and interest. By choosing the case method, the choice of case becomes an important methodological question. Flyvbjerg (1991) defines different strategies to select cases:

- The paradigmatic case is chosen when the wish is to have cases work as a metaphor or establish a new way of dealing with issues relevant to this study.
- Extreme and deviant cases are cases where you look for extreme or deviant characteristics for example the specifically problematic or the specifically successful.
- A critical case concerns a superior aspect and makes it possible to generalise within this superior aspect.
- Maximal variation cases are cases where we involve various different cases to examine the problem and where the cases are different concerning one or more dimensions.

These methodological strategies cannot be considered as separate strategies, but can be used to specify limits and possible generalised conclusions on the cases included. The last strategy of maximum variation cases is the most relevant methodological strategy to this particular study overall. But each of the case studies may inhibit characteristics that make each of them paradigmatic. The cases have been selected to reflect differences in:

- Construction business systems: France as an example of an industry-driven system versus Denmark as a profession-driven system.
- Business models: Production-oriented business models versus service-oriented business models.
- Product scales: Complete buildings versus system components.
- Types of users: The users defined broadly can be professional and non-professional users in both the construction phase and use phase.
- The innovation process: Open versus closed systems.

Data collection

It is characteristic for case studies that they make use of many diverse sources of information: interviews with key persons, documentary material, site observations etc. Consequently, the project team developed a common guideline to ensure the collection of data on a number of selected common issues to make comparisons and cross-cutting analysis possible.

Each case was analysed regarding its own national context. The different phases of the analysis are described below. Themes/questions are not exhaustive.

Theme 1: Context.

- Organisation of the industry in the country (based on the article written by Gann and Salter (2000: 960):
 - Regulatory and institutional framework (characteristics of the procurement process, technical, economic, environmental and social regulation).
 - Supply network (manufacturing firms).
 - Project-based firms (description of the dominant construction modes, role and place of the architect, the enterprises, and the clients...).
 - Technical support infrastructure (education and R&D institutes, industry and professional associations).
- What is the relationship between these actors within the national construction business system?

- Level of standardisation/industrialisation: How important is the industrialisation in the construction process in the country?

Theme 2: Criteria/reasons for choosing the case:

- How innovative is the case? From what perspective? Nature of the innovations introduced during the case: Organisational, product, process, and/or marketing innovations? What are the major breakthroughs in this case? Technological, organisational, financial?
- Type of building concerned: new or existing (in case of existing buildings: extensive refurbishment, small improvement of building...), type of use etc.
- Level of standardisation/industrialisation in the case.
- Who are the users in the case?
- What are the roles of the users? What are their competences?

Theme 3: Characteristics of the innovation process:

- The history and the context of the project.
- What are the sources of innovation (R&D institutes, manufacturers, contractors, users...)? Which actors are driving the process (architect, suppliers, builders, clients, users, owners...)?
- What are the motivations of these actors: commercial incentives, philosophical approach?
- Who benefits from the innovation?
- Are the conditions appropriate / inappropriate? Is the innovation protected by patent, trade secrets, copyrights etc.? What is the degree of replication by competitors?
- What actors finance the process?
- Relationships between supply network, project-based firms, technical support infrastructure, regulatory and institutional framework during this innovation process.
- Was it necessary to train employees, to develop new competencies/new techniques to ensure proper construction? Which kind of training? Which competences were used and developed by the actors during the innovative case?
- Cost of the industrialised and innovative approach. Is there any way to reduce these costs?
- Difficulties during implementation (regulation, lack of financial resources, cultural inertia...)?

Theme 4: Effects on the construction business system:

- Impact on the supply network, project-based firms, technical support infrastructures, regulatory and institutional framework.
- Impact of the know how of the actors involved during the innovative case.
- Evolution of the construction process (at the level of the innovative firm/the industry).
- Perception of end-user (thermal comfort, indoor air quality, acoustics...).
- Evaluation of the performance of the project: success or failure – why? Different points of view: clients, users, contractors, manufacturers... points of view.
- Major constraints? Cost, training of practitioners, lack of competences, change of traditional pattern...

Theme 5: Implications:

- The extent of learning from the project:
 - Learning per category of actors.
 - Learning per country on several cases.
 - Learning at the level of the “TRANS-USERS project”.

BoKlok: User-involvement in industrialised construction

By Kresten Storgaard

Reasons for choosing the case

Background

BoKlok is a concept developed by IKEA and Skanska in the mid-1990s. The aim was to provide low budget housing. Both companies identified a market for new and affordable housing in Sweden. Based on user involvement and analysis of users, houses for prefabrication was designed and produced (see Figure 6). The first apartment buildings were built in Sweden in 1997. Since then the concept has been exported to the other Nordic countries (in 2002 – 2003) and the United Kingdom (2006/2007).

Figure 6. BoKlok in Hillerød, Denmark.



Source: <http://www.boklok.com/Danmark/Om-BoKlok/>

Skanska is a Scandinavian-based contractor, and a major driver not only in the Scandinavian region, but with 54.000 employees in Europe, USA and Latin America and an annual turnover of 13.6 billion euros, it is one of the world-leading firms in construction. Skanska Boligudvikling Norden (Skanska Residential Development Nordic) is one of 14 companies in Skanska with

expertise in developing projects in housing e.g. apartments, one family houses and terraced houses. The annual production is about 4.200 new houses and apartments. The company has about 400 employees. In the Danish section there are 50 employees, and the turnover in 2006 was 57.9 million euros.

IKEA is developing and selling home furnishing based on a Scandinavian design of functionality and simplicity in solutions and in production. The market segment consists of families with children, low to middle income (Scandinavian level), and limited space for living. The company was founded in 1943 by Ingvar Kamprad. Since then it has expanded to be a major driver in Scandinavia and other places of the world with 118.000 employees in 44 countries (80 % in retail, 10 % in production and 10 % in purchase etc.). An annual turnover of more than 19 billion euros (2006/2007). Major markets are Germany (16 %), USA (10 %), UK (9 %), France (9 %) and Sweden (7 %). Major purchase takes place in China (22 %), Poland (16 %), Italy (8 %), Sweden (6 %) and Germany (6 %). In Denmark, IKEA has 1.100 employees and a turnover of 281 million euros.

Data collection

The case is based on written material, especially on the web, and on interviews at Skanska, Ballerup, February 2008, with:

- Ewa Magnusson, BoKlok AB, Malmø (head of marketing).
- Line Røtting, Skanska Bolig AS (head of project development).
- Elise Roed Rasmussen, BoKlok (project developer).
- Interviewer: Kresten Storgaard.

Innovation

The innovations cover several dimensions.

New process: The homes have been designed around factory processes that enable them to be far more efficiently constructed in quality-controlled conditions than would be possible through traditional site based construction. They are constructed from timber frames and come with a host of standard features, including extra high ceilings and large windows for a light and airy feeling, laminated wood flooring, IKEA kitchens and huge balconies to upper floor flats. The buildings are transported in 3D to the site, where assembling and finishing takes place.

New product and service: Houses are standardised, but the households will have time with one of IKEA's interior designers, as well as two hours help from a handyman.

Marketing innovation: Households with incomes of DKK 150.000 to DKK 350.000 (20.000 to 47.000 euros) per annum are the target group. The price policy in Sweden and Denmark is that the target group should afford the dwellings. The smallest apartment should be affordable for a single mother on median income, with one child, 3 years old. In UK, BoKlok has fixed the income span for the target group. This is seen as a new low income segment for a market for house or flats owners in the Scandinavian countries. Normally in urban areas this segment is tied to rented housing, private or social. In order to support the low price concept, the group looks for sites away from city centres, but with good access to communications and services.

New organisation: IKEA and Skanska established a strategic collaboration, which developed into a joint-venture company, BoKlok, which holds the intellectual property rights to the concept. BoKlok enters into licence agreements for the development of properties in various countries. In Denmark Skanska Bolig has the license.

Involvement and interaction with the customer: The product development is based on customer research. BoKlok checks how people want to live before developing a new product. User involvement continues during the process from information, selling and buying to the time when the households

have taken up residence. The Internet plays an increasing role in this process.

Evaluation and learning across the value chain: After each project the users participate in an evaluation of the process and the building. Also information from the pre-site production in a factory is brought in. Improvements of the buildings/ concept are based upon these flows of information.

Industrialisation

Production

BoKlok is based on prefabricated buildings, with a high degree of industrialisation in the process. About 80 % of the building process takes place on an enterprise in Gullringen in Småland (Sweden). The enterprise is a self dependent firm, but belonging to the Skanska Group. It has 70 employees and has a production of 2.5 apartments a day.

The building is transported in modules (3D) to the site, where assembling take place. To raise effectiveness and productivity and to lower the defect rate the same teams are on the job.

The process of user interaction

Also the involvement of users does follow a semi-standardised process, as does the take up of the information for further development of the product and the process. This allows both cost-effectiveness as well as a certain degree of flexibility in the deliveries. A high degree of standardisation is also achieved in the phases of launching, selling and delivery of the product.

Connection of the case with the theoretical elements of the TRANS-USERS project

The BoKlok case matches the aim of the 'TRANS-USERS' research project both concerning industrialisation and user involvement. Most parts in the buildings are prefabricated, so the degree of industrialisation is high. The house was designed and tested through massive involvement of users. Experiences from users and the process of production, marketing and selling are taken in as a process of bettering the processes and the product. This implies possibilities of adaption to current and future needs and lifestyles of the customers. This was the situation in the Danish case, where Danish users were involved in collaboration with designers (architects). The case also illustrates a strategic collaboration between firms in two sectors – construction and furnishing – in itself an innovation in itself.

The BoKlok case is a good example of prefabricated housing based on user-involvement. The needs of the users were integrated at the design stage. An evaluation based on examination of the household takes place after each project and lessons are used to better the process and the product to BoKlok and to Skanska. Households may furnish their houses with the help of IKEA's interior designers and this gives information for a process of bettering the services and products to IKEA.

The case also represents a widening of the understanding of the process of industrialisation. First of all industrialisation refers to the process of prefabrication off site. But secondly the case demonstrates that the idea of benefit connected to the process of industrialisation can be widened to other processes between the design phase and the taken-into-use phase. This implies a standardisation or routinisation of the interaction with the end-user through feedback information about the users' experiences of advantages and drawbacks in the process of interaction with the BoKlok firm – and with the use of and living in the dwelling. This includes information and marketing, sale, furnishing, as well as the failure and benefits of the dwelling and the building complex.

The users involved represent first of all everyday-users. But experiences from the whole delivery chain are collected and used for bettering of the

product and process, including marketing and selling. In this manner the case represent a widening of the understanding of who the users are.

Last but not least, the case provides information about the development in the contact between the firm – BoKlok – and the dwellers. This contact may be more and more dominated by the electronic media, first of all the web. The way the digital media is used does not only inform about the product, but invite to a collaborative relationship between dwellers and the firm. A result may be a creation of an identity of the dwellers' associated to the concept.

The innovation process

A concept is born

At a building exhibition in 1993 in Karlskrona, Sweden, IKEA had the task to furnish some of the homes. The founder of IKEA, Ingvar Kamprad, was inspired to get in a close cooperation with the building industry, to produce a 'folk-home', which allowed low-incomes groups to get affordable homes of good quality. For him the solution seemed to be industrialisation of the building process combined with intensive knowledge about user needs. It was difficult to get the building industry interested in a project, and not until 1996 did Skanska (Sweden) get involved. Together the consortium covered competences on knowledge about designing and furnishing, and of fabrication and producing and handling construction.

Through a market analysis in Sweden the consortium tried to get answers on three fundamental questions: who where the consumer segment, how much could they afford to pay, what was their expectations to their home? The analysis showed that users wanted low prices, did not want to live in high-rise blocks, but with access to neighbours and to green areas, a safe environment, light and airy, and the use of natural materials. Also access to schools and public transportation was rated high. But the localisation did not need to be close to urban centres.

This indicated a segment of small families or singles – younger or elderly. For example single mothers on median income but working part time (80 %). This is now changed to a concept where the single mother is working full time, but owns a car. An example would be a nurse or a teacher in kindergarten. In 1996 figures, this indicated a rent of SEK 3.000 per month, which equals SEK 6.070 at today's rate (2007) – or 650 euros.

Based on this information the IKEA team designed a compact living home for 1 to 3 people on 50 to 75 m² (note that in Sweden size in m² do not include outer walls). The result was a wing house in two storeys with 3 apartments on each floor. Access to the second storey flats was established via a balcony. The apartment block would have green areas around, an apple tree in the garden and a small separate building for storage (see Figure 7).

Figure 7. Site plan.



Source:

http://www.BoKlok.com/upload/Images/Surrounding%20areas/SE%20Sit.plan/Sitplan_Vadmalen_080117.jpg

The houses could be in a rural style with facades of timber or in an urban style with plastered facades (see Figure 8).

Figure 8. Exterior design.



Source: <http://www.BoKlok.com/Sverige/Fakta-lagenhet/Omgivande-miljo>.

The interior is a flexible open-plan solution with high ceilings and large windows giving the rooms a light, airy and contemporary feel (see Figure 9).

Figure 9. Space plan/interior design.



Source: <http://www.boklok.com/Sverige/Fakta-lagenhet/Arkitektur/>

Later on more models (terraced houses, villas) are developed based on experiences from users – both concerning the residents and the producers. Included in the price, the user got two hours consulting with IKEA experts on compact living and a cheque for SEK 3.000 for IKEA products. Also the customers have a two hours free use of a handyman.

From project to business

In 2001 the project was evaluated and it was decided to develop the project to a real business case. BoKlok was established as a private (limited) company with IKEA and Skanska owing fifty percent of the shares each.

A factory for producing the houses was established in Gullring in Sweden (in Småland). Later on collaboration with Moelven (module building) in Norway – and with a Moelven firm in Sweden – has been established and a part of the deliverances of buildings come from these firms.

In 2002 BoKlok was established in Norway. In 2003 BoKlok was established in Finland and Denmark. In 2006/2007 BoKlok entered UK. Today (February 2008) about 3.200 apartments have been sold:

- 2.500 in Sweden.
- 400 in Norway.
- 200 in Finland.
- 123 in Denmark – and further 24 are under construction.
- In UK, sale is planned to be realised in 2008.

Appropriability conditions and license

The product is sold through licensing. The license-holder has to sell the product in accordance with the concept. In a design manual these principles are described. It includes that the license keeper should be a country-wide organisation with great experiences in housing and development; access to a high capacity in production; at the least 4 sites for BoKlok projects in the pipeline; and a system for quality control.

It is not possible to prevent others from doing the same. The only answer is to perform better – in all parts and stages of the concept.

Financing

The development process was financed by IKEA and Skanska. Also the investment in BoKlok was shared by the two companies. The project is paid back through a licence agreement to national BoKlok organisations. In Denmark Skanska has a licence for Danish BoKlok activities. IKEA has none.

A new concept for development and innovation

User involvement, evaluation and learning for ongoing innovation

Before bringing the new terraced house concept on the market, the design was brought to IKEA and demonstrated and a user analysis took place. BoKlok recruited people already living in 2 storey terraced houses (100 persons in Sweden, 100 persons in Norway, and 100 persons in Denmark). The themes highlighted demands to the apartment, neighbours, the local area and environment, economy. National differences showed up. For example the size of the windows, which in Denmark was very appreciated, but seen as a source for extra work to maintain in Sweden. Focus groups have been used in all countries before starting on the market.

In Denmark two focus groups were established – one with young people and families, one with the elderly (62+). In the BoKlok project in Hilleroed, SophienborgBo, the Municipality of Hilleroed wanted 25 % of the flats for this group of citizens.

It has been developed to a standard procedure to make an evaluation after the finish of each building project. A PKI (Positive Customer Index) analysis takes place based on interviews with the residents. The focus themes include the whole process: information, sale, service and on the environment and the building.

In UK, IKEA is not such a commonly known feature as it is in the Scandinavian countries. So, more information had to be presented. The UK solutions differ in accordance with user requirements and UK traditions, e.g. a bath instead of shower cabinets.

A new concept for an ongoing innovation process has crystallised. This is a process which in nature might be interpreted as an industrialised process itself. This process of standardisation/industrialisation also includes the planning process, the sale and marketing process, facility management etc.

Contact between Boklok and dwellers: digital and face to face

The interaction between potential future dwellers and BoKlok has mainly two elements: Face-to-face and digital through the net on the BoKlok homepage. In the face-to-face interaction the IKEA scene has a special place, first of all through event-, information- and sales activities, which take place in IKEA sales stores. In Denmark, Skanska complemented this with a meeting point also at the Skanska Bolig sales store as well.

The digital meeting place is established through the BoKlok homepage. On this site the visitor gets information not only about the product – the dwellings – but also about the whole concept as well. The site contains facts about the products concerning price, the buildings and the plan, drawings, room sizes and functionalities. It also contains links to IKEA examples on furnishing. Each example is introduced by a description of an inhabitant profile in an everyday frame. Also the visitors got information about the concept and the creation of the concept through the cooperation by the two firms behind. In this way narratives become an important elements that invite the visitors to be included in or committed to the story and the concept – to being a part and an element of a story or of an ongoing process of the creation of a vision – of living and forming in the BoKlok community.

On the Danish homepages the visitors are invited to take an active part in bettering the BoKlok concept about two themes: First, which is often seen in other sites as well, about reaction and suggestions to the homepage itself. The second is more rarely seen: the visitors are invited to come with sugges-

tions about sites where BoKlok estates might be built. An important element all the while the numbers of attractive sites are limited and taken into account of the rather hesitant reaction from local authorities concerning approvals to this type of building projects.

The homepage does not take the visitors – or the dwellers – a step further towards a collaborative community, where experiences are distributed and shared, first of all by the dwellers themselves – but also between the Boklok people and the developers of IKEA, and the manufacturing staff at the Skanska Company in Gullringen.

Actually an inhabitant in one of the Danish BoKlok sites (in Måløv) has made an interactive webpage, where photos and comments from the first year in the apartment estate are distributed and shared with the other dwellers. That many of the photos are taken from above from a low-circling plane, make the site even more inciting. This step of collaborative involvement through the digital site is in the mind of the BoKlok people, and may be an action in the nearest future.

Sources of innovation and motivation of the actors

Corporate responsibility of IKEA

For IKEA it was a wish to contribute to the developing of a new market for housing for low incomes segments. This is complementary to its traditional activities (furniture, furnishing). IKEA wanted to show that the firm was ready to contribute to solving of social problems connected with low income segments, which was significant in many suburb municipalities. This was seen as an important value for the firm – and a feature one would want to offer to the municipalities. Hereby IKEA would demonstrate a corporate will to contribute to positive solutions to these municipalities, different to the way IKEA was often seen by the municipalities as a difficult planning task concerning location of their sale stores, infrastructure and regulation of the traffic generated by their success. In IKEA the process was driven by a small group of dedicated people from the department of development concerning big customers, offices, kindergarten. Also the department for PR was involved.

New market groups for Skanska

For Skanska the purpose was to extend the market so it included low – middle income segments. And to get experiences with this new form of concept – both concerning the strategic collaboration with an external firm, to the process of industrialisation based on user involvement – and to the concept of compact living.

For Skanska the project was an access to a new segment of customers in new geographical areas. In Skanska it was the department for Project Development and Construction which took part in the development process. Today it is RD Nordic (Residential Nordic), which has taken over most of the activities. RDN is working in their market area, in Sweden however, the construction part of Skanska is developing BoKlok buildings in areas outside the big cities of Malmö, Göteborg and Stockholm.

New competencies in the organisation

In the on-going development and improvement of the product and the process, people from the factory are involved, the ejectors as well as marketing and sales functions. In the development process, stakeholders from IKEA and Skanska were the main drivers. The factory was involved as well, as was the ejectors/fitters.

There have been regular meetings about sale and marketing for all involved. All the employees working with BoKlok have to participate in introduction courses. The human dimension is very important in the concept. It is important to give the same value – or mindset – for all people involved in the project.

Cost of the industrialised and innovative approach.

There are further rooms for reducing costs. The keyword is repetition – and systematic catch up of experiences – from all phases: contact to municipalities, customers, manufacturing, erection/ fitting, sale, evaluation, knowledge sharing and learning. But it is important not to cut out the R&D process in an effort to reduce the cost of the innovation process.

Knowledge sharing

The knowledge achieved by these methods is primarily accumulated by the individual persons in BoKlok. How to secure this knowledge to be a firm knowledge is a main target for future internal discussions in BoKlok. They have developed a method for collecting the information and evaluation and to communicate with the users, but effective methods are missing for internal knowledge sharing in the firm – and between the stakeholders – the residents, the BoKlok, the Factory in Gullringen and Skanska.

Industrialisation of production

The industrialisation process is guided by a team from the factory, Skanska and BoKlok. Gullringen is only producing for Sweden. Moelven Sweden has delivered buildings for Denmark and Moelven Norway is one of the Norwegian suppliers. The erection/fitting is carried out by the same teams on each project.

Differences and flexibility in solutions

The main differences are in the exterior of the buildings. Most of the in-house solutions and materials are identical. In UK the solutions differ in some degree in accordance with customer and client traditions, and there is no tradition for involving low-income residents like in the Scandinavian countries. It is important that the variations in solutions are within limits that are in accordance with the BoKlok concept.

Further involvement of the users

BoKlok are developing the process of involvement of the users through the net. This has been done in web-based interview analysis of potential customers. And the net is seen as a means of further involvement of all stakeholders. Net based communities of BoKlok residents interchange experiences and in contact to stakeholders in BoKlok, IKEA, Skanska and the factories have great potentials.

Difficulties during implementation

Concerning the market, a main barrier has shown up to be linked to the process of acceptance and approval by the municipality authorities. The local plans are often not ready for the 'untraditional' architecture of the BoKlok building e.g. the L-shaped house, the façades, and the roofs. Often applications for exceptions to the local plans have to be done. Also many municipalities may go for high income households.

Differences in regulations between the different countries are brought in through the license-keeper and have not been a barrier. In a process of dialogue between the licence-keeper, BoKlok and the factory decisions are made about changes of the standard building. Often the BoKlok houses have higher performance than is required by building regulations in countries outside Scandinavia.

The project organisation in the construction sector may also be seen as a barrier. Traditionally one starts up more or less from scratch, every time a new project is born. The BoKlok concept is the opposite. Here one re-uses every bit – if possible. And if it is not possible to transform the "necessary" changes into the process of industrialisation, the project will stop. For the people working in a project organisation it will often be a challenge to solve all the problems showing up – not through industrialisation – but often

through clever improvisation and creativity, which presuppose a high level of professional experience, competence and skill. For these people it may not be quite so challenging to work with set solutions.

The process of finding the balance between the standard BoKlok solutions and customised versions can be very difficult and negotiations take place between the stakeholders (the local license holder, the BoKlok Company and the manufacturing firm). An operationalisation of this process might be profitable.

Experiences

Effect on Skanska and IKEA

For IKEA it is only a very small amount of the firm's yearly sales that originates from BoKlok. But IKEA uses the project for testing and development of their designs and their concept of compact living. In a way it is a kind of controlled experiment – seen in a methodological perspective. In this way it is a living lab and test-bed for a steady improvement of some of the IKEA products and concepts. Also the PR and the contact to the municipalities and the demonstration of a corporate will to take social responsibilities are important. The hesitating reactions from the municipalities might be a new issue brought in.

For Skanska the main benefits have been related to the access to a new market both concerning the customers and geographical areas. But there have also been benefits concerning the experiences with the process of industrialisation. Skanska has also got experiences with the concept of compact living. Last but not least, potentially there is good economy in the project. Skanska in Denmark joined the project, because the experiences from Sweden seemed promising, and because they want to get involved in this new segment of the market. The response from the municipality of Hilleroed resulted in a positive collaboration around the project and a successful integration of apartments for elderly people was achieved. Not least the process of systematic evaluation and learning has been a benefit for the company – in other projects as a whole. Concerning the industrialisation of the building process there has been spin-off on other projects. It has increased the focus on possibilities for using the same modules and processes in different projects. Even the experiences of contact to the municipalities, potential customers, sale and follow-ups have led to a higher degree of standardisation of these activities in the organisation. At Skanska itself, it is a challenge to catch the opportunities of the concept and provide room for it to grow within the firm. The market of the customers might be expanding, even if the municipalities are hesitant. The sales procedure is quite different from ordinary projects, where estate agents take over the sales function. At BoKlok in Denmark, most of the sales take place at special events in the IKEA store. Normally the interest has been so great that lots has to be drawn. This implies a very concentrated period of time for selling. In a present project in Denmark, some apartments have to be sold afterwards. Skanska has taken this function in-house. In the Skanska organisation the concept has led to more focus on the user/customer. For Skanska there has been a positive effect on the way the firm thinks about how to include the evaluation, the concept of the user and other stakeholders, the concept of compact living, and about the process of industrialisation.

For BoKlok the concept is central to the firm's success. The boom in the housing market has implied rising prices of materials. Long-time agreements with the materials industries are therefore wanted, especially when contracts can be entered in periods with low demand. IKEA has such arrangements: A sort of strategic cooperation with supply industries. For BoKlok it may be a

main challenge, yet not solved, to get access to local sites for building and to get positive contacts to specific municipalities. This process is complicated, and it has had the effect that in Denmark it has been difficult to maintain a continuous production process from one project to the next.

Learning and knowledge sharing

The whole process of evaluation of every project in Skanska has been influenced by the experiences gained by BoKlok. In BoKlok this includes the use of evaluation, focus groups and the subsequent process of learning and implantation.

An understanding has to be built up and acceptance for the industrialised production in the traditional Skanska group. Handling, way of problem solutions and qualifications may be different, and some of the competences that are needed in traditional construction may have to be changed to others in the industrial organisation. The mix of qualification is challenged – at several levels in the organisation.

Production and erection/fitting

In Sweden there has been a solid increase in productivity – both in the production process at the factory and on the erection/ fitter part. On the factory the productivity increased 120 % in four years. On site, rises in productivity and in transportation and delivery have taken place as well. On the site in Hilleroed in Denmark, 14 L-shaped houses were built. The two first took some time. The last houses took less than half the time.

Sales work, planning and preparation

There has been an increase in productivity of at the least 10 to 15 %. Important here is also a value creation of how to implement experiences in the development of the concept.

Defects and failure in the construction

There has been a radical decrease in failures in the built solutions. On the Hilleroed project only 7 items had to be changed when the project was delivered. Compared with normal projects this is a radical change. Normally a failure list may contain more than a two digit number of failures per apartment. The reason is partly the prefabrication process in a controlled environment, partly that the building is covered with a roof and independent of outdoor climate and weather conditions and partly that during the final weeks, there was time for repairs, if failure had happened.

Energy and waste

On site the amount of waste is very small. At the factory most waste can be recycled. The energy consumed on site was very small compared with traditional projects, e.g. when using heat-cans for drying the concrete in a non-insulated carcass.

Facility management

Facility management is to some degree built into the solutions. But there is a potential for improvements of facility management.

The market and the involvement of residents

There has been and still is a significant demand and interest in the buildings. In Denmark 150 buyers are on a list, waiting for projects to take place in their area. The evaluations show that the residents are very satisfied with the building and the whole concept. There is a world of difference between some suburban residence areas with housing estates based on industrialised buildings – and the BoKlok estates.

Perspectives and effects on the construction business system

In this part the results are seen in the perspective of potentials for innovative action and challenges to the firms and to the sector.

A challenge to the traditional supply chain

The concept has the potential to challenge the traditional chain of delivery in the construction sector. The supply side may see that more work is moved to the site for the prefabrication – and not to a demand from the local building site. Also a higher productivity may decrease the amount of work connected with every type of supply. Especially in the local areas, this might affect the demand for the local supplier's work. Therefore rather negative reactions turned up from other links in the traditional value chain in the sector when the first project in Sweden took place. Some of the suppliers reacted against the concept.

Neither the component industry nor the building materials industry has been very positive to the concept. The local materials suppliers might see a decreasing market in building projects of this sort.

Also, the estate agents are not very pleased with this development, especially if sales and re-sales are arranged through the BoKlok or IKEA organisations.

Some architects have even refused to cooperate when changes should be worked out – combining the strict frames of construction principles and the user needs. Others see it as a challenge.

These elements may be part of the reason why local authorities do not always welcome a BoKlok project in their local area.

Potentials and perspectives for construction

A market for user-based industrialised buildings?

The boom is over for now (2008) and a recession might be starting up. Then prices of buildings will be a significant competitive factor. Under these conditions the BoKlok concept might be very competitive.

In Skanska one has to assess which of the BoKlok buildings may suit a demand under these conditions. A new villa concept developed in BoKlok may be of interest. But building detached houses is a new feature in Skanska. In this market, buying a house is also an investment for the buyer. Seen as an investment it might be a problem if expectations to and possibilities for profit should be reduced by special sales conditions, reducing this element.

If parallel projects should be developed – e.g. extra super inexpensive flat – or a super expensive flat, one should be very aware of avoiding message mess in the communication to the different segments. There might be a market for low-cost buildings also in the municipality market for institutions, schools – and in the business sector for offices, plants etc.

The concept is also suited for export. But two issues are of significant importance: The concept has to be adjusted to the users. And if the manufacture takes place in other countries – the concept and the solutions have to be adjusted to the culture, tradition for production etc. User involvement may be crucial.

The experiences – especially from the UK case – showed that there was a lot of tacit knowledge about the IKEA concept – and of the BoKlok concept in the Scandinavian market. Knowledge, which actually was important to communicate if one wants to realize the product in other countries.

What kind of Industrialisation?

In BoKlok one has gained a lot of the necessary experiences: about the industrialised production, about the industrialisation or standardisation of a continued development of incremental innovation of the product involving all

relevant stakeholders from residents to producers, about the industrialisation of marketing, sale, PR, communication etc. One still has to better these methods. But the first steps have been taken.

In the Scandinavian market it seems that user involvement is a must – a precondition - if industrialised production is to succeed. The case also demonstrates that the process of industrialisation refers not only to the process of production and montage – but also to all other processes for sale, facility management – and – important – the ongoing process of bettering the product and the process. It is first when most of these elements are included in the process of industrialisation that benefits may evolve. It seems to be a demanding task to get all these elements to play together. The concept of industrialisation as a whole does clash with the traditional activities in a construction firm – where project-based activities will normally be dominating and occupy most employees. It will be a task to get these two parts in a constructive dialogue – or to live side by side.

Who are the users?

The case illustrates that the concept of user should cover all stakeholders in the value chain: dwellers, clients, designers, production people, fitters, constructors. In the BoKlok case even stakeholders outside this chain may have been relevant to include: planners and local politicians. Both have turned out to be rather hesitant to give local approval to projects.

How to involve the user for collaboration?

The case also indicates that user involvement might in the future be supported heavily through digital media, especially through the web. Identity, involvement and inclusion might be strengthened through a virtual set-up, especially through web-based tools, as communities and talk-boards, but also through more visualised means as second-world platforms, nD modelling and interactive avatars etc. The collaborative involvement of users might be strengthened by this means. Hereby the process of bodied collaboration in the building process between user and the building sector will change to virtual collaboration. Thus everybody has the possibility to participate and to take an active part of the finished product – not through the building process itself – but through participation in the planning process, especially in the process of information, selling, planning and furnishing. And through the participation, users can be a part of the fulfilment of a vision.

HTH: Web-based configurators of kitchens

By Peter Vogelius

Introduction

This case describes and analyses how a major Danish supplier of kitchen elements makes use of a configurator as an instrument for user driven design and innovation. The focus is on the overall relationship between innovation at the one hand and market, user preferences, technological opportunities and the context as a barrier for user involvement, on the other hand.

This case is a part of the project 'TRANS-USERS – transforming the construction sector through user-driven innovation' conducted at SBI, Danish Building Research Institute/Aalborg University in cooperation with CSTB, Centre Scientifique et Technique du Bâtiment, France, and carried out in 2007 and 2008.

Figure 10. Website.

> [Home](#) > Inspiration > [Drawing program](#)



Drawing program

Lad drømmene få frit løb!

Become a true kitchen designer...

You can use the drawing program to design your own kitchen. Give free rein to your imagination - test your ideas - and then visit your local HTH Kitchen Showroom for good advice and expert guidance.

Source: www.hth.dk

Background

HTH is a leading kitchen manufacturer in the Nordic region (which is regarded as the home market). HTH Kitchens presents itself with these figures at there website:

'Northern Europe's largest kitchen manufacturers with an annual production of more than 1 million cupboards.

HTH is represented in 11 countries and sales are run exclusively through a chain of 130 inspiring stores owned by independent franchi-

sees. HTH's three factories in Denmark employ more than 1,000 people and our franchisees employ a corresponding number of sales staff.

HTH is part of the listed Swedish Nobia Group, which is the largest kitchen manufacturer in Europe.'

It can be estimated that HTH's market share in Denmark is more than 20%. Number two is the quick growing IKEA with approximately 10 %, the rest of the market is divided between a number of minor actors, both Danish and from abroad.

HTH has competitors with a much lower degree of industrialisation. Those minor actors have different niches and brand identities. Some are importers of very fancy design brands from southern Europe or are representatives of high quality handmade systems with expensive raw materials etc. Basically HTH operate in two markets, the professional and the private.

The professional market is directed against major dwelling estates and office buildings. It consists mostly of kitchens in fixed designs, with a few standard deviations, in great quantities. The structure of the professional market is very different from private, and will not be dealt with in this case presentation.

Regarding the private customer market HTH today defines it along two axes:

- The first is directed towards the do it yourself (DIY) market.
- The second is the traditional kitchen buyer market. This divide is accordingly reflected in the structure of the company's web site¹. The two sub-markets share the same version of the product configurator, but are otherwise organised differently.

The DIY market is a fast-growing market, not only in Denmark but also in the rest of Scandinavia and in the most of Europe for that matter. Price is a strong competition factor at the DIY market. The company has a dedicated part of the web specifically for this market. The traditional kitchen buyer market is the important main market which has played a major role in decades, and still counts for most the sale in the private market.

The company's head office and major manufacturing site is situated in the small provincial town of Ølgod in Jutland. The company has had an important role for the local labour market and for the regional development as such, since the 70s. According to the company's webpage, it is concerned with social aspects of production both within the company and outside. Working environment, health and the input materials for production are checked and can be looked up the webpage.

Industrialisation

HTH is highly industrialised with regard to all aspects of production. It is already more than 10 years since all kinds of stocks were abolished, and a fully just-in-time approach was adopted (both with regard to inputs and outputs). At specified times every day trucks arrive with tons of chipboards, and on the output side, production lines practically "end" at the loading platforms with each order labelled with the address of the end-user (whether it is a big construction site or a single family dwelling). The input of manpower compared with produced volumes, has steadily been reduced. The focus of production today is closely connected to the ongoing efforts of improving quality.

The understanding and optimisation of the production has traditionally been the background for strategy decisions about the development of the com-

¹ HTH's web consultancy, see <http://www.pn1.dk/Cases.aspx?ProductID=PROD19>

pany. In the recent years this has in changed. Today the main focus is on the market; naturally this shift has also created an increased focus on buyers seen both as customers and users.

The major strategic decisions today are not primarily connected to the regime of production but to the market, and demands for innovations and user engagement. Saying this is not to argue that the production task today is an easy one, but only to stress that the core of the business seems to be bound to developments outside production.

Innovation

The web-based product generator

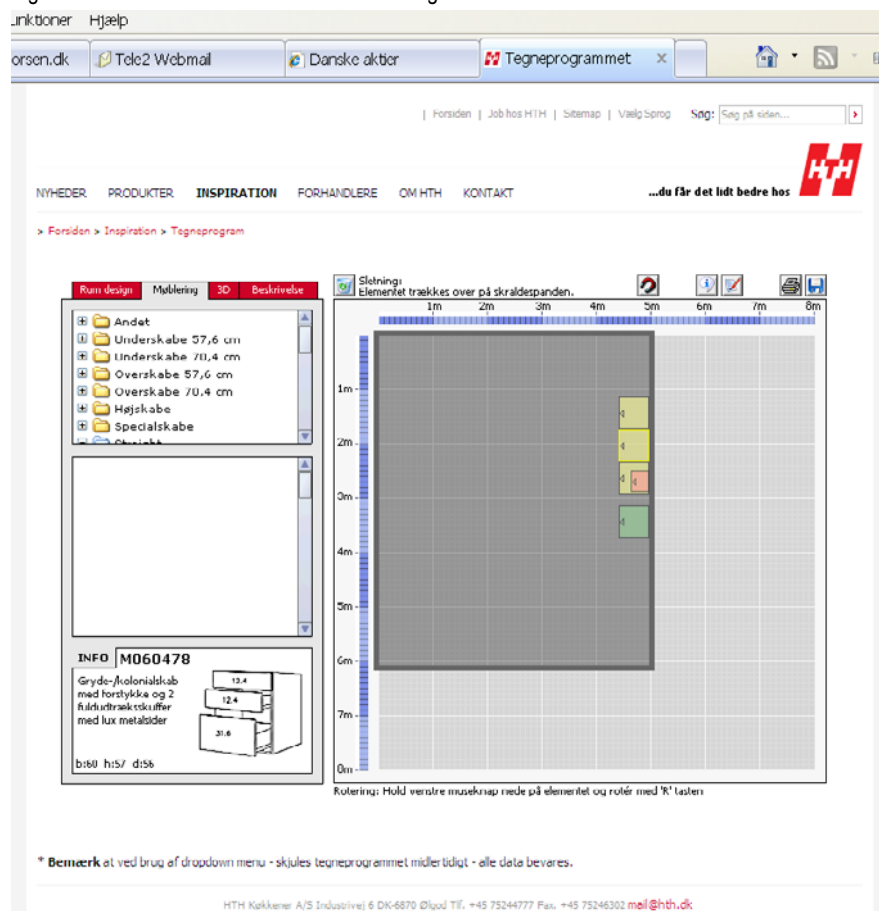
In fact the user will probably call it a drawing program. In it's originally form, it was developed as an instrument for production planning. The inspiration came from several concepts dominating the understanding of industrial production in the late 1980s and '90s. Among others we can mention TQM and BPR which were used as internal production concepts facilitated by ERP systems (SAP, Baan etc) that in combination with logistic considerations following the just-in-time concept, should ensure that the production also in the future would be competitive. Still in the late 90s the configurator was solely used in the shops by the sales men. At that time it was a rather sophisticated and complicated tool.

From an enterprise point of view, the main challenge back then, was to establish a smooth integration between the ordering function in the sales shops and the direct transfer to the production system. From a customer point of view the configurator gave a great advance when it came to discuss different design alternatives with the sales man; the discussion could take place on the basis of visions developing in front of the customer.

Today's product configurator

Regarding its functions, the contemporary configurator resembles the production-oriented predecessor, but without its precision, its ability to reflect all the separate components (thousands) and the integration with the production system. On the other hand, the system today is very easy to use, and an interested user will be able to draw his own kitchen from scratch in a couple of hours or so (an Internet connection is of course a precondition). The system can then present the kitchen vision at different angels, including 3D and with different layout etc. (see Figure 11).

Figure 11: Screen shot of HTH web-based configurator. Source: www.hth.dk.



The drawing is saved, at a server maintained by HTH. An ID number is allocated and the drawing can later be downloaded to a local PC in the shop, where it typically will be the starting point for further discussions about the exact design solution created in cooperation with the sales man.

In practise the sales man visit the customers' kitchen to discuss alternative solutions and to make exact measurements which can serve as base for the professional drawing. It is a rather time-consuming task. Calculating the final price of the total solution and making the CAD drawing can often take as long as 6 – 10 hours.

At the shop they redo the drawing in the comprehensive HTH system which also generates the parts list and finally sends the order including automatically generated files that corresponds directly with production and stock systems centrally at HTH's factory.

Different dimensions in the innovation of the configurator

It is difficult to separate and identify the how, and to which extent different innovative contributions have formed the configurator. Nonetheless we will try to comment on the configurator seen as a product innovation, a market innovation and as an innovation in the organisational company structure.

Seen as an isolated product, the web-based configurator is not a spectacular innovation. As described above it was a more or less natural extension of a former configurator which was intended primarily as a tool for production planning. The innovative idea, which has been used in many sub-sectors, was to spread it to every customer/user, who had ambitions about expressing their own ideas in the design solution. The configurator is formed in a way where simplicity and user friendly interface has had priority, though as a product innovation the configurator cannot be regarded as a 'revolution'.

Seen in relation to the market, the configurator has the potential to be a major innovation. Provided that HTH should decide to reduce the service for

traditional customers in the sales shops and develop in direction of the DIY market, it is likely that the configurator could be a key instrument in the sales mechanism. This discussion is intimately connected to the configurators potential as a pivotal point for organisational innovation.

The iweb-based product generator is an interesting example of direct user involvement in the design process although it is more doubtful whether you can call it user-driven in a more rigid understanding of the term.

For an outsider it seems obvious that the user drawings could be a brick in the further process. Nonetheless it is a fact that the drawings alone serves as an inspiration (to make it clear, there is no reuse of the user drawing aside from the ideas in the final design drawing made by the sales man).

The configurator's contemporary function and interface with the rest of the HTH has to be seen as a result of a mediating process in the company where market relations as well as internal company structure also have a major role to play.

A new company model adjusted for the DIY market?

In a situation where priorities at the market is changed in favour of the DIY and "near DIY" customers² the rather big sales organisation, as we know it today, will to some extent be superfluous. A new sales model oriented more directly towards the customers and based on their active participation as users will in that case replace the former model.

Whether or not the potential will be fulfilled, depends on how the ongoing, strategic discussion at senior management level evaluates different strategies for the future development of the company. Among others, factors like risk assessment, product price, market estimates and consumer references will be in focus. In addition competitors' (e.g. IKEA) active use of web-based user involvement on the web can challenge HTH' s position at the DIY market and push the company to further initiatives, if they will defend their position at the that market segment.

Compared with traditional, private customers, the DIY customers are pretty much on their own. They have to design their future kitchen layout themselves, including identification of correct modules and fittings. And more crucial, they have to go through all the measurements required for making the precise drawing suited for selecting (and in a later phase also) mounting the kitchen elements. In spite of the big technical challenges facing the DIY customer, the HTH web urges the DIY folks to carry on and use both the web guides and the possibility for guidance in the shops.

One could ask whether the situation, seen from HTH's point of view, is new? Well it seems the answer is yes.

The combination of a line of new opportunities for direct user involvement in design, and a corresponding streamlining of sales operations (both due to the Internet) on one hand and changed user preferences on the other hand can outline a new model for the DIY and near-DIY market which can be difficult to accommodate in the contemporary organization of HTH.

The future interplay of sales function, market and configurator

The role of web-based user design of kitchens in the future can hardly be discussed without reference to a more detailed market understanding. Like in other sub-sectors it can be expected that the divide between user groups will also call for different potentials for ICT-based solutions that facilitate further user-driven design and innovation.

² Here used about a segment of customers who wants to/ or don't reject to be closely involved in the design and planning process when buying a new kitchen, although they don't do the practical work themselves.

According to an experienced (from both the private and the professional market) sales man in one the major HTH shops in greater Copenhagen there will be strict limits to the absolute share of the DIY market. He based his argument upon two points:

- Firstly the investment in a new kitchen for many families represents a considerable cost that you would not like to play with in a hazardous way – (meaning to believe in your own amateur expertise).
- Secondly, it is very time consuming to make precise drawings – not to mention – the practical work with building the kitchen – the majority of users will simply back off from this kind of tasks.

The sales man acknowledged the (theoretical) argument that the elimination of his and his colleagues' support could lower the price of finished kitchen solutions, but doubted that a minor (?) lowering of prices could move the relations at the market – at least not for the great majority of customers.

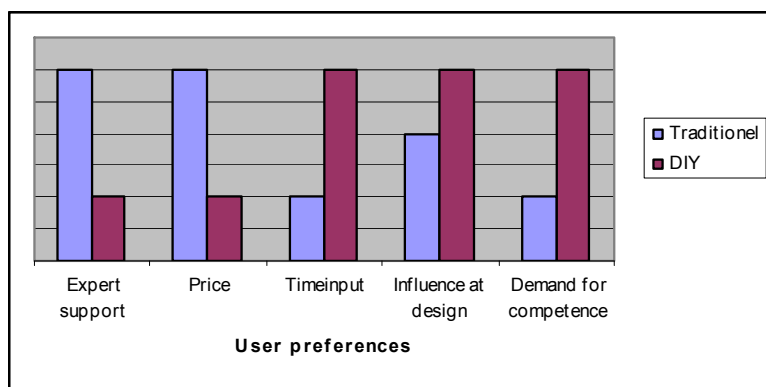
The central HTH marketing function at HTH sees great potentials in web-based configurator/drawing programs in the future. In spite of this, the potential has not been fully used. As an example one may wonder why the company has not used the opportunity to make any analysis of tendencies or types of drawing at the server hosting the drawings. Nonetheless it is the plan to make further steps towards a more fully web-based product configurator / drawing solution where data are reused - and maybe with some sort of sales opportunity related to the site. As an initiative in this direction the web page has recently been supplemented with an advanced 3D model of a whole flat, equipped entirely with HTH modules. It is advanced, but still it does not represent a full step in a user-interactive direction. The user cannot actively use the information in the model as a help in an ordering situation (or just as a listing of the properties of the modules you meet in the model).

Roughly speaking, it seems as if HTH deals with two major user roles, the "Traditional customer" and the "DIY customer". As a way of illustrating how the consumer can be biased in the two user roles, we suggest five central variables to differentiate them.

First in line is "expert support". In many ways the fact that users articulate a need for assistance from experts can be vital for which solution to choose. Secondly the price is nearly always an important variable. Thirdly the time input can be important; not all have the time, or prioritise to use the time that a half - not to mention a full DIY solution demands. Fourthly the total influence at the design solution can be more easily achieved by the DIY user than by the traditional user – this is a matter of self-determination and must be expected to have relevance for some users. As the fifth and last variable, it is obvious that your own capability in practical skills relevant for construction – here designated with the more broad term "competence" - can be a strong limitation for some customers. This last variable is an issue which HTH (and competitors) is working hard to minimise. Different help facilities are introduced on the web page. Detailed instruction videos covering many situations and with practice-oriented learning contexts, written instructions ready for download etc. etc. The web pages urge people to start their own kitchen projects from scratch and not to worry.

The companies' competence in communicating in a relevant pedagogical way with respect to the user context and with the use of simple and low demanding detail solutions, incorporating materials which can be treated and joined by the use of modern multi-tools can be an important factor in the future competition (see Figure 12).

Figure 12. Priorities in two user roles at the kitchen market.



	Traditional customer	DIY customer
Expert support	+++	+
Price	+++	+
Time input	+	+++
Influence at design	++	+++
Demand for competence	+	+++

The ranking in the diagram is purely subjective and alone meant as an illustration. But nonetheless it is based on trends shown in the empirical material. The active user role is, as it is known from other sub-sectors, followed by high demand on competence and time input; construction does not seem to be different here.

Centrally at HTH, it is the impression that as long as we are talking about a stronger drawing program which could eliminate the need for drawings made in the shops it will be positively received in the sale. As mentioned earlier the sales men invest a lot of time in drawing for the customer – a time which could have been spent on more sales.

The internal HTH understanding of the user role, today and in the future

The design and function of the different utilities, the customer can get access to at the HTH webpage, is developing and get increasingly more advanced. But at the same time, it has to be noted that the interactive functions which potentially could support the users' own design is still missing. It is not possible, for the time being, to combine a full user-drawn kitchen design with an ordering function over the net, followed by a delivery to the customers' address. One could suppose that at least a part of the DIY market would use those possibilities, if they were available.

It seems that at least two principal different positions exist regarding how to evaluate the need for a more extended role for the customers.

The first conclude that a further involvement of the customers are not a wish by the customers, and nor it is practical. The argument goes that a further involvement is a time consuming task which the average customer certainly will pay to avoid and that design, measurement and mounting the kitchen on location is a job for trained people, due to the complexity of construction.

The second position argues that the DIY market is increasingly important and that HTH can't afford to fall behind in competition on this market segment. The DIY market is dominated by customers who will like to take advantage of all kinds of utilities on the web while they at the same time expect

low prices. Nursing this group demands a strong development of the possibilities at the web.

It is important to stress that the net-based sales functionality is dealt with in a very sensible way by HTH. A realisation will, according to HTH, require a strategic analysis of markets but also of whole structure of the sales function in the future.

Among other things, the analyses must include the contractual obligations for the sales shops (organised in a franchisee model). Also the obvious question whether users doing there own business at the net without any contact to the shops should be offered lower prices? It is of course a central and controversial question.

Considerations about the exact function and form of the future model for a new generation of the product generator, will in other words, cause a re-evaluation of central business processes in the company. At HTH the guess is that this internal "clarification process" will take a couple of years – but it is one the other hand indispensable.

Rockwool: When an employee becomes a user

By Marianne Forman

Reasons for choosing the case

Background

Recently the energy consumption in buildings has been the subject of growing attention and among other things this has influenced the Danish Building Regulations. In 2006, the Building Regulations introduced new requirements to the energy performance of buildings with the aim of reducing their energy consumption. Changes in the Building Regulation (BR06) required:

- That an energy calculation has to be provided together with application for a building permit,
- That new buildings comply with an energy frame provision,
- That specific energy requirements to extensions and larger renovations/refurbishments are complied,
- That requirements to the tightness of new buildings are complied with.
- That low energy buildings are classified in two classes,
- That new buildings have to be energy labelled before they are taken into use (Aggerholm & Grau 2007:10).

For the different actors in the building sector these new requirements have shaped uncertainty about how you could meet the new requirements in practice.

Rockwool is a big producer of building materials delivering different insulation products to the building industry. In this case an employee builds his own low energy house for his family. The employee is educated both as a carpenter and a building engineer and works as a key account manager at Rockwool, where he services the customers. The marketing department has followed the building process of the employee and the story has been communicated on Rockwool's homepage as a new way of communicating with the market (see Figure 13).

Figure 13. Picture showing the built low energy house in the project (Rockwool's Homepage).



The case shows how a concept of tightness concerning low energy houses and a new method of marketing is formed on the basis of building components, suppliers, professional skills, user perspectives, Building Regulations and a homepage.

Data collection

The story about the building project can be studied in more detail at the website: www.rockwool.dk. This study is based on documentary material, including the website mentioned, and two interviews with:

- Steen Krogh Regel, Key Account Manager (consultant), Rockwool.
- Peter Hestbæk, Scandinavian Internet Manager, Rockwool.

Innovation

The central innovation in this case concerns a combined product and marketing innovation. Characteristic of this case is also that the project shows a lot of small single innovations that are weaved into each other and forms a technical, social, organisational etc. reality.

Product innovation

Just prior to the employee's building project, Rockwool had developed a tightness programme consisting of different products that can be used in the building process to ensure tightness of the building. The tightness programme was developed to meet the new requirements in BR06. In the building process the product was tested in real life and the programme demonstrated its functionality, as the house built passed the test of tightness required by BR06. At the same time the employee developed new technical solutions to tightness of houses through the building process. In this sense the tightness programme had use descriptions added that were anchored in use situations. As the last product perspective, the product was incorporated in a concept of low energy houses. At present low energy houses are not very common in Denmark. Together with the other components used in the building process, the tightness programme gives a cohesive offer of a low energy house. The concept is linked by components as different as other insulations products, heat and ventilation systems, windows, solar heating system, thermostats, prefabricated elements etc.

Marketing innovation

Viewed from a marketing perspective, the project resulted in a new marketing method, where the testing of new products, development of new technical building solutions and promotion of the products are integrated processes that take place in a public space on Rockwool's homepage. During the building process, newsletters are published with descriptions of the different phases in the building project, the different situations of choice and problems and solutions are highlighted in the running story. With this communication method Rockwool has both reached their traditional target groups (architects, consultant, entrepreneurs and "do-it-yourself" (DIY) users) in new ways and a new target group that they have identified as "do it yourself – do it for me" users. This new target group consists of consumers who want to have a more pronounced influence on their own buildings but do not want to build their buildings themselves. The target group is characterised by being critical of the building sector and that is one of the reasons why they want to secure the quality of their buildings by qualifying themselves to be better by being in dialogue with the actors in the building sector.

This new marketing method requires a new openness from the company and a redefinition of what kind of experiences it is possible to share with the market.

Organisational innovation

Viewed from an organisational perspective the project has indicated the possibility of using employees as users in the innovation work of the company. For the individual company it is an opportunity to combine professional skills and user perspectives in the same activity, but it requires that the company has the capacity to identify the opportunities when they occur, to trans-

form the opportunities into action and to anchor the results in the organisation.

Industrialisation

For this case the products used in the building process are generally known. The single products are produced industrially and are on the market. Viewed from an industrialisation perspective, the new thing is not the production of the individual products, but domestication of the product in the building process and the linking of the products to a whole house. The industrialisation aspects of this case concern the facts that the development of the use-in-practice knowledge in the building process added new value to the product and the need for the users to see the product in context. The need can be seen as a need for the users to have the possibilities of configuring a whole house. The conditions can be made by linking the different products that are used in the production of a house, but experience from the project shows that companies have to make some strategic decisions before they realise virtual alliances on the Internet between suppliers.

The user

Rockwool and the employee play different roles in the project. Where the employee is the driver of the building process, Rockwool is the driver of the development of the marketing method. The employee's house would be built whether Rockwool participated or not, but on the other hand, Rockwool's development of their new marketing method is dependent on the employee's project – or a similar project.

In that sense, involvement of user perspectives in innovation work of companies may be not so much a question of whether a user perspective exists, but rather a question of how the companies can recognise where and when the user perspective is visible and how they can organise themselves around user perspective.

In this case, the employee represents a couple of users: The end user, the DIY builder and the professional user. The employee is end user in the sense that he is building the house for himself and his family. He is a DIY builder in the sense that he builds the house himself. And he is a professional user in the sense that he is a trained carpenter and a building engineer working as a consultant at Rockwool. The employee has recently renovated an old house for himself and his family and is therefore very conscious of their demands to the end-product. Through his work at Rockwool he has acquired a wide knowledge of insulation and Rockwool's products. The employee's competencies made him familiar with drawings, technical methods for buildings, Building Regulations, insulation etc.

As an end user and DIY builder, the employee makes demands and wishes to the product and building process visible. Aspects that would not have been made visible in traditionally developing projects. The employee's agenda dominates unlike traditionally developing project, where many other agendas will fight for being the dominating for example the architects', the advisers' and the contractors'. This is expressed through for example the employee's principle of using known methods and techniques with respect to reducing uncertainty. It also becomes visible in the employee's interpretation of the situation, where he wonders why there isn't more information about the actual possibilities, and in his conclusion that the advice you can get from the advisers and supplies are fragmentary and rooted more in the adviser's and supplier's own needs than in the user's need. This made him identify the user's need for a more connected whole concerning information and more knowledge about the relations of the products.

Connection of the case with the theoretical elements

Lead-user:

The user can be seen as a lead-user who formulates needs and problems related to the design of the concept of low energy houses, where he prefers well-known methods and techniques in order to reduce uncertainty. At the same time he has professional skills as a carpenter and a building engineer, which made it possible for him to develop design and practical solutions.

Social construction:

It is a story about how new energy provisions in the Building Regulations are interpreted by different actors and how well-known methods, techniques and products are being inscribed in the concept of low-energy houses. The project can be seen as a scene, where the user, the suppliers, Rockwool etc. formulate problems and find solutions and at last have developed a concept of a low-energy house. The question is whether there has been any controversies, how the controversies were solved and whether there has been a stabilisation.

Users as consumers/ users domesticating the products:

It is also a story about how DIY builders interpret the new energy provisions in the Building Regulations and how they domesticate these provisions into practice. The case shows how the users comply with the new requirements to new buildings concerning energy performance and their needs and solutions, both according to the product – the house, but also according to the building process. The user chose known methods and known technology but brings all the known components together in a new way. The reason is that the user wants to reduce uncertainty.

The innovation process

Rockwool A/S

Rockwool A/S is a Danish company with 700 employees. Rockwool A/S is part of Rockwool Scandinavia with markets in Denmark, Norway, Sweden, the Baltic States and Finland. Rockwool Scandinavia employs 1100 workers. Rockwool produces and sells insulation products made of stone wool for use in buildings, industrial plants, power stations, marine and offshore etc. Rockwool A/S is also part of the Danish Group Rockwool International A/S, with 8000 workers and has a turnover of EUR 1.5 billion. The core-products of the Group are products that contribute to energy efficient buildings with good fire safety and acoustic performance. The central solutions for the building industry range from insulation products via acoustic ceilings and decorative façade panels to software tools and consulting services for energy optimisations.

Rockwool International is divided into three subareas: Insulation, System Division and BuildDesk (consultant services). Insulation is the biggest area. Europe is the most important market with sales organisations etc. in several of European countries, but also other regions are important.

Recently Rockwool International A/S has grown in connection with new buildings and renovation of existing buildings with focus on insulation. This development has both been supported by the European energy legislation, which is implemented in the EU Member States through their building regulations, and a high level of building activity. The new aspect in the Danish Building Regulations is the special focus on energy efficient performance of the buildings. In EU and North America buildings use about 40 % of the total energy consumption and heating and cooling consume the most.

To counter an expected stagnation in building activities while at the same time maintaining its growth, Rockwool International A/S already in 2006 focused on the possibilities for improving their competitive capacity by improving sales and marketing performance.

For a rather long time Rockwool A/S has been engaged in developing new energy concepts concerning buildings and has participated in developing projects with focus on systems for supporting energy efficient buildings, for example office buildings, a low-energy houses and renovation of different types of existing houses.

In this case, the employee designed the house before Rockwool participated in the project. The design process took place at the same time as the BR06 was implemented and tightness became an important issue for the employee. At that time there was not much experience of how to secure tightness of foundations, windows, roof etc. Therefore, the actors of the construction were concerned and uncertain of the new requirements to tightness. How should tightness be understood, how could it be taken into account in the design process and during the building process, and what was a pressure test? Furthermore the discussion was growing about energy consumption, low-energy classes and future requirements to the energy performance of the buildings.

Development of a marketing concept and technical building solutions

Rockwool wanted a closer communication with its users. In the project a marketing method was developed based on story telling, where the employee's building process is followed and documented and published on Rockwool's homepage. In this way the process has been made into an open learning process for interested users etc. The building process has been followed and all the problems described that the employee encountered in the process and all the decisions made by the employee. This method made it possible to follow a low-energy house from the planning stage through the building process until the house was built. When the house was finished, Rockwool and the employee held an open-house arrangement, where suppliers, professional users, end-users etc could meet and exchange knowledge and experience. The open-house arrangement was not planned from the beginning, but the idea arose because of the great interest from all kinds of actors during the process. In this way the project has been characterised by learning by doing. The purpose of the open-house arrangement was both to gather all the questions from the interested actors and to provide an arena for dialogue.

Target groups and homepage

The direct customers of Rockwool are the suppliers, who distribute their products. Although these suppliers are not the most important target group for Rockwool's marketing, as they sell products from many different companies and in that sense they are indifferent to which products they sell. Rockwool reflects the different users of their products as the important groups they have to inform and influence, so they will demand Rockwool's products. The different user groups are architects, consultant, contractors and DIY people. Rockwool used to develop different marketing materials for different user groups, but in this case Rockwool expected that all the user groups could benefit from the story. Besides the traditional user groups, Rockwool also wanted to target a new user group – the people who are going to live in the houses and who want to have influence on it, but who do not want to build the houses themselves - "do it yourself – do it for me" people. This user group is new and is represented by persons, who want to improve to be better to enter into a dialogue with the actors in the building sector for in this way to obtain greater influence on the product and to reduce uncertainty. Rockwool believes that many end-users feel uncertain, because of fear of bankruptcy by standard-house producers, stories about bad workmen, many

defects, etc. It is a market, where the end-users feel they have to be better prepared to ensure that they get what they want. The building market is complex with poor overview, and it is this complexity and poor overview that meet the end-user, when they speak to architects, consultants, producers etc. It is very difficult for the end-user to get advice and information about what the new rules mean and also simple information about the possibilities, for example that you can apply to be exempted from connecting to the district heating system and in that way save money.

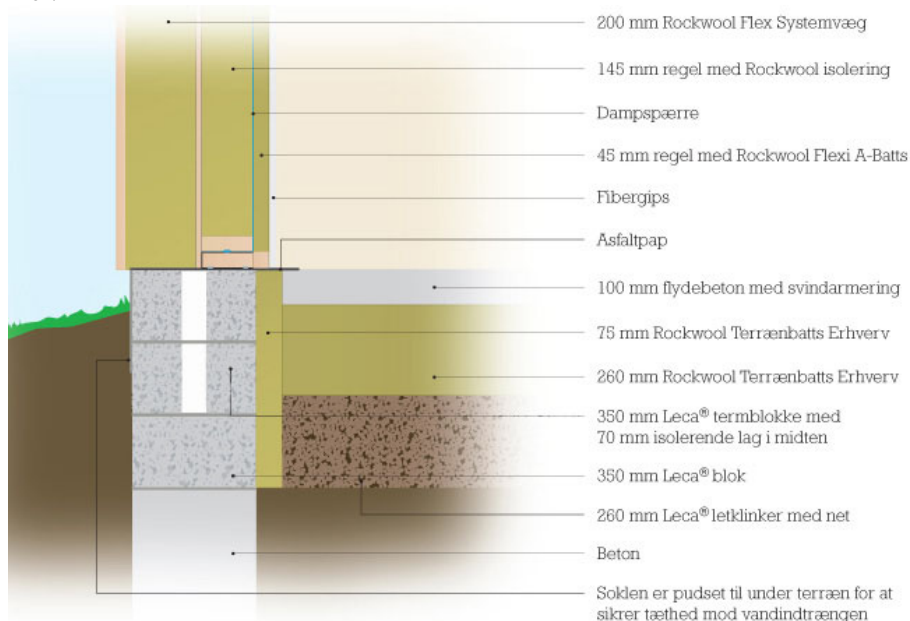
The central actors in the building process are the employee and the suppliers and craftsmen. The employee has chosen all the suppliers and craftsmen. When the employee had chosen the suppliers, he told Rockwool, and afterwards Rockwool contacted the suppliers to ask them to prepare descriptions to the homepage. The homepage is characterised by:

- Language written so that all the target groups can understand the content and what is going on.
- A story reflecting that the content should have a form that made it possible for the reader to identify himself with the story while at the same time providing information so that he could learn from it. Requirements to the content were that it should be reliable (if there were problems, they should be told), that the process could be followed for all the problems, choices and solutions in the process, and that the content should be explanatory rather than advertising.
- The product, process and actor network in the building sector are complex and in the story all these aspects are linked and make up the story. The building is composed by a lot of components and to keep this complexity, all the suppliers wrote about their own products. They were asked to write informatively about the specific problem area that their product targets solutions for and the solutions given by the products. By giving the suppliers space on the homepage, the actor network is becoming visible. It has been very important that the suppliers are some out of many, and in that sense they have been careful not to advertise the products. Although they have linked to the suppliers' homepage, because the suppliers need advertisement, but mostly due to the information on the linked homepages. By linking the homepage you also link information and the user needs linked information in a complex system, as a guided way of finding his way around the homepages.
- The homepage contains lots of photographs of the process, which makes it easy to follow the process, and many technical drawings showing the technical building solutions.

Product innovation

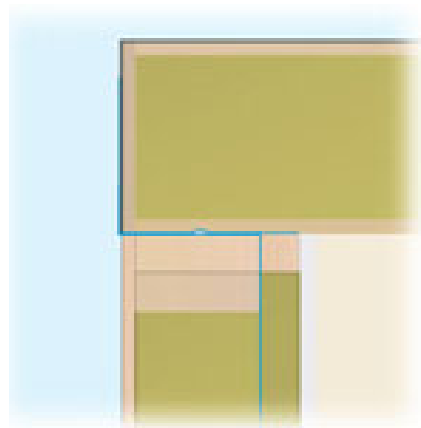
During the construction process the employee and the suppliers developed different practical technical building solutions of how the construction could be executed to ensure tightness. And the following test showed that the solutions were valid as the house was tight. One of the solutions was connected to the foundation, where they chose to place the roofing felt from the foundation to the top of the concrete foundation (see figure overleaf). As the roofing felt is first placed after the concrete foundation is poured, the roofing felt avoids contact with the pouring process and thus the risk of destroying or displacing the roofing felt is minimised (see Figure 14).

Figure 14: Example showing a drawing of a building technical solution: Foundation. (Rockwool's homepage).



Another of the solutions developed during the process was connected to the use of roof cassette. The employee chose a method, where the board on the roof cassette was folded around the roof cassette. By using this method the employee made a tightness solution and at the same time got his house tightened quickly (see Figure 15).

Figure 15: Example showing a drawing of a building technical solution: Steam block with the sampling between the roof cassettes and the wall. (Rockwool's homepage).



By using this method the steam block is lying on the top of a layer of insulation, but this problem is solved by putting twice as much insulation on the top of the steam block, so that the steam block is still on the warmest side. It is a big house and the employee did much of the work himself. That is why it was important to find a solution so that he could close the house quickly to avoid problems with dampness etc. This solution has not been seen before. It is a more expensive solution than other solutions, but it has afterwards been demonstrated that it is a good solution for ensuring tightness. In this situation the employee gave priority to the feasibility of the solution. The employee comments that *'You can draw a lot of good solutions, but they also have to function in practice on the construction site. If not, the solutions are not worth much – and there are very often big problems relating to damp and mould growth in the building. By using this method, the building was tight under the whole building process.'*

Experiences

There has been a keen interest in the project and the homepage. The need to answer all the questions that the project has raised and the way the experience has been communicated via the homepage has been successful. The interest in the homepage has been growing during the project period, and the interest has not stopped after the project was finished, as still many users visit the homepage. Rockwool explains the still growing interest by the need for this experience and that more and more users find out that the homepage exists. There have been 15000 visitors over a period of 7 months. Today if you search for low-energy houses or passive houses on Google, the homepage shows as a link.

It is new for Rockwool to communicate with users in this way. Rockwool wants to continue to communicate with their users in this way in situations that complies with this method. The method will also be used internationally in some of the other companies in the Rockwool Group. They can use the method but not the content. They have to make local stories about local construction processes based on local building traditions and norms.

The different technical building solutions related to tightness are described and illustrated with drawings on the homepage. At the same time the pressure test has shown that the solutions are valid. In that sense it is expected that the solutions will be used by others, both professionals and private users, and will be some kind of a norm. And still a lot of people call the employee to discuss the different solutions in details.

The employee assesses that the craftsmen have an advantage concerning understanding of the drawings due to their practical competencies. They can easily translate the drawings to their own practice.

Architects have also been very interested in the project, but it is more difficult for them. With the new energy requirements the architects need to change their performance. Earlier it was the design that was important and if there was something technical that they did not know how to draw owing to lack of technical knowledge, the problems were solved on the construction site. The employee assesses that today it is important that the design is well reflected concerning the building's energy performance and that is why architects today have to a higher degree to integrate technical knowledge into their design process. Already when the ground plan has been made, you have to use the energy frame in the further design process. The architects are very interested in this new area, which both Rockwool and the employee have noted. This new challenge can also be met by closer interaction between the architects and engineers during the design process.

Sources of innovation

The employee designed the house himself. Based on his competencies as a building engineer, he found it very easy to draw the house; the challenge was to find solutions that made the house tight. The employee only used an architect to draw his drawings into auto-cad. The employee drew three drawings as the process was ongoing. It was primarily negotiation with the municipality and financial circumstances that determined the final design. During the communication with the municipality about the planning permission, the employee used his knowledge about the Building Regulations.

The employee had chosen to use prefabricated element from a factory, produced after the architect's drawings. During the design phase, the employee chose the suppliers he wanted to use and used them as dialogue-partners. Apart from the architect and the suppliers, no other experts have been involved. As a carpenter, the employee could make much of the workmanship himself, which he did. What he could not make himself he hired craftsmen to do, for example plumbers.

Concerning Rockwool's development of the homepage, it was the product manager and employees from the marketing division who participated. The product manager had the responsibility of coordinating the product aspects

concerning the homepage, including contact to the suppliers, while the employees from the marketing division were responsible for the rest.

Motivation

The employee

The employee's motivation was to build a house for his family. First he just wanted to build a house that complied with the requirements in BR06. But after a while, when the project was in progress, he decided to build a low-energy house energy class 1, because of the challenge of building one and also the money he could save by a reduction in the energy consumption and because of the possible exemption from connecting to the district heating system.

The employee is a fiery soul and through his cooperation with Rockwool, he saw a possibility to try something new and a new way to meet Rockwool's users.

Rockwool

As the employee began to focus on tightness and energy in his building project, the product manager with responsibility for building insulation saw a possibility for testing Rockwool's products through a practical test and to get answers to all the questions asked by users. It was a special new product programme "Rocktæt" (Rocktight) and she wanted to follow it and to get feed-back on the product.

Furthermore Rockwool saw in the project a possibility of getting into contact with the users in a new and closer way. By following the project and describing the process, they could give some practical instructions concerning the problems that occur when you build and have to integrate considerations of energy performance. This was new for many actors and received a lot of attention. Among other things this became evident from all the questions Rockwool was asked by the architects and others at that time. Rockwool had already held workshops for architects about the new energy requirements and had encountered the great interest and the great uncertainty of the architects. Rockwool therefore saw a great need for further development of solutions and information about the area.

The suppliers

When it was decided that the project should be followed and described on Rockwool's homepage, the suppliers were very interested in participating in the project. The perspective shifted from just being an ordinary sales-situation to being a possibility of being participants in a public story, inscribed in a concept for a low-energy house, and a place on Rockwool's homepage. A place on Rockwool's homepage represents more than just free advertisement and has to be understood symbolically as a kind of network alliance between Rockwool and the suppliers, where the value is connected to trust, quality etc.

Financing

The product manager financed the marketing part of the project with money from her own department budget. The employee paid his own house, but used the general employee arrangement about employee discounts on Rockwool's product and leave of absence.

Difficulties during implementation

The combination of testing a new product programme, development of new technical building solutions and promotion of the product programme in the project was the occasion for reflections on what this new openness and sensitivity meant for Rockwool. At the same time the employee felt a pressure to succeed. What if the house did not become tight? Rockwool and the em-

employee agreed that focus had to be on the learning process and that honest communication was necessary to keep the credibility of the public. This was solved by an agreement made at the beginning that if it went wrong, that would be the story and then they must learn from their mistakes.

As the project was connected with Rockwool, a problem emerged around Rockwool's relations to suppliers in general and how Rockwool could avoid favouring some over others. It showed that many of the suppliers would have liked to participate in the project. Rockwool cooperates with many suppliers and cannot make any differences between them. To prevent favouring specific suppliers, the story has been told as generally as possible. The story is more about problems and solutions than specific suppliers and their products. But the argument is also that it is the employee, who has chosen the suppliers and not Rockwool.

Rockwool has not clarified how this dilemma can be solved in the future: on one hand the wish to participate in projects with other suppliers and on the other hand to treat all suppliers the same, but the following possibilities are discussed:

- To refer to the trade instead of one specific supplier, when it is possible
- To participate in projects, where the client chooses the suppliers
- To invite tenders for jobs/deliveries in connection with projects and in this way let the general market condition chose the suppliers
- To make it clear that the suppliers used in a specific project are not chosen specifically.

Effect on the business system governing construction

For the producers in the construction industry the case suggests important trends, when they involve user perspectives in new ways. The case is an example of an employee who becomes end-user. It illustrates that there is a potential for the company to go into this type of cooperation, as it gives the company access first of all to a new context – the user's context - which is detached from the traditional bindings of the company, and secondly to new knowledge that is based on the user's production of knowledge and lessons learnt in the use situation. In the case, this new type of knowledge showed that it can give the product further value by adding use knowledge (building technical methods) and at the same time well suited as a means of communicating with the customer.

In the case the user-driven innovation process concerned testing of a new product, development of new technical building solutions and promotion of the product, where all the processes are integrated.

A market segment

In the work out of the marketing method and through the experiences by using the method, Rockwool has identified a new segment among the end-users. For a long time Rockwool has known DIY builders, who is the only group of end-users that Rockwool was in contact with. The other end-users had only been represented indirectly by the architects, who traditionally have been Rockwool's most important target group. With the project a new type of end-users has been identified, which is "do it yourself – do it for me builders". Rockwool understands the segment as a critical group that wants to do thing themselves, but not by having a tool in the hand. The case suggests that this end-user group is becoming an important new target group for the suppliers of building components and that this new target group will raise new types of demands directed at the suppliers. This can mean that the suppliers of building components will get into a closer direct dialogue with the end-users and at the same time qualify the end-users to put pressure on the architects and the other actors in the building industry.

Marketing and virtual system products

Rockwool has always informed its customers of the context of their products, for example the actual provisions in the Building Regulations. What is new in the new energy requirements and also the new customer demands is that the companies have to refer to other products and producers. Today a house is so complex and complicated that users have to move between different knowledge and products spheres to understand the house in full. The employee from Rockwool for example points to the fact that it is insufficient only to talk about insulation if you talk about tightness, heat loss etc.

Rockwool develops physical system products with other suppliers. It is often the salesmen who get the ideas to system products when they visit building sites, where customers talk about ideas or you can have them by watching the working processes. The problems with system products are that although they are very obvious, they have a very long period of adoption on the market. The architects are often very pleased with system products because of the system products' guarantees, but they will not use them before the system products have long lists of references, and this will create a situation where everyone waits for everyone else.

User perspectives suggest new ways of thinking system products; you can call it virtual system products, where the products are connected with links. In this way the users do not experience the products as individual products but more as a whole – a building. Based on the network link this gives the users on the one hand the possibility of configuring their house, and on the other hand the possibility of getting qualified and cohesive information. In this way it can be the users who drive the system development. The target group, who is identified as "do it yourself – do it for me", can support this kind of development. On the one hand they do not want standard products, and on the other hand they want a context in relation to knowledge and products, when they want to build. This means that it is not enough for them that the suppliers explain about their own products, but the suppliers need to shape a context that contains both knowledge relations and specific product communities.

Apparently, a virtual network that links products, information and suppliers can shape the frame for the users to relate themselves to the whole and with that to the individual components. In the future Rockwool estimates that more suppliers begin to have more links on their homepage in order to tie the products together in a context. But it will be a common strategic question, how you can do it without favouring one over the others. The problem is also that it is not all companies that the company can vouch for and wants to recommend. Companies can in a hurry be connected in virtual networks through links and consequently benefit from each other but also share disadvantages. A future challenge will be the development of strategies for project cooperation between suppliers that handle the dilemma with inclusion/exclusion.

All in all trends suggest the establishment of stronger supplier network and a stronger focus on the end-users. And at the same time the new user group "do it yourself – do it for me" can introduce a new type of pressure on the building sector, which can contribute to a restructuration of relations in the building industry.

Company strategic considerations

Preconditions

This case indicates that it has been an advantage to the company to involve the employee as a user in their innovation work, but also that there is a couple of aspects that the company has to consider. User-driven innovation, where employees are used as users, will often be project-organised activities, and in that situation it will be necessary that the company has the ca-

capacity to identifying the possibilities and to organise the possibilities into a project. In this case, the preconditions for success were that:

- The employee was an enthusiast and a very competent person with many different skills.
- There is a very close cooperation between the product and marketing departments in Rockwool, which made the integration of testing of the product, development of technical building solutions and promotion of the project possible.
- There is a culture in the company, where you also talk about free-time activities that take place outside the company.
- The product manager was able to catch on to the idea and translate the idea into practice with money from her own department's budget; in other words the product manager had the capacity to translate the idea into a project organisation.

Learning process in public

In the case Rockwool redefined the relation between company knowledge and public knowledge. The case demonstrates that it is important to consider the frame conditions for learning processes in public. Innovation will always be characterised by being a learning process with the possibility that you do not achieve what you wanted or expected. In that sense it is important, how you ensure the frame conditions for the involved employees, so that the learning perspective is maintained in favour of the performance demands.

Relations to suppliers

In the case Rockwool cooperates with different suppliers. The case demonstrates that it is necessary for the company to develop new forms of project cooperation with suppliers that handle the dilemma of inclusion/exclusion.

Economic benefits

In projects like this, the possibilities for economic benefits will often arise. In this connection it is important to set matters straight, so that both the employees and the companies can maintain their integrity both concerning the internal relations – the other employees – and concerning the external relations for example the suppliers.

Maisons MACCHI: Prefabricated individual houses

By Frédéric Bougrain & Jean-Luc Salagnac

Introduction: the company 'Maisons MACCHI'

'Maisons MACCHI' is a family owned company. It was created in 1946 and employs 22 employees. Specialized in the construction of houses, the company is characterized by its innovative approach concerning a method for manufacturing prefabricated elements. Moreover the enterprise is involved in quality management.

It is the only builder of individual houses who is certified ISO 9001: 2000 in Alsace. It can be considered as one of the leading company on the French market for low energy houses.

By focusing on the low energy houses market, the company had to reduce its activity and to employ less people (number of employees reached 35 at its best).

On its regional market the company conveys an image of manufacturer of low energy houses. Thus it is out of the market for traditional houses where prices are usually lower. Moreover certain activities that were formerly carried out on the building site are from now on undertaken in a factory. Thus fewer personnel are required on the building site (see Figure 16).

Figure 16: Prefabrication and strong external insulation allows to achieve better energy performance.
(Foto: Frédéric Bougrain)



The innovative construction process

Origins of the innovation

The owner and manager of the company (Mr Pierre MACCHI) was for a long time at the head of the family company where it carried on also an activity of mason.

Its experiences and the health problems that he encountered during his professional life encouraged him to tackle the problem of the painfulness of the tasks on the building site.

Besides his professional activity, Mr Pierre MACCHI exerts a very active role in several regional building authorities. He is President of the local federation of the building industry, President of the environmental commission of the regional federation of the building industry. He is also involved in several committees aiming at improving the environmental quality of buildings. Very soon he realised that the construction of prefabricated elements was the main solution to reduce the painfulness of the building site but also to limit building misconception and to improve productivity.

Moreover the question of the reduction of the energy consumption has received lots of attention during the last few years. In France the building sector accounts for 43% of total energy consumption and for 25% of carbon emissions. Consequently mitigation policies for energy consumptions have focused on improving the energy efficiency of buildings (offices and houses).

The manager who is conscious of the energy stakes decided to develop a concept of low energy houses that goes beyond the actual building regulation.

The prefabricated process "MACC3" which was patented by "Pierre and Karine MACCHI", gives the company a competitive advantage on the market of low energy houses. This process rests on a prefabricated insulation system. The expanded layer of polystyrene (from 30 to 50 centimetres of thickness) is provided by a leading manufacturer. It is pressed in freshly-mixed concrete. The prefabricated wall is also very innovative because it integrates heating tablecloths and plumbing networks (see Figure 17).

Figure 17: Electric networks integrated in the prefabricated walls. (Foto: Frédéric Bougrain).



The development of this process is the fruit of the know-how accumulated by the contractor during his career. In addition the failure of the first industrial

collaboration that he tried to establish with a local manufacturer led the company to improve its constructive process.

A first local manufacturer, specialized in the prefabrication of walls had been solicited. A collaboration agreement was established but it quickly stopped because the manufacturer intended to imitate the constructive process.

“Maisons MACCHI” had to deliver ten houses. Consequently the company decided to prefabricate the walls in-house. This constrained strategic choice proved to be positive since it contributed to optimize the industrial approach. “Maisons MACCHI” realized that the constructive process was not optimized since it generated many waste during prefabrication. For each opening, polystyrene was cut out once posed in the course of the building site. This delicate operation required the greatest attention on behalf of the employees present on the building site. Moreover it generated a large quantity of wastes. Becoming aware of the limits of its constructive process, the company improved it. From now on this operation does not happen any more on the building site. The openings are anticipated at the stage of prefabrication, reducing the waste practically to zero.

Then the first houses, trials and errors and the certification process (ISO 9001:2000) in which the company was involved, lead to the improvement of the prefabrication process.

Characteristics and assets of the constructive system

A method for manufacturing insulated concrete elements

The invention which relates to a method for manufacturing insulated concrete element is protected by a European patent supported by ten claims³. The method for manufacturing the panels constitutes the major strength of the system. At the first stage of the prefabrication, fresh concrete is poured and places for windows and doors are already set up. Electric networks and an electric heating system are also integrated in the walls. When concrete has been poured, the insulation layer in polystyrene is then pressed against the concrete in the mould. No other element is necessary to maintain the assembly of the two elements.

The insulation layer is cut out according to preset openings. At the end of the chain, the prefabricated product is ready to be used.

The advantages of the process

The following advantages, among others, are achieved:

- The approach improves safety and health conditions on the building site:
 - The installation of peripheral scaffoldings before the installation of the walls improves safety conditions. Employees are more motivated because safety and health conditions are better.
 - Prefabricated elements are heavy and large but the use of cranes of strong tonnage reduces the work load of the employees of the building site.
- The prefabricated elements are ready to pose. As eighty percents of the networks are integrated in the panels in factory, it reduces the number of interfaces between trades on the building site.
- This is a key point because defects at the stage of construction will lead to increase energy consumption. Thus the standards for low energy houses would not be reached.
- The constructive process also limits the risks of cold bridges. With the preceding patented systems, the insulation layers were not integrated into

³ Many elements of this part are drawn from the *European Patent* n°EP 1.669.507 A2 which was published on June 14, 2006 after a deposit on December 9, 2005. The patent concern “*A method for realising prefabricated construction elements, and elements manufactured according to the method*”.

- the walls. They were pressed but the connexion required other elements. The risk was then related on the rupture or the defect of these elements.
- The quality of the end product is much better than with a traditional technique. Trades are never surprised. Prefabrication leads to precision and makes easier the work that they have to accomplish on the building site.
 - Productivity increases: Three well trained employees can assemble in one day the prefabricated walls and the stairs. Before the use and the assembly of prefabricated elements, five people were required and had to work for three or four days.
 - Finally with prefabrication it becomes easier to monitor and follow the planning of the building site. This innovating approach strongly reduced the length of the construction period. In this case, it is not any more necessary to envisage stopping the activity of the building site because of external parameters such as meteorology. For example, there is no more waiting period for interior paintings or the roughcast of the facades. Moreover electric heating systems which are integrated in the walls, enable to heat the house just after the shell.

Figure 18: Installation of peripheral scaffoldings before the installation of the walls. (Foto: Frédéric Bougrain).



Figure 19: With prefabrication there is no more waiting period for interior paintings or the roughcast of the facades. (Foto: Frédéric Bougrain).



Partnership strategy

The development of the prefabricated concrete elements rests on partnerships established with several actors of the construction industry.

A polystyrene supplier, leader in his field, is frequently solicited by the contractor to deliver new products which are integrated into the construction process. For example, in the first times of collaboration, polystyrene was delivered in modules of 1m by 1,20m. The contractor then asked his supplier to cut out polystyrene on his manufacturing unit in order to deliver a product that fits the features of the construction process.

A collaboration agreement has also been signed with a German manufacturer who is in charge of prefabricating the walls. This company does not fully master the realisation of the prefabricated walls. Consequently it still benefits from the technical assistance of one engineer and two employees of "Maisons MACCHI". The aim of their actions is to check that the electric boxes are stuck to the good place and the insulation layer in polystyrene is well positioned. The distance between these two partners increases the production costs of the houses by 1500 euros. Moreover these transportation costs trouble the environmental image of the constructive process which aims at reducing energy consumption.

Nevertheless this collaboration and the interest expressed by the manufacturer indicate to the contractor that the low energy houses can also be exported outside Alsace. This constructive process which is protected by a European patent could be diffused on the German, Austrians and Swiss markets. In these three countries low energy houses occupy already a more significant market share than in France. Some of the inhabitants of these countries already agreed to invest more at the construction stage in order to reduce energy consumption and increase the level of comfort.

A partnership is also engaged with a financial institution which grants a reduced loan of (3.5% up to 50000 Euros to every household who would choose to buy a low energy house).

The households who buy the low energy houses do not have the competences to be involved in the construction process. On the other hand they take part to the design of their house when they specify the characteristics of the house they wish to acquire.

The company also intends to publish some guidelines dedicated to the users. The aim would be to help them to adopt a behaviour which is con-

forming to the operating principles of a low energy house. For example a household which moved in October 2007 was quickly disappointed because of the cold in the house. The contractor found that the household slept with opened windows and left opened the door which connects the house to the basement which had been transformed into a dressing room. Consequently it was not possible to reach the temperatures announced by the builder because of the inertia that characterises these houses. This anecdotic example indicates that the diffusion of the concept of low energy houses will require an evolution of the behaviours and the psychology of the users of the building.

Besides this partnership strategy "Maisons MACCHI" has decided at the end of 2008 to create an affiliate called "MACC3" in charge of the marketing and distribution of the prefabricated elements. The creation of "MACC3" intends to improve the commercial visibility of the product and to separate two activities (the construction of individual houses and the manufacturing and distribution of the prefabricated concrete elements) which do not require the same competences and are not directed toward the same customers.

The quality management: a key point for a successful implementation of the prefabricated elements on the building site

Characteristics of the quality management system

"Houses MACCHI" is the only builder of houses located in Alsace who benefits from the certification ISO 9001: 2000.

The aim is to develop a product that meets design requirements, regulatory requirements and user needs.. Every stages (design, construction, commercial negotiations) are detailed and planned.

ISO 9000 is a family of standards for quality management systems. The procedures cover all key processes in the business. ISO 9001:2000 provides a number of requirements which an organization needs to fulfil if it is to achieve customer satisfaction through consistent products and services which meet customer expectations. It includes a requirement for the continual (i.e. planned) improvement of the Quality Management System. The 2000 version makes a radical change in thinking by actually placing the concept of process management in the centre. It also demands involvement by upper executives, in order to integrate quality into the business system. Another goal is to improve effectiveness via numerical measurement of the effectiveness of tasks and activities. Customer satisfaction is also at the core of the approach. Consequently any organisation has to determine customer requirements and create systems for communicating with customers about product information, inquiries, contracts, orders, feedback and complaints. The key question which governs the quality policy is: How to make the customers satisfied?

"Maisons MACCHI" wrote a documented procedure to map out all key processes: marketing, purchase, production. It also defined performance indicators to control them by monitoring, measurement and analysis; and ensure that product quality objectives are met. The aim of the approach is to make adjustments if the product does not meet user needs.

When a customer is interested by a low energy house, a salesman handles the case and will be in charge of the file until the signature of the contract. The salesman will start following the quality policy. All constructive choices are reviewed and have to be validated by the customer. The aim of this step is to be sure that the engineering and design department of the enterprise respects the choices and requirements of the customers. This analysis which lasts approximately four hours is the most important in the

process. The results are used as a starting point for the prefabrication of the walls. Then the plans are sent to the German manufacturer who is in charge of the prefabrication of the walls.⁴

At this first stage “Maisons MACCHI” makes a first satisfaction survey. Even customers who are not interested by the house but got information about the characteristics of the house were surveyed. The objective is to better know the expectations of the customers and to improve the marketing approach of the company.

Two other satisfaction surveys are undertaken with the customers who sign a contract with “Maisons MACCHI”. The first is done halfway when the shell is finished, and the last at the reception of the house. The objective at this last stage is to appreciate if the house has been built according to the expectations of the customers and to judge the relationship with the subcontractors.

During the building process, several procedures are defined. Each task is described in a chronological way in a quality handbook. With this document every workman is aware of quality objectives, implementation processes and the organisation of the building site. This approach which is quite unusual in the construction industry is similar to the quality policy implemented by most manufacturing companies. It helps “Maisons MACCHI” to plan and follow the stages of development of the building site and to be sure that adjustments can be made if the house does not meet user requirements. The other trades which are requested for the second work also benefit from this quality management procedures. Every process being well defined their interventions are never delayed by any unforeseen event.

The aim of this approach is also to improve quality of the work done on the building site. Internal meetings are organised every week to determine whether the quality system is working and what improvements can be made. Problems are recorded and a document has to be filled to deal with actual and potential nonconformance. To be successful this approach requires relying on good internal communication. Indeed each employee has to consider that this approach is not a constraint but a process which contributes to improve the quality of the work and the safety on the building site.

The subcontractors who are involved in the construction of low energy houses are not certified but they adhere to the quality management system ISO 9001: 2000. They receive documents which specify the location of the building site, the nature of the task to be achieved, the materials to be used... The length of their intervention is also given as an indication but it is not considered as a contractual engagement. Any subcontractor, who is not capable to respect assigned time, has to solve its problems.

However “Maisons MACCHI” prefers to select at least subcontractor who can benefit from a label. For example the fitters of thermal solar systems profit from the Qualisol label which gathers the professionals engaged in a specific quality approach (not as restricting as ISO 9001: 2000) for the installation of thermal solar systems.

At the end of each year, the subcontractors are evaluated in order to check that the way they fits the quality management system followed by “Maisons MACCHI” and contributes to the satisfaction of the customer.

The German manufacturer who provides the prefabricated walls is also gradually associated within the system. For the moment some employees working for “Maisons MACCHI” regularly cross the border and assist the manufacturer. “Maisons MACCHI” is writing a procedure to help the German personnel who regularly changes to work without assistance.

⁴ Each low energy house is made with prefabricated walls. But this prefabrication is not synonymous with standardization since each customer can ask for a specific design according to his budget and his needs.

The impact of ISO 9001: 2000 on the enterprise

So far the impact of the quality management system ISO 9001: 2000 is positive. Planning activities upstream requires a consequent investment but it also saves time on the building site. The activities become more fluid and the productivity is higher. The quality of the end product, the low energy house, appears also to be much higher than with traditional approaches. During the building site, the teams are not mobilized to correct defects. Thus the cost of nonconformance strongly decreased. It proves that improving quality reduces expenses while increasing productivity.

ISO 9001:2000 improves employee motivation, awareness, and morale only if all employees are involved in the approach. Consequently “Maisons MACCHI” strongly focused on communication actions towards its employees to explain them the advantages of the method and to reduce their fears. Some thought that the method was one way for the management to control the effectiveness of the personnel. But common and regular meetings show to the personnel that the goal is to improve customer satisfaction, safety conditions on the building site and the performance of the company. Each week a meeting is organized to give a progress report on the evolution of the projects, the future contracts, the expectations of the customers and the problems encountered in the course of the building site. This debriefing gathers the employees in charge of the building site, the manager, the quality management director and voluntary employees. These meetings are one way to show to the employees of the building site that people working in the offices care about building site activities.

“Maisons MACCHI” is currently setting up a new quality management system to go further than ISO 9001:2000. ISO 14001: 2004 which specifies a set of environmental management requirements for environmental management systems will be combined to OHSAS (Occupational Health and Safety Standards) 18001 and integrated to ISO 9001:2000. The objective is to formalise actions that the company already does as a builder of low energy houses.

For example the purpose of ISO 14001:2004 is to help all types of organizations to protect the environment, to prevent pollution, and to improve their environmental performance. In this field, the company is already concerned with the impact of its actions on the environment. Actions have already been taken to reduce wastes on the building site and also to involve all the stakeholders who play a role during the construction process of a low energy house (residents living in the neighbourhood, banks, insurers, suppliers...). Similarly the company already takes into account the health and safety issues concerning the employees of the building site.

Conclusion

The Australian report “Off-site manufacture in Australia: Current state and future directions”, published in 2007 by the CRC Construction Innovation (Blismas 2007) found that prefabrication offered numerous drivers and benefits of OSM. “OSM was seen to:

- reduce construction time,
- simplify construction processes,
- provide higher quality, better control and more consistency,
- produce products that are factory tried and tested,
- reduce costs when resources are scarce, or in remote areas,
- result in improved working conditions,
- reduce on-site risks,
- alleviate skills shortages in certain centres,
- provide fewer trades and interfaces to manage and coordinate on site,
- reduce waste on and off site,

- improve housekeeping on site,
- facilitate the incorporation of sustainable solutions,
- achieve better energy performance.”

The prefabricated low energy houses built by “Maisons MACCHI” offer the same advantages. However like in Australia where the uptake of OSM is limited, the diffusion of the concept developed by “Maisons MACCHI” is still rather limited. Only twenty low energy houses using prefabricated concrete elements were built by “Maisons MACCHI”. Even if the enterprise expects to sign a contract with a social housing company and to build about 18 houses, this level is not large enough to benefit from scale and learning economies.⁵ This is apparently the main barrier to a better diffusion of the concept constructive system. Indeed houses built by using traditional masonry remain less expensive. Consequently competitors who rely on traditional techniques can still attract most households who do not look at the life cycle costs but focus on the level of their initial investment (see Figure 20).

Figure 20: The use of cranes of strong tonnage to install prefabricated walls improves working conditions and reduces on-site risks. (Foto: Frédéric Bougrain).



The enterprise relied so far mainly on its own resources to innovate. The diffusion of the constructive system requires that the company receives additional funds to ensure its development. Any limitation at this level is likely to delay the diffusion of the process.

Conversely low energy houses which are not diffused in France could become the reference with a move towards more stringent regulation concerning energy consumption. The manager and owner of “Maisons MACCHI” considers that prefabrication is the only way to achieve better energy performance, to provide houses with better quality, to attract skilled people and to improve the image of the construction industry.

⁵ Scale economies happen when unit production costs decline as fixed costs are spread over increasing production volume. Learning economies also reduce costs. It is due to the accumulation of knowledge and skills that improve performance.

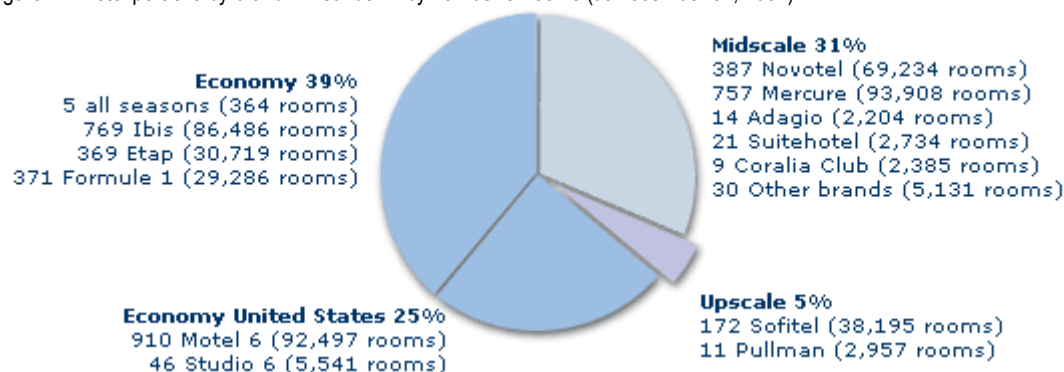
ACCOR Hotels: Renovating the low budget hotel brand Formule 1

By Frédéric Bougrain & Jean-Luc Salagnac

Introduction: Reasons for choosing the case

With 3,871 hotels and 461,698 rooms, ACCOR covers every segment of the world hospitality market (90 countries), from budget to upscale (see Figure 21). FORMULE 1 is the leader on the low-cost hotel segment. The 371 hotels are mainly located in France (282 hotels and 20 924 rooms), Europe (44 hotels), Africa/Middle-East (24 hotels), Asia Pacific (22 hotels).

Figure 21: Hotel portfolio by brand - Breakdown by number of rooms (at December 31, 2007).



Source: http://www.accor.com/gb/groupe/activites/hotellerie/chiffres/chiffres_hotellerie.asp#

The group ACCOR is an innovative company. Several times it has been a pioneer for the hotel industry:

- The “Formule 1” concept, a new hotel concept based on particularly innovative construction and management techniques, was considered as a radical innovation for the hotel industry;
- The “Académie ACCOR” was France’s first corporate university for service activities (1985);
- In 1998, ACCOR proposed an “Hotel Environment Charter”;
- The first energy saving guarantee contract was signed in France in 2002.
- The “Formule 1” concept is not only innovative but also the main successful example of an industrialised concept in the hotel industry.

The creation of Formule 1, the low-cost brand

Sources of the project

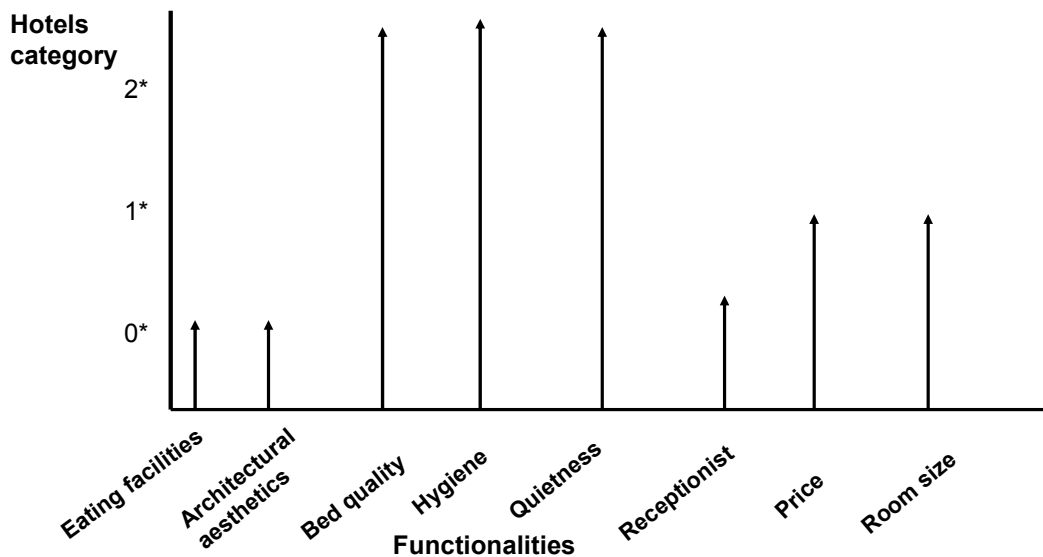
The creation and development of Formule 1, ACCOR’s chain of budget hotels, results from the decision of the top executives who intended to cover the low-cost segment. To implement this strategy aiming at developing new market space which was so far imperfectly served, they raised four questions (Kim et Mauborgne, 1997):

- 1 What factors are taken for granted by the hospitality industry and should be eliminated?
- 2 Which factors add little customer value and should be reduced?

- 3 Which factors create significant value and should be increased?
- 4 Which factors should be offered that are not currently available in the budget market?

A market survey and the enquiry of one of the project managers, who stayed in low budget hotel to understand the needs and expectations of the customers, revealed that they were expecting clean rooms with showers, TV and good insulations. These customers who traditionally stayed in low-budget hotels, really valued bed quality, hygiene, and quietness but did not find other factors such as on-site restaurants and architectural aesthetics particularly valuable. Consequently Accor's managers decided to withhold amenities such as on-site restaurants and architectural aesthetics that were less valuable to customers. Conversely they offered much better quality than even two-star competitors in the areas most valuable to customers (bed quality, hygiene, and quietness) at a price comparable with those of one-star hotels. The Figure 22 below highlights this strategic approach. For example, almost no eating facilities were offered in order to reduce the ratio private space / collective space⁶.

Figure 22: Functionalities of Formule 1 hotels and valeur d'usage hôtelière (adapted from Kim and Mauborgne, 1997).



The same strategic analysis was developed in 1999 before launching "Suitehotel", the brand proposing 30 m² modular suites for the price of a conventional midscale room. The managers evaluated the critical activities that could modify the business activities of three stars hotel and produce greater value for the customer. Rather than benchmarking to three star hotels, they radically deformed the industry value curve and emphasized attributes such as room size and facilities. To maximize the value for their target market, they designed a room with a size bigger than a four stars hotel, with more facilities than a three stars and for the price of a two/three stars (Dumont, 2001).

Characteristics of the design process: an example of concurrent engineering

The project team of group ACCOR

A functional reflexion based on a critical evaluation of all activities within the value chain was carried out by two executives named by the direction of

⁶ Only breakfast are served at the cafeteria located at the entrance of every hotel.

group ACCOR. They concluded that this new concept should be placed in rupture with other hotel occupying the budget market.

To be able to add value to budget hotels without modifying the price offered, it was necessary to minimize construction costs. The aim was to follow the rule established by Conrad Hilton in the sixties. According to his rule of thumb: *'If the construction cost is X then the price of the room has to be X/1000'* (Dumont 2001: 129). This economic constraint required to be innovative and to industrialise the process. It seems that only "repetitiveness" would lower the costs of construction.

The project managers had also to face a time constraint. They wished to construct rapidly the chain of budget hotels. The aim was to offer customers the same product wherever they stay and to keep their competitors away from the market.

A project team made up of an architect, a technical manager that was supported by the technical direction of the group, an operating manager and a construction manager, was constituted around the project managers. This team did not work within the traditional boundaries of the group. This decision aimed at circumventing potential resistances which could have appeared within the group. For example, the managers of IBIS' chain feared that the project cannibalised their chain. This development apart from the structures of group ACCOR limited the risks of resistance on behalf of the teams in place which perceived the project like a threat on the development of their daily activity.

The project team wrote the functional requirements which would be used as a basis for selecting the preferred contractor. Thus the invitation to tender was not based on binding tenders but on proposals on how the needs of the group ACCOR could possibly be met. However the client suggested some solutions (Ben Mahmoud Jouini and Midler, 1996):

- The sanitary block had to be placed outside the rooms in order to reduce both operating and maintenance costs;
- The rooms had to be equipped with individual heating (this requirement limits both capital and maintenance costs);
- The cleaning costs had to be limited;
- Industrialisation was recommended.

The collaboration between the preferred bidder and the project team of the group ACCOR

A contractor, DUMEZ, was selected as the preferred bidder because of the quality of its technical answer and its ability to maintain the functional requirements established by ACCOR's project team

Since the seventies this contractor had developed several concepts of prefabrication. In-house working groups gathering engineers and architects had already developed main-frame industrialised processes. This led to the development of prefabricated panels that were assembled on the building site (DUMEZ successfully implemented its approach in markets such as Iraq and Saudi Arabia).

The original proposal written by DUMEZ exceeded 50% the costs of objectives laid down by the project team (Ben Mahmoud Jouini and Midler, 1996). Consequently, a phase of co-operation began for the design of a prototype between this company and the project team in order to develop solutions which lower the initial costs of construction. A contract was signed between the two actors for fourteen months. But most of the time the client and the contractor went beyond their contractual agreement. The two partners rapidly trusted on another and worked with an open book approach. This information disclosure preserves the stability of the agreement and favours in-

novations. ⁷ Indeed the financial impacts of any new proposal were rapidly computed.

Concurrent engineering: an organisation stimulating innovations

The economic viability of the project was very uncertain after the selection of the preferred bidder. Consequently the stake of the collaboration consisted in optimizing the design of the hotel in order to industrialise the construction process and to limit the future exploitation costs. This stimulated innovations during the course of the project (Ben Mahmoud Jouini and Midler, 1996):

- The design, construction and operations team work closely together to take into account operating procedures and costs. For example, the room was designed to be easy to clean and to fulfil hygiene requirements.
- The contractor assigned a team of three employees at the design stage to coordinate the relationships with the finishings companies and the client.
- Any evolution at the design stage was carefully examined by the contractor who had to evaluate the economic impact of these changes.
- Both the client and the contractor were responsible for the design. Each actor brought its core competences: hotel trade for the client and construction for the contractor.
- At the design stage, the actors aimed at industrializing all the elements of the building. This concerned particularly the circulation of the fluids and the sanitary block.
- The finishings companies which had been selected by DUMEZ for the project were also involved at the design stage. They developed new design competences and went beyond their usual activities of execution. It was the case of a plumber who collaborates with the client to develop a new device that isolates the distribution of the fluids from a block of rooms. These subcontractors were regular partners of DUMEZ. They were selected for the competences that they brought to the project. Their activity was coordinate by DUMEZ. Conversely standard products such as TV, were bought from ACCOR regular suppliers.

Six months after the selection of the contractor, the construction of the first prototype started. The employees working on the building site were not specialised in one task. For the purpose of the project they had to develop several competences. For example, the employees who assembled the panels also posed the cables.

Despite the six months spent at the design stage, the first prototype required 5000 working hours to be built. The goal of the client was laid down at 2500 hours. The optimisation which followed, contributed to lower the execution time to 3500 hours for the second prototype. For eight months a value analysis was developed within the project team and showed the economic viability of the project. The prefabrication of the sanitary block contributed to reduce the construction costs. The project team was also able to reach the construction cost which was initially targeted because all the people involved in the construction of the three first hotels were the same. This entails learning among partners.

Characteristics of the construction process of the hotels

To avoid relying on a single contractor, group ACCOR worked at the construction stage with two other companies:

- VERCELLETTO, a SME proposing a solution mixing prefabricated 3 D concrete modules and dry walls;
- HOUOT, a SME which developed 3D prefabricated 3D wood modules.

⁷ "Because of the limited role of the price mechanism and of the uncertainties surrounding the appropriation of rent, information disclosure will be essential to the existence and stability of hybrid forms" (Menard, p.159, 1996).

Whereas the approach designed by VERCELLATTO and HOUOT consisted of the prefabrication of 3D blocks transported then by road, DUMEZ privileged the assembly on site of prefabricated panels. DUMEZ benefited from its experience on foreign markets.⁸

50% of the market was attributed to DUMEZ which took risks at the design stage when the profitability of project was not proved yet. It worked with a network of regional contractors to assemble and arrange the hotels. It also managed the supply chain (bed linen, televisions and electric connections).

The industrialised approach which was defended by the project managers since the first stages of the project, contribute quickly to the development of the chain. It also prevented the reactions of possible competitor projects.

Knowing that there are 282 hotels in France and that on average each hotel is composed of 72 rooms, more than 20000 blocks were thus built for the French market. This industrialised process was applied until the middle of the Nineties. Since no similar project was launched on such a broad market. The industrial know-how acquired by the three contractors thus disappeared.

This industrial concept was duplicated partially within the group ACCOR. After launching "Formule 1" in France, ACCOR sought to export this concept to Germany. But ACCOR was not allowed to duplicate it. Indeed the German regulation concerning the hotel industry stipulates that the showers have to be inside any hotel room. Consequently, a different version was designed for Germany. The sanitary block was inside the room. This led ACCOR to launch a new brand in the budget segment: ETAP Hotel. However the industrialisation only concerned the first hotels of this chain.

Moreover all the "Formule 1" hotels which operate abroad were not built according to an industrial logic. In certain countries like South Africa, ACCOR often does not own the hotel. The group prefers to develop franchise agreements with local managers. These latter benefit from the reputation of the brand but they do not adopt the construction techniques used for the French market.

This first industrial approach had a strong impact on the following construction projects of the group ACCOR. For example sanitary blocks were prefabricated for the first time for "Formule 1". Then this approach was used for the majority of the hotels of the group.

The quality of the marketing study carried out before the design of the hotel and the strong care attached to the design of the room, contributed to the commercial success of the low-cost chain and to the durability of the concept. This also explains why the evolutions which have affected the chain so far were minor and only aimed at putting the hotels in conformity with the regulation. For example it was the case of the technical installations of fluids.

Conclusion

The two main actors (the client and the contractor who contributed to the design of the room) had different motivations:

- The client wanted to create a new market and to fast become the leader of this market;
- The contractor who already had built several individual housings by using prefabricated panels, wanted to benefit from its competitive advantage and to diversify its market.

The results of the project were very uncertain at the beginning but both actors knew that a strong commitment to this project and a cooperative behaviour would lead to the creation of an innovative concept.

⁸ DUMEZ had built more than 10000 individual housings by relying on its industrialised approach (4000 in Iraq, 5100 in Saudi Arabia and 3000 in Cameroun). It was also in charge of the building site of the National Guard in Saudi Arabia.

Customers were not involved during the design and construction processes. But the group ACCOR as one of the leaders of the global hospitality industry can be considered as a professional user and a good “representative” of the customers, the end user of the rooms.

The case also proved how important is the design phase. Concurrent engineering is not widespread in the construction industry. This approach appears more common in other industries which benefit from economies of scale. Construction is also characterised by the project-based nature of activities project-based production (which means “a high turnover, a reluctance on the part of engineers to recycle designs and an incentive system within the profession, which rewards novelty rather than standardisation” - Gann and Salter, 2000, p.969). In this case the construction process was repetitive like for consumer-goods industries. This led the actors to spend time and money at the design stage. This time has to be considered as an investment and not as a cost.

Finally it appears that arm’s-length transactions were used instead of market transactions. This promoted trust and learning among partners.

The industrial refurbishments of the hotels 'Formule 1'

From the idea to the project

Sources of the project

In 2003, the managers of the low-cost chain thought that it was necessary to adapt the brand to changes in the marketplace. This resulted from the fall of the occupancy rate. This decrease started after 2000 is explained by four elements:

- The competition between low-cost hotels is fierce and requires to be innovative to benefit from a competitive advantage;
- The development of the “35 hours” strongly modified the business model of the hotel chain. 40 to 45% of the customers of the chain are employees who are on a business trip. Because they work less, from now on, they spent three nights per week instead of four in the rooms of the chain.
- Business customers were also not always satisfied with the offer of the chain.
- The chain conveyed a rather negative image and was perceived as not very cordial and dehumanized by leisure customers.

To reverse this tendency, it appears necessary to find solutions to increase the loyalty of business customers and to attract leisure customers. Consequently a refurbishment of the hotel portfolio was launched in order to create a more contemporary room while still offering customers the lowest price in the market. The project aimed at redesigning rooms, the cafeteria and common areas, and reworking the brand’s logo, signage (“Formule 1” is replaced by “F1”) and other aspects of its visual identity (see Figure 23).

Figure 23 (left/right): 'Old triple room'/'New triple room'⁹. The renovation aims at redesigning rooms. (Foto: Frédéric Bougrain).



To be economically viable, the renovation project had to fulfil three principles:

- an industrialised renovation,
- the use of materials and equipment easy to implement,
- a life-cycle cost approach (low maintenance and operating costs constitute key elements which contribute to the profitability of the chain).

The organisation of the design stage

The technical direction considered that only a “Plug and Play” approach was economically viable and would allow an industrialised approach. The brand “F1” was recognized and it was not appropriate to re-examine the external architecture which had proved its reliability. The role of architects and designer was thus limited. Their role was to apply a concept and to support the industrial renovation.

The objective was to reach the same result as the renovation project dedicated to the “ETAP Hotel” chain in 2003 (the furniture of about thirty hotels of this chain were replaced in 2003).

In 2006 eight pilot rooms were designed and renovated in one hotel “F1” located in the Parisian suburbs. The design was satisfactory while the renovation costs were too expensive.

Consequently a project team of six people representing the “Innovation and Design”¹⁰ unit, the architects, the technical direction of the chain “F1” and the marketing department of the chain was constituted to lower the cost of the project by 10%.

An output brief was tested during the renovation of two hotels. The goal of the project team was to evaluate the economic viability of the concept and to test two contractors. The technical and logistics competences of the enterprises constituted the main criteria of judgement.

After the renovation of the hotels, the customers who stayed in these hotels had the opportunity to fill a questionnaire to give their opinion about the renovation and the furniture.

⁹ All photos were taken during the renovation of the hotel F1 located in Rungis.

¹⁰ Created in 1994, the Innovation & Design unit comprises 20 people from different professions. Within the Hotels and Brands Marketing Direction, the Innovation & Design unit plays a key role in conceptualizing long-term hotel and lodging trends and crafting new Accor Hospitality brand concepts. Its task is to foresee new ways in which space is used and develop environmentally friendly materials and technologies aligned with customer needs and concerns.

This long iterative process which involved several actors is similar to the process that led to the creation of the chain. Concurrent engineering was one of the key words of the renovation project. The length between the decision to renovate the hotels and the effective renovation of the first hotels helps the technical direction to improve its design, to ameliorate the supply-chain management and to optimise the process.

The energy consumption was not considered as an issue by the technical direction. "F1" hotels were built at a period where the energy was already expensive and their insulation is quite good for this category of hotels. Moreover because the chain provides a limited number of services, the energy consumption of the brand F1 is rather limited compared with the other brands of the group ACCOR (table 1).

Table 1: Energy consumption by hotel brand in kWh per day per available room in 2007.

Hotel brand	Energy consumption in kWh per day per available room in 2007
F1	10,8
Etap Hotel	13,7
Motel 6	22,6
Studio 6	24,6
All Seasons	26,0
Ibis	23,0
Suitehotel	28,9
Mercure	38,4
Novotel	48,9
pullman	59,5
Sofitel	84,6

Source: ACCOR's annual report (2007).

The renovation programme

Organisation of the industrialised renovation

The refurbishment project will be completed in 2010. It mainly aimed at re-designing rooms, the cafeteria and common areas, and reworking the brand's logo. It will concern the 282 hotels of the chain.

This project which will last for three years can be considered as one of the first industrialised projects dedicated to the renovation of buildings. The organisation of this three year programme was handled by the technical direction of the hotels "F1".

A three year contract was signed with the contractors who answered to the invitation to tender.

Seven people of the technical direction work on this project: Among them three project leaders, one employee focusing mainly on signage and other aspects of the visual identity, and the technical director. Two other employees of the group working with suppliers were dedicated to this project.

To minimise the costs of the renovation, the hotels of the chain "F1" were gathered in regional batches. Each of these batches was then entrusted to a project team including:

- One of the three project leaders,
- One contractor (sometimes a local finishing company who has already worked with the group ACCOR is involved),
- A technical designer,
- One coordinator in charge of OH&S (Occupational Health and Safety),
- An audit office.

The technical director of the hotels “F1” supervises the renovation program. For all the batches, there is one audit office.

To prevent accident on the building sites, a partnership was elaborated between OPPBTP (a professional organization in charge of promoting improved health and safety in the construction industry). Its mission is to encourage companies to adopt a safety culture and to change safety behaviours on the building site. The employees who will be involved in the renovation projects will be encouraged to develop positive safety attitudes. The aim is to increase risk awareness and preventive behaviours.

The raison d'être of this partnership is to improve quality and productivity. Indeed, the technical direction of the hotels “F1” considers that staff awareness lead to performance and better quality.

At the end of each renovation, a questionnaire designed by the technical direction of “F1” is sent to the employee in charge of operating and maintaining the hotel in order to measure his satisfaction during and after the renovation. In case of dissatisfaction, measures can be taken to improve the approaches of the project teams for the following renovation sites.

Ten contractors and five technical designers were distributed the batches which are controlled by three project leaders of the chain “F 1”. This organisation aims at maintaining competition among the contractors.

A project based on organisational innovations

To optimize the productivity of the building site and to promote learning, the technical direction set up several disposals:

1 Long-term contracts.

The technical direction signs a contract starting in 2007 and ending in 2010 with all contractors. It provides partners with opportunities to learn from one another. It also contributes to the establishment of common codes of information between partners. By providing the actors involved in the renovation project with an identical set of references, it favours communication, develops the stability needed for exchange and enhances the efficiency of coordination.

Long-term planning (until 2010) results from the decision of the technical direction to adopt an industrialised approach. Construction is often characterised by the lack of continuity of teams that is essential to efficient working. This kind of framework agreements aims at tackling this problem and at improving efficiency and quality. In this case the standardization of the hotels of the F1 chain and the fact that most hotels were built at the same period, opened the opportunity for an industrialised renovation.

Conversely the redesigning of the cafeteria was very specific to each hotel. Customisation is the only way to handle the renovation. Thus three industrial companies were selected over the duration of the renovation project to arrange and pose prefabricated equipments (see Figure 24).

Figures 24: The cafeteria and the reception desk before and after the renovation. (Foto: Frédéric Bougrain).



2 A “Plug and Play” approach

The same process is used for the renovation of any hotels of the chain. Only sixteen rooms are blocked in order to keep the hotels opened. Each week eight rooms are released and eight new rooms closed in order to be renovated. This fast rotation results from a “Plug and Play” approach. Once the companies have carried out painting and plaster works, the equipment is delivered and posed. No layout is necessary. All tasks are done in close relationship with the operating manager of each hotel who has to inform the customers.

3 The supply-chain management of the building site: a Just in time approach

Several manufacturers have been selected. For strategic batches such as furniture, this strategy avoids being dependent from one supplier. Each contractor can also rely on a stock corresponding to the renovation of sixteen rooms. The aim is to avoid an interruption of the supply chain. Typically there are three containers for each building site in order to store equipments and materials. The containers are empty the first day but the companies are in charge to fill it with the furniture and equipments that are delivered the first day of the building site. The containers were supposed to allow the renovation of 35 rooms. Every four week a new delivery is organised by ACCOR which is in contact with its own suppliers. However, this typical scheme does not always correspond to the approach adopted by the contractors which have the freedom to adopt a different organisation. For example one contractor prefers to store in its own company the equipments and materials. His approach proved to be more efficient (see Figure 25).

Figures 25: Containers storing equipments and materials. (Foto: Frédéric Bougrain).



4 The presence of a “back-up” company

An eleventh company which is not “titular” of one of the seventeen batches can be called and replace one contractor who encounters temporary difficulties during the renovation of the hotels. It already happened. The objective was to enable the failing contractor to modify its organisation in order to improve its efficiency. This company answered to the invitation to tender but was not selected because its price was above the price targeted by ACCOR. In the past, it already worked with ACCOR. Consequently the technical direction of F1 decided to keep this company in case of problems.

Difficulties during implementation

According to the technical director of the hotels F1 among general contractors there is a lack of organisational know-how. For example, 19 hotels were already renovated in 2007 (84 are planned in 2008). It appears that several companies have difficulties in planning repetitive tasks.

Another major difficulty encountered by the contractors relates to the “acceptance”. At the end of one task the client and the contractor are supposed to check and agree on the quality of the work. But most contractors tend to delay this checking to the end of the renovation. To put an end to this waste of time, the technical direction of the hotels “F1” imposes building site meetings and “acceptance” every fifteen days. It also asks the contractors to send the minutes of these meetings within forty-eight hours and to do the checking between two meetings. The aim is to avoid spending too much time at the end of the renovation. Moreover checking all the rooms at the end of the renovation would be difficult because they are occupied again.

To improve the organisation of the building site, the technical direction wrote an operational guide presenting the procedures and the best practices. All tasks that have to be implemented are presented in a chronological way. The technical direction was in charge of this guide but it also collaborated with the technical designer, the general contractor and the operating managers. The objective was to formalise the steps which usually remains tacit. It was also one way to transform tacit knowledge into codified knowledge and to improve the productivity of the renovation project.

Moreover a “toolkit” presenting all the equipments and materials has also been conceived by the technical direction in order to improve the delivery on the renovation sites.

The case of the F1 located in Rungis

This hotel is located around the airport of Orly and the huge logistic platform of Rungis. Before the renovation, the hotel had 72 triple rooms. After the renovation, the hotel will offer 56 triple rooms and 16 double.

Figures 26: New double rooms. (Foto: Frédéric Bougrain).



The actors of the building site

This was the sixth renovation that gathered the same group of actors:

- The building company employs 120 people with a turnover reaching 20 millions euros. It is in charge of 2 of the 17 batches. It is mainly specialised in paintings.
- The project manager works for the technical direction of F1.
- The architect who is in charge of supervising the renovation project works with ACCOR since 1988. He is involved in two batches. His role is mainly to coordinate building meetings, to write and send the minutes of the meetings in a standardized way to the technical direction and to take part to the acceptance. He is also responsible to draw the draft of the cafeteria. Indeed there are three types of cafeteria for all the hotels of the chain. But the specificities of the sites may differ from one hotel to the other.
- The electrical company employs 35 people. It has worked with ACCOR for the last four years. It works on the same batches as the building company.
- The company in charge of renovating the cafeteria. It works only one week and has just to plug the furniture and the equipments that it receives on Monday.
- A security company deals with all ICT and video-supervision matters.

The planning of the building site

The building site started the 30th of June 2008 and will be finished at the beginning of September. Three empty containers and a wagon for the waste were delivered by ACCOR the first day. The planning of the building site is the following (table 2):

Table 2: The planning of the renovation (10 weeks - 72 rooms).

Weeks	Tasks to be done
30 June – 13 July	Renovation of 16 rooms
14 July – 27 July	Renovation of 24 rooms
28 July – 10 August	16 rooms and beginning of the renovation of the cafeteria
11 August – 17 August	24 rooms and intervention of the company in charge of plugging the equipment of the cafeteria
18 August - 24 August	Renovation of 24 rooms
25 August – 7 September	Final acceptance

This planning differs from the initial approach developed by the technical direction which thought that a maximum of 16 rooms would be closed every

week. This change indicates that companies learnt from one project to the other.¹¹

Only 16 rooms are renovated at the beginning because building companies have also to spend time receiving and storing the furniture and the equipments. Similarly when the building companies prepare the field to the company in charge of plugging the elements of the cafeteria, only 16 rooms are renovated.

The renovation work is not complex but working in occupied buildings requires lots of care. Users of the hotel are still occupying the hotel during the renovation. Thus companies have to avoid making noise in the morning and to respect the planning. Otherwise the hotel manager will have to refuse customers who have already booked (see Figure 27).

Figures 27: Renovation works. (Foto: Frédéric Bougrain).



The learning effect

All actors learned during the initial stages of the renovation programme which was launched in 2007:

- The management of the supply-chain improved a lot over the course of the project. During the first renovation project, companies did not consider that the reception of the equipments and furniture was a key element. Containers were rapidly full and employees wasted lots of time in looking for the elements that they needed. Elements such as carpets occupied most of the space of the containers. The contractor even failed during the first renovation project. Thus for the following renovation projects, ACCOR asked the back-up company to work and the contractor to focus only on one of its two batches. To circumvent the bottleneck due to the delivery and the lack of space in the containers, it focused on the reception and decided to store the carpets in its own buildings. Then it uses its own truck to deliver the carpets just on time. Similarly the electrical company stores the flat screens of the TV in its own buildings. It also avoids stealing on the building site.

¹¹ During one previous renovation work, enterprises were able to renovate 30 rooms in two weeks. This decision allowed the hotel to be totally opened for two weeks at the peak season in the middle of the renovation project. Moreover the renovation ended two weeks earlier.

- ACCOR also modified its deliveries which increased from two to three. It enlarged the space available in the containers and the productivity of the people working on the building site.
- The initial planning indicated that 16 rooms had to be closed for renovation for two weeks and that 8 new rooms had to be opened every week (see Table 3). But companies decided to renovate more rooms (up to 24 rooms in two weeks) in order to benefit from economies of scale (see Table 4).

Table 3: The initial planning.

Weeks	Tasks to be done
1st week	Delivery, reception and renovation of 8 rooms
2nd week	16 rooms are being renovated
3rd week	8 rooms are opened, 8 are in their first week of renovation and 8 in their second week
.....

Table 4: Comparison of the number of people employed to renovate 16 and 24 rooms.

People required to renovate 16 rooms	Extra people required to renovate 24 rooms
3 or 4 painters	1 painter
3 fitters	-
2 or 3 electricians	1 electrician
1 plumber	1 plumber

The operational guide presenting the procedures and the “toolkit” which were developed after the first renovations of the hotels helped the enterprises to improve their productivity. This is a very sensitive issue during holidays. During this period most enterprises employ temporary workers. Thus these guiding materials helped these employees to have a better understanding of their tasks.

Showers and toilets are not any more painted (the painting was not appropriate). A strong cleaning is carried out.

The acceptance is done every two weeks when rooms are opened. The aim is to avoid companies to come back on the building site once finished and to be free to start the renovation of the next F1.

The building company also improved its waste management by identifying recycling opportunities. It selects the wastes and tries to find local associations which can be interested by some items of the hotel (such as mattress, see Figure 28). At the beginning wastes of twelve rooms were stored in one container. But now better waste management allows the contractor to store twenty-four rooms and to decrease the transportation costs until the recycling platform.

Figures 28: Mattresses are stored outside before being handed over by local associations. (Foto: Frédéric Bougrain).



Conclusion

“F1” technical direction launched an ambitious renovation programme to modernise the brand and to strengthen its leadership in the low-cost hotel segment. It was decided to implement an industrial renovation in order to lower costs. Long term contracts were signed with contractors to favour communication, develop the stability needed for exchange and enhance the efficiency of coordination.

In construction learning is often limited. The fragmentation that usually characterises the industry prevents the continuity of teams and learning from one project to the other. Conversely this unique case shows that learning is possible when tasks are repetitive and teams similar. But learning effects were optimised because the client drove the process. It coordinated the renovation sites and elaborated tools that favour learning. The decision to sign long term contracts with the contractors and the “Plug and Play” approach also allowed enterprises to improve their productivity and the organisation of the renovation site.

Even if such industrial renovation is quite unique and cannot be widespread, it shows that clients can get better value for their projects when they play a pro-active role during the construction process.

Discussion and conclusion

By Marianne Forman, Kim Haugbølle & Frédéric Bougrain

Setting the scene

The project resulted in new knowledge about the interplay between consumption and production within in the construction sector. Special focus is put on the mediating process between product criteria and user demands in the design process and the transformation of the companies in the construction sector, when they combine new innovation strategies and new industrialisation strategies. The results manifested themselves as strategic recommendations to the construction sector about what does and what does not work in the transformation of the companies and their network relations. The result of the project may be seen as new knowledge for authorities, innovatively oriented companies (or investors in new companies) and clients, who may plan their activity with a greater probability of success.

For a long period industrialisation was considered the way to increase productivity in the construction sector, but it did not grow as expected. The main question is now, where do we go from here?

The aim of the project is to examine the interplay between user-driven innovation and industrialisation strategies in the construction sector from user needs to mass customisation. By focusing on cases in the construction sector that deal with system deliveries (Maisons MACCHI, BoKlok), industrialised work methods (ACCOR Hotels) and configurations aspects (HTH and Rockwool), it is possible to identify central preconditions and mechanisms that have worked in the transforming process. The project aims to transfer the identified experiences and mechanisms into strategic aspects so that they can be taken into account in the decision-making process in companies and in developing public policies for industrialising the construction sector.

It is this project's assumption that there are many strategies for industrialisation in different business models. Central aspects of the strategies for industrialisation are innovation, cooperation, differentiation and integration within and between the companies and customers. Much experience already exists, but it is necessary to accumulate it and learn from it.

User-driven innovation

User-driven innovation refers to how users' acknowledged and unacknowledged needs can be a basis for innovation. User-driven innovation is often mentioned as a more direct involvement of the user/consumer in the innovation process, either through observation processes, tool kits, or a DIY approach. The aim is to understand not only the stated, but also tacit consumer needs and focus more on developing solutions to meet consumer needs. A report from the Nordic Council of Ministers (TemaNord 2006) distinguishes between "the voice of the customer perspective" and "the lead-user innovation perspective". The voice of the customer perspective refers to innovation that takes place in a company often with external support and by using multiple skills e.g. by adding actors as ethnologists, anthropologists or others.

The lead-user innovation perspective refers to innovation that takes place outside the company.

There are various factors that should be considered in a discussion of who the users are. In connection with acknowledged needs of users, it is feasible to identify specific users with specific characteristics / features, where these users will be carriers of the needs. In this context it may be relevant first to identify the user groups and then to assess whether their needs have a broader support among a wider audience of users, either by the growing of the user group, or by other user groups having the same needs. In this context the analysis can benefit from the lead-user approach.

In connection with unacknowledged needs, the needs are embedded in values, cultures, technological opportunities as potential needs. At this stage there is not necessarily user groups in existence. The articulation of unacknowledged needs and the constitution of user groups are parallel processes and the development will take place through interaction between various actors who interpret and negotiate the "needs" rather than identifying their needs. In this context one cannot necessarily point to an existing user, but should rather focus on the forming process of "needs" and "user groups". In this context the analysis should rather draw on the social construction approach to catch the understanding of the shaping of the users.

In this project, both approaches have been used depending on the nature of the cases. In the project the term 'users' is limited to clients and end-users of the products and the point of departure is that "users" have to be a part of the innovation process, but do not need to drive the process in the sense that they must necessarily be the front actors. The question is how the users influence the development.

Context

Concerning the construction business system the analytical focus on the supply chain, project-based firms and projects (see Figure 2 in Introduction) but with attention to the interplay between the system level and actor level (see Figure 3 in Introduction). The actors in the cases are manufacturers (Rockwool and HTH), contractors (Maisons MACCHI, BoKlok) and a professional client (ACCOR Hotels). It is normal to distinguish between the actors who produce building materials and actors who plan and build houses. One reason is that producers of building materials are organised as industrial companies while consultants and construction companies are project-organised companies. In that sense the change towards increasing system deliveries is not only a change of materials and products but also has to be considered as a change in methods of production and traditions. For instance, if a bathroom is pre-manufactured off the construction site, the production environment changes from being project-organised to being industrialised.

The users' role and function in innovation – Who are the users?

The cases show different methods to identify "users" and "user requirements" and show different user roles in the innovation process:

- Users can be constituted by Society's demands, focus groups, market surveys, a competitors' target group, lead-users. They can be more or less constituted and be more or less stable. In that sense "the users" exist as social categories that can be the objects for interpretation and negotiating.

- Generalised users can be used to target a concept in the innovation process e.g. BoKlok and the low-energy houses of Maisons MACCHI. Collaboration with lead-users can give direct access to user requirements and preferences concerning building process and product e.g. Rockwool, where the employee act as lead-user and ACCOR Hotels, where ACCOR Hotels as a client act as a lead-user.
- The cases show that users - both lead-users and generalised users can contribute to innovation in the construction sector. The OECD Oslo Manual identifies four different types of innovation: product, process, organisational and marketing innovation. The cases show that innovation within all the four types of innovation can take place with involvement or representation of lead-users and generalised users.

BoKlok is a classical example of traditional market research. Identifying different user groups and conducting a market survey among a segment provided BoKlok with valuable information of what the important design criteria are. The users were not directly involved in the innovation process to any significant degree. Thus, the users played a predominant role as data sources, leaving aside the development activities for the development teams in IKEA and SKANSKA. But the case of BoKlok is interesting in two other aspects. First, this approach differs substantially from the usual process of designing a house with a specific client and a specific location in mind. It is rather rare to witness an innovation process where the development takes place *between* the individual building projects and not *within* the individual building project. Second, this approach also differs significantly from the usual design process of housing in which the users generally (at least in Scandinavia) will be involved in the design process through different types of e.g. workshops, hearings, user groups etc. Consequently, the approach may be characterised as an approach, where BoKlok shaped a new user "house owner with low income".

In the case of HTH, the company has identified an existing user at the market by looking at one of their competitors. A user who wants to design his kitchen himself by means of a configurator. The case of HTH, the company provides the customer with the use of a configurator to design their own kitchen on the basis of modules. This gave rise to a discussion between HTH and the shops selling the kitchen, about user competences due to internal relationship and division of labour between HTH and the sales people; they ended up constructing a user with competence to make only a raw design of the kitchen. The final design is still made by the sales people.

Rockwool uses an employee in the role of lead-user by following his private building project of his own low energy house. This gave Rockwool direct access to the users' preferences through the users' choice during the building-project concerning the building process and the product. Rockwool communicates the building project on their homepage as a part of their marketing. Running evaluation of the marketing concept and the direct contact from users to the employee caused the company to identify a new user group "Do it yourself do it for me". They constituted the new user group as a group that demands information so that they could qualify themselves to control their own building projects, but still with professionals to do the practical work.

In the case of ACCOR Hotels, the client acts as a lead-user and drives the renovation of the hotels. They put forward requirements to the renovation process and the product. This made it possible for the collaborators who work with ACCOR Hotels during the project to identify user requirements concerning the process and product.

In the case of Maisons MACCHI, the company owner shapes the user and the user is constituted with different needs, which the company owner has identified as important future requirements. Firstly demands concerning reduction of the building's energy consumption, which is implemented through new regulation. Secondly a common demand about quality. As the user is shaped by the company owner, the user did not participate directly in the innovation process at the company and in the company's network but the user is represented in the company owner's choice of product and in the implementation of a quality management system.

Power of context

The constitution of a user depends of the construction system and the stability of the construction system depends on the market. As illustrated by several of the case studies, the context plays an important role in shaping the direction and potential of industrialising construction and the market. The project shows different relationships between on the one hand the constitution of users and the context of the construction system and on the other hand the development of the construction system and the market:

- The constitution of "users" depends on existing traditions in the construction sector and the companies' readiness to change. Existing traditions include the strategic orientation of the companies, the division of labour, communication and collaboration forms in and between companies and methods to interact with customers.
- The strength of a "user" as a social category depends on a responsive supply chain. The strength of a user is shaped, on the one hand, by existing traditions within the companies and among the companies and customers, and on the other hand, by pressure put on the companies to introduce user efforts through growing requirement to the value of the products from external and internal actors, including governmental regulation.
- The constitution of a user can be both supported and repressed by the construction sector, as the constitution of a user depends on a responsive supplier system and product. It can be question whether a user as a social category exists if there is not is an adequate production system and a product.
- The constitution of a concept/product and a company/supplier chain can be both supported and repressed by the market, as the stabilisation of a concept/product and a company/supplier chain depends on a responsive market in the sense of need, needed infrastructure, policies, etc.

Skanska is a contractor usually working in a project-oriented way. In the case of BoKlok, Skanska and IKEA developed a new concept of owner-occupied homes for low income groups. By so doing, Skanska moved toward industrialised production of cheap houses and at the same time supported the development of a new user group "house owner with low income". At the same time the export of BoKlok from Sweden to other Scandinavian countries like Denmark may from the outset be considered to be unproblematic due to the proximity of the countries both in terms of geography and culture. However, it turned out that significant differences do exist with respect to the demands and aspirations of housing users and public authorities in different countries. Consequently, adaptation of the housing concept of BoKlok needed to be taken into account if the concept were to succeed outside

Sweden. Thus, the context of the market has shaped the concept of BoKlok in two important ways. First, the exterior of the housing concept needed to be redesigned in order to suit the local context of Denmark e.g. facades and windows. Anticipating the problems of getting a building permit in many municipalities, BoKlok decided to have the exterior redesigned by one of the leading Danish architectural firms. Similarly, BoKlok needed to redesign the concept in order to adapt to British building traditions. We may speculate that a similar adaptation needs to be undertaken if the BoKlok concept is to be exported to France, which to a large extent favours heavy-built structures of concrete. Second, the interior of the housing concept needed to be redesigned in order to accommodate differences in user preferences with respect to e.g. toilet rooms. These user preferences are not necessarily clearly expressed from the outset, but may emerge when the concept is applied in a different national context.

HTH is a manufacturer that introduces a configurator that targets users who want to design their own kitchens. HTH did not change their existing work methods and relationship between the factory and the shops, but the introduction of the configurator put pressure on the company to change the existing structures. Depending on whether the company chose to change the structure or continue with the existing practice, the constitution of the "user with design competence" will either be strengthened or repressed. At the same time the context of users has played an important role for the development of practice at HTH. The case has illustrated the importance of being able to make valid measurements of dimensions and similar in e.g. a kitchen. Clearly, this is obviously not an easy task, but rather a time-consuming process that demands a high level of rule following in order to succeed. First of all, the dimensions of the kitchen are not prefixed by the manufacturer but rather dictated by the existing building. As a consequence, the kitchen manufacturer has to pay much more attention to the context. Second, the tolerances of kitchens are very high. The dimensions of the walls, ceiling and floor of a kitchen in a 50-100 year old building are not likely to be overly precise or accurate. Consequently, the amount of measurement data required to correctly process and install kitchen cabinets is very high. As we saw in the case of HTH, the detailing of the design can take as much as 6-10 hours.

Rockwool is a manufacturer. Because of changes in the energy regulation they introduced a new marketing concept that would satisfy the customers' uncertainty. Through use of the new concept they discovered a new user group "Do it yourself - do it for me". To comply with this new user group, Rockwool had to change their relationship to the other manufacturers from being independent to alliances. Depending on the strategic choice that Rockwool has to make, the constitution of the new user group will be either strengthened or repressed. Most likely Rockwool will not take this step, and there is a risk that the user group will disappear because of a missing responsive supply chain. At the same time one of Rockwool's traditional target groups, the architects, play an important role for Rockwool's choice. One of the characteristics of architects is that they want freedom to choose the various building components by themselves. By linking different building components, Rockwool risks that their products will be perceived as having closer connection with some than with others.

Maisons MACCHI is a manufacturer. Due to the growing attention paid to building's energy consumption and a wish to better the working condition on the building site, the company introduced a new concept of prefabricated walls. In the case the manufacturer supported the constitution of a user with low energy house preferences. At the same time Maisons MACCHI is very

dependent on development of an adequate policy and regulation of the energy area.

ACCOR Hotels is a major professional client. Because of its size and internal competences in building projects, ACCOR Hotels had the option of choosing work methods in the renovation process. The contractors participated in the process coordinated by the client. The client represented a user that demanded industrialised work methods. Depending on the contractors' adoption of the work methods into their own organisation, the constitution of the user demanding industrialised work methods will be either strengthened or repressed. The experience showed that the contractors did not adopt the work methods as practice. If clients have preferences like this, they have to articulate their demands in the same way as ACCOR Hotels.

The role of governmental regulation

This part analyses the role of different types of governmental regulation for shaping user-driven innovation and industrialisation in the construction sector. By governmental regulation is also meant regulations issued by other actors than local or national governmental authorities. The cases show several examples where a different type of governmental regulation has been important as a driving force or barrier for shaping and embedding initiatives in the construction sector.

The analyses of the cases have identified the following types of governmental and international regulation as important for shaping and embedding the initiatives:

New regulation initiatives can be interpreted as articulation of future user demands, as they shape the frame for developing new user preferences. They are not articulated by the users themselves but by spokespersons for the users e.g. companies who interpret the regulation and translate the regulation into merits of products. In the cases of Rockwool and Maison MACCHI, the new energy performance requirements to buildings play an important role as being the occasion of the companies' initiatives.

National building regulations guide building design. In BoKlok's export of the concept to Denmark and England, BoKlok had to align their concept with the Danish Building Regulations.

Local politics, plans and their administration play an important role concerning who has access to drive a building process. In the case of Rockwool, the user was capable of negotiating with the local administration due to his professional competence as a building engineer. It would have been difficult for him without his professional skills. In that sense the local municipalities work as a gatekeeper for user-driven innovation.

There is not a simple relationship between regulation and user preferences. In the case of Maison MACCH, the regulation already existed, but the users did not arrive either because they did not exist or because of lack of information or lack of priority. These houses are usually more expensive than traditional ones. In the case of BoKlok the experience was the opposite. The users in Denmark already existed and were very interested in buying BoKlok homes, but it has been very difficult for BoKlok to get access to building sites and building permits from the local authorities.

Industrialisation requires collaboration between various actors

Industrialisation in construction has been on the agenda for more than 50 years. Whereas industrialisation has previously largely been interpreted in terms of factory mass-production of buildings and building components, recent developments suggest a much broader approach. Not least that the market has to play a much bigger role in the industrialisation process (Jacobsen, Peter Holm and Kreiner, Kristian 2009).

Industrial processes deal with the conflict between efficiency and flexibility. Nick Blismas wrote: " 'Efficiency' describes an understanding of value, the elimination of process and material waste, the synchronisation of supply chains, and the continuous improvement of process and product. 'Flexibility' alludes to delivering customer-controlled solutions – now and in the future." (Blismas 2007 p.1).

And continue: "The struggle to resolve the conflict between uniformity and variation, and between maximum standardisation and flexibility, still continues to be a source of tension. The requirement for standardisation to include interchangeability of components highlights that the interfaces between the components are important, rather than the components themselves (Gibb 2001)" (Blismas 2007 p.2).

The section examined industrialisation strategies followed by different actors of the building and construction industry. The cases showed different aspects within the process:

- A successful industrialisation requires collaboration between the actors of the production chain and the market.
- All actors in the supplier chain and lead-users can drive industrialisation.
- There has to be a driver.
- All actors have to find advantages with the process.
- The internet can support possibilities for direct interfacing between manufacturers and users e.g. configurators, where the users work within a closed system and loosely linked systems, where the users work with an open system consisting of a network of manufacturers.

Contractors driving industrialisation

The goal of BoKlok is to sell buildings to low-income groups. To do this, they developed a process similar to what one finds in the industry. The homes have been designed around factory processes that facilitated that they were far more efficiently constructed in quality-controlled conditions. The buildings are transported in 3D to the site where the same team mounts and finishes the homes. They build up feedback systems to ensure continuing improvements concerning the processes and the product. They succeeded in building up an industrial production system in cooperation with actors in the construction sector.

As a part of their business plan, they have to export the homes. They succeeded in adapting to cultural differences between end-users in the different countries e.g. size of windows, bath instead of shower head. The concept was flexible and could be tailored to the differences in local requirements. In the Danish context the barrier for diffusing the homes was not the end-users, but local authorities who have (to sell sites and) issue building permits There are different explanations of why the local authorities did not always wel-

come a BoKlok project in their local area, but the lesson learned is that important market structures can be a major barrier for a successful implementation of an industrial concept. Strategies have to be developed to integrate not only the end-users in industrial concepts, but also stakeholders who shape and maintain market structures.

House producers driving industrialisation

The goal of MACCHI is to sell individual high-energy-performance houses. The innovation concerns the product and the organisation of the building site. The company developed a quality management system similar to what one finds in the industry. The quality management system shaped the frame for continuing improvements in the whole production system from the suppliers to the work on site. Despite the successful implementation of an industrial concept in the construction system, the end-users did not buy the product. The market in France is not prepared for this type of low energy houses. Furthermore, MACCHI is a small company and in general small companies do not have enough money to do marketing and promote their products. This seems to be major barriers for a successful implementation of the industrial concept. To prepare the market for such products, a more stringent regulation concerning energy consumption can be necessary to change the end-users' preferences.

Clients driving industrialisation

The goal of ACCOR Hotels was to renovate the hotels but without spending too much money. The industrialised approach is one way to reach this goal. They designed a process, where they invite contractors to participate in an industrially organised working process. They succeeded with the project, also because of the size of the renovation project. They optimised the concept by using industrialised principles such as repetition and feedback processes for continuing improvements of the process. When the renovation project was finalised, the market disappeared and the principles were not anchored by the contractors. The experience gained became project-dependent.

Manufacturers driving industrialisation

The goal of HTH was to compete with other kitchen producers about the DIY market. They were pressed by the market to introduce a user-configurator, so that the end-users could configurate their own kitchen. At that time HTH already had an industrialised production process, where the shops' orders through a configurator directly linked to the production in the factory. It is an open question whether HTH reorganises the relationship between the shops selling the kitchen and the production of the kitchen so that they get the industrial effect of the user-configurator. The strategic question for HTH is, whether they can handle two different target groups on the market, with different needs and solve internal aspects concerning positions of the different actors.

End-users driving industrialisation

The employee at Rockwool can be seen as an end-user. He built his own house mindful of using well know methods and products to reduce uncertainty. In that sense he used industrial principles. He used prefabrication of different subsystems which he put together to a low energy house. Rockwool borrowed his network of suppliers of subsystems, because Rockwool itself did not want to be a part of a strategic partnership. The market, especially DIY and a new market segment, a critical group "do it your self- do it for me", were very interested in the relationship between the different subsystems, which together made a whole low energy house. In that sense the case showed that it is not only the physical interface between subsystems that are important to focus on in an industrial perspective but also relationship be-

tween products, suppliers (actors) and information. In spite of market needs, it is still an open question whether the materials producers want to form closer strategic partnerships together in order to meet the market needs.

The cases show that when the market-actors drive the industrialisation process it is difficult for the actors in the construction sector to anchor the new structures that ensure the continuing industrialisation. According to the case of ACCOR Hotels, the involved contractors did not transfer the concept of repetitious work-processes to other projects, as they did not see the need. According to the case of Rockwool, Rockwool did not follow the strategy of going into strategic partnerships with the other material producers.

The cases show that when contractors drive the industrialisation process, they build new structures in the construction sector, but they do not reach the market. The market did not change attitude and it was difficult for the contractors to reach a volume, where the production was adequate for the market conditions. Accordingly BoKlok, the institutional framework e.g. local plans hindered the expansion.

Redefining the boundaries of companies, concepts/products and users

New mediating processes between product criteria and user demands put pressure on the existing boundaries between companies, concepts/products and users if the effort has to be stabilised as a new industrial reality. In the co-production of companies, concepts/products and users, the change processes influence the structures within the company itself, between companies and between the companies and the users.

The cases show examples of shifting and change within the overall system such as:

- Functions of design, coordination and workmanship, where parts of the function or the function as a whole move between different companies or between companies and users.
- Division of labour and competence.
- Relations between the various actors, e.g. new partnerships, inclusion or exclusion of actors and new alliances.

In the cases of HTH and Rockwool, there was a pressure towards a shift in design and planning from the sales people and the architects to the end-users. In the cases of Formule 1 and Rockwool, there was a shift in the coordination from the contractors towards a client and the end-user. In the case of BoKlok, there was a shift in the production from the building site to manufacture.

In the case of Rockwool, architects have traditionally been their main target group, because they interpreted the needs of the end-users. If Rockwool chooses to accommodate the needs of the new type of end users "do it yourself – do it for me" and starts to link their own products to those of other manufacturers' products, then the new type of users can guide themselves through the choice of building materials. This new alliance can contribute to added pressure on the architect' role thus creating a shift in competence.

In the case of Formule 1 the client takes over the coordination of the building process which is traditionally done by architects and contractors. This exemplifies the need of a clients for industrialised work processes. If the contractors collaborating with Formule 1 want to accommodate the needs of the client, they have to apply the industrialised work processes in their own organisation, thus creating a shift in function and competence.

In the case of BoKlok, the concept of BoKlok was created by Skanska and IKEA, which constitutes a new type of partnership in the construction sector. IKEA has not been involved in the construction process before, but as it was a lifestyle innovator in the fields of furniture design, production and sale, it injects new competences into the processes.

In the case of HTH, the company is faced with a strategic choice: It can choose to leave the design and planning competences with the sales people which will exclude the users who want to design and plan on their own. Or it can choose to leave the design and planning competences with the users, which will exclude the sales people. At the moment the sales people are in a strong position and not likely to let go of their competences.

The distribution infrastructure of products is important structures relating companies and customers. Rockwool sells its products through do-it-yourself markets that distribute building components in general. HTH sells its product through a franchising system. It seems that distribution infrastructure can be put under pressure to change, if manufactures begin to reflect and integrate user-driven innovation in their innovation work. In both cases a dilemma of strategic character arises. If the customers/users are going to have the possibility for configuring their own products it is obviously the users need to have a closer connection to the manufactures.

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This report addresses user-orientated strategies for industrialising the construction industry.

In the first part, the objectives of the study are described along with the theoretical framework and the research design of the study.

The second part of this report contains five case studies conducted in Denmark, Sweden and France. The five case studies are: The industrialised home building concept BoKlok, a web based product configurator for kitchens by HTH, the innovative potential of the dual role of employees as both user and employee in Rockwool, the application of quality management systems to redesign production and business processes to accommodate for users' requirements (Maisons MACCHI), and the client as driver of innovation on the construction and renovation of the low budget hotel brand Formule 1 of ACCOR Hotels.

In the third part, the discussion and conclusion addresses three interlinked issues related to the role of users, the impact on the construction business system and the reconfiguration of the boundaries between companies, products and users.

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