10 questions concerning sustainable building renovation

In countries all over Europe the need for building renovation is receiving increased attention. One reason for this is an ageing building stock. Another reason is the need for more environmentally sustainable buildings with reductions in energy consumption and greenhouse gas emissions to limit the harmful climate impact. There is at the same time a need to upgrade many buildings to improve the quality of life – social sustainability, for instance improve indoor climate; and to increase productivity in the building process to ensure affordable housing – economic sustainability. Low productivity and frequent conflicts in the construction sector have led to an increasing interest in new forms of collaboration between the different stakeholders involved in construction projects. Development of strategic partnerships concerning a portfolio of renovation projects are seen as a promising way to achieve more sustainable building renovation for some large building clients and for companies with a high maturity in collaborative practice. There is a large number of tools for design decision support and systems for sustainability certification of buildings, but there are not many tools and systems dedicated to building renovation. Measuring the different dimensions of sustainability is a challenge. Regulations play a central role in opening the markets for sustainable building renovation through incentive schemes, building codes, etc. Although traditional approaches to energy renovation emphasize more efficient heating and lighting systems and better insulation, there is a tendency to address the challenge more holistically by emphasizing social targets.
A call for action: Constructing solutions for the sustainable development goals

The Sustainable Development Goals (SDGs) are the current, global call for action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The built environment, hereunder the construction management community, plays a central role in developing solution to meet the SDGs. This paper reports on the findings from a workshop organised as part of ARCOM 2017 conference, where the participants explored “what the academic community around construction management can do to address the SDGs?” The results reveal a consensus that the SDGs are important and that researchers and educators have a pivotal role in addressing them. However, this requires connecting research and education with other domains like policy, industry, technology and civil society. In addition, the suggested strategies all includes social and technological components, including winning the hearts and minds of the wider public and creating international mind-sets, and bridging developing and developed countries. Based on the findings from the workshop, a research agenda informed by the SDGs is suggested. The agenda should cover activities like (1) understanding the complex relationships between different goals, solutions and stakeholders, (2) establishing measures for evaluating progress and impact, (3) formulating specific projects for addressing targets of the goals globally and locally and (4) facilitating knowledge transfer between developed and developing countries.

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A new framework for construction project definition stage

One major reason for the poor performance of construction project delivery is related to the ‘ill’-performed project definition stage. The emphasis on rational decision-making and methods have stifled the creativity important to problem structuring and solution generation. Problem is in the poor conceptualization of the project definition stage in construction. Taking the design literature as starting point, the intent here is to clarify the underlying concepts and principles related to project definition stage, and propose a simplified prescriptive framework for the project definition stage.

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Construction transformation

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Disrupting the ecosystem: The challenges of circular construction

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Identifying Disruptive Technologies in Design: Horizon Scanning in the Early Stages of Design
Technology development is accelerating, driving disruption. Design is seen as key differentiator in creating innovative offerings but few design methods consider future technologies explicitly. In this article, we explore how a foresight method, namely horizon scanning, may be applied in a design context to anticipate disruption of construction. By means of a 3-step horizon scan, we identify 133 potentially disruptive technologies from across industries. We find that when preparing for disruption, design may benefit from the future-oriented and technology-focused features of horizon scanning.

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Is construction ripe for disruption?
The notion of ‘disruption’ and particularly that of ‘disruptive innovation’ is now widely used by researchers as well as management practitioners, and the construction industry is being described as ‘ripe for disruption’. By comparing this industry to healthcare (another massive, societally important industry also considered ripe for disruption), this paper applies the lens of disruption theory to analyse the current and anticipated status of the construction industry. To do so, we ask and answer three central questions: Why should construction be ripe for disruption? When will disruption potentially occur? How will disruption likely manifest? We find that both industries share a number of challenges, including a fragmented stakeholder network, complex incentive structures and a sense of being in a deadlock that makes change difficult. Furthermore, we find that in both industries the term ‘ripe for disruption’ describes a process rather than prescribe when disruption will occur. By applying central notions from disruption theory (disruptive technologies, low-end disruption, new-market disruption, and a focus on value creation), we identify several potential disruptors of the construction industry. To conclude, we discuss the benefits and limitations of applying disruption theory to the construction industry.

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Learning from Digitalised Industries: Designing Value Propositions for Disruption
Digitalisation changes the way business is made. In some industries, digital disruption has been caused by companies like AirBnB and Netflix, whereas in other industries the opportunities stemming from digitalisation have still not been fully utilised. In this article, we explore how companies from less digital industries may create digital business opportunities by learning from successful digital companies in other industries. A 3-hour workshop set-up is developed and the findings
from two workshops with 17 participants from the construction industry are described. It is shown how an analysis of the customer profiles of well-known companies facilitate cross-industrial learning and aid the creation of new ideas for digital value propositions. Although substantial further work is necessary before the full potential of the ideas may be harvested, we believe the described workshop method represents a tangible first step in creating digital business model innovation.

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**Murmuration as Metaphor for Sustainable Innovation processes**
The construction industry stands before an extensive and essential transition towards sustainability; however, the configuration of the innovation processes that lead to such transition is unclear. In this paper, the concept of murmuration, i.e. the collective behaviour of starlings, is introduced as a metaphor for sustainable innovation processes in construction. The murmuration metaphor captures the flowing, ever-changing non-structure that characterises innovation processes within sustainable construction. This conceptual hypothesis is based on an empirical observation, and the potentials of the metaphor are explored at two interdisciplinary workshops with actors from the Danish construction industry. The empirical validation shows that the murmuration metaphor can generate a useful framework for understanding and discussing sustainable innovation processes in construction. Furthermore, murmuration can be a fruitful addition to the understanding of the societal transition towards sustainability as an elaboration of the niche-to-regime processes emphasised in the Multi-Level Perspective.

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**Supporting sustainable construction with sustainable business models**

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Being, doing and leading in the project society

The last decades have seen a proliferation of projects across different contexts, from the building of an iconic venue to the planning of a family vacation. Building on Jensen (2009) work on the project society and Jensen et al (2016) articulation of projects as human conditions, this article explores strategies for living in the project society. Guided by the philosophical concepts of activity, time, space and relations, we explore the project society as an ideal type, in opposition to the disciplinary society. We discuss implications of being, doing and leading in a project society. Taken together this analysis describes some of the key challenges emerging from the project society and suggests some ideas and advice to fellow project man and woman, navigating in project society.

The work extends our understanding of projects beyond organizational settings – to a societal and individual level. We argue that, first, our growing and insightful body of literature on project organizing can become useful for each one of us as individuals navigating in project society. Second, it opens up to a more extensive empirical context – studying behaviour of people in projects, outside classic organizational settings. In this respect, the article serves as a basis for future research on living in the project society where nothing lasts forever but our projects define who we are and what we can become.

Educating reflective practitioners in large classrooms

Projects abound in society, and turned from an ‘accidental profession’ to an attractive career path (Pinto & Kharbanda, 1995). In this line, engineers and engineering students are increasingly recognizing the criticality of project management to their own profession. The consequence is that we need to educate an increasing number of students in project management. At the Technical University of Denmark (DTU) - one of the leading engineering universities in Scandinavia - the number of students taking our courses has increased organically from 150 to over 300 in the last 5 years - a number that is believed to grow even further in the coming years. We thus face the challenge of educating an increasing number of students. One alternative is a focus on traditional learning methods, multiple-choice exams, and a deterministic learning path. However, such tactic is unlikely to develop the reflective practitioner that are required in practice, as seminally argued by Schön (Schön, 1983, 1987), and also applied and argued to project management specifically (Crawford, Morris, Thomas, & Winter, 2006). This hands-on section will describe and analyze our experience – successes and failures – our program to change education of project engineers at DTU with the vision to educate large number of students and enable them to reflect and experience how to DO projects, as oppose to teaching normative tools and techniques. This hands-on section will facilitate discussion about practices to encourage the development of reflective practitioners in large classrooms. It will do so by creating a context for you to experience being a student in a large classroom, and hence being detached from the ‘actual author of the work’. Akin blended learning strategies, you will watch an introductory video, and you will do individual and group exercises, discussing your experiences and this experience of being detached from the ‘teachers’. The discussion will be facilitated by another person (instead of the authors), which will act like a ‘teaching assistant’, as students experience in large classrooms. We will instruct this other person, but will not be there in the discussions itself. We then join by the end of the discussion, when we will close the session sharing our practices and experiences in dealing with large classrooms. Our program included thirteen mini-projects with implementation of peer grade, blended learning, modularization of education, ISO21500 certification, project games, development of flexible teaching material, embeddedness of project management throughout student practices, connection to societal and global challenges, industry advisory board, and the development of a Project Laboratory. Our work makes two key contributions. First, it points to some pragmatic struggles directly from the classroom, when attempting to reach out to large number of students, while not compromising on a practice approach to projects, and still carrying out an active research career. Second, it positions the relevance of a holistic and systemic view on university education of project managers to

Modularising design processes of façades in Denmark: re-exploring the use of design structure matrix

Modularity has shown great potential in the manufacturing industry, reducing order lead time and creating variety with limited resources. In the construction industry, the implementation of modularity has been limited to off-site production (OSP). The construction design process incorporates a substantial number of disciplines and stakeholders. Moreover, in the application OSP, the design phase is critical due to the necessity of freezing the design early in the process. This study explores the opportunities for optimising the design processes for OSP through the application of modularity. Framed by a large general contractor, the research is based on a case study of façade design, which is representative of design processes for OSP. Research is based on a theoretical framing within design management and modularity, combined with empirical material from 20 interviews and a two-hour-long workshop with a cross-functional design team. The findings were that (1) the application of a modularity perspective in design has the advantage of accelerating the execution process, as the workload and coordination are transferred to the design process, which, in turn, requires enhanced design management. (2) The design structure matrix (DSM), an approach for operationalising modularity theory, is a promising tool for planning and scheduling complex design processes. The DSM method successfully enabled the identification of dependencies and interfaces between the crucial cross-organisational design activities that are related to the façade design process. (3) The developed process modules are helpful to visualise and execute the process for both project participants and managers.
Prerequisites for Successful Strategic Partnerships for Sustainable Building Renovation

The purpose of this paper is to identify the prerequisites for establishing successful strategic partnerships in relation to renovating buildings sustainably. Establishing strategic partnerships is in the paper seen as a potential way to make building renovation more sustainable in Denmark particularly in terms of reducing energy consumption and use of resources and increase productivity. However, until now we have only had a limited number of such partnerships implemented and the few examples that do exist, mostly concern the construction of new buildings. The paper is based on an investigation and analysis of strategic partnerships models as well as typical processes used in building renovation. Experiences from development of new strategic partnerships have particularly been found in the UK and Sweden. Based on two workshops with practitioners representing the whole value chain in the construction industry and analyses of two exemplary cases the paper suggests prerequisites for establishing successful strategic partnerships for sustainable building renovation. The results show that strategic partnerships are collaborations set up between two or more organizations that remain independent with the purpose of obtaining a goal of mutual and high priority based on a binding commitment and a long term perspective by a consecutive number of projects. An essential prerequisite for most of the identified challenges in building renovation processes is stable project partners. Framework agreements is a way to legally establish collaboration with more stable project partners, but it is also in itself an important prerequisite to target challenges related to tender, competition and an extreme focus on lowest price.

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The Global Goals for Sustainable Development in Engineering Education

History is full of examples of how engineers for good and bad have invented and implemented technologies, with consequence far beyond their imaginations. Think for instance on the development of the combustion engine which enabled a revolution in transport and individual mobility but at the same time contributed to CO2 emissions and thus global warming. Or digital technologies that through the internet and social media have created platforms for information sharing and identity building in a globalized world but at same time creates more polarized and post factual societies. A recent study by across 11 countries conducted among 10,341 respondents finds that engineering indeed played a vital role in creating our past and will continue to play a critical role in shaping our future. While this finding mirrors the common understanding of engineering, the study points to a need to change the role of engineering from “inspire new innovations” to “solving the world’s problems”. (QEPrize 2015) United Nations recently conceptualized crucial world’s problems in the form of Sustainable Development Goals (SDGs) as illustrated in the following figure. The SDGs are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. (United Nations 2015). Today the goals are adopted by all 193 UN member states and explicitly addressed by more than 9,000 companies in 170 countries representing nearly every sector and size (Global Compact 2017). Despite its current widespread diffusion, continues support for the SDGs through science and education is of outmost importance in the actual realization of the goals by 2030 (UN-SG-SAB 2014). This workshop targets the role of engineers as persons who solve societal challenges. It will facilitate a discussion and will share some approaches to address the following question:
“How could we embed SDGs in engineering education?” We do this through a workshop facilitated as a knowledge café where the participants collectively explore how could we embed SDGs in engineering education, through several educational practices across the learning journey of engineers. A “Knowledge Café” aims to provide an open and creative conversation on a topic of mutual interest to surface their collective knowledge, share ideas and insights, and gain a deeper understanding of the subject and the issues involved.” (Wikipedia). Participants of a ‘Knowledge Café’ rotate in small groups across different ‘stations’, in each station the group will discuss a different aspect of the problem, in our case, how to embed SDGs in engineering education. Specifically we will explore practices to connect the SDGs to core educational activities: courses, extra curriculum projects, individual major pieces of work like master and bachelor thesis, the overall learning environment of the university. Following the collective discussion and wrap of the workshop, the authors present their experiences working with SDGs in teaching project management to engineering students. Our findings from educating more than 500+ students is that the SDGs represent an outstanding tool to convey the importance of engineering and to create a sense of purpose that represent a key driver for motivation. It further it enables collaboration between various disciplines and stimulates personal reflections on “what legacy do I want to leave?” and “what projects should I engage in?”

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Organising Sustainable Transition: Understanding the Product, Project and Service Domain of the Built Environment
Sustainable transition of the built environment construction industry is challenging the existing construction practices and business models. This article presents a framework for understanding and facilitating sustainable transition in the built environment. The framework was developed through a four years innovation project based on theories on sectorial and business model innovation and ten detailed case studies of different types of companies and their experimentation with different management and sustainability concepts. The framework interprets the construction industry as a collection of three generic domains - the Project, Product and Service domain - with widely different markets, companies, business models and regulation. Besides identifying the characteristics of the different domains, the findings show that these domains are interdependent, but largely live their own lives with internal agendas. Furthermore, it is shown that the domains are subject to more or less consciously coordinated innovation activities. The research concludes that the three-domain-model represents a promising framework for understanding and facilitating sustainable transition of the construction industry and built environment.

General information
Organising Sustainable Transition: Understanding the Product, Project, and Service Domain of the Built Environment

The purpose of this study is to identify the effects of interorganizational relationships in construction projects by investigating how complexities are manifested in variance and repetitions across projects. The case is a set of 27 hospital projects in Denmark including new buildings as well as extensions of existing hospitals. The key empirical material consists of detailed drawings of each of the projects along with information of the participating organizations. The implications of the interorganizational relationships is studied thorough a theoretical framework of modularity by looking for variance and repetition. The analysis shows that the projects are designed for each specific location (region) with unsystematic and limited use of processual, organizational and technical repetitions. Overall, the projects are executed in parallel and follow the same phases with a high degree of user involvement in each of the projects; here inputs are gathered for the specific project that subsequently is designed by a unique team of architects and consultants. Although some of the participating companies are involved in several projects (especially as the client consultant), there is a high degree of variance in the project teams. Despite the variance of the project teams the overall and detailed design of the hospitals look remarkably the same. However, a detailed analysis of the patient rooms reveals that although 70% of the projects use the same architype (the L-type) they are different from each project. This lead us to the conclusion that the hospital is reinvented in each project leaving behind unrealized potential for leveraging similarity across the projects. This could have been achieved by a stronger central coordination, thinking of super hospitals as programs and portfolios rather than individual projects.

Sustainable Building in Scandinavia: Directions of Innovations for Supporting the Transition

Buildings are essential for securing a sustainable society, and the Scandinavian building sector is viewed upon globally as the one to lead the way. This paper investigates in which directions sustainable building in Scandinavia is likely to move and outlines a number of areas where sustainable innovations are necessary for supporting this movement. The focus on innovations as essential support for the sustainable transition of the building sector derives from the Multi-Level Perspective, which has been applied to this study as a framework for understanding sustainable transitions of socio-technical systems. The findings are based on twelve expert interviews with key persons from central companies, research institutions and associations in Denmark, Norway and Sweden. The experts identify five directions for sustainable building in Scandinavia and list a number of innovations that will support the movement of the sector in these directions. These paths to the future for sustainable building seem remarkable clear and manageable, and the paper discusses the risk of the experts being too optimistic in their assessment of the sustainable
transition of the Scandinavian building sector.

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**The projectification of everything: Projects as a human condition**
Projects have become omnipresent not only in the economy but also in our society and our lives. Projects organize and shape our actions at work, in our professional profiles and networks, and also in our homes and free time activities. Drawing on the philosophical cornerstone concepts of activity, time, space, and relations, this article introduces an alternative conceptualization of projects as a "human condition." The article concludes with implications to the project management community, in terms of both project management practice and research.

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**Complexity Management for Projects, Programmes, and Portfolios: An Engineering Systems Perspective**

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Exploring Factors of Successful Tendering Practices using Qualitative Comparative Analysis (QCA): The Study of Organizational Repetitions

The purpose of this paper is to introduce and evaluate Qualitative Comparative Analysis (QCA) as a method for exploring the complexity of practices of project organizing and management combining the benefits of top-down and bottom-up research strategies. The QCA method is used in order to describe combinations of factors leading to particular results of tendering practices. Empirical material collected through data mining in previously completed project records (quantitative data) is supported by data obtained from project managers of a general contractor company (qualitative data) in order to holistically describe the combination of conditions resulting in particular tender results. As a result of the analysis, a solution set is found explaining the path leading to project contract winning; previous work experience between client and general contractor together with either previous work experience between architect and general contractor for design-bid-build projects or senior project responsible involvement from the contractors side in design-build projects. The analysis illustrates how QCA is a powerful strategy for exploring the complexity of project practices being able to bridge the divide between topdown and bottom-up research strategies.

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It's Just Rocket Science, Not Project Management

This paper presents an inductive, empirically based research on the Danish non-profit voluntary space association Copenhagen Suborbitals. The purpose was to execute a qualitative constructivist grounded theory study to discover and explain the behavior and operation of the case subject. Based on this, grounded theory methodology was found highly adequate, as it allowed an investigation without predetermined hypotheses, specific research questions, and a theoretical framework. The central question was: What are they actually doing? Therefore, prior to the study, the researcher formed no specific expectations or demands, and thus, the research could develop in either way. The primary data collection involved observations, open interviews, and conversations. Observations of meetings and conducted work at the organizational location enabled the study of participants who acted in their natural environment, while interviews and conversations enabled a source of more concentrated and direct information. Secondary data was also collected, which primarily consisted of an extensive research of web-blog posts from the study subject. Primarily based on the primary data the grounded theories were developed. Subsequently to the analysis, the study was contextualized with literature to identify the academic relations. The study showed that the subject had successfully integrated the concepts of consensus and initiative, and achieved an organizational form that, at one level promoted member unity and collective steering, and at another level encouraged individual initiative. The association rejected hierarchy, and thus the executive coalition involved all members. Moreover, the study discovered two distinctive operational processes: (1) direction, established a flexible organizational heading, and (2) navigation, allowed liberated groups to develop accordingly, but ensured that evaluation and coordination was done in collectivity. The processes of direction and navigation were congruent with well-known methods of trial-and-error and parallel trails, and based on iterative processes and learning by doing. Unexpectedly the research evolved to support contemporary claims that the practice of project management has forgotten these values, and that intuitive and alternative methods should be accepted as viable project management.
Mapping practices of project management – merging top-down and bottom-up perspectives

This paper presents a new methodology for studying different accounts of project management practices based on network mapping and analysis. Drawing upon network mapping and visualization as an analytical strategy top-down and bottom-up accounts of project management practice are analysed and compared. The analysis initially reveals a substantial difference between the top-down and bottom-up accounts of practice. Furthermore it identifies a soft side of project management that is central in the bottom-up account but absent from the top-down. Finally, the study shows that network mapping is a promising strategy for visualizing and analysing different accounts of project management practices.

Public acceptance of wind farm development: Developer practices and review of scientific literature: Wind2050 WP3 Deliverable 1

This report is the first deliverable of Work Package 3 of the Wind2050 project. The Wind2050 project is about the public perception of wind power in Denmark, its role in the planning and development of wind farms and, ultimately, the meaning it has for reaching the Danish government’s targets for wind power in 2050. Work Package 3 looks specifically at how private developers handle the public’s perception of wind power and what it means for their projects. This report firstly outlines the common stages found in wind farm development and then discusses what manner of interaction the developer commonly has with the public at each stage. The report then shifts focus to what scientific literature says about two important topics in this realm: public risk perception and the NIMBY concept. Finally, the report concludes with suggested topics for research questions and highlights the next steps necessary for WP3 to take.
Understanding Complex Construction Systems Through Modularity

This paper develops a framework for understanding complexity in construction projects by combining theories of complexity management and modularization. The framework incorporates three dimensions of product, process, and organizational modularity with the case of gypsum wall elements. The analysis finds that the main driver of complexity is the fragmentation of the design and production, which causes the production modules to construct and install new product types and variants for each project as the designers are swapped for every project. The many interfaces are characteristics of an integral system, rather than a modular, although the industry forces modular organizational structures. This creates a high complexity degree caused by the non-alignment of building parts and organizations and the frequent swapping of modules.

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Conceptualizing the use of system products and system deliveries in the building industry
This article describes the concepts system products and system deliveries based on the use of product modularization and product configuration. The concepts are outlined and discussed based on examples from both the construction industry and related industry. The description focuses partly on the product architecture and partly of the setup of the business processes by using e.g. Configure to Order processes and Engineer to Order processes. Furthermore the potential impacts from using system products and system deliveries are discussed based on the examples included.

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Enabling Mass Customization in Construction – Making the long tail work
The chapter discusses the development of construction management practices the past 50 years outlining the academic and practical context for the adoption of Mass Customization in Construction.
Theoretically, the chapter builds on two fundamental insights: The Pareto principle and the Thomas theorem - a fundamental sociological principle. The Pareto principle is applied using the concept “The long tail”. Based on “the long tail” the three different production paradigms of Mass Production, Mass Customization, and Individual Customization are identified. It is argued that construction in the 1950s and 1960s was driven by a “Mass Production” paradigm that gradually from the beginning of the 1970s was replaced by an “Individual Customization” paradigm in which construction became a matter of tailoring unique buildings to each customer.
It is identified how these two different paradigms have been driven by two partial articulated myths. In the 1960s buildings were viewed as standardized while they from the 1980s onwards have been viewed as unique.
Based on the Thomas theorem it is argued that these myths have had a substantial impact on the way we build. Consequently, today’s predominant view of buildings – as unique – implies that: 1) the nature of the construction processes is chaotic, 2) the buildings are realized through onsite project work rather than through offsite production; and 3) project management is the fundamental management principle.
The chapter further identifies how attempts to develop new construction practices like Lean implicitly reproduce this myth. The result is that construction research the past 25 years has been constructing the long tail in a way that hinders radical development of the construction industry. The chapter concludes that if we allow ourselves to view buildings as both unique but also as standardized we can create a new platform for developing the construction industry – a Mass Customization paradigm.

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Contributors: Thuesen, C., Jensen, J. S., Gottlieb, S. C.
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Interactive Configuration of High Performance Renovation of Apartment Buildings by the use of CSP

This paper is a prospective study which looks at the possibility of configuring high performance renovation of apartment buildings by the use of constraint satisfaction problem (CSP). This study is one part of a project called CRIBA which aims to industrialize high performance thermal renovation of mid-rise (up to seven stories) apartment buildings. The renovation is based on external rectangular panels, always comprising insulation and cladding, and sometimes including, in addition, doors, windows or solar modules. The panels can be fixed directly onto the walls or onto a metal structure around the whole building. With the new thermal envelope and equipment, the building must achieve a really low energy performance of 25 kWh/m²/year. A configuration system, based on CSP approaches, will simultaneously enable the interactive definition of the renovation, the associated bill of material (BOM) and the building site assembly process. In Section two, we set out the industrial problem of residential buildings renovation and explain how a configurator can support it. Then, in the third section, the renovation configuration process is described. In the fourth and final section, we present how the renovation configuration can be addressed with constraints, and we introduce relevant CSP approaches. Throughout the article, industrial examples illustrate our proposal.

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Interactive Configuration of High Performance Renovation of Apartment Buildings by the use of CSP

Knowledge sharing in construction partnering projects - redundancy, boundary objects and brokers

This article adopts practice-based theory for understanding inter-organisational knowledge work and extends it with a discussion of the role of redundancy. In this view, a constellation of firms is a multiple configuration of communities of practices, characterised by overlapping practises, multiple memberships and different levels of participation, and accompanied by a governance frame. The paper discusses central mechanisms for coordinating knowledge in such a complex construction project. The knowledge relations are conceptualised through focusing on redundancy, understood as negotiated common assignment of meaning, brokers (e.g., design managers), boundary objects (e.g., drawings) and
arenas (e.g., meetings). The paper presents an ethnographic case study of a project partnership between engineers, architects and contractors in construction using the partnering concept. The focus is on two dialogue excerpts, one on process, and one on product knowledge exchanges. The diversity and disjunctive feature of the practices form a condition of possibility for knowledge handling and synthesis into the built construct. Relation-based interaction is necessary with boundary objects and brokers, requisite redundancy and governance.

Knowledge Sharing in Construction Partnering - Redundancy, Boundary Objects and Brokers
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Mapping Best and Emerging Practices of Project Management

This paper presents results of a study of the connection between Best and Emerging practices of project management. Drawing upon network mapping as an analytical strategy, cases of Best and Emerging practices is analysed and juxtaposed. The case of Best practice is represented by the newly published ISO 21500 standard and the case for the Emerging practices by a deconstruction of the practices of a group of experienced project managers. The network analysis reveals a substantial difference between the Best and Emerging practices. Only two central concepts where shared namely Communication and Planning. Of these two concepts Communication where found to be the most central to both the Emerging and Best practices. The analysis further reveals a soft side of project management that is central in the Emerging practice but absent from the Best practices. Although this soft side might be interpreted as a contextual bias it also represents avenues of further development of Best practices. Finally have the study showed that network mapping is a promising approach for visualizing and interpreting project management practices. Furthermore it represents a tool with much broader areas of application within the study of project management and other phenomena.

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Modularization in the construction industry using a top-down approach

Throughout the last centuries, the manufacturing industry has experienced great improvements in efficiency and cost reductions, but the same improvements have not taken place in the construction industry. Based on the principles of mass customization that are known from the manufacturing industry, a case study of one of the largest construction companies in Northern Europe was carried out according to the principles of action research. This approach was used to clarify whether potential exists for using the principles of mass customization to improve efficiency and minimize costs connected with the construction of buildings; and if so, what they are. The main technical solutions used for residential and office buildings were analyzed using a top-down approach. These solutions were identified and their relations mapped using a Product Variant Master (PVM). When a satisfactory overview was achieved of the major technical solutions, a configuration system was made. Such a system is often used to communicate findings from the PVM to the user. Through the work of constructing the PVM and the configuration system, it was found that a great potential exists for implementation. Based on the findings and experiences gathered throughout the process, the conclusion is that the principles of mass customization are best used in the construction industry if used with a top-down perspective. © Kudsk et al.; Licensee Bentham Open.

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Observed benefits from product configuration systems

This article presents a study of the benefits obtained from applying product configuration systems based on a case study in four industry companies. The impacts are described according to main objectives in literature for implementing product configuration systems: lead time in the specification processes, on-time delivery of the specifications, and resource consumption for making specifications, quality of specifications, optimization of products and services, and other observations. The purpose of the study is partly to identify specific impacts observed from implementing product configuration systems in industry companies and partly to assess if the objectives suggested are appropriate for describing the impact of product configuration systems and identifying other possible objectives. The empirical study of the companies also gives an indication of more overall performance indicators being affected by the use of product configuration systems e.g. increased sales, decrease in the number of SKU's, improved ability to introduce new products, and cost reductions.

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Research output: Contribution to journal › Journal article – Annual report year: 2013 › Research › peer-review

Organizing Construction Practices in Different Cultural Contexts

This paper presents in-depth case studies of construction practices with a specific focus on understanding the emergent and dynamic nature of construction management in different cultural contexts. The cases are based on actual working-experiences by the author as an assistant project manager participating in the construction management on site working for three different contractors in different cultural contexts: (1) Construir Futuro S.A. in Quito, Ecuador; (2) Anker Hansen & co. A/S in Copenhagen, Denmark; and (3) E. Pihl & Soen A/S in Stockholm, Sweden. Based on these explorative case studies a number of characteristics and challenges related to the cultural context have been identified highlighting a central issue in existing and future construction practices due to the globalization and thereby increasing importance of cultural understanding in project-based organizing. The empirical findings emphasize a significant influence of the cultural
context on construction practices and suggest a general need to recognize the diversity rather than suppressing it. Lack of cultural understanding and recognition of its diversity may lead to considerable managerial challenges in construction practices.

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**Pride and Prejudice – Identity and Collaboration In Construction**
Based on an 18 month ethnographic case study of a construction partnering project, the paper adopts practice based theory for understanding the identity formation and practices of collaboration in construction. Drawing upon practice based theory in general and actor network theory and communities of practice in particular, the construction project is interpreted as configuration of networked practices characterized by strong professional practices (e.g. architects and contractors) and locally negotiated collaboration practices. During the construction project, actors gain experiences in relation to the actual building and their profession, but concurrently they learn how to engage in collaboration with other professions in the project. These practice-based learning processes are very influential and effective. Newcomers to a profession quickly learn the name of the game – for better or for worse. Overtime they learn to behave competently at the boundaries between professions forming their identity and a sense of belonging in relation to an institutionalized role and the realization of the physical building. In this process the actors develop “pride” in terms of authorship of the physical building and membership their profession. However another consequence of these learning processes is the development of prejudices. Prejudices are often viewed as a negative aspect of building processes as it hinders collaboration among the professions. Consequently prejudices is often seen as something which should be eliminated e.g. in the partnering concept. Stemming from practice based theory the paper on the contrary argues that prejudice represents accumulated experiences from previous projects shaped by the negotiation of meaning within professions. In this perspective prejudice is integrated in the daily building practices – enabling and inhibiting collaboration. Pride and prejudice are thus central constitutive elements of present construction practices in the formation of identity and development of collaboration processes.

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**Rethinking the Business Model in Construction by the Use of Off-Site System Deliverance: Case of the Shaft Project**
This paper presents a set of insights to be used in the development of business models for off-site system deliveries contributing to the development of Off-Site Manufacturing practices (OSM). The theoretical offset for discussing the development of business models is the blue ocean strategy literature combined with theories on mass-customization and platform development identifying the optimization of cost and value through the handling of complexity as the central
process. This framework is developed in order to analyze a specific case on system deliverances – the prefabrication of installation shafts. Findings from the development and production of the installation shaft show that system deliveries represent a promising strategy for moving from red ocean competitive environment with the predominant cost+ business model, to a blue ocean situation in which the competition emerges in the constant pursuit of value creation and cost reduction. On the basis of that system deliverances represent a promising strategy in the future development and application of off-site manufacturing practices. The application of system deliveries is however demanding as it represents a fundamental shift in the existing design and production practices. More specifically the development of system deliverances requires: (1) an explicit market focus, enabling the achievement of economy of scale, (2) a coordinated and coherent development around the system deliverance focusing on its internal and external modularity, (3) development of processes and configuration practices which make it possible to put together (configure) the product matching the needs of the individual building project. (4) development of alliances between companies in enabling value chain integration.

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Stepwise modularization in the construction industry using a bottom-up approach
The manufacturing industry has experienced a great deal of improvement in efficiency and cost reductions throughout the last centuries. But although there have been improvements in the manufacturing industry, the principles and work methods in the construction industry have stood still for more than a hundred years. Based on principles of mass customization applied in the manufacturing industry, two cases of successful implementation of mass customization and modularization have been investigated as a means of showcasing the possibility to incorporate standardization in parts of the construction industry. The investigation examined two different companies that have standardized parts of a construction. One, Altan.dk, standardized the method for constructing balconies; and NCC Skakt standardized the construction of shafts. Altan.dk standardized their balconies by studying the balconies they previously built and constructing solution spaces in which a configured balcony can be constructed. The information gathered from studying these balconies was then put into a Product Variant Master, so that an overview of the product was achieved. All the information gathered was put into a configurator in order to guide the entire construction process. NCC Skakt standardized their shafts by studying apartments already constructed and extracting different archetypes of toilets and kitchens. Much information was gathered, which was fed into a Product Variant Master, so that an overview could be achieved. This led to a standardization of the shafts. Three types of shafts that make up 95 percent of the investigated market were defined. Based on the findings and experiences gathered through the standardization, it is concluded that the principles of mass customization of a sub-part can be successful when implemented stepwise. The case shows that substantial benefits can be gained through implementing modularized construction. It is especially interesting to note that these benefits are achieved through the development of a module with focus on the internal interfaces. © Kudsk et al.; Licensee Bentham Open.

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Using a Configuration System to Design Toilets and Place Installation Shafts

The aim of this research is to discover how configuration systems can support a product's design process when a high degree of variation is required and a very open or endless space exists for possible configurations. The article is based on an industrial case involving a firm that wishes to offer a bathroom configurator to architects. The aim of the configurator is to help architects design a bathroom according to relevant requirements and norms. In offering the configurator, the firm aims to enable a design that can be coordinated with a prefabricated installation shaft sold by the firm, and also to create customer leads. Four scenarios are developed for how design can be supported by four different types of configuration technologies. The four scenarios are evaluated in relation to a number of functional and technical requirements. The scenarios indicate that a good and varied range of opportunities exist for using configuration systems in the construction industry. They also show that it can be done without fundamentally changing the present process. © Kudsk et al.; Licensee Bentham Open.

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Understanding Project Based Production through Socio-technical Modularity

This paper develops an approach for understanding Project Based Production. This form of production is characterized by unique deliverables, high complexity, high value, high risk, profound uncertainty and many stakeholders and is increasingly important in the postmodern society. Common to the practices of PBP and other production practices is the goal of balancing the dilemma between creativity and productivity.

In response to industrialized production, the concept of modularity gained popularity for addressing this dilemma by exploring product, process and organization structures. However, with the starting point in system theory and a strong bias towards industrial production, the predominant understanding of modularity faces difficulty in explaining practices of Project Based Production in both social和技术 and dynamic-stable aspects.

Illustrated by a case, the paper addresses this gap, by offering a reinterpretation of the modularity concept from a socio-technical perspective in general and Actor Network Theory (ANT) in particular. By formulating modularity from an ANT perspective covering social, material and process aspects, the modularity of a socio-technical practice can be understood as an entanglement of product, process, organizational and institutional modularity. The paper concludes proposing central questions for the development of the concept of modularity for understanding, designing and managing of PBP.
modularity from an ANT perspective covering social, material and process aspects, the modularity of a socio-technical system can be understood as an entanglement of product, process, organizational and institutional modularity dimension. The developed theoretical framework is used for analyzing the modularity of three different production systems the pre-modern, modern and post-modern construction practices.

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**Construction sector development: frames and governance responses**
The governance of construction sector development constitutes an important policy issue in many European countries due to the increasing impact that construction as well as the built environment have on gross domestic product and the environment. Previous studies have discussed how national construction industries have been framed as objects of development. However, less attention has been placed on exploring how an industry is recognized and framed as an object that can be subjected to organized development activities from the viewpoint of strategically motivated actors, and how such framing activities may be governed. Based on a case study of the sector development activities in the Danish construction industry, this paper argues that governance strategies should not necessarily be designed to ensure the development of a single industrial conceptualization. First, drawing on concepts from institutional theory it is suggested that strategic framing activities aiming to conceptualize an industry as a sectoral object of development are likely to generate multiple and incommensurable representations with different and conflicting strategic implications. Second, if faced with a development agenda composed of multiple incommensurable sector representations, then the most productive governance response may be to recognize and accept their conflicting strategic implications.

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DRIVING SUSTAINABLE INNOVATION IN CONSTRUCTION COMPANIES
By adopting a theoretical framework from strategic niche management research (SNM) this paper presents an analysis of the innovation system of the Danish Construction industry. Theories within SNM look upon innovation in a sector as a socio-technical phenomenon and identify three levels of socio-technical interaction within which sectorial innovation can be explained. The analysis shows a multifaceted landscape of innovation around an existing regime, built in the existing ways of working and developed over generations. The regime is challenged from various niches and the socio-technical landscape through trends as globalization. Three niches (Lean Construction, BIM and System Deliveries) are subject to a detailed analysis showing partly incompatible rationales and various degrees of innovation potential. Based on the analysis, the paper further explores how companies can be introduced as drivers for innovation in the construction industry. By bridging SNM with business development activities through an adapted version of Ansoffs growth matrix, companies continuously and consciously can develop a competitive advantage by targeting new and existing markets with new or existing competencies/niches. The paper concludes with a discussion of how this approach can help to solve the challenge of retrofitting the existing building stock and thereby enabling the development a low energy consuming society.

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Efficient on-site construction: - learning points from a German platform for housing
Purpose – This research aims to analyse the implementation of a German platform for housing projects through a successful case on modern methods of construction featuring efficient on-site construction. Through continuous development, the platform has been carefully designed to suit a carefully selected market – optimising cost and value. Based on the platform, the company has managed to create a high-quality product at low cost. In fact, they have managed to reduce costs by more than 30 per cent, enabling the company to sell houses to people that normally would not be able to afford a house of their own. Design/methodology/approach – The paper adopts a case study approach combining a qualitative collection of empirical material with an analytical framework drawing upon classical modelling techniques for development of product platforms. Findings – The paper identifies some central learning points from the German platform such as: platform does not imply that “off-site manufacturing” is the most optimal production method, rather it is a matter of handling complexity; strong commitment and loyalty from the whole organization is needed; importance of having a specific customer focus (target costing); and incremental rather than radical innovation. Originality/value – The findings challenge the predominant understanding of industrialisation of the construction processes, illustrating how substantial improvements can be achieved through platform thinking, on-site production and traditional construction practices.

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Indicators for Building Process without Final Defects: Methodology and Theoretical Foundation

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Indicators for Building Process without Final Defects: methodology and theoretical foundation
This article introduces the preliminary data analysis, as well as the underlying theories and methods for identifying the indicators for building process without final defects. Since 2004, the Benchmark Centre for the Danish Construction Sector (BEC) has collected information about legal defects in connection with Danish construction enterprises that have been handed over. The project aims to utilise the knowledge potential available in BEC’s database in order to locate key performance indicators of construction failures and defects. The empirical data from BEC is applied in a more academic context than has been the case until now. The idea is to survey which indicators differentiate good construction and processes of construction from bad ones. The method is a retrospective analysis, which is based on data on the handing over. The data used has been partly that which BEC has already collected and partly additional focused data collected through interviews and electronic questionnaires directed to developers, designers and contractors. The first results from the data collection will be available in spring 2011 and will be able to indicate the differences between construction without or with only a few defects and construction that is handed over with many and serious defects.

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MAPPING INNOVATION: FACILITATING INNOVATION IN THE DANISH CONSTRUCTION INDUSTRY

By adopting a theoretical framework from strategic niche management research (SNM) this paper presents an analysis of the innovation system of the Danish Construction industry. The analysis shows a multifaceted landscape of innovation around an existing regime, built around existing ways of working and developed over generations. The regime is challenged from various niches and the socio-technical landscape through trends as globalization. Three niches (Lean Construction, BIM and System Deliveries) are subject to a detailed analysis showing partly incompatible rationales and various degrees of innovation potential. The paper further discusses how existing policymaking operates in a number of tensions one being between government and governance. Based on the concepts from SNM the paper introduces an innovation map in order to support the development of meta-governance policymaking. By mapping some of the most influential trends and promising niche innovations and relate these to the existing regime, the innovation map can act as a medium in which policymakers, interest organization and companies can develop and coordinate future innovation activities.

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Keywords: SNM, sector development, Innovation, niches, policymaking

MAPPING INNOVATION: FACILITATING INNOVATION IN THE DANISH CONSTRUCTION INDUSTRY

By adopting a theoretical framework from strategic niche management research (SNM) this paper presents an analysis of the innovation system of the Danish Construction industry. Theories within SNM look upon innovation in a sector as a socio-technical phenomenon and identifies three levels of socio-technical interaction within which sectorial innovation can be explained. The analysis shows a multifaceted landscape of innovation around an existing regime, built in the existing ways of working and developing over generations. The regime is challenged from various niches and the sociotechnical landscape through trends as globalization. Three niches (Lean Construction, BIM and System Deliveries) are subject to a detailed analysis showing partly incompatible rationales and various degrees of innovation potential. The paper further discusses how existing policymakers operates in a number of tensions one being between government and governance. Based on the concepts from SNM the paper introduces an innovation map in order to support the development of meta-governance policymaking. By mapping some of the most influential trends and promising niche innovations and relate these to the existing regime, the innovation map can act as a medium in which policymakers, interest organization and companies can develop and coordinate future innovation activities.

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering, Aarhus University
Contributors: Thuesen, C. L., Koch, C.
Number of pages: 694
Pages: 641-652
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the 6th Nordic Conference on Construction Economics and Organisation
Place of publication: Hørsholm
Publisher: Danish Building Research Institute, Aalborg University
ISBN (Print): 978-87-563-1519-7
Keywords: SNM, sector development, Innovation, niches, policymaking
Modules in historic building construction according to the Copenhagen Building Code
This paper describes an analysis of building works from Copenhagen, Denmark in the period 1850 to 1950. In the study we investigate, based on the theory of product architecture and product modularization, if examples of the use of well-defined interfaces can be found. Furthermore, the aim is to study how the use of such interfaces has influenced former building processes and how they were implemented and kept stable over decades. The result of the study is that at that time a number of standardized interfaces between the individual parts of the building work existed, and that these interfaces have remained unchanged for many years. The interfaces have been identified and modeled seen from a product, process and organizational perspective. The standardized interfaces have been implemented and kept primarily because of the existing legislation, training of project supervisors and craftsmen, and arrangements / agreements between the individual professional groups.

General information
Publication status: Published
Organisations: Operations Management, Department of Management Engineering, Planning and Management of the Built Environment
Contributors: Kudsk, A., Thuesen, C. L., Hvam, L.
Publication date: 2011

Styrkelse af dansk byggeris innovationssystem
The construction industry is often characterised as a tradition bound low innovation sector which struggles with low productivity. Consequently, a small but significant strand of research has been conducted around innovation in construction e.g. Clausen (2002), Simonsen (2007) and Vind and Thomassen (2009). By adopting a theoretical framework from primarily strategic niche management research (SNM) (Schot and Geels 2008) this report presents an analysis of the innovation system of the Danish Construction industry. Theories within SNM look upon innovation in a sector as a socio-technical phenomenon and identify three levels of socio-technical interaction within which sectorial innovation can be explained (Schot and Geels 2008, p. 545). Niches form the micro-level where radical novelties emerge. The socio-technical regime forms the meso-level, which accounts for the dominating stabilized socio-technical pattern of interaction which is reproduced by institutionalised learning processes. The macro-level is formed by the socio-technical landscape, an exogenous environment beyond the direct influence of niche and regime actors (e.g. macro-economics, deep cultural patterns, macro-political developments). The analysis shows a multifaceted landscape of innovation around an existing regime, built in the existing ways of working and developing over generations. The regime is challenged from various niches and the socio-technical landscape through trends as globalization. Three niches (Lean Construction, Digitalization and System Deliveries) are subject to a detailed analysis showing partly incompatible rationales and various degrees of innovation potential. The report discusses how existing policymaking sits between two chairs; That of government and that of governance. A practice which seems inappropriate for nurturing innovation in the current organization of the sector. Based on the concepts from SNM the report introduces an innovation map in order to support the development of meta-governance policymaking. By mapping some of the most influential trends and promising niche innovations and relate these to the existing paradigm, the innovation map can act as a medium in which policymakers, interest organization and companies can develop and coordinate future innovation activities.

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering, Aarhus University, Danish Technological Institute
Contributors: Thuesen, C. L., Koch, C., Monrad, D., Henriks, M., Lambrecht, J. F., Hall-Andersen, H.
Number of pages: 177
Publication date: 2011
Understanding Socio Technical Modularity: reinterpreting modularity from Actor Network Theory

Modularity has gained an increasing popularity as a central concept for exploring product structure, process structure, organization structure and supply chain structure. With the offset in system theory the predominant understanding of modularity however faces difficulties in explaining the social dimension of modularity like irrational behaviors, cultural differences, learning processes, social organization and institutional influences on modularity. The paper addresses this gap offering a reinterpretation of the modularity concept from a socio-technical perspective in general and Actor Network Theory in particular. By formulating modularity from an ANT perspective covering social, material and process aspects, the modularity of a socio-technical system can be understood as an entanglement of product, process, organizational and institutional modularity. The theoretical framework is illustrated in a small case of construction products and practices in Copenhagen between 1850 and 1900. Based on this exemplary case central questions for the development of the concept of modularity is put forward.

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering, Operations Management
Contributors: Thuesen, C. L., Kudsk, A., Hvam, L.
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the World Conference on Mass Customization, Personalization, and Co-Creation
Publisher: Lulu, Inc.
Source: orbit
Source-ID: 280653
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2011 › Research › peer-review

Bæredygtige forretningsmodeller

General information
Publication status: Published
Organisations: Department of Management Engineering, Planning and Management of the Built Environment
Contributors: Thuesen, C. L.
Publication date: 2010
Peer-reviewed: Unknown
Event: Poster session presented at InnoBYG kick-off konference, Kolding.

Electronic versions:
sustainable-businessmodels-poster-101011.pptx
Source: orbit
Source-ID: 271951
Research output: Contribution to conference › Poster – Annual report year: 2010 › Communication

Hvordan arbejder virksomheden i byggebranchen med forretningsudvikling?

General information
Publication status: Published
Organisations: Department of Management Engineering, Planning and Management of the Built Environment, Aarhus University
Contributors: Nielsen, J. S., Thuesen, C. L., Koch, C.
Number of pages: 73
Publication date: 2010

Publication Information
Original language: Danish
Electronic versions:
Leveraging Economy of Scale across Construction Projects by Implementing Coordinated Purchasing

The paper presents a case study of the implementation of coordinated purchasing in a large Nordic contractor as an example of a successful but challenging radical innovation. The paper describes the practices and tools for analysing the existing purchasing activities, categorizing the purchasing volume, and the different strategies for addressing the different categories. In particular the interface between the project and central purchasing activities is portrayed. The paper further describes the implementation struggle, which have required a significant change of mindset in the organisation. A much greater challenge than initially imagined. The implementation of central purchasing activities has been in direct conflict with predominant project culture, as the project culture and identity formation is tightly coupled to the project based purchasing activities. Finally the paper discusses how coordinated purchasing is an important step in the attempt to rethink the existing business model in construction. Going from competing on overhead (in a red ocean) to start to compete on company specific core competencies. The paper concludes highlighting the next milestones at the journey leveraging economy of scale even further, though the use of platforms, modularization and configuration.

General information
Publication status: E-pub ahead of print
Organisations: Planning and Management of the Built Environment, Department of Management Engineering
Contributors: Thuesen, C. L.
Publication date: 2010

Strategy and business development practices in Danish construction industry SMEs.

The paper presents a qualitative study of strategy and business development practices in Small and Medium Sizes Enterprises (SME) in the Danish construction industry. Theoretically the paper draws upon theories on how strategy is developed and practiced as an integrated part of everyday management practices. 19 qualitative interviews have been conducted in total representing architects, engineering companies, contractors and subcontractors. Based on an in-depth analysis of this empirical material, the study finds: (1) he market is characterized by a typical ”red ocean” environment, where the companies compete on their overhead rather than their ability to reduce production cost and create value. (2) the companies have a reactive practice towards development, where they try to follow the development in the market rather than shaping their own market. (3) their approach towards strategy development is characterized by being unstructured, undocumented and nonreflexive. This is interpreted as a sign of unprofessional management practices in the businesses, which reproduces the existing institutionalized division of labour in the construction industry. The paper concludes that business development represents an important but unacknowledged practice for innovation of the building industry and suggests that strategy processes should be facilitated and subject to more detailed research in order to escape the present unhealthy market practices in the construction industry.

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering, Aarhus University, Quo Vadis Forretningsudvikling ApS
Contributors: Thuesen, C. L., Koch, C., Nielsen, J. S.
Number of pages: 1,535
Pages: 919-928
Publication date: 2010
Building a design community for sustainable homes through configuration and open innovation

This paper presents a development project which aims to create a market place for sustainable homes – around a design community where the users and producers collectively can develop new energy efficient solutions and thereby reduce the emission of CO2. The core functionality of the design community is a configurator where the users based on the produceres templates can design their own home at a selected address visualizing and estimating the energy consumption, total cost, CO2 emission etc. All the designs will be collected and rated in a design space creating transparency over the market and technologies. Furthermore will an idea space collect and rate ideas from the users. Through a combination of technical and user driven innovation the design community will act as a learning tool for the users and producers and thereby facilitate the development of a market for sustainable homes.

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering, Aarhus University
Contributors: Thuesen, C. L., Jespersen, K. R.
Publication date: 2009

KNOWLEDGE SHARING IN PARTNERING: – REDUNDANCY, BOUNDARY OBJECTS AND BROKERS

This paper adopts practicebased theory for understanding interorganisational knowledge work and extents it with a discussion of the role of redundancy. The paper presents a case study of a project partnership in construction using the partnering concept. The project group responsible for the building design counts members from different companies like architects, engineers, and contractors. The paper discusses three central mechanisms for coordinating knowledge in a complex construction project, redundancy, relations, and governance. The knowledge relations is conceptualised through focusing on arenas (e.g. meetings), brokers (e.g. design manager), and boundary objects (e.g. drawings). The constellation of firms is interpreted as a multiple configuration of communities of practices, characterised by overlapping practises, multiple memberships and different levels of participation. The diversity and disjunct feature of the practices is a condition of possibility of knowledge handling as it is a prerequisite for the synthesis of various forms of knowledge in the building construct. Here an orchestrated combination of relationbased interaction with boundary objects and brokers, requisite redundancy and governance is necessary.

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering, Aarhus University
Contributors: Koch, C., Thuesen, C. L.
Publication date: 2009
Peer-reviewed: No
Event: Paper presented at The 3rd Annual Copenhagen Conference on Partnerships, Copenhagen, Denmark.
Source: orbit
Source-ID: 252497
Research output: Contribution to conference › Paper – Annual report year: 2009 › Research

Making the long tail work: reflections on the development of the construction industry the past 25 years

The paper discusses the development and impact of construction research the past 25 years. Theoretically, the paper builds on two fundamental insights: The Pareto principle (the 80-20 rule) and the Thomas theorem: "If men define situations as real, they are real in their consequences" (Thomas and Thomas 1928: 572) - a fundamental sociological principle. The Pareto principle is applied using the concept "The long tail" (Anderson 2006). Based on "the long tail" the three different production paradigms of mass production, mass customisation, and individual customisation are identified. The paper argues that construction in the 1950s and 1960s was driven by a "mass production" paradigm that from the beginning of the 1980s was replaced by an "individual customisation" paradigm in which construction became a matter of tailoring unique buildings to each customer. These two different paradigms have been driven by two more or less unarticulated myths. In the 1960s buildings were viewed as standardised while they from the 1980s onwards have been
viewed as unique. Based on the Thomas theorem it is argued that these myths have had a substantial impact on the way we build. Consequently, today’s predominant view of buildings – as unique – implies that: 1) the nature of the construction processes is chaotic, 2) the buildings are realised through onsite project work rather than through offsite production; and 3) project management is the fundamental management principle. The paper further identifies how attempts to develop new construction practices like partnering and lean implicitly reproduce this myth. The result is that construction research the past 25 years has been constructing the long tail in a way that hinders radical development of the construction industry. The paper concludes that if we allow ourselves to view buildings as both unique but also as standardised we can create a new platform for developing the construction industry – a Mass Customisation paradigm.
The Long Tail and Innovation of New Construction Practices: Learning Points from Two Case Studies

This chapter juxtaposes two initiatives that tried to rethink the construction business within NCC – the NCC Komplett™ and the German platform for house building. It is found that both initiatives, more or less articulated, have applied a mass customization strategy – in line with the fundamental ideas of ManuBuild. However, their point of departure has been different. While the NCC Komplett™ worked with a high degree of manufacturing off-site (90%), the German platform is all in-situ based. The official results of the initiatives have been completely different. The German platform has created a unique competitive position for NCC in Germany – resulting in dramatically improved revenues and an offset for organic growth. In contrast, the NCC Komplett™ was discontinued due to uncontrollable costs. The paper concludes that “manufacturing” not by default is the only solution to the improvement of the construction industry. The German case shows how a very committed implementation of a platform – which optimises customer value and production cost – can give substantial benefits. Furthermore, it is found that radical innovation initiatives poses a high risk of failure.

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering, NCC
Contributors: Thuesen, C. L., Jonsson, C. C.
Number of pages: 172
Pages: 51-64
Publication date: 2009

Host publication information
Title of host publication: Open Building Manufacturing: Key Technologies, Applications, and Industrial Cases
Publisher: ManuBuild
ISBN (Print): 978-951-38-7144-4
Keywords: Mass Customization, The long tail, Innovation, flexible and configurable buildings, building manufacturing technologies
Source: orbit
Source-ID: 250265

Anvendelse af den rette viden - et studie af byggeriets kulturelle organisering

General information
Publication status: Published
Organisations: Planning and Management of the Built Environment, Department of Management Engineering
Contributors: Thuesen, C. L.
Publication date: Jan 2007

Publication information
Original language: English
Electronic versions: Web-fil_PHD_CHRISTIAN_THUESEN.pdf
Source: orbit
Source-ID: 208901

Knowledge Utilization in Projects – a Practice-based

Drawing upon Practice-based theorizing in general and Actor Network Theory and theories of Communities of Practices in particular the paper develops an analytical strategy for understanding “life” in projects. The analytical strategy is applied on empirical material from an 18-month ethnographic study of a construction project. The project is interpreted as constellation of networked practices, which always is in the making. Participation in this project is a learning process where existing practices are reproduced and developed. This understanding of “life” in the project, frames a concluding analysis and discussion of the utilization of knowledge in the project.

General information
Publication status: Published
Organisations: Section for Planning and Management of Building Processes, Department of Civil Engineering
Contributors: Thuesen, C.
Publication date: 2005
Peer-reviewed: No
URLs:
The Process of Partnering: Gluing Contracts, Organising and Financing together
This paper discusses management of partnering projects where construction companies and clients cooperate in developing buildings and services. Taking a practice based theory and political process approach, partnering is seen as an example of a complex project operation, characterised by processual interactions between an emergent conceptual frame and the project's operational activities. Drawing on two case studies, it is analyzed how the governance frame of partnering projects is constituted by a combination of partnering elements, traditional contracts and financial arrangements. On the operational level these elements is continuously mobilized, negotiated and stabilized in their intersection with the practices and skill basis for the project. It is thus shown how incentives becomes especially problematic for the architects due to tensions between new and old contractual forms, and that project management levels are more successful in one case in mediating between operations and governance frames than in the other. The research imply that the governance frame and the operations of the projects are mutually interacting throughout the projects, in contrast to the traditional sequential phase breakdown structure as often assumed in the partnering literature. The contradictory governance becomes a recurrent barrier for project operation management; forcing project participants to develop new sets of skills in dealing with partnering. In doing so they enter in an emergent process of developing the partnering practices on top of existing practices and institutions.

Knowledge Management at Contractors – Developing communities of practice to support the reuse of Knowledge

The beauty and the beast? Creativity and knowledge management in building design
**Projects:**

**Strategic Partnerships in the municipality of Copenhagen.**
Evaluation of strategic partnerships in the municipality of Copenhagen. Funded by Realdania.
Thuesen, C., PI, Department of Management Engineering, Engineering Systems
Berg, J. B., CoI, Engineering Systems, Department of Management Engineering
Project ID: 81591
01/01/2017 → 31/12/2021
Nature of activity type: Research
Collaborators: Aalborg University, KTH - Royal Institute of Technology, Byggeriets Evaluering Center
Project: Research

**Anchoring, quantifying and implementing sustainability in the Danish building industry - The development of a robust tool to embed social sustainability**
Larsen, N. B., PhD Student, Department of Civil Engineering
Jensen, L. B., Main Supervisor
Dyring, C., Supervisor
Thuesen, C., Supervisor
Industrial PhD
01/08/2018 → 31/07/2021
Award relations: Anchoring, quantifying and implementing sustainability in the Danish building industry - The development of a robust tool to embed social sustainability
Project: PhD

**Application of Product Configuration Systems in Engineering Companies**
Kristjansdottir, K., PhD Student, Department of Management Engineering
Hvam, L., Main Supervisor, Department of Management Engineering
Mortensen, N. H., Supervisor, Department of Management Engineering
Thuesen, C., Examiner, Department of Management Engineering
Anisic, Z., Examiner
Jensen, L. J., Examiner
Samfinansieret - Andet
15/11/2014 → 14/11/2017
Award relations: Application of Product Configuration Systems in Engineering Companies
Documents:
PhD_Katrin Kristjansdottir
Project: Research

**Advanced Digital Design and Design Automation in the Construction Industry**
The main objective of the project is to conduct research on Advanced Digital Design, in particular Design Automation, in the context of the construction industry. This includes leveraging "Industry 4.0" approaches. The project will leverage digital capabilities to significantly improve engineering design productivity through better design coordination, higher design quality, and reduced risk during construction.
Oehmen, J., Project Manager, Department of Management Engineering, Engineering Systems
Pikas, E., Project Coordinator, Department of Management Engineering, Engineering Systems
Thuesen, C., Project Participant, Department of Management Engineering, Engineering Systems
MADE - Manufacturing Academy of Denmark, NCC
01/12/2017 → 01/12/2019
Collaborators: MADE - Manufacturing Academy of Denmark, NCC
Award relations: Advanced Digital Design and Design Automation in the Construction Industry, Advanced Digital Design and Design Automation in the Construction Industry
Disruptive technologies in design
Ernstsen, S. K., PhD Student, Department of Management Engineering
Maier, A., Main Supervisor
Larsen, L. R., Supervisor
Thuesen, C., Supervisor
Industrial PhD
01/01/2017 → 31/12/2019
Award relations: Disruptive technologies in design
Project: PhD

Udvikling af systemleverancer hos entreprenører
Kudsk, A., PhD Student, Department of Management Engineering
Hvam, L., Main Supervisor
Thuesen, C., Supervisor
Jacobsen, P., Examiner
Sannersjö, S. C., Examiner
Vibæk, K. S., Examiner
ErhvervsPhD-ordningen VTU
01/01/2010 → 22/11/2013
Award relations: Udvikling af systemleverancer hos entreprenører
Project: PhD

Videnledelse i praksisfællesskaber i byggeproduktion
Thuesen, C., PhD Student, Department of Civil Engineering
Koch, C., Main Supervisor
Magelhøj, T., Supervisor
Bonke, S., Examiner
Eikjaer, B., Examiner
Ansat ekstrern
01/03/2002 → 29/01/2007
Award relations: Videnledelse i praksisfællesskaber i byggeproduktion
Project: PhD

Radical improvements in sustainable building renovation based on new forms of collaboration and business models
Berg, J. B., PhD Student, Department of Management Engineering
Thuesen, C., Main Supervisor
Jensen, P. A., Supervisor
Forskningsrådsfinansiering
01/08/2016 → 25/12/2019
Award relations: Radical improvements in sustainable building renovation based on new forms of collaboration and business models
Project: PhD

Radical innovation of sustainable building
Koch-Ørvad, N., PhD Student, Department of Management Engineering
Thuesen, C., Main Supervisor
Berker, T., Supervisor
Koch, C., Supervisor
Rosati, F., Examiner
THOMASSEN, M. A., Examiner
Chan, P. W., Examiner
Technical University of Denmark
01/09/2015 → 05/04/2019
Award relations: Radical innovation of sustainable building
Project: PhD

Assessing the Capabilities of Advanced Risk Methods for Engineering Systems Management
Tegeltija, M., PhD Student, Department of Management Engineering
Oehmen, J., Main Supervisor
Kozin, I., Supervisor
Thuesen, C., Examiner
Steinert, M., Examiner
Sahlin, U., Examiner
Technical University of Denmark
01/02/2015 → 06/09/2018
Award relations: Assessing the Capabilities of Advanced Risk Methods for Engineering Systems Management
Project: PhD

Application of Product Configuration Systems in Engineering Companies
Kristjansdottir, K., PhD Student, Department of Management Engineering
Hvam, L., Main Supervisor
Mortensen, N. H., Supervisor
Thuesen, C., Examiner
Jensen, L. J., Examiner
Anisic, Z., Examiner
Samfinansieret - Andet
15/11/2014 → 06/03/2018
Award relations: Application of Product Configuration Systems in Engineering Companies
Project: PhD

Improving Quality and Productivity in Construction by reusing similarities in Products, Processes and Organizations
Bekdik, B., PhD Student, Department of Management Engineering
Thuesen, C., Main Supervisor
Büchmann-Slorup, R., Supervisor
Fuhr Pedersen, L., Supervisor
Oehmen, J., Examiner
Simonsen, R. B., Examiner
Ballard, G., Examiner
Industrial PhD
01/12/2013 → 23/03/2017
Award relations: Improving Quality and Productivity in Construction by reusing similarities in Products, Processes and Organizations
Project: PhD

Requirements management with multiple product platforms
Bonev, M., PhD Student, Department of Management Engineering
Hvam, L., Main Supervisor
Mortensen, N. H., Supervisor
Thuesen, C., Examiner
Elgh, F., Examiner
Jensen, L. J., Examiner
Institut, samfinansiering
01/10/2011 → 21/05/2015
Award relations: Requirements management with multiple product platforms
Project: PhD

Formative phases of technology specific innovation systems - regions' role in H2&FC development
Tanner, A. N., PhD Student, Department of Management Engineering
Andersen, M. M., Main Supervisor
Andersen, P. D., Supervisor
Borrás, S., Supervisor
Borup, M., Supervisor
Thuesen, C., Examiner
Boschma, R., Examiner
Winther, L., Examiner
DTU-lønnet stipendie
15/09/2008 → 25/06/2012
Award relations: Formative phases of technology specific innovation systems - regions' role in H2&FC development
Project: PhD
**Byggeriets Innovationssystem: Styrkelse af dansk byggeris innovationssystem**

Thuesen, C., Project Participant, Department of Management Engineering, Production and Service Management

01/04/2009 → 31/12/2010

Collaborators: Aarhus University, Danish Technological Institute

Project: Research

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**InnoBYG: Innovation network for energy efficient and sustainable construction**

The innovation network for energy efficient and sustainable construction - InnoBYG - is the innovation network of the construction industry in Denmark. The Danish Agency for Science, Technology and Innovation has granted a co-financing of 20 million DKK to the network.

InnoBYG brings the industry together across professional competency. The network has focus on knowledge sharing, networking and development of the industry among its members, both domestically and internationally. Between 2010-2014 InnoBYG will facilitate the development of the construction industry by addressing a number of societal and technical challenges, all of which are related to energy efficiency and sustainability in the construction industry.

DTU Management Engineering is responsible for the subproject on development of sustainable business models in construction.

Thuesen, C., Project Manager, Department of Management Engineering, Production and Service Management

Maslesa, E., Project Participant, Department of Management Engineering, Production and Service Management

Arnklit, S. R., Project Participant

01/06/2010 → 30/06/2014

Collaborators: Tekniq, Danish Construction Association, Dansk Industri, DBI - The Danish Institute of Fire and Security Technology, Aalborg University, BAT-Kartellet, Danish Technological Institute

Project: Research

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**Kompetence og kvalifikationsprofiler for den moderne byggeproduktionsingeniører**

Koch, C., Project Manager, Department of Civil Engineering

Thuesen, C., Project Participant, Department of Civil Engineering

Project ID: 25382

Sam.arb.aftaler, Private danske - Andre virksomheder: DKK122,600.00

01/01/2001 → 01/01/2002

Collaborators: NCC

Award relations: Kompetence og kvalifikationsprofiler for den moderne byggeproduktionsingeniører

Project: Research

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**Activities:**

**BLOXHUB (External organisation)**

Period: 1 Jan 2017

Christian Thuesen (Member)

Department of Management Engineering

Description

BLOXHUB scientific advisory board

**Related external organisation**

**BLOXHUB**

Fæstningens Materialgård, Frederikholms Kanal 30, 1220, København V, Denmark

Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**Technical University of Denmark (External organisation)**

Period: 1 Jan 2015 → 31 Dec 2017

Christian Thuesen (Chairman)

Department of Management Engineering

**Related external organisation**

**Technical University of Denmark**

2800, Kgs. Lyngby, Denmark
The Industrial PhD Programme Committee (External organisation)
Period: 1 Jan 2014 → 31 Dec 2019
Christian Thuesen (Vice-chairman)
Department of Management Engineering

Description
The Industrial PhD Programme Committee (IPPC) is appointed by The Danish Council for Technology and Innovation (DCTI). The committee has 25 members and can be supplemented with members appointed by the Minister.

IPPC is an ad hoc committee, and DCTI has the decision making authority. The task for IPPC is to evaluate applications for the Industrial PhD Programme, and IPPC recommends the marking (approved/conditionally approved/rejected) to DCTI. The authorization to approve/reject applications is lawfully delegated by DCTI to The Danish Agency for Science, Technology and Innovation, and the latter makes the final decision on approving/rejecting applications.

Links:
http://ufm.dk/forskning-og-innovation/rad-og-udvalg/andre-udvalg-og-fonde/erhvervsforskergudvalget?set_language=da&c=da (Link to committee homepage)

Related external organisation
The Industrial PhD Programme Committee
Denmark

InnoBYG (External organisation)
Period: 1 Jun 2010 → 31 May 2014
Christian Thuesen (Participant)
Department of Management Engineering
Production and Service Management
Engineering Systems Group

Description
The innovation network for energy efficient and sustainable construction - InnoBYG - is the new innovation network of the construction industry in Denmark. The Danish Agency for Science, Technology and Innovation has granted a co-financing of 20 million DKK to the new network.

InnoBYG brings the industry together across professional competency. The network has focus on knowledge sharing, networking and development of the industry among its members, both domestically and internationally.

Board member.

Links:
http://www.innobyg.dk/

Related external organisation
Innovationsnetværket for Bæredygtigt Byggeri
Denmark

Prizes:
Best paper award at the 25. ARCOM conference September 2009.
Christian Thuesen (Recipient)
Department of Management Engineering, Engineering Systems

Description
The paper titled "Making the Long Tail Work - Reflections on the Development of the Construction Industry in the past 25 years" was awarded at the CIOB 175'th Anniversary Prize among 130 papers. The assessment was "A fascinating
account of the development of the industry. Rich in insights about our industry and our possible future.

**Details**

Awarded date: 10 Sep 2009  
Degree of recognition: International  
Granting Organisations: Association of Researchers in Construction Management (ARCOM)  
event: Annual ARCOM Conference  
Prize: Prizes, scholarships, distinctions

**CIOB Award**

Nina Koch-Ørvad (Recipient), Christian Thuesen (Recipient), Christian Koch (Recipient) & Thomas Berker (Recipient)  
Department of Management Engineering, Engineering Systems

**Description**

Best Paper award on Innovation and Sustainability for the paper "Murmuration as Methaphor for Sustainable Innovation Processes"

**Details**

Awarded date: 4 Sep 2018  
Degree of recognition: International  
Granting Organisations: Association of Researchers in Construction Management (ARCOM)  
event: 34th Annual Conference ARCOM 2018  
Keywords: Innovation, Construction, Sustainability  
Prize: Prizes, scholarships, distinctions

**Project Management Journal Paper of the Year Award 2017**

Christian Thuesen (Recipient), Joana Geraldi (Recipient) & Anders Fogh Jensen (Recipient)  
Department of Management Engineering, Engineering Systems

**Description**

Two Associate Professors from the Engineering Systems Division, Christian Thuesen and Joana Geraldi, received the "Best Paper 2016"-Award from the Project Management Journal. The honoured publication "The projectification of everything: projects as a human condition" was written in collaboration with the philosopher Anders Jensen.

**Details**

Awarded date: 26 Jun 2017  
Granting Organisations: Project Management Institute  
event: International Research Network on Organizing by Projects, IRNOP 2017  
Prize: Prizes, scholarships, distinctions

**The Paul Townsend Commemorative Award**

Sidsel Katrine Ernstsen (Recipient), Christian Thuesen (Recipient) & Anja Maier (Recipient)  
Department of Management Engineering, Engineering Systems

**Description**

Best paper award for the research paper "Is Construction Ripe for Disruption"

**Details**

Awarded date: 4 Sep 2018  
Degree of recognition: International  
Granting Organisations: Association of Researchers in Construction Management (ARCOM)  
event: 34th Annual Conference ARCOM 2018  
Keywords: Innovation, Sustainability, Construction, Design, Disruption  
Prize: Prizes, scholarships, distinctions

**Press clippings:**

**Ekspert: Herlev-udfordringer er ud over det sædvanlige**

Christian Thuesen  
12/04/2019

**Description**
Hele processen om de store sygehusbyggerier kunne have haft gavn af at løse tingene mere på tværs, lyder det
Department of Technology, Management and Economics, Engineering Systems, Innovation

Media coverage (1)

Ekspert: Herlev-udfordringer er ud over det sædvanlige
12/04/2019
Licitationen (National), Denmark, Print
https://www.licitationen.dk/article/view/656592/ekspert_herlevudfordringer_er_ud_over_det_saedvanlige
Christian Thuesen
Press/Media: Press / Media

Entreprenør til staten: Mere bæredygtighed
Christian Thuesen
04/04/2019
Department of Technology, Management and Economics, Engineering Systems, Innovation

Media contribution (1)

Entreprenør til staten: Mere bæredygtighed
04/04/2019
Børsen (National), Denmark, Print
https://borsen.dk/nyheder/avisen/artikel/11/222585/artikel.html?hl=YToxOntpOjA7czo3OiJUaHVlc2VuIjt9
Christian Thuesen
Press/Media: Press / Media

‘Tiny homes’ fra Airbnb kan disrupte byggeriet
Sidsel Katrine Ernstsen, Nina Koch-Ørvad & Christian Thuesen
28/02/2019

Description
https://ing.dk/artikel/kronik-tiny-homes-airbnb-kan-disrupte-byggeriet-224228
Department of Management Engineering, Engineering Systems

Media contribution (1)

‘Tiny homes’ from AirBnB might disrupt construction
28/02/2019
Ingeniøren (National), Denmark, Print
https://ing.dk/artikel/kronik-tiny-homes-airbnb-kan-disrupte-byggeriet-224228
Sidsel Katrine Ernstsen, Nina Koch-Ørvad & Christian Thuesen
Department of Management Engineering, Engineering Systems
Press/Media: Press / Media

Nyt OUH: Chefflugt kan blive dyrt
Christian Thuesen
29/05/2017

Description
Expert interview
Department of Management Engineering, Engineering Systems

Media contribution (1)

Nyt OUH: Chefflugt kan blive dyrt
29/05/2017
TV2 Fyn (Regional), Denmark, Television
Christian Thuesen
Press/Media: Press / Media
**Waste of public money: Super hospitals**  
Christian Thuesen  
21/09/2015

**Description**  
Interviews on Danish Radio (P1) and Danish Television (DR1 and DR2) on standardisation and customisation in the building process of superhospitals across the Regions.  
Department of Management Engineering, Engineering Systems

**Media contributions (4)**

**Interview in P1 Morgen**  
21/09/2015  
P1 Morgen (National), Denmark, Radio  
http://www.dr.dk/radio/ondemand/p1/p1-morgen-2015-09-21#!/02:36:15  
"Waste of public money"  
Christian Thuesen

**Interview in DR2 Morgen**  
21/09/2015  
DR2 (National), Denmark, Television  
DR  
https://www.dr.dk/tv/se/dr2-morgen#!/01:55:45  
"Waste of public money"  
Christian Thuesen  
Engineering Systems, Department of Management Engineering

**Program "waste of public money"**  
21/09/2015  
DR1 (International), Denmark, Television  
DR  
https://www.dr.dk/tv/se/spild-af-dine-penge/spild-af-dine-penge-2-4#!/  
Christian Thuesen  
Engineering Systems, Department of Management Engineering

**Waste of public money: Super hospitals**  
21/09/2015  
DR (National), Denmark, Web  
DR  
https://www.dr.dk/nyheder/penge/ekspert-regioner-kunne-have-sparet-milliarder-paa-supersygehuse  
Christian Thuesen  
Engineering Systems, Department of Management Engineering

**Relations**

Research outputs:  
Reinventing the Hospital – A Study of Lost Synergies in Danish Healthcare  
Press/Media: Press / Media