



The Sectorial Code - an inquiry into the contemporary sector development activities in the Danish construction industry

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Publication date:
2011

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Citation (APA):

Jensen, J. S. (2011). *The Sectorial Code - an inquiry into the contemporary sector development activities in the Danish construction industry*. Technical University of Denmark.

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The Sectorial Code

**- an inquiry into the contemporary sector
development activities in the Danish construction
industry**

Jens Stissing Jensen

Abstract

Since the early 1990'ties the Danish construction industry has been exposed to organised activities aiming to develop the industry from a sectorial point of view. It has however been difficult for these activities to establish a coherent and attractive sectorial development agenda which has been able to generate detectable and widespread effects in the industry as a whole.

The objective of this thesis is to develop a vocabulary which is able to penetrate and explain the experiences of these contemporary sector development processes in the Danish construction industry as they have unfolded since the early 1990'ties. The purpose of this vocabulary is to make sense of these experiences in order to provide actors involved in these processes with a possible response as to how they may be managed or governed.

The thesis is organised into three blocks

The first block develops a theoretical understanding of how a sector may be recognised as a strategic object of development by strategically motivated actors and it further discusses how this understanding may inform empirical research. The second block analyses the contemporary sector development activities in the Danish construction industry. The third block identifies the present-day conditions under which these development efforts operate and outlines a possible response as to how such processes may be managed and supported

In order develop an understanding of how strategically motivated actors may recognise a sector as a strategic object of development the first block sets out by introducing the concepts of systems, regimes and fields. These concepts are introduced as they offer different vocabularies which may be used to understand how sectors condition industrial development. More importantly these vocabularies however also offer different ideas of the tensions and contradictions which sectors generate and different ideas of how such tensions and contradictions are experienced. The discussion of these concepts accordingly allows strategic sector development activities to be introduced as processes by which actors deal with the experiences of contradictions and tensions.

It is then argued that actor-network theory can help to turn this analytical perspective into an empirical research strategy as the actor network approach allows strategic sector development activities to be addressed as attempts to build so-called macro-actors. In conclusion it is argued that sector development activities may be empirically identified as configurations of theorization, concretization and institutionalisation processes. Theorization signifies the process of constructing a sectorial representation which is able to make sense of a complex set of otherwise conflicting and incompatible experiences by perceiving them as symptoms of a sectorial malfunction in a way which defines new strategic opportunities or necessities. Concretization signifies processes by which the strategic orientation of the theorized sector representation is turned into experimental activities. Finally, institutionalization signifies strategies which aim to diffuse and anchor the strategic orientation across a wider social space.

Based on these concepts the empirical analysis finds that the Danish construction industry was established as a contemporary sectorial object of development in the early 1990'ties. It is then demonstrated that the attempts of the early theorization activities in defining the industry as a sectorial object of development were unable to directly inform experimental concretization activities in any coordinated way. The early theorization activities however portrayed the industry as a series of challenges such as 'low productivity', 'low level of innovation', 'organizational fragmentation', and 'poor collaboration'. It further indicated that these challenges were interconnected in some sectorial way. The early sector development activities thus theorized the sector as an object of development by establishing a differentiation between a series of 'symptoms' which indicated some kind of sectorial 'root cause'. The contemporary sector development activities may thus be seen as attempts to diagnose a series of theorised industrial symptoms the effects of some underlying sectorial 'root cause'.

In the period from the early 1990'ties and until 2001 it however proved very difficult to make productive use of the sectorial differentiation between the symptoms and the root cause. From a sectorial point of view the various experimental concretization activities in the period thus tended to target the symptoms in an

uncoordinated way. No coherent and durable configurations of theorization, concretization and institutionalization processes were thus established.

After 2001 two more coherent strategic configuration however emerged which made productive use of the differentiation between the symptoms and the underlying root cause. One of these configurations was represented by a sector development initiative called Digital Construction (DC) and the other was represented by a sector development initiative called Building Lab DK. These two initiatives however diagnosed the theorized symptoms as effects of very different sectorial root causes. DC argued that the symptoms were caused by a project oriented construction process organised by a series of uncoordinated and inconsistent information flows and suggested that a digital information infrastructure based on 3d object oriented building models needed to be developed and implemented in the industry. Building Lab on the other hand diagnosed the symptoms as the effects of an under modularized production environment characterized by project specific problem solving and short term collaboration that hindered organization specialization and innovation. This initiative thus suggested that an industrial transition based configurable system deliverances developed and produced independent of the individual construction project needed to be initiated.

The image of rational behaviour which informed DC thus suggested that the organization of the project oriented construction process needed to be optimized and coordinated by means of a comprehensive and shared digital information infrastructure whereas the image of rational behaviour which informed Building Lab DK suggested that the project oriented organization of the industry needed to transcend rather than optimised in order to facilitate organizational differentiation and company specific learning and capability building based on project independent production and development processes.

The two sector development strategies did however not only differ in concern to the sector representation which informed them. Also their concretization and institutionalization strategies were very different.

A priority of DC was to calibrate its strategic orientation with the organised interests in the industry and furthermore to engage as many industrial partners as possible in

the concretization activities in order to ensure ownership to the initiative in the industry. The consequence was that the concretization activities were not sufficiently coordinated. As the digital information infrastructure had to be implemented through mandatory public procurement policies it accordingly turned out not to be operational. While the initiative thus failed to develop and institutionalise an operational digital information infrastructure in the industry it however succeeded to build organizational capacity on the area coordinated ICT use in the industry. Digitalization thus remains a dominant logic on the sectorial development agenda.

While the strategy of DC was to engage with the organised industrial interests, Building Lab DK perceived these interests as a barrier to an industrial reorganization based on configurable system deliverances. The strategy of this initiative accordingly was to target the companies of the industry through local and direct development activities. Building lab DK succeeded to establish and influence a series of innovation consortiums by means of their strategic orientation. The initiative was however characterised by the belief that 'sun-shine stories' would be able to catalyse a broader development towards modular system deliverances in the industry. The consequence of this belief was that the initiative did not engage in activities which aimed to anchor its strategic orientation through organised community building or political agenda setting. Modularization as a sectorial development strategy thus largely disintegrated with the close down of building lab dk.

The analysis in conclusion demonstrates a sector development agenda are only under very special circumstances likely to be dominated by a single dominant configuration of theorization, concretization and institutionalization processes. It is further argued that under alternative circumstances where no dominant strategic orientations can be established a key governance objective is to actively cope with the co-existence of multiple strategic orientations by recognizing and organizing the incompatibilities between these different strategic orientations.

It is then demonstrated that the actual attempts at organising the contemporary sector development agenda in the Danish construction industry have been weak in recognizing and coping with the tensions and incompatibilities of the development

agenda. These attempts have thus tried to align very conflicting strategic orientations into a unified development agenda. The consequence has been that the different strategic orientations of the sector development agenda have been highly unstable when they have not been supported and shielded by specific development initiatives.

The thesis consequently concludes that under circumstances where no dominant strategic orientation can be established the appropriate governance response is to actively recognise the co-existence of several strategic orientations and allow them to develop and operate independent of each other. Such a governance approach consequently needs to dispense with the vision of an integrated uni-directional transition from one industrial configuration to another and rather begin to imagine the future operation of the construction industry as the co-existence of production and development activities organised by a set of very different mechanisms of coordination and development. This implies that governance interventions should articulate the sector development agenda as a choice between a structured and transparent set of different problem representations and strategic orientations.

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Chapter 1 - The sectorial code

Since time immemorial there has been talk about construction activities as a specific area of human enterprise. Early discourses about construction activities are displayed as far back in time as in the biblical myth of Babel. Accordingly to this religious myth god intervened against the arrogance of men when they joined forces in order to construct a tower high enough to take them into the heaven by inflicting them with incommensurable languages. The result was that the enterprise disintegrated as the communication failed and conflicts of how to coordinate and proceed emerged (Genesis 11:1-9)

As it goes for any collective discourse about a complex enterprise such a way of talking is not an inert reflection of a bare fact. It is rather a specific story of failed intentions tacitly suggesting an order that needs to be restored. The Babel myth thus implicitly suggests that the success of a construction project depend on the disclosure of the original language of men and on the shared understanding which this language is suggested to provide in order to coordinate the interdependent actions and processes of a common enterprise. Ways of talking about the construction process is thus never just an objective 'report on a situation'. Such talk rather provides actors engaged in such processes with a specific perception of rational or meaningful agency and with a 'code' by which to organise and evaluate experiences.

The organization and development of construction activities have also in more modern time been greatly influenced by Babel like codes. In the decades after WW2 a powerful code was accordingly established which turned in the Danish construction industry into a coherent sectorial object of development. The crafting of this strategic codification was orchestrated by a newly established housing ministry and was designed to provide actors in the industry with a new coordinated perception of rational agency and with a new way by which to organise their activities and evaluate their experiences (Indenrigsministeriet 1945; Gottlieb 2010).

This new code was heavily inspired by the ideal of industrialised factory production and it utilised the methods of the engineer as its key point of orientation (Dansk

Ingeniørforening 1951). An instruction from the National Building Research Institute on how to organise the construction process from 1968 may serve as an example of how this code operated (SBI 1968). Compared to industrialised manufacturing the instruction problematised the dominant craft oriented organization of construction process. In order to cope with the problematic state of affairs it developed a series of production principles designed to ensure a rational factory-like production process. These were repetition, a single point of planning, an unequivocal construction programme, a complete project material, planning of the construction process, management and control of the construction process and post calculation. It thus interconnected elements of order, calculation, transparency and the eradication of ambiguity into an integrative and centralised planning paradigm.

In a more general sense the sectorial code portrayed the operation and organisation of the industry as opaque, traditional and craft oriented and on this background it suggested that the industry needed to be rationalized (Dansk ingeniørforening 1951:7). This rationalization implied that the operation of the industry should be turned into a transparent hierarchy of individual functional elements, processes and connections. Drawing on this transparent functional re-organization of elements, processes and connections it introduced a new difference between planning and execution. Planning and execution thus had to be separated in a way which established the planning activities at the top of the functional hierarchy (Jørgensen & Schou Pedersen 1983:142).

During 30 years of coordinated development activities informed by this sectorial code the organization and operation of major parts of the construction industry was radically transformed. The craft oriented production of buildings was thus superseded by the industrialised construction industry. This industrialised construction industry was characterised by the use of building systems composed of factory produced concrete elements (Gravensen 1980), a new polarized division of work which separated the skilled planning engineers from the increasingly unskilled construction workers (Jørgensen & Schou Pedersen 1983) as well as new planning tools and machinery designed to optimise the operation and coordination of the new construction processes (Munch-Petersen 1980). The effect of this industrialisation was a drastic increase in productivity as well as cities with a radical new architectural expression (Laursen 1980).

The ability of the sectorial code in insuring coordinated industrial development however disintegrated during the economic recession in the 1970ties (Gotlieb 2010; Laursen 1980) and until the early 1990ties no coherent attempts were made to develop an alternative sectorial code aiming to define a new coordinated strategic orientation for the sector as a whole. Of course, this did not imply that important strategic development activities were not carried out in this period. These activities did however not operate from a sectorial perspective.

Since the early 1990ties strategic development activities aiming to develop the construction industry from a sectorial point of view have however once again emerged (EFS 1993, FRI 1990). In contrast to the post WW2 sector development agenda which was dominated by a single and stabile sectorial code, the last 20 years of sector development activities have been characterised by difficulties in stabilising a coherent and unequivocal sectorial code able to offer a coordinated perception of rational agency and a coherent way by which to organise and evaluate experiences (EBST 2006, EFS 2000). It has thus been difficult for these activities to establish a coherent and attractive sectorial development agenda which has been able to generate detectable and widespread effects in the industry.

The objective of this thesis is to develop a vocabulary which is able to penetrate and explain the experiences of these contemporary sector development processes in the Danish construction industry as they have unfolded since the early 1990ties. The purpose of this vocabulary is to make sense of these experiences in a way which provide actors involved in these processes with a possible response as to how they may be managed or governed.

The objective of this thesis in conclusion is to develop an understanding of *contemporary* strategy processes operating with a specific *sectorial* perspective. While strategic agency may operate from a variety of more local viewpoints such as the viewpoint of the individual, the company, or a particular profession or trade the research agenda of this thesis is thus specifically concerned with strategic agency operating from the more encompassing viewpoint of the sector. The aim thus is to understand and analyse how local strategic perspectives which are likely to exist in conflict may be transcended and organised by the development of a more

encompassing strategic orientation. The aim is furthermore to understand and analyse how such coordinated industrial development activities may be established in a specific contemporary context. Finally, in order to understand the contemporary sector development activities in the Danish Construction industry as a strategic process the objective is to unfold this research agenda from the viewpoint of the strategically motivated actors who are engaged in such industrial development processes.

In a very condensed version the agenda the thesis accordingly is to:

- a) Develop a theoretical understanding of how strategic agency aiming to coordinate or transcend local strategic interests from a sectorial perspective emerges and unfolds.
- b) Analyse the contemporary sector development activities in the Danish construction industry.
- c) Identify the present day conditions under which these development efforts operate and outline a response as to how such processes may be governed and supported

Motivating the research agenda

While the empirical focus of this thesis is the contemporary attempts at developing the Danish construction industry from a sectorial point of view the analytical ambition is to contribute to a more general investigation and understanding of the contemporary condition for building collective capacity for coordinated societal change.

Thus, as indicated above the contemporary sector development activities have faced much greater difficulties in establishing a coordinated and coherent development agenda for the industry as a whole compared to the post WW2 sector development activities. A hypothesis which has motivated the research agenda outlined above has been that the contemporary difficulties in establishing a collective development

agenda for the Danish construction industry reflect a more general tendency. The coordinated sectorial industrialization of the construction industry in the post WW2 decades was accordingly embedded in a more pervasive societal modernization strategy which took place from the 1930ties and until the 1970ties. The hypothesis which has motivated the research agenda is that this broader societal modernization strategy has disintegrated in the previous decades and that this disintegration has resulted in a general erosion of the capability to orchestrate coordinated development at a sectorial or societal level. This hypothesis accordingly suggests that the condition for developing collective capacity for coordinated change has fundamentally changed since the development efforts in the post WW2 decades.

The hypothesis is analytically inspired by the idea that modernity has been superseded by post modernity. This idea suggests that many of the stable point of orientation and many of the hierarchies which characterised the modern social order and the modern institutions in which this order was encoded has eroded or at least been weakened. These modern points of orientation which were able to give direction to societal development processes included dichotomies between public and private interest, between the expert the non expert and between subjective and objective judgements. In the words of Lyotard the post modern social order is thus characterised by the disintegration of the 'grand narratives' of the modern times which offered collective ideas about societal progress (Lyotard 1979).

Inspired by the concept of post modernity this thesis has accordingly been motivated the idea that a weakening of the modern dichotomies, institution and hierarchies has greatly altered the condition for building capacity for collective action since collective identities and public societal ideas of the common good has become increasingly unstable and elusive. Processes aiming to build collective capacity for change do accordingly not operate in a strategically pre-given environment with established identities, interest, objectives and challenges. This implies that building collective capacity for change requires a co-construction of as well the collective challenges which are to be addresses as well as the identity and interest of those collective and individual actors and elements which are supposed to be involved in the development activities.

But is it at all necessary to build collective capacity for change if the traditional modernist hierarchies and dichotomies have broken down? Haven't the need for a collective orientation been superseded by the individual quest for meaning? Haven't coordinated societal development been superseded by individualised innovation activities?

I suggest that the ability to build collective capacity for change even under an increasingly post modernist societal order indeed does matter because the reciprocities which conditions individual agency has not evaporated or disappeared. On the contrary I suggest these reciprocities may proliferate and become still more difficult to understand and command under a post modernist societal order.

This argument may be illustrated by taking traffic regulation as an example. Traditional traffic regulation may be seen as a modern way to code activities as it ensures relatively coherent patterns of coordination. So how would traffic be organised and regulated according to a postmodern code? This would not imply that collective codes of coordination would disappear altogether. It would rather imply the disintegration of a single dominant code of coordination in favour of the co-existence of several partly compatible codes of coordination. This would obviously generate dangerous situations as accidents would be likely to occur in case of coordination achieved by means of different and conflicting codes of coordination. Under post modernist circumstances the purpose of building collective capacity for change is accordingly as much to cope with the co-existence of different and partly incompatible codes of coordination and development as it is to ensure societal progress.

The purpose of the thesis is not to determine whether a modernist societal order has been superseded by post modernist one. The aim of the brief discussion above has rather been to indicate the initial motivation for addressing strategic sector development as a relevant strategic phenomenon which has a specific character in a contemporary context. The analytical ambitions of this thesis has accordingly been to develop a vocabulary which is sensitive to the processes which has become critical for present day sector development activities and more generally for attempts at building capacity for coordinated change at a societal level.

Outline of the thesis

The structure of the thesis reflects the three research questions which make up the overall research agenda and it is accordingly structured into three blocks.

The first block consists of chapter 2 and chapter 3. Chapter 2 reviews and discusses existing theory in order to develop an understanding of how a sector may emerge as a strategic object of development. It is suggested that the prevailing literature tends to operate from an objectifying ‘outside position’ by constructing a privileged scientific perspective from where the scientist is able to bring the sector into view as a system, regime or field. The aim of chapter 2 is however to move on the ‘inside’ by developing an understanding of how actors embedded in industrial activities and industry policy formulation may come to understand their context as sector *in the absence of a scientifically constructed ‘outside position’*. The chapter argues that the ability of embedded actor to develop an understanding of their context as a sector depends on a) the experience of unresolved contradictions in their engagement with their environment as well as b) sectorial strategies for making sense of these experiences. Chapter three elaborates on this ‘inside’ understanding of strategic sector development by drawing on actor-network theory. It is thus suggested that strategic sector development processes may be investigated as attempts to build so-called macro-actors. The chapter in conclusion argues that strategic sector development activities may be empirically investigated as configurations of theorization, concretization and institutionalization processes.

The second block consists of chapter 4, 5, 6 and 7. This block offers an empirical analysis of the contemporary sector development activities in the Danish construction industry. Chapter 4 however sets out by analysing the sector development activities of the post WW2 decades where the construction industry for the first time was recognised as a sector which could be subjected to orchestrated development activities. It is argued that the sector development activities of the post WW2 decades succeeded to industrialise part of the industry by subjecting the industry to the gaze of the planning engineer. As the industrialization agenda was predicated on large scale coordinated demand this sectorial development agenda however disintegrated as the demand decreased in the 1970’ties.

From the early 1990'ties and onwards the Danish construction industry was however once again subjected to a sectorial development agenda. Chapter 4 introduces these contemporary sector development activities. The analysis suggests that the early sectorial development activities in this period faced difficulties in bringing the industry into view as coherent sectorial challenge. The sectorial development agenda thus developed into a series of uncoordinated experimental development activities with no overall sectorial direction. From a sectorial point of view the development agenda thus became increasingly opaque.

From 2001 the opaque strategic situation was however transcended by two more coherently crafted attempts at understanding the Danish construction industry as a coherent sectorial challenge. One of these was inspired by ICT technology and articulated the sectorial challenge as a construction process coordinated by a series of uncoordinated information flows of drawings descriptions and calculations. It thus suggested that a digital information infrastructure needed to be developed and implemented in the industry in order to integrate these un-coordinated information flows. The other attempts at understanding the Danish construction industry as a coherent sectorial challenge was inspired by the principle of product modularization and suggested that the project- and craft oriented organization of the industry needed to be transcended by producers of modular subsystems or system deliverances developed and manufactured independent of the individual construction project and the craft oriented organisation. Chapter 5 and 6 analyses how these two sectorial development agendas were formulated and transformed into development activities aiming to produce more widespread effects in the industry. It is concluded that the initiatives only partly succeeded to concretise their strategic orientation in a form which have been able to produce wider organised effects in the industry. The strategic orientations of the two initiatives were thus left in radical uncertainty at the close down of the initiatives.

Chapter 8 makes up the final and conclusive part of the thesis. This part argues that the contemporary sector development agenda in the Danish construction industry has been characterised by ongoing horizontal negotiations without any clear leadership and that it has furthermore operated in the absence of clear societal objectives. The analysis thus demonstrates that it has not been possible to establish a sector development agenda characterised by a single dominant or hegemonic

strategic orientation capable of transcending and organising more local interests. It is further argued that the attempts at managing or governing the sector development agenda in its totality has failed to accept that it has not been possible to establish a sector development agenda dominated by a single coherent strategic orientation. These governance attempts have thus been characterised by the development of very general and very inclusive visions and analysis. They have consequently failed to indentify and organise the incompatibilities between different strategic orientations. These governance attempts have thus left the sectorial development agenda in an under specified state of uncertainty. It is finally argued that governance strategies must be able to accept that it may not be possible to establish a sector development agenda dominated by a single strategic orientation. It is suggested that such a governance approach needs to actively recognise, articulate and organise the incompatibilities between the different and partly incompatible strategic orientations, as this would stabilise each strategic orientation in its own right and enable actors to engage in these strategic orientation on a more informed basis.

Chapter 2 - Understanding strategic sector development

The agenda of this chapter is to develop an understanding of the strategic process of doing sector development based on a critical review of the existing research literature. The strategy is to develop this understanding by addressing the two questions below:

- i) In what sense may a sector be analytically conceptualised as a phenomenon of importance to industrial performance and development?
- ii) How may strategically motivated actors turn an industry into a sectorial object of development which is able to transcend and organise local and uncoordinated strategic interventions?

The aim of the chapter accordingly is to move from a scientifically constructed ‘out-side’ understanding designed to enable the scientist to bring an industry into view as a sector by means of an elaborated scientific vocabulary and towards a more phenomenological ‘in-side’ understanding of a sector. The objective of this ‘in-side’ understanding is to conceptualise how strategically motivated actors embedded in industrial development activities and industrial policy formulation come to develop an understanding of a complex and opaque context as a sector *in the absence of a scientifically constructed out-side position*.

Drawing on the understanding of the strategic process of doing sector development presented in this chapter the aim of chapter 3 is to develop a research strategy by which to engage with the contemporary sector development activities in the Danish construction industry as an empirical phenomenon.

Systems, regimes and fields

So, in what sense do sectors condition industrial performance and development and in what sense can a sector become an object of strategic development in the eyes of strategically motivated actors?

Orthodox economy would suggest that industrial performance and development is conditioned a) by the ability of atomized economic agents to b) interact and coordinate through anonymous market relations by selecting products and services with the best available cost/utility ratio. This line of argument implies that innovation, productivity and industrial performance is most appropriately supported by optimizing the operation of the market by ensuring transparency and competition and by avoiding monopolies.

In recent decades policy on how to support industrial development and competitiveness has however been complimented by a more institutional perspective (OECD 2004, 2005) suggesting that industrial activities and the development and transformation of these activities are embedded in institutional settings that cannot be reduced to anonymous market interactions between independent and atomised economic agents. This chapter takes its starting point in some of the conceptual contributions which has made it possible to define industrial policy as a question of institutional configuration. The main interest of this chapter is however strategic rather than analytical. The aim is thus not mainly to understand how institutional configurations may be analytically understood as a condition for industrial performance and development by researchers in universities. It is rather to understand the processes by which strategically motivated actors involved in industrial development activities and in industrial policy making may come to understand their context as a sectorial identity which can be subjected to development activities with transcend and organise more local strategic activities.

Informed by a series of different analytical vocabularies on how a sector may be argued to condition industrial performance and development the agenda of this chapter accordingly is to develop an understanding of how a sector may emerge as an object of development in the eyes of strategically motivate actors.

The starting point of this chapter is thus a discussion of a series of analytical concepts which argue for the existence 'systems', 'regimes' and 'fields' characterised

by dynamics of a super-organisational sort. These super-organisational dynamics are suggested to condition the activities, performance and worldview of the individual companies and organizations which they embrace.

In a general sense the idea of these concepts may be compared to the way language works. Language may accordingly be de-composed into individual primitives, i.e. words. However, in order to make sense and be use-full, the individual words need to be combined and organized according to specific principles of association called grammar. Grammar thus constitutes the “rules” or “institutions” of language which prescribes a relational ordering that allows the language-user to build complex and elaborated sentences. Grammar is thus enabling to the language-user. However, structures do not come without limitations. Certain complex expressions may accordingly be impossible to translate from one language to another because they are conditioned by different grammars. Likewise, some logics are more obvious within one grammar than within others.

The relation between the words and the grammar concerns the link between the *identity of the individual entity* and the *relational totality* in which these individual entities take part and become useful or productive. If the argument that the totality is nothing but the sum of the individual primitives is applied to the question of industrial performance and development one would explain such phenomena from the isolated perspective of the individual material, component, technology or organisation. However, one may also argue for the existence of an industrial grammar that prescribes specific principles of interaction which the individual primitives must confer to in order to be use-full. It is basically such an industrial grammar which the concepts reviewed below aim to identify in order to explain industrial performance and development from a super organisational or sectorial perspective.

As noted above this chapter reviews three approaches which mobilise different vocabularies in order to understand the industrial grammars and the strategic opportunities and challenges of coping with such grammars. These three vocabularies are discussed because they offer different understandings of strategic agency aiming to develop or transform such grammars. As all of these approaches are characterised by considerable internal variation my review represents a

simplification which draws attention to the characteristics which are important to the understanding of strategic agency which I aim to cultivate. The review of the system vocabulary thus focuses specifically on the innovation system literature (Nelson & Nelson 2002) and not e.g. on the business system literature (Whitley 2000). And while the regime vocabulary is probably best known in the guise of Nelson and Winter's conceptualisation of technological regimes (Nelson & Winter 1982) and has also been used by the innovation system literature (Malerba & Osenigo 1993, 1997) my review focuses on the broader concept of socio-technical regimes (Geels 2004). Finally, my discussion of the field vocabulary draws on institutional literature and more specifically on the institutional literature which focus on agency (Battilana et al 2009; Friedland & Alford 1991) rather than isomorphism and reproduction (DiMaggio & Powell 1983, Meyer & Rowan 1977).

So how can these three vocabularies inform an understanding of strategic agency?

Because the system vocabulary is rooted in an evolutionary ontology it is rather weak in conceptualising how actors recognise and strategically cope with the industrial grammar in which they are embedded. The second vocabulary which conceptualises the industrial grammar as a socio-technical regime draws on some of the same arguments as the system approach but locates the regime in a wider context of local but radical niche experimentation and broader societal landscape dynamics. This allows tensions to emerge between the regime and its contexts and by organising these tensions strategically motivated actors may develop strategies which aim to replace an existing industrial grammar with a new one. Finally, the field vocabulary offers a less integrative and less coherent conceptualization of the industrial grammar and suggests that strategic agency is located in the reflexive interpretations of the inconsistencies and contradictions generated by the industrial grammar.

The vocabularies thus advance different ideas of how to conceptualise the industrial grammar and accordingly also of how to conceptualise strategic agency aiming to optimise, develop or overthrow an industrial grammar.

But why departure from a discussion of the system vocabulary with its evolutionary and strategically un-friendly perspective as the aim of this chapter is to inform the

analysis of strategic agency aiming to developed or transform the industrial grammar?

First, the innovation system literature has had critical impact on the way in which it has become commonplace to understand industrial performance and development from a national, sectorial or regional perspective. At the same time the system vocabulary however also represent a barrier to understanding processes of strategic sector development precisely because of its evolutionary and non strategic ontology. In this way the evolutionary vocabulary marks both a natural starting point but also a framework which needs to be transcended in order to understand the strategic process of doing sector development.

From the evolutionary starting point of the system vocabulary the aim of this chapter accordingly is to develop an understanding of sector development activities by positioning the grammar in a wider context and by adding some messiness and reflexiveness to the picture.

Systems

At first glance the literature on innovation systems may seem highly diverse and analytically heterogeneous. A brief overview of the literature thus reveals a complex of both national-, regional-, sectorial- and technology specific innovation and production systems (Nelson & Nelson 2002). The more generic character of the approaches is accordingly not so much the specific analytical delimitation of the system, but rather its distinct idea of a super-organizational system-ness which condition or govern dynamics of learning and innovation.

By this system-ness it is suggested that nations (Lundvall 1998), sectors (Malerba 2002) or technological communities (Carlsson & Stankiewicz 1991) are characterised by super-organisational dynamics which are at the command of no-one in particular but none the less affect and condition the performance, activities and strategic orientation of everyone. These super-organisational dynamics are thus suggested to generate a particular industrial order and define a trajectory of development. It is

accordingly the operation of these super-organizational dynamics which is at heart of the system approach.

The concept of organized markets developed within the National Innovation Systems approach is an example of such a super-organizational dynamic (Lundvall et al. 2002:218). The argument of this concept goes that market interactions very seldom can be reduced to transparent and anonymous mechanisms of exchange. Some types of market interactions are thus argued to facilitate so-called interactive learning processes between companies and organizations in the value-chain (Lundvall et al. 2002:202). The flow within such chains does not only include services and commodities exchanged through price mechanisms but also experiences, ideas and knowledge. Such interactive learning is typically facilitated by long term market relation characterised by stable and trustful relationships and institutionalised channels of communication. Other markets are on the other hand argued to generate short-sighted, unstable and frequently changing inter-organizational relations where the price mechanism is much more dominant. Such markets are suggested to reduce the level of interactive learning within the value-chain and increase the need for company internal knowledge generation (Lundvall et al. 2002:202).

The dominant type of market interactions which interconnect companies and organizations are accordingly argued to determine (1) the time horizon of agents, (2) the level of trust, i.e. expectations about consistency in behaviour and propensity to restrain from exploiting temporary weaknesses in partners; and (3) the mix of rationality i.e. the relative prevalence of instrumental or communicative rationality (Lundvall 1998:409; Lundvall et al. 2002:220). These three characteristics are seen as critical for the overall direction and speed of industrial learning and innovation.

The concepts of organised markets and interactive learning thus launch a critique of the traditional idea of the market as anonymous and transparent mechanisms of inter organizational exchange and coordination which blindly rewards individual innovators for bringing new products or services to the market. It consequently also questions the argument that industrial productivity and development can be explained from the viewpoint of the individual organisation as this pre-supposes the idea of the transparent and anonymous market (Lundvall 1998:408). Rather it is

suggested that markets actively exercise a force of their own to those who do business in them. The basic argument accordingly goes that the performance and development activities of organizations and companies are actively shaped by the markets in which they engage. It is thus the institutionalised type of market interactions that become the defining drive behind industrial organization performance and development rather than the individual companies and organizations.

Within the National innovation system approach the core question is thus not how to optimise the market but rather why markets become institutionalised or organised in a specific way. It is in addressing this question that the approach becomes specifically national in scope as it is suggested that it is the national culture, institutions, and regulations which determine how markets are organised (Lundvall 1998:412).

An alternative coining of the system approach takes the sector rather than the nation as its analytical identity (Malerba & Osenigo 1997; Malerba 2002). The sectorial innovation system approach suggests that different industrial sectors are characterised by specific types of production and innovation dynamics. This approach suggests that it is the type of knowledge which informs the operation of a sector - rather than the organized type of market interaction - which is the key determinant behind industrial organization, performance and development. (Malerba & Osenigo 2000:290; Malerba 2002:255) The industrial dynamics are more specifically suggested to be shaped by the accessibility, appropriability and cumulativeness of the knowledge produced and utilised within a sector (Malerba & Osenigo 2000:300; Malerba 2002:255). High level of accessibility signifies that knowledge is easy to utilise by new firms. The level of appropriability on the other hand signifies the extent to which firms are able to shield their knowledge from competitors. High level of appropriability is suggested to decrease industrial concentration and *vice-versa*. Furthermore knowledge may also be characterised as more or less cumulative. The level of cumulativeness designates the degree to which the generation of new knowledge is predicated upon an existing knowledge base embedded in the organization. High level of cumulativeness is argued to result in a situation where knowledge can only be produced and exploited by firms which have specialised organizational capabilities build up over time.

These knowledge-derived dynamics are suggested generate a sectorial structure defined by (1) knowledge and technologies (2) actors and networks, and (3) institutions (Malerba 2004:10). Knowledge and technologies designates the specific knowledge base and a specific set of technologies. Actors and networks designates individuals, firms and non-firm organizations which are connected by market and non-market relationships. Finally, institutions include norms, routines, common habits, rules, laws and standards which guide and pattern interactions.

Yet another version of the systemic heuristics is offered by the technological innovation system approach (Carlsson & Stankiewicz 1991; Carlsson 1997).

According to this approach a technological system may be defined as:

“a network of agents interacting in a particular area of technology to generate, diffuse and utilize technology’ (Carlsson 1997:776).”

By this approach it is suggested that the industrial dynamics within a technological field is determined by

- (i) the nature of knowledge (tacit or codified, embodied or disembodied, components specific or architectural)
- (ii) receiver competences, i.e. competences in acquiring new knowledge from outside the firm
- (iii) mechanism of connectivity, i.e. mechanisms of knowledge diffusion within the field (Carlsson 1997:776).

The variety creation in a technological system is thus suggested to depend on receiver competences which designate the competences of first movers such as highly skilled labour and R&D investments to acquire knowledge from outside the system. Mechanisms of connectivity and spill over designate the ability of the system to diffuse new solutions and new knowledge through e.g. standards, education, business transactions and imitation by competitors. The connectivity is further dependent on different kind of networks such as user-supplier networks, technical problem-solving networks and informal community networks.

The system literature in conclusion offers a series of different analytical perspectives on how to understand industrial organization and development as the effects of specific super-organizational dynamics.

Regimes

An alternative vocabulary which also draws on some of the system heuristics is represented by the concept of socio-technical regimes (Geels 2004). In relation to the understanding of strategic agency this concept however differs from the system approaches as the regime has been situated in a context of broader societal landscape forces and local experimental processes within the so-called multi level perspective (Geels 2002). This allows tensions and conflicts to emerge between the regime and these societal and experimental forces and these tensions and conflicts function to conceptualise change and transformation of regimes. The ambition of the multi level perspective accordingly is to conceptualise how new technological opportunities may succeed to challenge and replace the operation of an existing socio-technical regime. (Geels 2006b).

The socio-technical regime concept itself is however introduced as refinement of the sectorial innovation system approach briefly outline above (Geels 2004) although the concept seems to display stronger resemblance to the technological innovation system concept, as a regime is suggested to be organised on the basis of a technological provision of a societal function. The concept is however also directly inspired by the concept of technological regimes as this concept was originally introduced by Nelson and Winter (1982) and as it has been elaborated by Rip and Kemp (1998) who conceptualise a technological regime as a rule-set or grammar:

”A technological regime is the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artifacts and persons, ways of defining problems—all of them embedded in institutions and infrastructures”

(Rip and Kemp 1998:338).

The concept of socio-technical regimes may be seen as attempt to broaden the concept of technological regimes inspired by the idea that a regime can be seen as such a rule-set or grammar. The purpose of the socio-technical regime concept accordingly is to understand how a socio-technical (ST) system operates. A ST system is defined in a ‘somewhat abstract functional sense’ as ‘the linkages between elements necessary to fulfil a societal functions’ (Geels 2004:900). A socio-technical system thus designates the linkages between technology, culture, policy, science and markets and user preferences necessary to provide a societal function of e.g. transportation or communication.

It is however the concept of the regime which is the conceptual corner-stone of the approach as the regime designates the processes or rules by which the ST system is continuously produced and reproduced as suggested in the quotation below:

“I understand *regimes* as semi-coherent sets of rules, which are linked together. It is difficult to change on rule, without altering others. The alignment between rules gives a regime stability and ‘strength’ to coordinate activities’ (Geels 2004:904)”

Referring to the evolutionary arguments originally cultivated by Nelson and Winter (1982) these regimes are argued to constitute the ‘genes’ of the ST system and they are suggested to be embedded in both rules and regulations, values and cognitive structures (Geels 2004:906). Different social groups within the ST-system are however suggested to share different rules. It is accordingly possible to differentiate between regimes such as the technological regime, the science regime, the policy regime, the socio-cultural regime and the user- and market regime. Within each ST-system these different regimes are however argued to be coordinated by a socio-technical meta-regime:

“To understand this meta-coordination I propose the concept of *socio-technical regimes*. ST-regimes can be understood as the ‘deep-structure’ or grammar of ST systems (...) (Geels 2004:904)”

In total the stability and of a ST-system is suggested to be ensured by (i) the regimes, (ii) the actors and organizations and the (iii) technological interdependencies.

Part of an ST-system is thus constituted by shared cognitive rules which guide the perception and problem solving activities of engineers and designers. These are complemented by normative and regulative rules. Normative rules stabilises mutual roles perception and expectations and regulative rules stabilise the st-system through laws and contracts.

Also the ST system is stabilised as actors and organizations are embedded in mutual interdependencies. It is further argued that actors and organizations develop vested interests and that their identities and interest may also be stabilised by the emergence of professional business organisations lobbying on their behalf.

Finally, the complementarities of technological artefacts may contribute to the stability of the system. These complementarities are likely to be formalised into e.g. compatibility standards. (Geels 2004:910-911)

The ST system and the regimes by which they operate is however not entirely conservative and integrative. It is thus argued that ST systems may be subject to incremental change on various dimensions as long as these changes do not endanger the overall system- and regime architecture.

Fields

Finally, the concept of the organizational field offers a less integrative and functional perception of industrial ordering than the system and regime vocabularies. This concept thus allows strategic activities to emerge in the tensions and contradiction of the field itself.

Drawing on interpretive as well as political arguments the concept of the organisational field has been developed to account for the generation of

organizational identities and interests in specific domains of activity. Powell & DiMaggio (1983) thus define an organizational field as:

“those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resources and products, consumers, regulatory agencies, and other organizations that produce similar services and products (Powell & DiMaggio 1983)”

Scott & Meyer (1994) further argue that an organizational field is constituted by interactions between elements which are guided and regulated by a distinct complex of meaning systems and symbolic processes. They accordingly conceptualise an organizational field as:

“a community of organizations that partakes of a common meaning system and whose participants interact more frequently and fatefully with one another than with actors outside the field (Scott & Meyer 1994:56)”

According to this definition the meaning systems which characterise a field are not just a set of exterior conditions which individual actors rationally adjust to in order to advance their individual pre-given interest. The identity and interest of actors and organization are rather perceived as an effect of these field processes.

In order to conceptualise how the order of an organizational field is dynamically generated Friedland & Alford (1991) has advanced the concept of institutional logics. They suggest such institutional logics exist as co-constituting relationships between symbolic orders and material practices which actively generate the motives, self-identity and means-end relations of actors and organization (Friedland & Alford 1991:248). An example of such an institutional logic is private property which exists as a symbolic order that is concretized through relationship of ownership, and buying and selling (Friedland & Alford 1991:249). They argue that such institutional logics:

“(...) provide individuals with vocabularies of motives and with a sense of self. They generate not only that which is valued, but the rules by

which it is calibrated and distributed. Institutions set the limits on the very nature of rationality and, by implication, on individuality. (Friedland & Alford 1991:251)”

Despite the argument that institutional logics equip actors with a 'sense of self' they however go on to argue that:

“Nonetheless, individuals, groups, and organizations try to use institutional orders to their own advantage (Friedland & Alford 1991:251)”

According to Friedland & Alford the organisational identities which exists within an organizational field are thus always partly unstable and contested since any area of social life is always exposed to different, mutual incompatible institutional logics. It is thus argued that individuals, groups and organizations strategically operate to exploit the incompatibilities and contradictions within and between the institutional logics of a field. And as they do so:

“(...) they produce new truths, new models by which they understand themselves and their societies, as well as new forms of behaviour and material practices (Friedland & Alford 1991:251)”

Thus, an organizational field is always characterised by potential conflicts and contradictions and because of these potential contradictions the orders by which a field operate may become subject to processes of reflexive interpretation by those who operate in them.

Transformation and agency

The previous section introduced systems, regimes and fields as different vocabularies which may be mobilised to understand how industrial organisation and industrial development processes can be seen as controlled less by individuals and individual organizations and more by the ordering effects of various super-organizational dynamics. These vocabularies may accordingly also be applied in

order to understand how sectors matter in relation to industrial performance and development.

These vocabularies thus offer a hint about the stuff which strategic sector development activities aim to develop, transform or transcend - namely the super-organizations dynamics. But how do these super-organizational dynamics change and may they be strategically manipulated?

The purpose of the next sections is to discuss how the three vocabularies conceptualise the transformation or development of the super-organizational dynamics. Specific attention is paid to the question of strategic agency, i.e. to the question of whether strategically motivated actors may succeed to deliberately transform and develop the super-organizational institutions, and thus introduce new sectorial trajectories of industrial development.

Strategy and systems

The system vocabulary is moulded upon evolutionary concepts of change and transformation. In line with evolutionary logics as they have been developed within biology the dynamics of systems are thus conceptualised as processes of selection and variety creation.

Within the sectorial innovation system approach it is thus argued that variety is created through activities which introduce new technologies, products, processes and actors. These activities increase heterogeneity. Heterogeneity is on the other hand decreased through various market and non-marked selection pressures (Malerba 2004:30). In their traditional guise the evolutionary logics are however not very friendly towards strategic agency as actors are supposed to remain blind to the selection- and variety creation processes which shape their behaviour and determine the successes and failures of these behaviours.

Some ideas have however been advanced to coin the evolutionary logics in a more actor friendly way. Within the so-called triple-helix framework – which argues that the system should be analysed as the institutionalized patterns of interaction and

exchange between state, industry and academia (a rather research-biased approach) – it is suggested that:

“The biological metaphor cannot work because the difference between cultural and biological evolution. Biological evolution theory assumes variation as a driver and selection to be naturally given. Cultural evolution, however, is driven by individuals and groups who make conscious decisions as well as the appearance of unintended consequences (Etzcowitz & Leydesdorff 2000)”

In a discussion of the system literature Schot et al. (1994) further suggests the evolutionary approaches of the system literature differs from biological evolution in the sense that it allows selection to take place both Ex Post and Ex ante. Ex post selection (Darwinian selection) takes place as variations are generated with no anticipation of the selection pressures of the system. Ex ante selection (Lamarckian selection) on the other hand takes place as actors generate variations in anticipation of the selection-pressures of the system. In both cases the selection pressures are however perceived as a natural given condition of the system (Schot et al. 1994:1063).

The innovation system literature is thus primarily focused on how the system-ness shapes and conditions industrial performance and development, while the question of whether and how this system-ness may deliberately be manipulated through conscious strategic intervention is paid less attention.

This general tendency does however not imply that there are no openings towards more actor friendly concepts on how to impact prevailing system logics. In the development of their technological innovation systems approach Carlsson & Stankiewicz (1991) for an example appear reluctant to buy into the non-strategic bias of the biology-derived evolutionary argument. They accordingly outline an entrepreneur who does only operate blindly or merely try to anticipate given selection pressures but who is also intentionally aiming to transform the rules of the system itself. They accordingly suggest that:

“(...) the role of the entrepreneur is to provide the spark or the vision that turns a network into a development block. He must be able to see beyond that which currently exists to what is possible in the future. He has to perceive the (future) need, identify the necessary ingredients, secure the resources that is missing initially, and communicate his vision to the relevant agents (Carlsson & Stankiewicz 1991:106)”

Here the contours of an entrepreneur who is able to transcend the evolutionary selection processes comes into view, although rather tentatively. By turning fragile ‘networks’ into more durable ‘development blocks’ which is defined by an alternative configuration of ‘needs, ingredients and resources’ such entrepreneurs may accordingly succeed to overcome and transform the selection pressures of a prevailing system configuration.

Drawing on the technological innovation system framework a more dynamic system approach has furthermore been cultivated by focussing of the functions of the system (Jacobsen & Johnson 2000; Bergek et al 2008). This approach thus outlines a picture of how the system may be reshaped by refraining from drawing a very hard line between the structuring performed by the system and the agency of entrepreneurs. In line with the argument by Carlsson & Stankiewicz (1991) this softening suggests that strategic agency should be seen as the outcome of collaborative network processes that contributes to the structural functioning of the system. Drawing on the original conceptual framework of the technological innovation system approach it is thus suggest that the emergence of new technological innovation systems (TIS) depend on the re-alignment of firms, networks and institution aiming to take advantage of new technological opportunities (Jacobsen & Johnson 2000:629-630)

In order to conceptualise how such a re-alignment may take place the following seven so-called key functions of a TIS are identified:

- a) Knowledge development and diffusion
- b) Influence on the direction of research
- c) Entrepreneurial experimentation
- d) Market formation

- e) Legitimization
 - f) Resource mobilization
 - g) Development of positive externalities
- (Bergek et al 2008:414)

The system is accordingly perceived as the effects of ongoing processes of interaction on these functional dimensions. The purpose of introducing these functions accordingly is to displace the traditional non-strategic evolutionary bias of the innovation system approach in favour of a more micro process- and actor friendly perspective.

Along these lines Hekkert et al. (2007) have argued that this functional approach addresses two major flaws in the system approach namely that (a) it is too static and (b) that it lacks attention for the micro level (Hekkert et al 2007:429). Still, however, the functional perspective tends to remain only partially developed as the approach maintains a highly integrative system-position by conceptualising the different micro processes as coherent and well integrated functions of an overall, uni-directional logic of 'the system'.

Hekkert et al (2007) cope with this criticism by stressing that the notion of functions does not reflect an ontological position but rather represents a 'heuristic device'(Hekkert et al 2007:429). As Hekkert et al. unfold the strategic implications of the approach they however cannot help to tacitly re-introduce an overall strategic purpose of the system. It is accordingly suggested that policy should utilise the functional analysis to smooth the dynamics of the innovation system by “stimulating weak functions or by removing blocking mechanisms that prohibit good ‘system functioning’ (Hekkert et al 2007:430)”. The various micro-level dynamics are thus portrayed only as meaningful from the viewpoint of a single aggregate system definition.

The approach thus neglects the possibility that different micro processes may be struggling to promote different system-definitions and that such struggles may constitute a vital function of the system. By suggesting that ‘good system functioning’ provides an attractive strategic point of orientation the approach thus

remains rather conservative as the objective of strategic intervention becomes to avoid tensions and conflicts.

Strategy and regimes

Maybe then, the aim of strategic agency could also be to cultivate and support a variety of partly competing and partly incompatible definitions of 'good functioning' rather than ensuring 'smooth functioning'? By pursuing this line of argument the regime approach positions itself as an alternative to the system literature, which it characterises in the following way:

“(...) the main focus in the system of innovation approach has been the *functioning* of systems (e.g. a static or comparative analysis of the innovative performance of countries) (Geels 2004:899)”

Compared to the system literature with its focus on the functioning of systems the regime approach is then introduced as an attempt to develop a more dynamic 'sociological' conceptualization which:

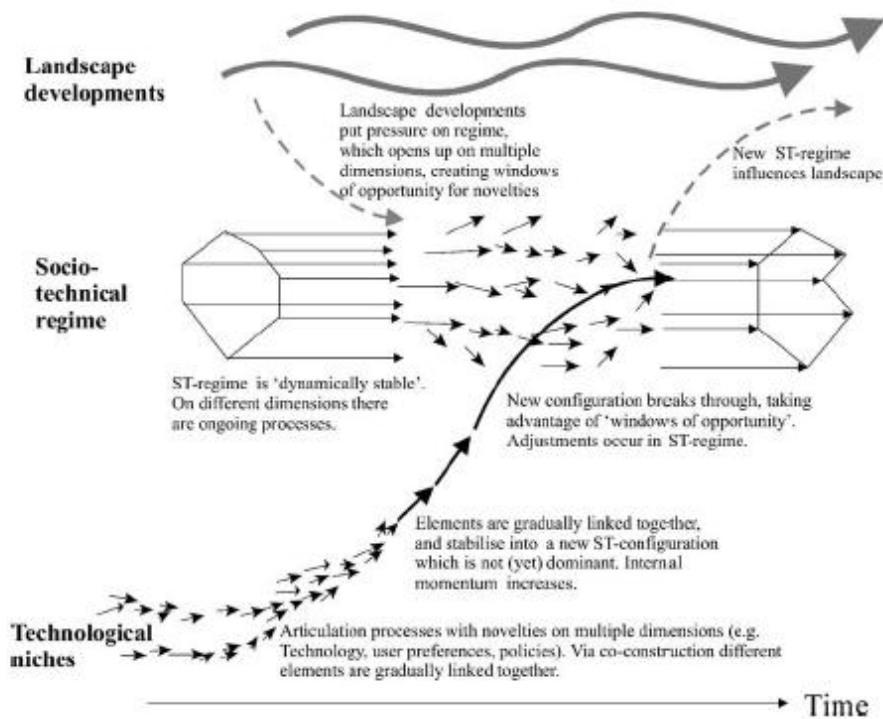
"(...) on the one hand perceives human agency as structured but on the other hand leaves room for 'intelligent perception and strategic action'" (Geels 2004:899).

The ambition of the regime approach thus is to transcend the idea that strategic agency come down to ensuring 'good functioning' of a given system-definition. Rather than 'good functioning' the focus of the approach is to understand and develop strategies by which to support radical re-organizations or transitions of existing regimes. Squarely formulated the focus thus comes down to revolution rather than optimization in the view of the regime approach.

But why this focus on revolution rather than on optimization?

As much as this focus is anchored in theoretical argumentation it also reflects that the concept has been developed to support a 'green' or 'ecological' development of industrial and societal processes. The approach thus reflects the belief that a greening of industry depends on radical new configurations of the existing production and consumption patterns rather than an optimisation of existing ones. It has thus been suggested that new system configurations may generate a factor ten improvement in environmental efficiency while strategies which are limited to system optimization are only likely to generate factor two improvements in environmental efficiency (Geels 2006b:1)

The means by which to add some revolutionary spice to the evolutionary ontology – in which actors and their doings are seen as products of evolutionary dynamics rather than the masters of change - is by embedding regimes in a broader context of macro-level societal changes and micro-level experimental processes. One element of this context is constituted by so-called technological niches (Geels 2002:1261). Such niches consist of development activities experimenting to bring new technologies into use which are more or less incompatible with the socio-technical configuration of the existing regimes. It is however suggested that such niches do constitute potential alternatives to incumbent regimes. It is however also argued that niches are only likely to be able to challenge the dominance of incumbent regimes if these regimes have been weakened. The stability of the incumbent regimes is conceptualised relative to their compatibility with so-called landscape processes which signify broader and more aggregate societal trends and values (Geels 2002:1261). It is thus argued that radical transitions of existing industrial regimes are only likely to occur in situations characterised by a) well established niche processes and b) by a regime which is weakened due to incompatibilities with the broader societal landscape processes (Geels 2002:1262). In totality these arguments are reflected in the multi-level perspective (MLP) which is represented in the figure below



Multi-level perspective on system innovations (Geels 2004:915)

So what does this framework imply for the understanding of strategic agency?

In order to address this question it is central to note that the niche concept is used in two different ways which draw on two very different theoretical traditions and which have different implication for the question of strategic agency. The first tradition is developed largely in line with the evolutionary framework while the second tradition draws on a much stronger belief in agency.

In order to understand how the multi-level perspective may inform the understanding of strategic agency aiming to transform regimes these two traditions accordingly need to be addressed separately.

The evolutionary concept of niches

As suggested above the niche concept is used in both an evolutionary and strategic way. The purpose of the evolutionary niche concept has been to develop a dynamic evolutionary model of regime transitions processes which often takes place over a time span of several decades. This evolutionary niche concept has been used to

inform a series of historical transitions studies concerning the transition in the aviation system from propeller to turbojet (Geels 2006), the transition from horse drawn carriages to the automobiles (Geels 2005), the transition from sailing ships to steamships (Geels 2002) and the transitions in water supply system from surface water to piped water (Geels 2005). These studies draw on the explanatory framework briefly outlined above which suggest that transitions are conditioned by technological niche processes which link up with incompatibilities between the incumbent regime and broader societal landscape processes and thereby succeed to destabilise and replace the incumbent regime.

The study of the transition from surface water to piped water in the Netherlands in the 19th century may serve as an example of how this evolutionary niche conceptualization works to provide an understanding of the transition of socio-technical systems and the regimes by which they operate (Geels 2005). The analysis demonstrates that piped water systems appeared in cities with specific needs as early as the 1850s (Geels 2005:376). Despite increasing internal problems within the established surface-based water regime these piped-water systems did not diffuse until the 1880s and 1890s. According to the analysis the diffusion of the piped water niche was not triggered until broad cultural and political landscape developments appeared such as soap, toilets, bath and an increasing focus on health care and personal hygiene (Geels 2005:379). These broad landscape trends thus destabilized the incumbent surface water regime and allowed the piped water niche to diffuse and become dominant.

The transition studies which have been informed by the explanatory model outlined above have further resulted in the identification of four transition pathways (Geels & Schot 2007).

The so-called transformation path designates a situation where moderate landscape pressures combined with immature niche-innovations allow regime actors to modify the incumbent regime in an incremental way (Geels & Schot 2007:406).

The de-alignment and re-alignment path signify a situation where landscape pressures are divergent, large and sudden but where niche innovations are not sufficiently developed. In this situation it is argued that several niches may co-exist

and compete, but that one niche will eventually become dominant and form the basis for the alignment of a new regime (Geels & Schot 2007:408).

The technological substitution path signifies a situation characterised by much landscape pressure and a mature niche. In this situation the niche is likely to break through and replace the existing regime (Geels & Schot 2007:409)

Finally the reconfiguration pathway signify a situation where so-called symbiotic niche innovations, i.e. niche innovations which can be adopted as competence-enhancing add-ons to the existing regime is absorb by the incumbent regime (Geels & Schot 2007:409).

The explanatory framework which informs the historical transition studies however operates without introducing the idea of a regime challenging strategies formulated and implemented by strategically motivated actors. In these studies the niche concept thus operates as an analytical category invented in the research process and not as a strategic category actively used by the actors involved in experimental niche activities.

This analytical use of the niche concept thus resembles the idea of ‘technological speciation’ (Levinthal 1998). Inspired by the vocabulary of biological evolutions the idea of this concept goes that radical technological developments may be analysed analogous to the development of new biological species. Within biology speciation processes by which distinct new species emerges are explained as the result of specific circumstances which allows minor initial variations to develop into different development paths as suggested below:

“The initial speciation event is minor in the sense that the form does not differ substantially from its predecessor. However, as a result of a separate reproductive process driven by genetic drift and a possible distinct selection environment, the speciation event may trigger a divergent evolutionary path (Levinthal 1998:218)”

Processes of speciation are thus explained as the effects of geographical separation. Due to geographical separation the same species may accordingly be exposed to

different selection environments. In such a situation some functionality which is of limited importance in one of the locations may turn out to be vital in the other another location and *vice versa*. Over time such different selection environments may thus generate different trajectories of development, as the advantages of initial minor variations accumulate into distinct species. Translated to the sphere of technological development it is suggested that a processes of speciation may be initiated if an existing technology is being applied in an new contexts or niche where particular elements of its functionality which were irrelevant to its traditional domain of application becomes highly important (Levinthal 1998:221). Niche environments characterised by alternative selection dynamics may accordingly turns out to have radical consequence for the technological form. Processes of technological speciation are thus seen as predicated by the ability of the technology to circulate across un-even selection environments.

In relation to the question of strategic agency the important aspect of the argument is however that speciation processes are not strategically indented. The speciation of a radical new technological form is no more the outcome of strategically designed and controlled activities than the evolution of new biological spices is the result of conscious and coordinated actions of a coalition of especially bright and innovative animals, plants or organisms.

In line with the concept of speciation the historical transition studies employ the niche concept as an analytical concept aiming to explain transitions. Niches are accordingly not seen as phenomena which have been strategically constructed by someone who has been intentionally operating to support the transformation of an existing regime.

The strategic niche concept

While the concept of speciation is an example of an analytical and purely explanatory use of the niche concept a much more strategic use of the niche concept has been introduced by Schot et al (1994), who criticise the un-strategic propensities of the evolutionary ontology as indicated by the quotation below:

“We argue that simple evolutionary models are necessarily incomplete because selection and variation processes, the building block of any evolutionary model, are envisaged as independent instead of being coupled. To emphasize the intentional and strategic character of these coupling we prefer to speak of quasi evolution (Schot et al. 1994:1062)”

By the concept of ‘quasi evolution’ it is suggested that governments, which are implicitly argued to represent regime level interests, may strategically perform coupling activities which mediates between variation- and selection processes in order to establish a so-called ‘technological nexus’. This ‘technological nexus’ should at the same time develop alternative variations processes and modify the selection environment. The initial processes of such a strategy is conceptualised as strategic niche management. The strategic management of such niches is suggested to consist in a) experimentation designed to gain experience and bring about an articulation; and b) processes designed to selectively expose the niche to the environment in order to allow the new technology and the existing environment to adjust to each other (Schot et al 1994:1073).

A somewhat similar employment of the niche concept has been advanced by Kemp et al (1998) who suggest that:

“Although our understanding of how technological transitions come about is limited, historical evidence suggests that entrepreneurs/system builders and niches play an important role in the transition process. The development of a new technological system is often associated with the names of entrepreneurs (Kemp et al 1998:175)”

Kemp et al. (1998) thus argue that niches may be strategically crafted in order to support technologies which do not readily comply with the operation of incumbent regimes. The strategy advocated by Kemp et al. is to establish a protected or shielded space in which the normal selection pressures of the regime are dispensed with, in order for new promising technologies to develop and mature into an alternative socio-technical configuration.

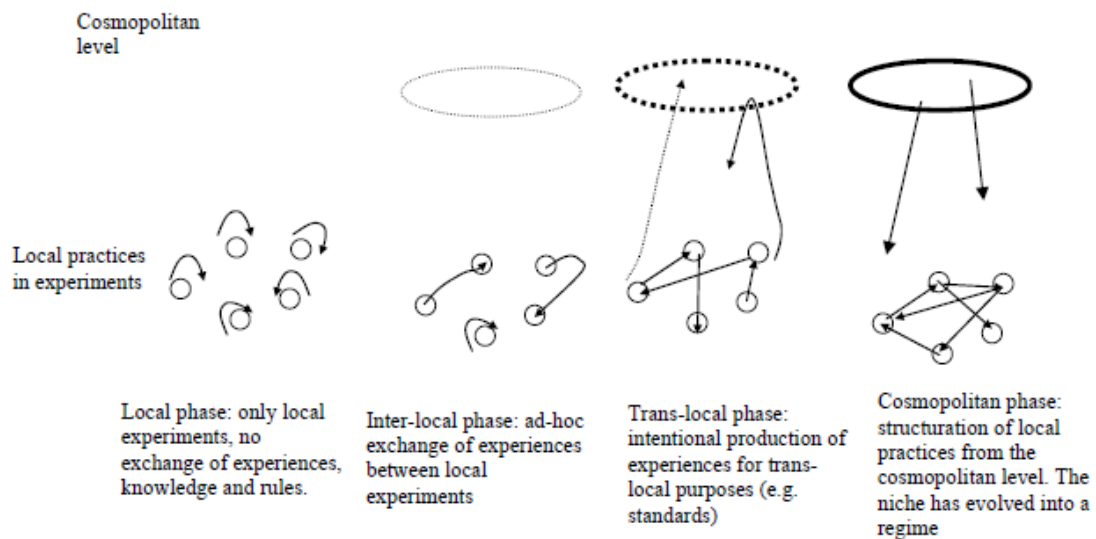
Within such semi-protected niches experimental activities should thus not only be developed on the technological dimension. The activities should rather aim at developing a configuration of mutually re-enforcing complementarities in order to render the niche strong and durable. Kemp et al (1998:187) specifically suggests that technological niches may be initiated and supported through policy programs. They recommend that such policy programmes should support technologies which are of 'general societal interest' and which meet the following four preconditions:

- (i) The social precondition: The new technology must alleviate a social problem like environmental degradation at a cost that is not prohibitively high
 - (ii) The technological/scientific precondition: The new technology must have major technological opportunities embedded in it, have sufficient scope for branding and extension and for overcoming initial limitations
 - (iii) The economic precondition: The new technology must exhibit increasing returns of learning economies
 - (iv) The managerial and institutional precondition: The new technology must be consistent with actual or feasible forms of organization and control and be compatible with important user needs and values
- (Kemp et al 1998:187)

The argument of this strategic niche management approach thus goes that governments should not only operate to streamline and optimise the innovative capabilities of existing regimes but that they should also support more radical niche activities if these point towards ends that are of general societal interest.

In a series of publications the niche management perspective has been further elaboration (Geels 2005; Raven 2005; Schot & Geels 2008). According to this strategic niche management literature niche development activities should operate on three dimensions. The first dimension is about initiating and aligning experimental activities with new technology which support leaning on several dimensions such as technology, user preferences, symbolic meaning, and regulation. This process should be followed by the build-up of a social network which supports the niche. Thirdly, visions and expectations should to be articulated in order to

guide the development of the niche (Geels & Schot 2008:541). Also, to stabilise the niche and give the experimental activities direction it is suggested that first-order experiences emanating directly from different experimental activities need to be transcended by global or second-order learning which should define a set of common or collective visions, methods and expectations for the niche as a whole. This second-order learning is supposed to guide and interconnect the various niche activities as suggested by the figure below:



Raven 2005:47

The aim of strategic niche management activities is accordingly to develop an increasingly institutionalised normality within the niche. This normality has to eliminate or reduce the risk and uncertainties of entering the niche by establishing an increasingly efficient working configuration.

So the argument of the SNM literature goes that governments may support transitions through strategic niche management. But what kind of strategic capabilities does this kind of strategic agency presuppose?

In order to address this question it is critical to note that the niche, regime and landscape is conceptualised as a nested hierarchy. This implies that the idea of strategic niche management only makes sense relative to a specific set of regimes and landscape processes. Niches thus by definition don't exist in a vacuum as they are necessarily a niche in relation to something bigger. Governments or other strategically motivated actors who want to engage in the strategic design of niche

processes must accordingly also be able to specify what counts as regime and landscape.

But how do strategically motivated actors embedded in a complex reality recognise what type of activities and relations that belongs to a regime and how to conceptualise the landscape processes at work? And how should the understanding of the regime and landscape processes inform the design of the niche activities?

Here matters begin to complicate as a regime and landscape definition is notoriously difficult to archive or monopolise from any neutral or privileged position. These difficulties are reflected specifically in the innovation system literature where systems are suggested to operate both nationally, sectorially and technologically. Within the system literature there is accordingly no convergence towards a single neutral and unifying system definition. Systemic innovation dynamics in other words seems to operate across very different domains in very complicated ways. Any system definition thus constitutes a strategic choice which makes some lines of strategic agency more obvious than others.

The historical transition studies on the other hand seem to be able to establish a privileged and neutral position from where to bring the niche, regime and landscape into vision. This privileged position is however only rendered possible because the niche, regime and landscape are brought into view by a specific break in continuity. In the historical transition studies the monolithic identification of niche regime and landscape thus depend on an identifiable historical transition which separates a 'before' from an 'after' and allows these to be compared. These studies accordingly represents the perspective of the winning niche rather than a neutral and privileged analytical position.

These considerations indicate that there is no analytical and neutral position from where to conceptualise regimes and landscape pressures by strategically motivated actors engaged in strategic niche management activities. Any strategic engagement in niche processes thus presupposes a strategic co-construction of some specific understanding of the regime and the landscape processes at work. This implies that the defintory power and defintory struggles over the regime and the landscape

processes is vital since it is these definitions which establish the orientation of the niche management activities.

This has also been indicated by a discussion of how ‘future visions’ are generated and deployed to support processes of regime transition (Berkhout 2006). This discussion suggests that the SNM literature neglects the socio-political dimension of regime change and thus argue for the need for a:

“less functionalist, more actor based analysis of regime transformation that sees regime change as being motivated by resource-interdependent actor networks situated both within incumbent regimes and outside them (Berkhout 2006:304).”

Future visions are then portrayed as politically motivated constructs by which specific actors within and outside regimes strive to influence and shape the expectations and actions of others. Expectations, interests and identities are thus pictured as contested socio-political construct rather than neatly ordered effects of evolutionary dynamics. Visions by which actors guide their activities are accordingly suggested not to have an analytical neutral “meta-existence” which represents an aggregate functional ‘interest’ of the regime but they are rather suggested to be specific to the interests of actors or coalitions of actors (Berkhout 2006:300). Visions are thus pictured as expectations or “bids” of what the future might or should be like which compete with the “bids” of other actors.

It is further argued that visions operate both as a heuristic device, which frames a specific understanding of the regime (in terms of the institutional, technological and behavioural problems which need to be addressed), and as metaphors for building actor networks, i.e. metaphors which include (and exclude) actors and bring together and focus resources (Berkhout 2006:305).

Following the same line of reasoning Smith et al. (2005) suggest that a strategic key element of transition processes is the ability to articulate the pressures on the regime:

“There is typically no shortage of pressures acting on any given regime, often pushing in opposing directions. In practice, it is therefore not simply the existence of such pressures that is decisive. Instead, it is what we term the *articulation* of pressures for any given regime transformation (Smith et al 2005:1495)”

It is accordingly suggested strategic articulation activities typically need to align incoherent pressures and render these pressures explicit in a form which enables a response by the regime (Smith et al 2005:1495).

The critique outlined above in conclusion indicates that it is a much more strategically complex and sensitive process to turn experimental activities into a niche than recognized by the SNM literature because such processes implicitly or explicitly depend on a specific construction of the regime and landscape processes at work. This implies that strategic niche management cannot be isolated to something which has to do with aligning experimental development processes inside a niche. As much as niche management activities is about shielding and aligning experimental activities inside the niche such activities do accordingly also represent an intervention in the reality outside the niche. Strategic niche management is thus an indirect way by which to institutionalise a specific set of political tensions, interests and coalitions through the representation of the regime and landscape which the niche implicitly or explicitly reflects.

The strategic niche management literature may accordingly be criticised for underplaying the broader strategic dynamics and implications of niche management activities by tacitly implying that the regime and the landscape processes can be objectively identified by governments which operate in the interest of the common good.

Strategy and fields

Compared to the system concepts the MLP model and the SNM literature represent a prominent attempt to develop a more vibrant concept of strategic agency by

situating the regime within a broader context of experimental micro level activities and higher level societal landscape forces.

As indicated by Berkhout (2006) and Smith et al. (2005) the regime- and landscape processes which are used to strategically orientate the niche processes are however not likely to stand out as objective facts to actors engaged in transition management processes, as it seems to be tacitly implied by the SNM literature. This implies that the understanding of the regime and landscape processes which informs niche management activities need to be perceived as strategically or politically informed constructs. This has also been at least partly recognised in some of the more recent debates concerning the SNM literature as indicated below:

"It is indeed quintessential to realise that delineating 'the' system at hand involves politically laden definitional choices: what regimes to consider, which stakeholders to include, what landscape tendencies to consider etc. Hence the unit of analysis in for example a MLP or system analysis should be treated as a matter of strategic choice (Grin 2010:307)"

In order to understand strategic agency aiming to challenge the operation of incumbent regimes it is thus critical not only to focus on the alignment of experimental activities inside niches but also to understand how and why actors generate regime- and landscape representations and how these representations condition and interact with the alignment of experimental development activities.

The purpose of the following discussion is to address these questions by exploring a concept of strategy agency called institutional entrepreneurship which has been cultivated within the literature on organizational fields (Battilana et al. 2009; Garud et al. 2007).

Levy & Scully (2007:973) define *institutional entrepreneurship* as “patterns of organizational action concerned with the formation and transformation of institutions, fields, and the rules and standards that control those structures” and they locate such agency in the “interstices and contradictions of plural, overlapping and incomplete logics (Levy & Scully 2007:974)”.

In contrast to the MLP model and the SNM literature which locates strategic agency in the tensions and contradiction *between* the regime- the niche- and the landscape levels, the institutional entrepreneurship literature thus locates strategic agency *within* the organizational field itself. This understanding of agency thus presupposes that fields are conceptualised in a less integrated and functional way than regimes are in order to allow for tensions and contradictions with can resolve the paradox of embedded agency (Holm 1995:398; Seo & Creed 2002:226).

As discussed earlier the concept of organizational fields offers such a less integrative conceptualization. Complimentary to the line of reasoning offered by Friedland & Alford (1991) a more operationalized framework of institutionalisation and institutionalization and institutional change has been developed by Seo & Creed (2002). They suggest that dynamics of institutionalization and institutional change may be understood as a dialectic process consisting of (1) social construction (2) totality (3) contradiction and (4) praxis (Seo & Creed 2002:225).

According to this model 'social construction' designates processes through which orderly and predictable relations are produced and reproduced. An organizational field - such as an industrial sector - thus emerges as activities directed by power and interests crystallize into a predictable patterns of interactions embedded in set of institutional arrangements (Seo & Creed 2002:225). Totality refers to the interconnectedness of the various institutional arrangements as:

“Any particular social structure is viewed not as an isolated, abstract phenomenon but, rather, as part of a larger whole composed of multiple, interpenetrating social structures operating at multiple levels and in multiple sectors (Seo & Creed 2002:225)”

Note the difference between the conceptualization of regimes and the organizational fields. Whereas the various structures which make up a regime are seen as orchestrated by their relation to a 'societal function' the social structures which make up an organizational field are not seen as coordinated aspects of a integrative societal function. Contrary to the regime concept which tends to rationalize cognitive, regulatory and material structures as sub functions of an

aggregate societal need the organizational field concept perceives such structures as sedimented interests and power-relations. This allows for a less coherent and integrative picture where social structures operate at multiple levels. Some may operate on a local scale while other may operate more global. The relations and dependencies between the various structures of an organizational field are thus neither perceived as complete nor coherent. This perception of social structures in other words indicates that the identification of a field cannot be done from any objective and neutral position. Such an identification rather implies a choice with political and strategic consequences.

As any totality is thus always incomplete the model suggests that contradictions are continuously generated in the tensions and inconsistencies between the various social structures. It is these contradictions which may be turned into strategic agency aiming to change or challenge an institutional order as a whole. Praxis thus refers to the creative re-construction of social patterns based on the experiences of tensions and conflicts (Seo & Creed 2002:225).

Thus, as much as a field may be seen as a totality by which to provide a 'societal function' as suggested by the regime concept it may thus also be experienced as a universe of interests, conflicts and contradictions by the actors who operate in the field.

But how do institutional entrepreneurs operate to exploit the experiences of conflict and contradiction and how can the strategy of such entrepreneurship be conceptualised?

According to Fligstein (2001) institutional entrepreneurs are characterised by social skill, which indicate that they are motivated by - and skilled in - inducing cooperation among others rather than pursuing narrow self-interests. According to Fligstein such entrepreneurs:

“(...) do whatever it takes to induce cooperation, and if one path is closed off, they will choose another. This means that skilled social actors are neither narrowly self-interested nor do they have fixed goals. They do not have individual fixed interests but instead focus on the

evolving collective ends. They keep their goals somewhat open-ended and they are prepared to take what the system will give (Fligstein 2001:113)”

Fligstein further suggests that one of the tactics institutional entrepreneurs pursue in their brokering-efforts is the framing of stories which strategically align otherwise incompatible identities and interests. Agenda setting - i.e. the ability to decide the parameters of conflicts and discussions - is suggested to be another important strategy. It is however also suggested that the ability to hide ones intention may be important by maintaining “goallessness” and ambiguity (Fligstein 1997:339).

Inspired by the work of Gramsci Levy and Scully (2007) further suggest that activities of institutional entrepreneurship need to be coordinated by so-called ‘organic intellectuals’ who are able to interconnect multiple power-bases in a long-term strategy in order to avoid futile ‘frontal attacks’ on powerful established interests. (Levy and Scully 2007: 978-979) The aim of such organic micro-strategies is accordingly to gain legitimacy and develop organizational capacity by actively participating in practical life.

Strategic activities of institutional entrepreneur are accordingly not isolated in a strategically shielded niche but these activities are rather embedded in the operation of field itself and their successes is accordingly predicated on political sensitivity and the ability to navigate in the contradictions and inconsistencies of the field.

On a more operational level the literature identifies the processes of theorization as a key strategic component of institutional entrepreneurship (Greenwood et al 2002:2003). The purpose of this concept is to understand how strategically motivated actors become aware of their context as an institutional whole which may be subjected to organised development processes.

The concept of theorization was however originally coined by Strang and Mayer (1993) who sought to understand how novel regularities in social patterns are diffused across a larger social space. They suggested that processes of diffusion are accelerated as novel practices become ‘theorized’. They defined theorization as ‘the self-conscious development and specification of abstract categories and the

formulation of patterned relationships such as chains of course and effects (Strang and Mayer 1993:492)'. According to Strang and Mayer theorization thus signifies a reflexive process by which practices are conceptually dis-embedded from their specific local context into a more generic guise which makes them applicable and attractive beyond their original location setting. By means of a theorized practise actors may thus become cognitively dis-embedded from the context in which they operate, as this context become de-naturalized through the perspective offered by the theorized practice. Theorized practices are thus characterised by their ability to establish an interpretative perspective which discloses a larger social space in some specific way.

Within the literature on institutional entrepreneurship theorization refers to the specification of *a general organizational failing* for which a local innovation is a solution or treatment (Greenwood et al 2002:2003). Theorization thus refers to the process by which strategically motivated actors develop an awareness and construct a representation of their context as a flawed institutional whole. Such representations are thus theorized in order to advance specific lines of strategic action aiming to re-organise or change the institutional whole in which these actors are embedded in its totality.

Whereas Strang and Mayer (1993) suggested that theorization activities is about abstracting local practices which deviate from prevailing conventions more recent works draw on the concept of institutional logics originally developed by Friedland & Alford (1991). These works accordingly suggest that theorization activities by which strategically motivated actors construct a representation of their context as a flawed institutional whole depend on the ability to identify and mobilise institutional logics. Lippi (2000) thus suggests that institutional change may be initiated by so-called agencies or 'significant others', who are able to translate global logics circulating in external institutional settings into solutions which are able to deal with field-internal problems:

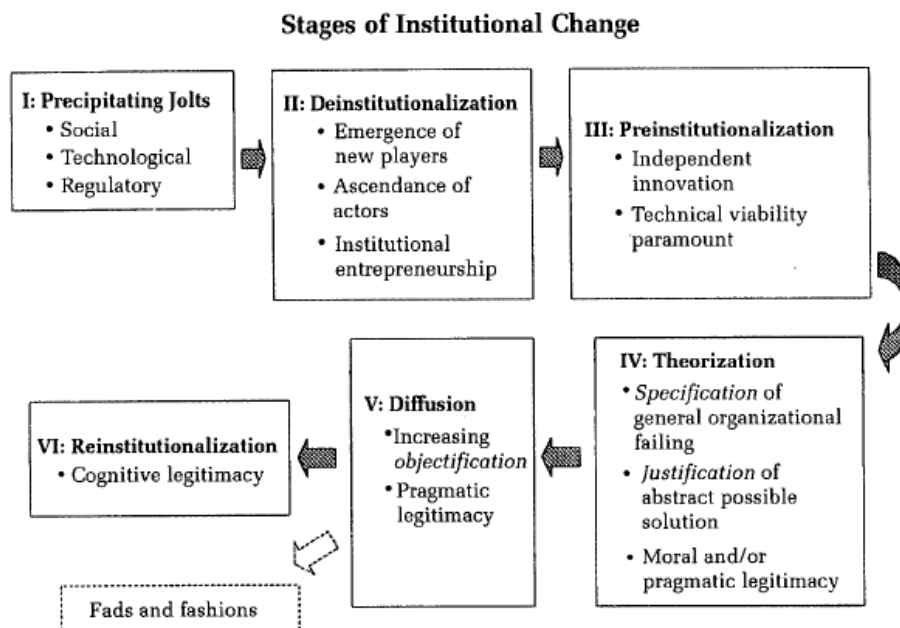
“The significant others are (...) filters able to modify the global element at the local level and to make it easier to adopt in that specific context. Their role is to standardize the innovation and to package it as

a language, a technological form, an organizational pattern or norm that is recognizable and acceptable to the recipient (Lippi 2000:459)

A similar argument has been advocated by Boxenbaum & Battilana (2005) in an analysis of how the U.S. managerial practice of ‘diversity management’ was theorized into a policy-solution in a Danish institutional context. (Boxenbaum & Battilana 2005:379; Boxenbaum 2006).

But under what type of circumstances are actors more specifically provoked to theorize their context as a flawed institutional whole.

Two types of triggers have been argued to catalyze processes of theorization. Greenwood et al (2002) suggest that theorization activities may be triggered by shocks or so-called precipitating jolts which magnify contradictions and tensions in the field. This argument is illustrated in the model below.



(Greenwood et al. 2002:60)

The model goes that precipitating jolts are followed by processes of de-institutionalization which renders embedded actors foreign to the existing institutional arrangements in which they operate as their existing routines and responses fail to make sense of their experiences. This ‘foreignness’ may accordingly

initiate processes of theorization, as actors strive to redefine their interests and identity through the conscious theorization of novel representations of their context.

The other and more endogenous account of how theorization dynamics are catalysed has been offered by Greenwood and Suddaby (2006). They suggest that otherwise embedded actors may be provoked to engage in theorization activities as they outgrow their traditional position in a field. They argue that such actors may be faced with experiences of 'boundary misalignment' if they e.g. come to operate in markets governed by different regulatory setups (Greenwood and Suddaby 2006:38). Such actors may also come to occupy a 'boundary bridging' position if they expand their activities into new fields (Greenwood and Suddaby 2006:37). Besides being faced with the experience of new contradictions actors which come to occupy a 'boundary bridging' position may also be exposed to different institutional logics which render them less embedded in their original institutional setting (Greenwood & Suddaby 2006:42).

A theorized representation of an institutional whole is in conclusion not the outcome of a neutral interest to analytically mirror reality. Theorization activities rather represent an attempt by strategically motivated actors to re-organise problematic or contradictory experiences in a way which allows them to engage in the world in a way which appears to be logical, consistent and rational. The purpose of a theorized representation accordingly is to provide actors with a world view that can inform consist and rational behaviour. The objective of theorization activities is thus strategic rather than analytical.

The institutional entrepreneurship approach and the concept of theorization in conclusion imply that a sector cannot be seen as a neutral analytical starting point for strategic agency. As an object of development a sector is rather an integral product of strategic agency. This implies that the analysis of strategic sector development activity needs to be sensitive to the processes by which the sector itself is constructed as an object of development.

Conclusion

In order to conclude this chapter I shall make use of a basic distinction between apprehending a phenomenon as 'present-at-hand' and apprehending it as 'ready-to-hand'. This is a distinction which was introduced by the German philosopher Martin Heidegger (Heidegger 1962).

Heidegger uses the term 'present-at-hand' to signify the structure of a theoretical apprehension, i.e. an apprehension which is not immediately indented in informing an active involvement with the phenomenon under consideration but rather aims to mirror it in an objective and dis-interested way (Heidegger 1962:79).

The term 'ready-to-hand' on the other hand signifies the structure of a practical apprehension which is intrinsically involved with specific ways of manipulating the phenomenon in question in order to get something done and produce specific outcomes (Heidegger 1962:98). In this apprehension practice and description melt together. In contrast to the theoretical apprehension the purpose of an apprehension which is 'ready-to-hand' thus is to construct or re-construct coherent images by which to engage with the phenomenon rather than reflecting or mirroring it in an objective or disinterested way.

The purpose of this chapter has been to develop an understanding of how a sector may be recognized as object of development by strategically motivated actors. This accordingly entails understanding how a sector becomes apprehended as something which is 'ready-to-hand' in an involving and strategic way.

So what is the precondition for the emergence of a sectorial representation of an industry which is 'ready-to-hand'? Since the aim of developing such a representation is to construct or reconstruct an image that enable actors to engage with their environment in a consistent and rational way the prerequisite is the experience of contradictions and failures in existing ways of engaging with the environment.

In order to develop an understanding of the strategic process of doing sector development this chapter began by introducing a series of concepts which may be used to analytically understand a sector as a phenomenon with is 'present-at-hand'.

These concepts were however not so much introduced because of their analytical virtues but rather because they operate with different ideas of contradictions and failures and also with different ideas of how such contradictions and failures are experienced. These different understandings have thus been used as a starting point for constructing an understanding of how a sector may emerge as an object of development which is 'ready-to-hand' in the eyes of strategically motivated actors.

So how do these different concepts conceptualise failure and contradiction and how do they consequently inform the understanding of strategic sector development processes?

First, the system vocabulary suggests that a sector may be perceived as a more or less well performing production- and innovation system. Here the possibility of understanding the sector as an object of development which is 'ready to hand' comes down to a question of integration, calibration and 'smooth functioning'. Likewise strategic agency becomes a question of ensuring optimal system functioning. From this perspective the experiences of failure and hence the possibility of strategic agency is furthermore exogenous to operation of the system itself. Strategic sector development thus presupposes external analysis informed the concepts and tools necessary to understand and analyse the systemness of a sector.

While the regime concept also conceptualise a sector as sort of evolutionary system this approach situates the sector within a context of macro level landscape processes and experimental micro level innovations dynamics and thus introduces a set of potential contradictions and conflicts between these levels. These levels accordingly introduces the possibility of problematizing a sector in its totality as it comes into contradiction with the macro-level processes of the landscape as well as micro level innovation processes. Strategic agency may accordingly challenge the dominant organization and operation of a sector by linking radical micro level innovations with the new macro level landscape developments. In contrast to the system concepts which imply that sector development processes becomes a question of system optimization the regime concept thus implies that sector development becomes a question of transcending and replacing the organization and operation of an existing sector in its totality. From the viewpoint of embedded actor this MLP framework however imply that the experience of contradiction between the levels

and hence the possibility of strategic agency remains limited. Actors which are engaged in experimental micro level innovations activities are thus supposed to be more or less blind to the potential contradictions between the regime and landscape level. External niche management expertise is thus needed to strategically link the micro level innovations with regime-landscape contradictions.

Despite their differences both the system and regime concepts agree in their view of systems or regimes as phenomena which are relatively well organized and well delineated. The field concept questions this assumption and it thereby introduces another set of contradictions. This concept thus argues that institutionalised patterns of interaction do hardly make up well organised systems or regimes which can be easily understood and separated from one another. The concept rather suggests that institutions operate on very different levels and often contradict with one another. This implies that institutionalized relations and dependencies may be conceptualised in a potential multiplicity of ways. As the idea of a sector as a well organised and delineated regime or system is rejected attention is consequently directed towards the processes by which a sector is defined as an object of development as sectors only exist as questionable and rationalised representations. The conceptualization of the sector accordingly becomes a strategic intervention in social reality rather than a neutral analytical starting point for strategic agency. But why and how are sector representations created if they are not naturally given? The literature on institutional entrepreneurship suggests that such representations may be seen as a means to deal with unresolved experiences of contradictions. The experiences of too many isolated contradictions may accordingly provoke actors to web these experiences together into an aggregate sectorial representation. It is further suggested that institutional logics play an important role in the crafting of such representation. In contrast to the system and regime concepts these arguments imply that strategic sector development becomes a phenomenon which is endogenous to the field itself. Embedded actors are thus themselves able to develop sector representations and to strategically act according to the strategic orientation of these representations.

Inspired by these consideration I suggest that strategic sector development activities can be understood as experimental development activities which are informed and coordinated by a theorized sector representation.

This working definition implies that the sector do not exist as a neutral analytical starting point for strategic sector development activities. As an object of development a sector is rather itself an integral product of strategic agency.

According to the working definition the key element in strategic sector development processes is accordingly the interpretative efforts by which otherwise conflicting and incompatible experiences and aspirations are explained and webbed together into a sector representation which is able to inform and coordinate experimental activities. Experimental development activities can thus only be characterised as strategic sector development activities if they are directly informed by a theorized sector representation.

The term theorization is accordingly of key importance in the working definition as it implies that a sector representation need to be understood as a strategic construct which enables collective and coordinated experimental activity by simplifying a complex, ambiguous and potentially paralysing mess of relations and identities by means of an overarching logic. As an object of development a sector do thus not come into being from a neutral analytical point of view but is rather the outcome of sense-making processes aiming to re-organise problematic or contradictory experiences in a way which enable actors to engage in the world in a way which appears to be logical, consistent and rational. From a strategic point of view a sector representation may thus be perceived as a sense-making devise capable of providing a collective and attractive sectorial interpretation which offers a specific understanding of the failures and limitations of an existing order, a possible bright future, and the interventions and experimental activities which are likely to bridge the present with this possible future.

Chapter 3 - Analysing strategic sector development

Building on the working definition which concluded the previous chapter the aim of this chapter is to develop a strategy and identify a set of concepts that can inform empirical analysis of strategic sector development activities in the Danish construction industry.

This chapter accordingly aims to develop the argument that the empirical analysis of strategic sector development activities need to pay attention to the complex interpretive processes by which actors rationalise otherwise conflicting and contradictory experiences and aspirations *as effects or symptoms of an underlying malfunctioning of a broader industrial whole such as a sector.*

As a strategic object of development this chapter accordingly argues that a sector should be empirically identified as a representation whose strategic attractiveness depend on its ability to systematically organise and make sense of problematic and incompatible experiences and priorities in a way which is able to inform and align experimental activities and interventions rather than its epistemological ability to objectively mirror the operation of an industry.

In relation to the empirical research strategic these arguments have at least two implications.

First, they imply that the empirical research strategy should not aim to measure the 'correctness' of sector representations in terms of mirroring the industry they claim to reflect. Rather sector representations should be analysed and evaluated according to their ability to actively encode actors, materials and technologies with attractive identities and interests, which can be turned into coordinated experimental activity. In a strategic sense the interesting thing about a sector representation is accordingly not how well or correct it reflects reality but rather if it succeeds to perform and bring things into motion in a coordinated way.

Secondly, they also imply that the empirical research strategy should not apriori narrow down strategic sector development activities to processes which are either predominantly experimental - as the strategic niche management approach tends to suggest - or as processes which are predominantly discursive - as the institutional entrepreneurship approach tends to suggest (Battilana et al 2009:94). Rather the empirical strategy should be sensitive to the ability of sector representations in producing organised and coordinated effects *across* a heterogeneous set of elements such as discourses, interests, regulations, technological artefacts and experimental activities.

Based on these considerations I suggest that strategic sector development activities, perceived as coordinated experimental activities informed by a theorized sector representation may be empirically investigated as an actor network (Law 1992). An actor network is a concept designed to facilitate empirical investigation of how a heterogeneous web of material, social and discursive associations may be aligned to generate controlled and organised effects for an example in the guise of strategic sector development activities.

The purpose of this chapter is according to (a) introduce and discuss actor network theory and (b) to develop a research strategy by which to engage with strategic sector development in the Danish construction industry as an empirical phenomenon

Strategic sector development as an actor network

As an empirical research strategy the actor network approach can be introduced as a member of a broader strand of research approaches within the social sciences which can be characterised as relational and performative. This strand also comprises Foucauldian analysis (Foucault 1990, 1991) and different types of discourse analysis (Laclau & Mouffe 2001) and in a broad sense they draw on a mix of phenomenological and post-structuralist arguments.

By this broader strand of research approaches it is argued that things or phenomena of the social world come into being relative to the way in which they are actively put into use in order to generate specific effects. It is thus argued that social science should refrain from attempts to transcend the contingent circumstances by which social reality is (re)produced and organised. This argument implies a rejection of methodological individualism which suggests that complex phenomena may be analysed by decomposing them into their individual parts. Rather it is argued that individual parts come into being relationally, i.e. as they are put into use within a specific context of other elements.

This broader strand of approaches however tends to take a split when it comes to the analysis of change and agency.

The one side of this split focuses on how phenomena of the social world which are experienced as natural or self evident have actually been constructed through associations which were once object of debate and uncertainty. By revealing the idiosyncratic historical becoming of phenomena which are now a day's taken for granted these analysis contain a critical potential for problematisation and change. Early examples of this approach can be found in the works of Heidegger (1977) and it has become more widely known in a series of iconic Foucauldian studies of how the subjectivity of the modern man has been moulded by an increasingly dense network of social technologies coordinated and enacted by the modern state (Foucault 1990, 1991). While this side of the split operates to unravel the idiosyncratic origins of sedimented normality and disclose the power relations which such normality cover up in taken-for-granted normality, the other side of the split is concerned with attempts at assembling new reality (Latour 1993). The actor-network approach represents this other side of the split in

- (i) analysing how new social reality emerge as various heterogeneous elements becomes allied or aligned in attempts to generate controlled and predictable effects (Law 1992:381)
- (ii) analysing strategic attempts to render such configuration robust and capable of monopolising the organization and performance of social reality across a wider social space (Law 1992:385)

In the following I shall argue that these characteristics make the actor network approach well suited in informing the empirical analysis of strategic sector development processes understood as experimental activities informed, aligned and coordinated by a theorized sector representation.

The Seamless Web of the Heterogeneous Engineer

The Actor-network approach may be introduced by reference to Hughes' concept of the heterogeneous engineer or system-builder (Hughes 1986). According to his *history of technology* such system-builders create 'technological systems' by forging so-called seamless webs of heterogeneous elements into coherent technological systems, as reflected in the quotation below:

“The creators of the network – the system builders, or the formulators of the actor world – are ‘heterogeneous engineers’ (...) The technological system of the system builders, such as an electric-light and power system, interconnect components so diverse as physical artifacts, mines, manufacturing firms, utility companies, academic research and development firms, and investment banks. These components make up a system because they fall under a central control and interact functionally to fulfil a system goal, or to contribute to a system output. (Hughes 1986:289)”

In line with this citation it is argued that new reality or so-called 'actor worlds' come into being as heterogeneous engineers succeed to coordinate and functionally integrate a variety of hitherto independent social and technical elements into a seamless web. Within such seamless webs elements melt together into a unified and robust piece of new reality meaning that the individual parts can no longer be differentiated from one another as they are made to interact under the guidance of a system goal.

Actor-network theory has further elaborated the heuristics implied by the concept of the seamless web by developing a research strategy which focuses on the work, creativity, effort and luck which is takes to make a series of heterogeneous web of

social and technical elements melt together into a new piece of coherently enacted reality.

While staying loyal to the fundamental methodological principles of Hughes ideas actor network theory thus provides a less glamorous picture of heterogeneous engineering and a more distributed and messy picture of agency. Also the actor network approach has expanded the applicability of the notion of the seamless web to account not only for the construction of large technological systems which was the interest of Hughes, but to account for all phenomena of social reality.

The actor-network concept

The actor-network concept basically suggests that any entity of human societies which is used *to get something done* - i.e. cope with a problem or produce and control an effect - may be studied as a heterogeneous web or network which often associates and combines a variety of as well social and technical elements in some kind of more or less stabilised configuration (Law 1992:381). It is thus a generic concept which may signify any phenomena of the social world; a car, a disease, an organization – or a sector development agenda.

According to the vocabulary of actor network theory such webs or networks remain actors as long as their performance may be counted upon and stay un-problematic. A television for an example remains an actor as long as its performance stays unproblematic. If, however, it breaks down, it becomes disclosed as an ensemble of bits and pieces which needs to be coordinated and related in a specific way in order to perform, i.e. as a network (Law 1992:384).

Analytically, any phenomena of the social world may accordingly be analysed both as a unified entity, i.e. as an actor, and as a questionable ensemble of different elements, i.e. as a heterogeneous network. Hence the term actor-network.

Actor network theory thus facilitate empirical analysis of how a heterogeneous set otherwise incompatible elements are forged into networks which are made to act as a coherent unity - i.e. as an actor - or conversely the processes by which actors are

turned into heterogeneous networks - i.e. processes by which the identity an actor become problematic.

A methodological consequence of the actor-network concept is that processes of change are perceived very different from the heterogeneous engineering of Hughes system builder. According to Hughes the process by which otherwise independent elements are melted into a stabilised new piece of reality as they come under the control of a unifying system goal marks a delimited period of change which separates more stable states of affairs. Processes of change are thus perceived as an exception from the more stable normality. Actor-network theory on the other hand perceives the coherent and well ordered state of affairs as the exception because the intermediate state between 'the network' and the 'actor' is seen as the prevailing state of affairs. According to Latour one of the central virtues of actor network theory accordingly is:

“(...) to take seriously the impossibility of staying in one of the two sites for a long period (Latour 2005:170)”

It is thus the "-" which mediates between the order of the "actor" and the dis-order of the "network" which is at heart of the approach. Both success and failure in their pure forms are accordingly perceived as exceptions in the ongoing struggle to keep the social world performing in a predictable and attractive way. As the problem of maintaining order is thus perceived as more or less omni-present the approach is highly sensitive to the phenomenon of strategy, i.e. to the ongoing work which it takes to cope with the semi-coherent ordering of the social world.

Operating from the presumption the social world should be understood as heterogeneous webs which are likely to exist in the intermediate state between 'the network' and the 'actor' the actor network approach has paid specific attention to two very different methodological questions which may both be of relevance to the empirical analysis of strategic sector development activities in the sense that this phenomenon was discussed and conceptualised in the previous chapter.

The first methodological question addresses the problem of how so-called macro actors are created and how force and control are exercised across time and space (Callon and Latour 1981; Law 1986).

The second methodological question addresses the challenges of making a phenomenon of the social world exist and perform in singularity or how to cope with situations where singularity breaks down (Law 2004).

The question of how macro actors are created, i.e. of how force and control are exercised across time and space were central specifically to the early actor network studies. A central text which addresses this question is inspired by the idea of the Leviathan originally put forward in the political philosophy of Hobbes. The question raised by Hobbes was how to create a societal order able to dispense with a situation where everyone are at war with everyone else given a situation of a multitude of equal and egoistic men. The solution put forward but Hobbes was a contract that every man made with every other man, giving one man, bound to no other, the right to speak on behalf of all. The question raised by Hobbes was accordingly how macro actors are created given a situation characterised by more or less equal micro actors. Addressing the question of how macro actors are created and maintained in order to make up a durable organization of society the actor network text points to the importance of enrolling durable materials. The size of a primitive baboon society is thus argued to remain limited because the social organization needs to be continuously maintained through the direct intervention by the dominating male (Callon & Latour 1981:284). Contrary to baboon societies it is then argued that human societies enlist different sorts of durable materials, which last longer than the interactions which formed them, and it is argued that it is this ability which allows human societies to build leviathans or macro actors, as indicated by the quotation below:

"By associating material of different durability, a set of practices are placed in a hierarchy in such a way that some become stable and need no longer be considered (Callon & Latour 1981:284)"

The text accordingly argues that an actor grows with the number of relationships which need no longer be re-considered as suggested below:

"(...) macro actors are micro actors seated on top of many (leaky) black boxes (Callon and Latour 1981:286)"

An example of how macro actors are created in order to organise and control a social space is offered by an analysis of how the Portuguese empire became able to exercise global control of the sea-ways in the 15th and 16th century (Law 1989). In short the analysis suggests that the Portuguese empire succeeded to dominate the global seaways by forging a particular web of documents, devices and drilled people into a durable and robust macro-actor.

First the Portuguese navy developed a vessel called the carrack which compared to other vessels as the time was (i) relatively resistant to attacks by boarding from small crafts (ii) able to carry large amounts of cargo (iii) able to navigate under difficult weather conditions. This vessel was thus rendered immune to some adversaries of the environment (attacks) while other adversaries were turned into allies (the wind and the currents). The vessel itself was thus relatively durable, manoeuvrable and independent of the environment in which it operated (Law 1989:4).

The vessel was however only one element of a larger heterogeneous structure which made long distance control possible. Another element of the network was the invention of navigational practices which were independent of coastline observations. A major invention in the navigation practices was accordingly the development of tables and instruments which allowed navigation to utilise the position of the celestial bodies (Law 1989:9).

It was thus the combination of new vessels, new navigational instruments and tables and drilled people able to organise this heterogeneous network of artefacts and documents which made long distance control possible.

In line with the analysis outlined above, the early actor network studies focussed on how macro actors are created by paying attention to the importance of aligning and interconnecting very different types of materials, i.e. on the heterogeneity which it takes to render macro actors durable.

As suggested above macro-actors which are able to successfully monopolise a social space for a longer period of time are however rare. More typically the social world tends to operate somewhere between the order of the actor and the disorder of the network. In contrast to the early actor network studies more recent actor-network studies have paid attention to the challenges of making the social world exist and perform in singularity or cope with situations where singularity breaks down. This focus is derived from ANTs performative perception of the social world which argues that being comes down to the production of detectable as suggested below.

“(...) the scope of the network being studied is determined by the existence of actors that are able to make their presence individually felt on it (...) if an element does not make its presence felt by influencing the structure of the network in a noticeable and individual way, then from the standpoint of that network the element in question does not exist (Law 1989:131)”

In the more recent development of the actor network theory this performative orientation has been developed into a full-fledged relation ontology. By Mol and Law this relational ontology goes under the heading of ‘semiotic materiality’ which suggests that:

“(...) bits and pieces don’t exist in and of themselves. They are constituted in the network of which they form a part. Objects, entities, actors, processes – all are semiotic effects: network nodes are set of relations; or are set of relations between relations. Press the logic one step further: materials are interactively constituted; outside their interactions they have no existence, no reality (Law & Mol 1995:277).

The consequence of this argument is that the being of an element depend on its relations to other elements. Consequently, elements of the social world may be more than 'one thing' (Law 2004) if their relations to other elements do not remain constant or fixed. A typical argument in these more recent studies accordingly goes that seemingly unequivocal phenomena actually become enacted through a variety of different associations which are only partly compatible and partly overlapping

with each another. It is thus suggested that the social world is full of cracks and inconsistencies.

An actor-network inspired study of disease of anaemia (Mol 1999) may serve as an example of this line of argument. This study identifies three different ways in which anaemia is performed: a clinical one, a statistical one and a pathopsycological one.

In the clinical performance a patient may be diagnosed as anaemic if he suffers from tiredness and if his eyelids look pale. Visible and verbal accounts of symptoms are thus signs of anaemia. In the statistical performance of anaemia a patient is diagnosed as anaemic if a blood sample shows that his haemoglobin-level is more than two standard deviations below the average in a norm group. Finally, in the pathophysiological performance of anaemia, it is assessed whether the haemoglobin level is high enough to transport sufficient amounts of oxygen to the organs of the patient. If the haemoglobin level drops below the set level the patient is said to have anaemia (Mol 1999: 77-78).

According to Jensen (2001) the interesting point of the analysis is that the three performances of anaemia are not always concordant:

“A number of patients deviate from the statistical norm, but show no sign of tiredness. There are also cases in which the haemoglobin level drops to such an extent that sufficient oxygen is not transported to the organs, but the patient is nevertheless above the statistical cut-off point. So the idea that anaemia is a single thing, or that a single thing is underlying all the ”instances” of anaemia will have to go. (Jensen 2001:69)”

The different performances thus enact the seemingly identical phenomenon through different mechanisms of inclusion and exclusion: it becomes de-centered or distributed. This does however not necessarily imply that anaemia in its various guises does not work. It however implies that an omni present challenge is to coordinate the effects of only partly compatible enactments of the same phenomenon. As formulated by Law (1999:12) the strategic challenge is to cope with phenomena which 'are more than one but less than many'.

Summing up the methodological implications of the semiotic materiality Law (2004:59-60) has cultivated a discussion of the difference between perspectivalism and fractionality. Perspectivalism refers to a series of enactments of a phenomenon which can be reconciled in a single perspective. Here the idea of ontological singularity can be maintained. Fractionality on the other hand refers to a series of enactments of a seemingly identical phenomenon which however contradict with one another. In such instances the idea of ontological singularity breaks down. The methodological argument of Law thus goes that the analysis of the social world need to be sensitive to instances where ontological singularity break down if the analysis is to understand the strategic challenge of keeping the social world working and organized.

Actor-network studies of the social world is thus the study of activities aiming to strategically cover up or expose the cracks and inconsistencies of the social world in order to generate certain effects. It is the study of the relentless efforts to associate elements and make them perform in predictable ways - and at the same time it is the study of the constant failures and limitations of these efforts.

From a methodological point of view the actor network concept may accordingly serve to inform the empirical analysis of strategic sector development in two interrelated respects.

First, it may help to analyse how sector development activities operate to create macro-actors able to produce widespread and lasting effects by webbing up a heterogeneity of different materials such as discourses, technological artefacts, regulatory interventions, and experiences of failure and contradictions. Secondly it may also help to see the sector as a potentially de-centered phenomenon characterised by fractionality. As an object of development the sector may accordingly be constituted by attempts to create very different macro-actors which enlist very different materials and web them together in very different architectures.

Symmetry as the principles of analysis

So what kind of principles and what kind of concepts may serve to bring the actor network concept into play in the empirical investigation of strategic sector development in the Danish construction industry?

A basic principle of the actor-network approach is that of free association (Callon 1986). This principle implies that actors-networks may associate any kinds of elements, and that no elements can be accorded the organizing role in an actor-network *a priori*. Actors-networks are thus seldom entirely technical, material, or human, but they are rather constituted by associations between heterogeneous elements and often consist of a multiplicity of cross-cutting relations.

The methodological implication of the principle of free association is that of a generalised symmetry, i.e. the use of a general vocabulary in the description of as well social as technical or material relations as formulated by Latour & Callon:

”We must (...) examine with the same method the strategies which enlist bodies, materials, discourses, techniques, feelings, laws, organizations. Instead of dividing the subject with the social/technical, or with the human/animal, or with the micro/macro dichotomies, we will only retain for the analysis gradients of resistivity and consider only the variations in relative solidity and durability of different sort of materials (Callon & Latour 1981:285)”

The analysis of an project launched by Electricity de France (EDF), aiming to invent an electric vehicle in the early 1970 may serve as an example of how this generalised vocabulary works (Callon 1986b).

According to the analysis this project was initiated by efforts aiming to forge a range of highly heterogeneous elements into a coherent actor-network. One of these elements was a consumer theory arguing that the all-out consumption of the post-war period was at its end (Callon 1986b:21). The EDF framed the petrol car as the symbol of this dying consumerism and subsequently presented the electric vehicle as its imperative successor. This consumer theory was accordingly associated with the development of new generations of generators (Callon 1986b:21).

By associating the consumer theory with the new type of generators both these entities were thus turned into something new. On the one hand the association thus turned the generators into the vehicle of a new type of consumerism rather than just some technical stuff in a laboratory. At the same time the association turned the consumer theory into more than just theory as it came to inform the role of the generators and the future of transportation.

The analysis however also reflects that socio-technical associations do not easily melt together. Eventually an inconsistency was accordingly exposed which the actor network did not succeed to cope with. Despite an increase in petrol prices the demand for petrol cars thus kept growing. This allowed the Renault Cooperation which was operating within the old configuration of consumerism and the combustion engine technology to call the seemingly imperative character of the VEL actor-network into question (Callon 1986b:25). Encouraged by this contradiction between the actor-network of the VEL and the consumer behaviour, the Renault Cooperation set out to test in detail the rest of the association which made up the actor network of the VEL. Eventually it succeeded to bring more associations into question and the seemingly durable actor-network crumbled into a questionable ensemble of only weakly coupled, and partially compatible, elements.

Some concepts of analysis: Translation, Mediators and Intermediaries

As demonstrated by the analysis outlined above the actor network approach is sensitive to the strategic process of crafting new reality which on the one hand operates on the edge of being but which may on the other hand also have the potential of producing lasting and widespread effects by becoming a black boxed macro actor.

The dynamics by which actor networks are created is addressed by the concept of translation (Law 1992:385, Latour 2005:108). It is thus through processes of translation that otherwise coherent actors are turned into questionable heterogeneities or heterogeneities are forged into coherent actors. Translations thus

designate all kind of strategies (persuasion, force, etc.) by which elements are assigned a specific role within an actor-network.

The concept of translation signifies that the processes by which actor networks grow or deteriorate are not transparent and smooth. The core characteristic of processes of translations is accordingly that they distort in much the same way that the meaning of a word may be distorted as it is translated from one language to another language or from one language using context to another language using context. Through processes of translation elements are thus transformed, enlarged, broken down or build up as they are webbed up in specific sets of relations in order to perform within alternative actor-networks

Thus, whenever smoothness seems to be archived in the organization of the social world the concept of translation re-direct focus towards to the laborious work which it takes to produce and maintain the image of smoothness. And it also draws attention to the localness and limits of smoothness in both time and space.

Fundamentally translation is accordingly about the work it takes to maintain asymmetries which are able to produce organised and controlled effects. Translations may thus be pictured as processes by which an asymmetry is created and maintained which allows some entity to speak on the behalf of others or borrow the strength of others in order to produce organised effects.

An often cited operationalisation of the concept of translation is presented in Callon (1986). Here it is suggested that translations consist of the following four moments: (i) problematisation, (ii) intersement, (iii) enrolment and (iv) mobilisation. The problematisation refers to a process through which a focal actor frames problems in order to define the interest of other actors (thereby making himself indispensable). It is suggested that these problems must all refer to a single 'obligatory passage point' which all entities to be enlisted in the actor network must accept. Intersement refers to a series of processes through which the focal actor locks other actors into the roles prescribed by the problematisation. Enrolment refers to the processes through which the various roles are defined and interrelated and mobilization refers to the process of establishing a 'spokesman' able to talk and act on the behalf of the collective.

A complimentary set of concepts are mediators and intermediaries (Latour 2005:37). An element can be characterised as an intermediary to the extent that the relations by which it is enacted has succeeded to monopolise its materiality. In this case the element has been 'black-boxed' or 'punctuated' and a fixed performance which may be counted upon has been established, as suggested by Law:

“(...) network patterns that are widely performed are often those that can be punctualized. This is because they are network packages – routines - that can, if precariously, be more or less taken for granted in the process of heterogeneous engineering. In other words, they can be counted as resources which may come in a variety of forms: agents, devises, texts, relative standardized sets of organizational relations, social technologies, boundary protocols, organizational forms - any or all of these. (Law 1992:385)”

However if the web of associations through which an element is enacted becomes contested its materiality is de-centred and its performance becomes a question of uncertainty. Such a de-centered entities act as mediators, meaning that:

“(...) their specificity has to be taken into account every time. Mediators transform, translate, distort, and modify the meaning of the elements they are supposed to carry. (Latour 2005:39)”

Mediators are thus elements whose nature and performance is contended, as their relational identity has become unstable. These are accordingly resources which may be brought into play to create new or alternative actor-networks. A central point in the analysis of actor-networks is thus the translation of intermediaries into mediators and *vice versa*.

Does ANT ignore the context of agency?

As discussed above one of the fundamental principles of the actor-network approach is the methodological principle that anything may be associated with anything else as new actor-networks are created.

But doesn't the principle of free association result in strategic voluntarism? As processes by which existing actor-networks are decomposed into their individual components and then reconfigured into alternative actor networks?

Such a picture would imply that the crafting of actor-networks could be seen as independent of the constraints of the existing social order. As smooth processes without resistance. Some of the early actor-network studies were characterised by a tendency to implicitly reify the idea of the individual and independent entrepreneur who is able to compose actor networks at will. These studies thus more or less described actor-network processes as neat, coherent and well-ordered processes at the command of heroic entrepreneurs. In the more recent actor-network literature the tendencies to look for order and coherence at the expense of incoherence and disorder have however been critically addressed as reflected in the quotation below:

“It's possible to note this, and raise eyebrows about it in a variety of ways. For instance: that it tended towards the managerialist; that it was about Nietzschean mastery; that it was about Machiavellian strategies”
(Law 1997:6)

These tendencies have thus been critically addressed especially within the works of Law and Mol who have advocated a thoroughly relational concept of human subjectivity:

“(…) semiotic relational materialism is non-humanist: like inanimate objects, human actors are not primitive components or atoms. Humans may, but need not be, actors; and actors may, but need not be, humans
(Law & Mol 1995:277)”

From this non-humanist perspective actor-network processes are thus not at the command of independent human entrepreneurs.

Also if the principle of free association is elaborated from the ontological perspective of semiotic materiality the voluntaristic interpretation appears to be a contradiction. Semiotic materiality thus implies that the existence of any individual entity is predicated on its enactment and performance within a specific relational whole. This implies that if an entity becomes isolated from the network in which it is performed it evaporates into nothingness. As a technology, a person, a concept, an organization or any other entity is enrolled into an actor-network this necessarily implies that the network of associations by which this entity is constituted is also enrolled. Any enrolment which adds a performance to an actor-network thus comes at the cost of embedding the actor-network in all the relations that enables the new entity to perform. Isolating an entity from its pre-existing relations thus implies that its performativity is annihilated. In this way the enrolment of new entities in an actor-network is never free of cost, but is rather likely to require a lot of effort, be very troublesome and it may even destabilise or re-configure the actor-network which it was supposed to support.

To actor network theory the limitations of agency imposed by 'the context' is thus very real. These limitations are however accounted for as they are experienced from within the actor-network in the form of failed enrolments or so-called programmes and anti programmes promoted by different entities which strive to re-organize the actor networks in different ways (Latour 1992:251). In an actor-network analysis the somewhat grey and anonymous concepts of 'the context' or 'the institutional rule' are thus accounted for as the ordering or webbing activities of a specific actor network becomes questioned or interrupted in some specific way.

The actor network approach thus rejects that the outcome of specific associations can be inferred from abstracted 'institutional rules' as these rules may always be prone to cracks and inconsistencies which may be exploited to produce unanticipated effects, as suggested by Latour :

"A single context can bring about contrary effects. Hence the idiocy of the notion of "preestablished context." The people are missing; the work of contextualization is missing. The context is not the spirit of the times, which would penetrate all things equally. (Latour 1996:137)"

Actor-network theory thus implies that new associations are always uncertain and experimental and need to be analysed as unique. Where institutional theory thus employ concepts like 'institutional rules' as explanatory principles, actor-network theory look upon regularities as the phenomenon which is to be explained.

The empirical research strategy

So how may the actor network approach be used to elaborate the understanding of strategic sector development activities outlined in the previous chapter?

In the previous chapter the strategic process of doing sector development was conceptualised as experimental activities catalysed and coordinated by a theorized sector representations. I suggest that this understanding may be elaborated by perceiving strategic sector development activities as attempts to build macro-actors.

The central argument of the previous chapter accordingly was that strategic sector development activities depend on the ability to identify, mobilise and organise local experiences of contradiction and failure through the development of an attractive sectorial representation informed by some kind of sectorial logic. The process of constructing such a sectorial representation may thus be characterised as an attempt to align a heterogeneous set of elements in order to create a sector-level macro-actor capable of monopolising the socio-technical organization and performance of a wider social space.

An implication of this argument is that the development of a sector representation is fundamentally a process of construction and play where new generative associations are tested. The same set of local experiences may accordingly be turned into different sector representations from the different perspectives offered by alternative sectorial logics. This argument implies that a sector development agenda may be constituted by attempt to develop more than a single macro-actor. It can accordingly not be presumed that the natural development of a sector development is characterised by convergence towards a single integrated strategic orientation. The development of a sector development agenda may as well be characterised by the

theorization of several more or less compatible representations.

Drawing on these arguments I suggest that processes of strategic sector development may be empirically analysed as the crafting of one or several macro-actors and that this process can be analytically divided into processes of a) theorization, b) concretization and c) institutionalization.

Theorization signifies the process of constructing a sector representation which is able to make sense of a complex set of otherwise conflicting and incompatible experiences as the symptoms of a sectorial malfunction in a way which is able to define new strategic opportunities or necessities. This process is thus equivalent to Latours concept of problematisation, and the purpose of this process is to create an image which defines how to be a rational actor.

Concretization comes close to the idea of an experimental niche. Concretization thus designates the activities by which the elements identified by the strategic orientation of the theorized sector representation are enlisted and mobilised through experimental activities. During the concretization process the ability of the strategic orientation in organizing a robust and coordinated socio-technical actor-network is thus tested. Discourses, regulations, interests, technologies and tools thus need to be specified and coordinated according to the strategic orientation of the sector representation. During the concretization processes the coordinative strength of the representation is thus tested as well as its ability to cope with contradictions, dis-alignment and failure.

The relation between the theorization and concretization processes should however not be perceived as unidirectional, i.e. as a relation where a set of experimental activities are passively informed and aligned by the strategic orientation of the sector representation. The strategic orientation of a sector representation should in other words not be taken to be a fixed recipe. A theorized sector representation is thus likely to offer only a loose orientation which may develop into different and even conflicting directions. This also implies that the sector representations may need to continuously integrate the experiences of the concretisation process in order to remain attractive.

Finally, institutionalization signifies strategies and activities designed to turn the strategic orientation into a durable sector-level macro-actor which is capable of defining how relations are organised and how effects are generated across a wider social space. The aim of these processes accordingly is to package or blackbox the local experiences of the concretization processes in a form which can be diffused and anchored.

The critical reader may now question how well such analytical categories correspond with the basic intentions of the actor network approach because such analytical categories are far from neutral to the empirical research process. During the research process these concepts have thus actively functioned to organise my encounter with the complex empirical reality. It may then be argued that such an analytical structuring of the empirical phenomenon *a priori* is in conflict with the basic intentions of the actor network approach. The actor network approach can accordingly be seen as an antidote toward analytical *apriori* assumptions. Rather than fixing the empirical focus through an analytical structure prior to the empirical analysis the actor network approach thus advocate for empirical drift, by urging the researcher to follow the actor or the conflict wherever this takes him.

However, rather than perceiving the actor network approach as directly in conflict with an empirical analysis informed by the analytical concepts outlined above I advocate for a more reconciling stance. I thus suggest that that the actor-network approach may be applied to increase the sensitivity towards the heterogeneity and the precariousness of strategic sector development processes as they come into view by means of the concepts outlined above.

Analysing strategic sector development as heterogeneous alignment activities thus entails sensitivity to the uncertainties and the work related to attempts at webbing and translating discourses, experimental experiences, technologies, interests and regulation by means of a specific sectorial representation. Many of these materials, as well as the representation by which they are supposed to be organised, may thus act as mediators in the sense that their effects may be difficult to control and anticipate

Analysing strategic sector development as precarious processes further implies accepting that such processes do not operate in an independent abstracted space. It thus entails sensitivity to the wider play of strategic activities in which sector development activities are embedded. Strategies, interest and identities are thus formulated and enacted from a multiplicity of viewpoints. Sector development processes accordingly develop both in conflicts and interaction with the strategies and ordering effects brought into play by professions, unions, companies, technologies, regulations, planning tools etc.

The actor network perspective however also implies that sector development processes cannot be reduced to a reflection of other strategic perspectives or to a reflection of the heterogeneous entities which such activities enrol and align. This is because sector development processes from an actor-network point of view are seen as effects of translation processes which always distort and modify. The concept of translation thus implies that there is no simple and transparent way by which to reflect existing interests, identities and materials in a sectorial development agenda. As much as sector development processes reflect existing power balances, interests and identities, such processes accordingly also transform and distort these identities and interests through translation processes.

Concluding the discussions above the empirical investigation presented in the following chapters has been informed by the following concepts and convictions:

- (i) Strategic sector development activities can be investigated as configurations of theorization, concretization and institutionalization processes which aim to identify, mobilise and translate a heterogeneous set of entities into coherent sector level macro-actors.
- (ii) A sector development agenda may be characterised by the co-existence of several configurations of theorization, concretization and institutionalization processes. Convergence towards a single dominant configuration cannot be assumed to be a natural line of development
- (iii) Strategic sector development activities do not develop in an independent abstract space. Such activities thus depend of the alignment of material, social and discursive elements which also or even primarily reflect alternative strategic perspectives than that of the sector.

- (iv) As strategic sector development activities develop through translation processes such activities cannot be reduced to a reflection of the materials and interests by which they are constructed.

Empirical design and case selection

As argued above sector development activities come into existence as a traceable empirical phenomenon by the emergence of one or several theorized sector representations. Somebody in other words needs to articulate the sector as a distinct object of development in an empirically traceable way in order for strategic sector development processes to become an object of empirical analysis.

The design of the empirical analysis of the contemporary sector development activities in the Danish construction industry presented in the next chapters was initiated by identifying the dominant sector representations in the Danish construction industry. This investigation concentrated on the identification of representations

- (i) Which explicitly portrayed themselves as sectorial in scope and which operated with an articulated means end-relation on how to develop the sector
- (ii) Which had succeeded to catalyse and organise experimental concretization activities

Based on these two criteria two sector representations were identified. One of these representations had succeeded to inform an initiative called Digital Construction which aimed to develop the construction industry by digitalising the information flow in the construction process. The other representation had succeeded to inform an initiative called Building Lab DK which was pushing for an industrial reconfiguration guided by modularization and system deliverances.

It should however be stressed that another case selection would have been possible. The concept of partner for an example represents another traceable representation which however plays a minor role in my analysis of the contemporary strategic

sector development activities in the Danish construction industry. In a recent analysis Gottlieb (2010) accordingly argues that partnering represent a so-called collaborative turn in the organization of the Danish construction industry. In my analysis Partnering however plays a minor role because this strategic phenomenon has not as clearly been framed as a sectorial development agenda as the two initiatives introduced above. Partnering can however be seen as a typical example of the precarious being of a strategic orientation in the sense that this concept has simultaneously been advocated in the interest of the sector, of specific companies and specific trades and professions. Both Digital Construction and Building Lab DK represent the same type of precarious strategic constructs which have operated both as a sectorial orientation as well as in the interest of specific companies and professions.

The discussion above illustrates that it is difficult to develop any clear analytical demarcation which can separate strategic orientations operating from a sectorial point of view from the more local strategic orientations of specific companies or professions within the construction industry. As suggested above partnering represents an initiative that is informed by a representation with sectorial traces. Other examples of initiatives which operate with a partly sectorial orientation include Lean Construction and the Benchmark Centre for the Danish Construction Sector.

I have however chosen to concentrate on the two initiatives mentioned above for two reasons

One reason is that the two initiatives have been informed by coherent and elaborated sector representations. They accordingly represent examples of the work and effort which it takes to establish and gain support in favour of a specific sector representation.

This case selection is furthermore an example of so-called maximum variation (Flyvbjerg 2006:230). The sector representations accordingly display similarities in the sense that

- (i) they have both aimed to develop the Danish construction industry from a sectorial point of view

- (ii) they emerged at approximately the same time (after 2001)
- (iii) they operated with approximately the same budget (approx. 50 mio dkk)

They however at the same time display maximum variation in regard to the sector representation by which they are informed and hence regarding the type and design of concretization and institutionalization activities which they have succeeded to establish and coordinate. I have chosen to concentrate on initiatives characterised by this type of maximum variation because the co-existence of different and potential incompatible strategic orientations represent a core characteristics of the contemporary sector development activities and also a core governance challenge.

The analysis which follows in the next chapters does accordingly not intend to offer a complete or neutral empirical picture of the contemporary sector development agenda in the Danish Construction industry. Rather than aiming for the entire empirical picture the ambition of the analysis has been to identify the mechanisms by which strategic sector development activities operate and the challenges and opportunities which these activities face in a present day context.

Studying the process of sector development

The two sector representations informing Digital Construction and Building Lab DK were the basis of the second stage of the research process which aimed to understand the sector development activities as *a process* by mobilising the concepts of theorization, concretization and institutionalization.

The analysis of the theorization activities aimed to trace how these representations had been constructed by the mobilisation of sectorial logics that enabled some elements or materials to speak on behalf of others.

The initial step in this analysis was to follow the different textual traces which the theorization processes had left behind. Starting from the sector representations as they were formulated in the programme proposals of the two initiatives it was thus possible to partly reconstruct the theorization processes through textual references. The initial research strategy accordingly was to move back in the textual chains of

references in order to gain an impression of how the sector representations had been constructed.

This strategy of moving back through the textual links did however not come without limitations as the analysis tended to be restricted to the particular theorization activities of the two initiatives. This strategy accordingly failed to identify the broader complex of theorization and concretization processes in which the theorization activities of the two initiatives were situated. By narrowly reconstructing the theorization processes of the two initiatives the wider sector development processes in which these theorization processes were embedded thus remained hidden.

During the initial process of moving backward in the inter-textual chain a much more encompassing field of sector development activities was however indicated. It thus became apparent that the theorization activities of the two initiatives only very selectively enacted bits and pieces of the broader body of references which they drew upon. This field could now be investigated by moving forward from the textual reference in other directions than those pointing in the direction of the theorization activities of the two sector representations which had initially brought them into attention. Using this technique the theorization processes of the two initiatives became located in a broader field of strategic sector development activities. Linking the theorization process to this field of strategic sector development activities made it possible to understand the theorization processes as more than arbitrary contingency or heroic mastery. The theorization processes rather came into view as realised possibilities within a structured strategic field.

These research activities further resulted in a periodization of the sector development activities in the Danish construction industry. It thus became apparent that the two sector representations which had been the starting point of the research processes were both situated in a broader series of strategic sector development activities which were initiated in the early 1990'ties. But how could the sector development activities of the post 1990 period be characterised? In order to characterise the contemporary sector development activities of this period I choose to compare them with another period of sector development activities which was initiated in the years after WW2 and disintegrated in the 1970'ties and which was

characterised by another configuration of theorization, concretization and institutionalization processes .

In the further empirical investigation of the two sector development initiatives document studies were supplement by interviews.

After concluding the analysis of the theorization activities the next step of the empirical research process focussed on the concretization and institutionalization processes which the sector representations had succeeded to catalyse. During this research process the ability of the sector representations in turning questionable and ambiguous mediators into a stabile and trustworthy web of intermediaries through experimental concretization were identified. The focus of this research process was to trace how activities were organised in order to translate the sector representations into specific experimental activities, and how breakdowns, controversies and ambiguities were generated and handled. Also these processes were investigated through documents and interviews

The final step of the research process focussed on the strategies by which the initiatives aimed package and black box the heterogeneous mix of representations, experiences, technical codes and organizational identities generated during the theorization and concretization processes into attractive and convincingly macro-actors designed to monopolise or at least affect the organization of the construction industry more broadly.

Using texts and interviews as empirical data

As mentioned above the empirical analysis which is presented in the next chapters draws on written texts and interviews. Another method which may be used in actor network inspired studies is ethnographic field studies. A practical reason why my study has not used ethnographic methods is that it concerns past events. Also the study covers a period of approximately 20 years beginning in the early 1990ties and ending in spring 2010. Finally, the object of my study has not emerged in a single and easily identifiable location but has rather been constructed and shaped in processes taking place across very different locations and forums. The very object of

analysis thus points towards text and interviews as the most suitable sources of empirical material.

As sources for empirical investigations of past events documents and interviews are however very different.

Written texts are able to fix a certain position and point in time very differently from interviews. Texts are thus able to conserve a situation or a state of affairs with its uncertainties, beliefs and anticipations as it was experienced or strategically framed from a specific point of view at the time of its conception. Also texts deal with matters and reflect priorities in a way which is not constructed in the research process. Documents thus reflect the process under investigation rather than the research process itself.

The empirical material created during interviews is on the other hand influenced by processes of as well co-construction as re-construction.

Co-construction refers to way knowledge is co-constructed as an effect of the interaction between the researcher and the interview person. An interview is accordingly a process where parameters of relevance and the point of view from where events are perceived are negotiated in the interaction between the researcher and the interview person. The empirical data constructed during an interview does thus not authentically belong to the process under investigation but it is rather generated from a viewpoint generated in the interaction between the researcher and the interview person. An interview is thus likely to generate reflections which would not have been created outside the interview situation itself.

Re-construction refers to the identity work performed by the interview person himself. In the interview process the interview persons is thus likely to rationalise and communicate past experiences in a way which make the identity and actions of the interview person himself appear coherent and rational. The empirical material generated during an interview may thus be seen as a rationalised account of the interview persons' experiences, leaving out part of the experienced inconsistencies and controversies of the actual process.

These dynamics of co-construction (between the interview person and the researcher) and re-construction (identity-work which organises past experiences in the light of the present) should not as much be seen as conscious acts of manipulation from either the researcher or the interview person but rather as the necessary condition of communicative processes as such.

Texts

So what type of texts has been included in the empirical analysis and how have they been identified?

At a general level the analysis draws on the following two types of texts.

- (1) Texts which have been generated in the process of the sector development activities and with the intention of organising and giving direction to these activities
- (2) Reflexive texts which are about the sector development activities

The analysis of the contemporary sector development activities which began in the early 1990'ties including the analysis of two sector development initiatives which are the empirical backbone of the analysis draw exclusively on the first type of texts.

The second type of texts, which are themselves interpretations of sector development activities have been used to inform the brief analysis of strategic sector development activities which characterised the period from the end of WW2 and until the 1970'ties. To some extent this analysis is accordingly a second order interpretation.

As noted above texts and documents have mainly been identified through chains of textual references. Most of these texts have been publicly available. Through interviews it has however also been possible gain access to some internal minutes and drafts of documents which disclose some of the strategic choices and ambiguities which are often rendered more opaque in the final version.

The study however builds only on available texts and much written material has not been available. On request I was e.g. only permitted limited access to the internal archive on the sector development initiative Building Lab DK which was hosted by the foundation Realdania. The access to texts and documents concerning the other initiative, Digital Construction, was much less controlled. As this initiative was continuously negotiated publicly between the many involved parties the flow of texts and documents was not at the command of a single gate keeper.

Interviews

As mentioned above interviews persons were identified mainly by snowballing - i.e. by suggestion from other interview persons. Each interview was accordingly concluded by asking for suggestions for other relevant interview persons, typically representing the opposite view or holding an opposite position than that of interview person himself.

The interviews themselves were loosely informed by my own understanding of strategic sector development activities as configurations of theorization, concretization and institutionalization processes.

The interviews were initiated by an introduction to my research interest in strategic sector development. Each interview lasted for approximately one hour. The willingness and motivation by the interview persons to address the subject of inquiry was generally very high. In the first half of the interview I did generally not intervene very much. This allowed the interview persons to offer their own view and experiences of the processes in which they had been involved. In the second half of the interviews I more intentionally aimed to test some of my own hypothesis of conflicts and tensions.

The interviews were recorded and after each interview the recording was more or less fully transcribed (5-10 pages per hour)

A list and a short description of the interview persons can be found after the list of references at the end of the thesis

The write-up of the empirical analysis

The empirical analysis of the contemporary sector development activities in the Danish construction industry which follows in the next chapters has been reconstructed in chronological order. The structure of the analysis does accordingly not reflect the structure of the research process.

The ambition has been to communicate the analysis with limited use of theoretical concepts. The idea accordingly is that the analysis may be read independently of the theoretical and conceptual part of the thesis. The only theoretical concepts which appear in the empirical storylines are the concepts of theorization, concretization and institutionalization. These concepts are however used extensively to organise the arguments as well as the structure of the text.

Citations from both texts and interviews have been used to anchor the analysis in the empirical data. Interview citations have not explicitly been cleared with the interview persons themselves before use. The context in which these citations appear is thus exclusively the responsibility of the author. The ambition has however been to take a sympathetic stance towards all positions and arguments reflected in the empirical material. The aim has thus been to avoid storylines created along good/bad or conservative/visionary dichotomies. Rather, the strategy has been to represent the different actions and responses as logical effects of the networked identities, interest and responsibilities.

During the analytical work few interesting points have emerged from the individual text or the individual interview as each text and interview tends to produce a smooth and consistent image. In order to understand the translation processes it has thus been crucial to operate across individual documents and interviews in order to identify how elements are broken down, build up, re-shaped and web up into new hierarchies and patterns in order to produce new and alternative strategic orientations.

Finally, as argued above sector development activities do not come in any pure form. Sector development strategies thus co-exist in the interest of the sector as well as in the interest of companies, organisations, individuals, professions and trades. The analysis which is unfolded in the following chapters has however taken the perspective of the sector. The analysis thus inevitably displays a sectorial bias, since

events have been reconstructed by giving primacy to sectorial argument and connections. Some may accordingly find that the events which in the following chapters are portrayed as predominantly sectorial could also be described as much less sectorial. The analysis thus re-constructs events based on a specific sectorial perspective.

Chapter 4 – Empirical introduction

How is the Danish construction industry made to appear as a sectorial object of development in a present-day context in the eyes of strategically motivated actors? In what way may a sector as such an object of development be turned into coordinated development activities and which type of threats and opportunities do such activities face? And how are sector development activities to be catalysed guided or governed?

As indicated by the questions above the phenomenon of interest to the analysis which follows in the succeeding chapters is the contemporary processes of strategic sector development seen from the perspective of those who actually do them.

However, before turning to the contemporary sector development activities in the Danish construction industry which began in the early 1990'ties a brief historical analysis portrays how a field of activities was subjected to a specific sector representation after WW2 whereby the modern Danish construction sector came into being as a coherent object of strategic development.

The Danish construction industry as a sectorial object of development

As suggested in the last chapter sectorial development activities may be perceived as configurations of theorisation, concretization and institutionalization processes, aiming to develop and enact a specific sector representation of an industry in order to guide and organize experimental activities. The prerequisite of such a configuration is however the existence of a sectorial identity. Strategic dynamics of sector development thus presupposes the possibility of talking and acting in the interest of the sector rather than in the interest of specific companies or professions within the industry.

Roughly speaking, the construction sector - conceived of as a coherent strategic object of development – is a specific post WW2 phenomenon in a Danish context (Gottlieb 2010:135). This does of course not imply that the construction of buildings as a field of industrial activities was not constituted and regulated by norms, standards, regulations, professional identities, materials and codes of conduct prior to this period. It was however not until the post WW2 period that the industrial activities concerned with the production of housing was strategically enacted as an independent sectorial entity.

The enactment of the Danish construction industry as a sectorial object of development can be seen as an element of broader societal modernization processes initiated after WW2 which aimed to stabilise the Danish society on the capitalist side of the evolving division between communist Russia and social capitalist America. Within this broader policy objective the construction industry was enacted as one of several sectorial objects of development. Part of the Marshall funding which Denmark received from USA in the re-building and stabilization of a capitalist economy and a democratic rule was thus channelled into the development of the construction industry. Among other things this funding went into the establishment of concrete element factories, the development of consultancy services and the establishment of a series of machine stations aiming to support the mechanization of the construction industry (Munch-Petersen 1980:10).

The establishment of the construction industry as a sectorial object of development was however closely associated to the establishment the Housing Ministry in 1947. This ministry was established in order to cope with the housing shortage in the major cities which was singled out as a prioritized societal challenge after the war (Gottlieb 2010:134). The Danish construction industry was in other words not established as a sectorial object of development because it reflected a naturally demarcated set of industrial activities waiting to be recognized as a sector. The sector was rather established as a tool-box by which to address a prioritized societal end.

With the establishment of the housing ministry the industrial activities concerned with the production of houses thus became institutionalised as an independent regulatory entity and on behalf of the societal interest the ministry was accorded the

right to intervene in the affairs of this sector. The ministry was thus positioned to encode these industrial activities with a new set of strategic opportunities and necessities and initiate a fundamental re-organisation of the existing configuration of identities, interests and activities from the viewpoint of the sector.

In order to establish the sector as a manageable object of coordinated governmental intervention - capable to boost productivity and deal with the societal housing shortage - it was turned into an independent regulatory identity. Additional to the ministry this regulatory identity was created through the establishment of a national building research institute established to provide independent consultancy to underpin the regulation of the sector. In the proposal to the law by which this National Building Research Institute was founded it was stated that:

“The objective of the institute will be to support and integrate technical, economic and other types of scientific research, which may contribute to an improvement and cost reduction of the activities of the construction industry, to distribute the finding of building research, and to council and guide public authorities in matters, presented to the institute (Indenrigsministeriet 1945:204)”

In the notes to the proposal it was further specified that research and development activities would need to be better coordinated if an improvement and cost reduction in the activities of the sector was to be realised. It was thus found that the fragmentation of the research activities and the complex organizational structures of the industry impeded a coordinated progress in the general interest of the sector (Indenrigsministeriet 1945:205).

As suggested above the sector was established as an object of development out of a general societal concern. This did however imply that the sectorial identity was established completely independent of the existing complex of interests in the industry. The aim was rather to compliment, interconnect and align existing interests within a coordinated sector orientation. Also the balance between the new societal orientation and the existing interests of the industry was carefully taken into consideration in the proposal to the national building research institute as reflected below:

“The institute performs its activities in close association to existing institutions concerned with investigations of significant importance for the construction industry, but the institute can also initiate independent investigations, specific experimentation etc. of interest to the construction industry (Indenrigsministeriet 1945:204) ”

This balancing between an independent sectorial identity and interest and collaboration with established interests was further reflected in a note concerning the composition of the board:

“Each member of the board is assumed to possess a broad professional knowledge about the construction industry, but to ensure that the management of the institute reflects an independent and societal orientation, persons should not be appointed who represent specific interests within the construction industry (Indenrigsministeriet 1945:206)”

The most critical production generated from this new sectorial orientation by the ministry and the national building research institute was a shared and commonly recognized sector representation. This sector representation was developed by exposing the industry to the gaze of the engineer profession, which until then had not played a significant role in operation of the industry. (Dansk ingeniør forening 1951). From this perspective the industry was portrayed in the following way:

"The approach which is commonly characterised as good craftsmanship, has been developed through centuries, and this has been possible because there has at no time been demand for higher productivity than it has been possible to deliver by means of the prevailing technology at the time or through minor adjustments in that technology. The materials has by and large been the same - bricks and wood - and the techniques has not in the course of time undergone radical changes (Dansk ingeniør forening 1951:14)"

Heavily inspired by the organization and operation of the manufacturing industries a sector representation of the construction industry was developed by utilising factory-like *rationalization* as the defining sectorial logic. An instruction from Danish Building Research Institute concerning the design of the building-site which is cited below is typical example of a strategic production generated by this sector representation:

“Good, fast and cheap work-processes can only be accomplished in a well designed workspace. This fact has long since been established and recognized in the factories. In the design of a factory space it has become common to devote preparation on planning of the best workspaces and the most simple work procedures (SBI 1956:5)”

Another instruction from the Danish Building Research Institute (SBI 1968) provides a more condensed overview of the defining strategic orientation of the sector representation theorized by using the interpretative logic of rationalization. Compared to industrialized manufacturing this instruction argued that the performance of construction industry was too unpredictable in relation to both time and quality. In order to cope with this unsatisfactory state of affairs a series of production principles were suggested in order to ensure a rational factory-like production process. These were repetition, a single point of planning, an unequivocal construction program, a complete project material, planning of the construction process, management and control of the construction process and finally post calculation procedures. This instruction thus interconnected notions of order, calculation, transparency and the eradication of ambiguity into a single integrative and centralized planning paradigm.

In a general sense the rationalization of *the irrational construction sector* thus came to revolve around the three core principles listed below in the decades which followed WW2:

- (i) The establishment of a centralized point of planning and control represented by the planning engineer, designed to integrate the entire construction process
- (ii) The division of planning and execution of the construction process

- (iii) Development activities based on calculative optimization

To be a rational tool, building component or a piece of labour within this sectorial representation accordingly implied being transparent and manageable to centralised planning based on calculative optimization. The aim of the sector representation accordingly was to achieve a fundamental reorganisation of the traditional guild system where trades integrated planning and execution and where the professional identity was based on tacit knowledge maintained through onsite apprenticeship.

Based on the three core principles of rationalization listed above a broad series of coordinated interventions were crafted to align all processes, materials, identities, interest, and technologies of the industry.

In the 1950'ies the sectorial rationalization strategy was initiated by a development scheme called 'untraditional construction' aiming to a) decrease the level of skilled labour especially in the construction of the shell and b) introduce new planning methods. In the 1960'ties this scheme was followed by the so-called 'assemblage quota' prescribing an increase in the use of prefabricated, factory produced building elements, along with continuous development of planning tools and methods. These schemes were integrated in large-scale public demand in social housing. (Munch-Petersen 1980:21-27)

These schemes were furthermore followed by a series of regulatory interventions of which some of the central ones are listed below

- (i) A variety of local regulations- and standards were harmonized on a national level and a national building code was established. This allowed standardized components to be used throughout the country.
- (ii) Material-specific instructions were replaced by function-specific instructions. This implied that new materials and processes could be more easily integrated in the operation of the industry.
- (iii) A series of construction-norms were added to the national building code. These construction norms introduced a coordinate-system of standardized grid-measures, which ensured compatibility among pre-

fabricated, factory produced components.
(Munch-Petersen 1980:15)

The interventions and development activities generated and coordinated by the sector representation thus aimed to turn the sector into a field of processes, entities and connection which were transparent and manageable to a single centre of planning and control represented by the planning engineer.

Two of the central strategic productions of the sectorial rationalization activities were the building system and the industrial work-division. Gravesen (1980) defines a building system as "A set of factory produced building components for the shell (bearing and supportive constructions), where the planning efforts are archived once and for all (Gravesen 1980:1)" and goes on to suggest that this so-called structuralist method functioned by subsuming 'the accidental functions' of a building under a guiding and coordinative frame. The organizational structure corresponding to the design and construction principles of the building system was a new work division which separated the design of the building and the planning of the construction process from the actual construction activities on the construction site. Jørgensen & Schou-Pedersen (1983) thus argue that the industrialised construction processes rendered much of the traditional craftsmanship redundant by replacing it with a more polarized work division between the highly skilled planning engineers and more or less unskilled construction workers, as reflected in the quotation below:

"The construction work is being specified within a fixed framework which enables it to be conducted by semi-skilled workers, and the planning and control of the work is being transferred to engineering departments. Here the planning of the building and the planning and management of the construction process is achieved, supported by a series of specialised technicians (Jørgensen & Schou-Pedersen 1980:142)"

Especially the 1960'ties and early 1970'ties represented the iconic age of the sectorial rationalization. A series of large contractors thus succeeded to bring major parts of the entire construction process under a centralised control and thus achieve substantial productivity gains. One of the leading contractors was Larsen and

Nielsen which established its own concrete element factory in 1951. From an initial production of 2.000 ton/year the factory reached a production of 207.000 ton/year in 1971. In 1971 the contractor succeeded to produce 2500 flats or 240.000 floor m² (Laursen 1980:35). From 1950 to 1970 the man-hours required in the production of a single flat was furthermore reduced by no less than 50 pct. - from 1700 to 850 hours (Munch-Petersen 1980:3)

The success of the sectorial rationalization strategy in integrating, controlling and optimising the construction process from a single point of planning and control however disintegrated with the economic recession in the 1970'ties and 1980'ties. The sector development dynamics were thus predicated on large scale demand for standardized residential tower blocks constructed from pre-cast concrete elements. This demand however came to a sudden stop as a consequence of oil crisis and the economic recession in the 1970'ties and 1980'ties. The production figures of Larsen & Nielsen may serve as an illustration of how the economic recession impacted on the activities of the rationalized construction sector. From its peak production in 1971 on 2500 flats the production dropped to 542 flats in 1977 and from 1970 to 1976 the number of employees was reduced from 1680 to 800 (Laursen 1980:35).

The sector development activities of post WW2 decades were in conclusion organised and coordinated by a single and undisputed sector representation created and enacted by an alliance among governmental authorities, the engineer profession and some large contractors. The strategic orientation of this representation was initially concretised under the experimental building schemes in the 1950'ties and was more widely and systematically used and developed under the large housing schemes of the 1960'ties. In this period it was also integrated into the regulation of the sector.

Chapter 5 - The contemporary sector development processes

During the economic recession in the 1970'ties the ability of the sector representation informed by the logic of rationalization to efficiently generate coordinated dynamics of sectorial development eroded, as suggested above. This did however not trigger immediate activities to develop and enact alternative sector representations. Rather, for a couple of decades the sector was not cultivated as an object of development. This did not imply that the sectorial identity of the industry disintegrated all together, as the industry remained subject to sectorial regulation and building codes.

The sector did however disintegrate as a strategic orientation from where to develop the industry. In 1994 this disintegration was put into words by Marius Keldsen who had been a central figure in the Housing Ministry during the rationalisation in the post WW2 decades:

"I think - if you put it simply - that it can be said, that the construction sector in reality only exists as a statistical measure, but that is does not play any significant role from a political point of view. Certainly not compared to a minor industry like fishery and an industry like agriculture. It may be, that some find, that the construction industry is subject to political attention, but that is mainly from an employment point of view and not from development point of view. Regardless of the many interested parties, many barriers and initiatives are described as if the sector exists as a totality, what it not the however not the case. (Keldsen 1994)"

According to the analysis offered by Keldsen no one seemed to have either the interest or the capacity to once again establish the construction industry as a coherent and relevant sectorial object of development. During the 1990ties coordinated strategic efforts were however initiated with the purpose of once again establish the sector as a dominant strategic orientation, though in a radically alternative guise than it had originally been established some 50 years earlier.

So why were new attempts launched to establish the Danish construction sector as a relevant strategic object of development?

An early indication of the sectorial development agenda was an initiative by the name of 'double up' launched in the very early 1990'ties (FRI 1990). The initiative was launched because a decrease in the domestic demand had created a surplus of production capacity in the construction industry. The basic sectorial theorization of the initiative thus went that the industry needed to double its market by going international - hence the title 'double up'. A central slogan thus went 'Export or die' (FRI 1990:8). The analysis of the initiative suggested that an internationalisation of the activities of the industry would presuppose an increase in productivity through higher R&D activities, the use of communication technology and a more qualified workforce. It was also suggested that horizontal integration among manufacturers, consultants and contractors would be needed in order to develop concepts suited for the international market (FRI 1990:4-5). The argument of the initiative accordingly was that coordinated sector development effort was needed (FRI 1990:20)

The establishment of the industry as a sectorial object of development was however predominantly framed by a large scale analysis covering the major areas of the Danish industry which was initiated in the beginning of the 1990ties. This industrial analysis was triggered by a governmental report which argued that a new industrial policy paradigm was needed in order for the Danish industry to survive the intensified competition which was anticipated as a result of the newly established common market within the European Community (Industi- og handelsstyrelsen 1991). According to the report this new industrial policy paradigm would need to address the industrial development processes in terms of 'networks of producers, customers and knowledge-institutions'. The idea was that such networks could be turned into so-called 'development blocks' resulting in a condensation of industrial development capabilities emanating from a multiplicity of interactions and synergies (Industi- og handelsstyrelsen 1991: 5-6, 37).

A large scale industrial analysis was triggered by these arguments. The analysis decomposed the Danish industry into 8 so-called resource areas. One of these

resource area analysis was concerned specifically with the construction industry. It was more than anything else this analysis which succeeded to once again establish the construction industry as a coherent sectorial object of development.

The resource area analysis of the construction industry was produced by a broad consortium which included the National Building Research Institute, Niras (an engineering consultant), The Danish Technological Institute (a semi-public provider of technological services), Handelshøjskolen (The leading Danish business school) and a small industry consultant. This consortium was further backed up by a reference group comprising all major organized interests within the industry. (EFS 1993:8). A core concern accordingly was to develop a sector representation which was politically robust and thus able to provide a shared perspective that would be able to ensure broad mobilization of different interests within the industry.

Though the resource area did not include civil engineering it nonetheless constituted the third largest resource area measured by value-production and the second largest measured by employment (EFS 1993:9). As a resource area the construction industry thus represented an economic unity of significant societal importance.

The analysis theorized the sector into a) an industry part, covering the industrialized recovery of raw materials and the production and distribution of building materials, and b) a construction part, concerned with planning and execution of construction projects. It further subcategorized a series of actors into these parts. The industry part was comprised of raw material manufacturers, building material manufacturers and building material retailers while the construction part was comprised of contractors, craftsmen and architects and engineers. Finally, other actors included the clients as well as mortgage credit companies, estate agents, manufacturers of tools and remedies and manufacturers of building materials (EFS 1993:9).

So what did the organization and performance of the industry look like as it was once again exposed to coherent sectorial scrutiny?

First and foremost the analysis concluded that the industrial concentration which the sector development activities in the post WW2 decades had succeeded in generating had largely eroded.

Utilising statistical measures the construction part thus consisted of no less than 28,000 companies employing in total 90,000 persons. 21,000 of these were craftsmen companies - i.e. companies which comprised only a single trade - with an average size of no more than 3 employees (EFS 1993:40). The activities of the construction part were portrayed as highly domestic as export accounted for less than 3 bn. Dkk. out of a total turnover of 65 bn. Dkk. (EFS 1993:40)

These figures were compared with the industry part which consisted of 4,800 companies employing in total 57,000 persons. Bigger companies with higher level of export were especially evident among the building material manufacturers which amounted to 1,200 companies with an average of 27 employees and an export ratio of 36 pct. (EFS 1993:40)

Elaborating on these statistical figures the resource area analysis offered the following conclusion regarding the performance of the construction part of the sector:

”It is specifically characteristic to the construction part of the resource area that the production takes place in varying collaborative arrangements with a new production site every time. It is furthermore characterised by one-piece order production, just as the productivity development has been lower than in the industry, and bygge/bolig has, despite a certain industrialization still strong traces of craftsmanship (EFS 1993:10)”

The analysis thus portrayed the construction part of the resource area as a field of activities organised by pre-industrial trade-specific pattern. This pattern was argued to be responsible for a relatively low increase in productivity compared to the increase in productivity in the manufacturing industries (EFS 1993:10).

The analysis then confronted this picture of the construction part with the future market-development (EFS 1993:11). In line with the double-up initiative the analysis identified a general supply-side surplus, not only in Denmark but in European countries in general. By associating this overall European supply-side surplus with

the emergence of a Common European Market the analysis anticipated a gradual increasing internationalisation of the market for construction services – especially within the refurbishment market.

In face of this coming-to-be intensification of the international competition the stagnating productivity figures and the lack of innovation due to organizational fragmentation of the construction part of the resource area was identified as the major strategic challenges. This sector representation was crystallized into the four main challenges listed below:

The internationalization challenge

The companies of the construction part lack competences and equity to meet the demands of the international market.

The transition challenge

The companies have to a too limited extend converted their actives and products to target the increasing market for refurbishment

The cooperation challenge

The coordination between the companies in the construction part is based on a traditional trade-specific work division. Vertical integration in cross-project collaboration is necessary to obtain the required productivity-gains.

The innovation challenge

Strategic product- and process development is highly limited within the construction part. The potentials for innovation-initiatives and information-sharing between the construction-part and the industry part are not exploited.

(EFS 1993:13)

While identifying these challenges the analysis further outlined a bleak picture of the sectorial development capabilities. According to the analysis the capability of the state-organized development infrastructure - relying on public regulation and on the diffusion of standards through public procurement policies, research programmes and education which had characterized the post WW2 had thus largely eroded:

”The pull in the development of the resource area from publicly supported demand has in general decreased, and the infrastructure has been weakened. A review of research and education thus shows, that the construction process and the internationalization only to a limited extend is addressed by the activities on the two areas (...) The overall assessment of the infrastructure is that it does not support the development and transition of the resource area to the extend that it could, and which it has done previously (EFS 1993:12-13)”

In conclusion the analysis theorized the sector into an object of development by stabilizing a net of association which pictured a) the organization and performance of the sector as problematic in light of the anticipated internationalization of construction services and b) the traditional public innovation and development infrastructure as largely eroded.

Action was thus mandatory!

The analysis accordingly outlined an ambitious sector-development strategy. The cornerstones were three large-scale development initiatives aiming at initiating so-called 'integrated sector development'. This strategy comprised 'Project refurbishment', 'Project Productivity' and 'Project House' (EFS 1993:151)

During the following eight years the sector representation outlined above informed a series of experimental concretization activities. In contrast to the strategic sector development efforts of the post WW2 era these activities were however not organised and coordinated by a sector representation with a coherent and clear-cut strategic orientation. The sector representation had thus pictured the sector in terms of a series of challenges but it remained unclear if there existed some unifying sectorial relation between these challenges. While the resource area analysis had theorized the construction sector as a mal-functioning industry threatened by the coming-to-be international competition it had not in any very precise sense made it clear how to interpret these mal functionings as sectorial effects which could be strategically addressed.

The representation did however catalyse concretization activities informed by its somewhat fuzzy analysis.

The first series of experimental concretization activities to be launched was organized in an initiative called 'Project Refurbishment'. The aim of this initiative was to address the transition problem. The ambition accordingly was to develop the capabilities needed to succeed in the expected internationalisation of the refurbishment market. The initiative was carried out from 1994-1998 and comprised no less than 100 individual refurbishment projects organized into nine different categories. (EBST & Socialministeriet 2004:5)

The design of the initiative was however highly experimental and its realisation consisted of a heterogeneity of local projects pointing in very different directions. One category of refurbishment projects thus aimed to integrate the construction- and industry part of the sector by focussing on the development of building-systems and components designed for refurbishment. Other categories focussed more specifically at 'industrialization strategies' in regard to the construction process such as 'new forms of procurement and collaboration' and 'new design and planning methods'. Yet another category of projects was concerned with the utilization of ICT in refurbishment. (EBST & Socialministeriet 2004:20-21). The experimental and somewhat uncoordinated design of the initiative was also reflected in the learning processes. An analysis thus concluded that learning among other things had concentrated on collaboration between trades, management of the construction process, systematization, international differences in marketing, product development and method problems (EBST & Socialministeriet 2004:15).

The next sector development initiative to be launched was 'project productivity' which was renamed 'product- and process development' abbreviated 'PPB' (EFS 2001a, 2001b). This project ran from 1994-2001. It was designed to increase productivity through long-term collaboration and industrialization. Four consortiums were established which included both contractors, architects, engineers and in some cases also component manufacturers. These consortiums carried out 33 construction projects of a total of 1600 flats. The four consortiums were:

- (i) **CASA NOVA**, focussing on the production of wood-based tower blocks

- (ii) **Comfort House**, focussing on the integration of architecture and industrial production
- (iii) **Habitat**, focussing on an increased industrialisation by modularising the building into prefabricated elements.
- (iv) **PPU**, focussing on new processes in the planning and construction processes.
(EFS 2001a:23)

In 1998 the initial experiences of these programmes were turned into a new governmental action-plan (By- og Boligministeriet 1998). This action-plan introduced two new strategic elements on the sector development agenda. One of these identified 'the client' as a leading change-agent. This was by no means a new idea as much of the post WW2 development had been driven by the diffusion of standards through public procurement policies. The argument of the 1998 action plan was however that also the private clients should act as change agents. One of the barriers experienced, especially by the PPB initiative was accordingly the lack of 'industrialized' demand. It was therefore argued that the clients needed to be better equipped in articulating their needs and choosing the best supplier, as suggested in the quotation below:

”The client has a central role in the construction industry and can contribute to increased quality in the construction process in general by placing specific demands to products and services. The client should in other words act as "the critical and demanding consumer" (By- og boligministeriet 1998:9)."

The other new element was ICT technology which was coined as a lever for an industrialisation of the construction process:

”The use of modern information technology creates the basis for a higher discipline of collaboration and more efficient communication between the parties of the industry (By og boligministeriet 1998:19)”

These new strategic elements were glued together by elements which had already been presented in the 1993 resource area analysis. One of these was the need for

strategic collaboration in order to increase productivity and innovation. In the action-plan these new elements became integrated into the final development programme outlined in the 1993 analysis, namely 'project house'.

'Project house' was initiated as an ambitious 10 year development project which aimed at fundamentally re-organising the organization and operation of the construction industry by means of client-demands and industrialized production of building components (By- og Boligministeriet 2000:5). The idea was to initiate the program with a concept-phase. In the period from 1999-2001 ten networks were established which had to develop ideas of specific development projects (By- og Boligministeriet 2000:2). In 2001 the overall sector development strategy was however fundamentally re-organized. One implication of this reorganization was the termination of 'Project house'. The project was accordingly never realised.

A somewhat different initiative initiated by the 1998 governmental action-plan was 'project new forms of collaboration' (EBST 2002). While an increased productivity was also the aim of this initiative the strategy did however not advocate industrialisation and strategic collaboration, which were framed as the core elements of 'project house'. Rather, this initiative advocated for better single project collaboration among clients, architects, consulting engineers and contractors.

This idea were mobilised through the concept of partnering, pointing to motivation, trust and involvement as critical factors of a more efficient coordination. Partnering was thus defined as:

"A form of collaboration between 2 or more parties, which is based on dialog and trust rather than conflict and mistrust (EBST 2002:5)"

The initiative articulated client demands as the central mechanism by which to promote the use for partnering principles. The initiative comprised in total 9 projects and suggested that partnering could lead to:

- (i) Significant economic saving (5-20%) in planning and execution, combined with the possibility of increased profit for the involved construction companies

- (ii) Better quality through closer and more trustful collaboration
 - (iii) Less resources used on disputes
 - (iv) Better collaboration climate in the entire construction process
- (EBST 2002:8)

As demonstrated above the 1990'ties were in conclusion characterised by new attempts to establish the construction industry as a sectorial object of development, and the decade was characterised by intense experimental activities too.

So, what were the effects of the sector development activities of the 1990ties? Had they succeeded to create coherent or at least semi-coherent configurations of theorization, concretization and institutionalization processes, capable of generating traceable effects in the industry?

An overall assessment of the development efforts was provided in a follow-up of the 1993 resource area analysis published in 2000 (EFS 2000). This 2000 resource area analysis emphasised industrialization of the construction process (standardizations and specialization) and industrialized factory-based production of larger and more complex building components as the central sector development strategies, as suggested below:

”Roughly speaking there are two types of improvement strategies, which is based on construction with variety: The one strategy solely addresses the process and organization. Increased efficiency happens through a standardization of the processes, which is invisible to the customer (...) The other strategy entails a "new-industrialization" by which the factory production is increased. It is not based on large series of identical apartments, but on "variations over a theme". (EFS 2000:10)”

While identifying these two strategies as potential means by which to develop the sector the analysis however concluded that the challenges outlined by the 1993 analysis still remained to be solved. It was accordingly concluded that (a) the fulfilment of customer needs remained insufficient, and (b) that the price was too

high and (c) that the quality was too low (too many flaws and defects) (EFS 2000:9). The overall assessment of the sector development efforts accordingly went that:

”There has been obtained a series of good results through these activities, but a breakthrough in relation to the central problems of the Resource area analysis has not been archived. Among other things the requested productivity gains has not been archived (EFS 2000:10)”

The analysis pointed to the problem of diffusion and institutionalization in particular. It was thus concluded that the experimental learning from the development activities in the 1990ties had only diffused marginally beyond their local settings. In relation to the PPB program it was accordingly noted that:

”So far (...) there have not been the necessary diffusion effects of the experiences (EFS 2000:10)”

This 'diffusion problem' was addressed by a re-theorization of the sector representation. While the sector representation of the 1993 analysis thus advocated for the possibility of initiating a transition of the sector through ‘integrated sector development activities’, the sectorial analysis of the 2000 resource area analysis suggested that a series of framework-conditions suppressed experimental learning from diffusing beyond their initial settings (EFS 2000:104).

A central logic which was to become an influential strategic element in the further theorization processes was that of a sector-level “lock-in” (EFS 2000:105). This “lock-in” logic was initially introduced in the evaluation of the PPB program (EFS 2001b) and acted as a central organizer in the 2000 resource area analysis. In the 2000 resource area analysis a “lock-in” was defined as:

”A result of some system- or network externalities combined with the fact that the technologies exist in close connection with their social and economic environment. The technological regime or paradigm exists, because it consists of a complex of scientific knowledge, engineering practise, process technologies, infrastructure, product properties, qualifications and procedures, which in combination makes up a

technological totality, which it is extremely difficult to change in its entirety (EFS 2000:105-106)”

By utilising this "lock-in" concept to re-theorize the sector representation a patchwork of framework conditions were identified. These framework conditions, which are listed below, were argued to render the traditional craft-based organization and operation of the construction-part resistant to the learning of the experimental concretisations activities of the 1990s.

- (i) Regulatory conditions such as the legal frameworks which regulated entrepreneur- and consulting services were found to establish a conflict oriented contractual basis for coordination on projects and to position the client in a weak position.
 - (ii) Public procurement regulations which were found hinder the promotion of vertical cross-project collaboration efforts.
 - (iii) The more general regulation of procurement and competitive bidding which emphasised price-competition and prescribed high levels of detail was found to hinder quality-development
 - (iv) Few market segments were found to be characterized by full competitions and this was suggested to hinder the optimal satisfaction of customer needs.
 - (v) Collective agreements on the labour market and piece-work agreements was suggested to hinder productivity development by maintaining and supporting traditional working methods and by preventing work-gangs of different professions
 - (vi) Educations were suggested to maintain the traditional craft-based working-division and to hinder work-gangs of different professions and the development of ICT competences.
- (EFS 2000:105)

While the 2000 resource area analysis offered a re-theorization of the sector representation it was however less clear about the strategic interventions needed to cope the problem of diffusion and institutionalization.

A strategic response to this new sector representation was however offered by a governmental action-plan called “The future of construction - from tradition to innovation” (By- og Boligministeriet & Erhvervsfremme Styrelsen 2000). Rather than supporting further experimental development activities the strategy of this action plan predominantly was to develop more supportive framework-conditions which would allow experimental learning to diffuse and generate broader industrial effects.

This action-plan introduced four ‘development packages’ concerned with (i) empowerment of the client, (ii) increase of competition, (iii) collaboration, and (iv) innovation (By- og Boligministeriet & Erhvervsfremme Styrelsen 2000:6-7). Some main strategies of these packages were new procurement forms such as public-private-partnership, professionalization and competence development of the client, better collaboration between academia and industry in order to accelerate innovation and to establish a more systematic development of relevant knowledge.

Also less framework oriented development strategies were however included in the action-plan such as partnering and industrialised production of building components. Main focus was however on the development of new framework conditions focussing on the development of a more competitive and fertile environment for innovation- and development activities.

Conclusion on the 1993-2001 sector development activities

As demonstrated above the 1993 resource area analysis marked an attempt to re-establish the Danish construction industry as a relevant sectorial object of development.

The concretization activities which came to operate within in this 1993 sector representation were however unfocussed. Experimental activities thus aimed to exploit very different possibilities and strategies, drawing on new planning technologies, new materials, new product architectures and new forms of inter-organizational collaboration.

While a wide range of local experiences were generated as a result of these concretization activities, they did however not to any significant extend inform and support the emergence of coherent configurations of theorization, concretization and institutionalization processes. The concretization activities did thus only to a very limited extend succeed in developing a shared sense of sectorial directionality. Rather they turned into an increasingly dense and messy patchwork of local and specific productions, capable only of generating local and mutually uncoordinated effects.

An illustration of this lack of strategic transparency and directionality may be indicated by comparing the 2000 resource area analysis with the 2001 action plan. In the 2000 resource area analysis 'industrialization' was thus singled out as the most promising strategic perspective in catalysing sectorial development. While the 2000 resource area analysis operated with two types of industrialization (By- og Boligministeriet & Erhvervsfremme Styrelsen 2000:10) the concept had disintegrated into four the different meanings listed below in the 2001 action plan:

The application of industrial management and steering. The transfer and adaptation of production processes from the industry concerning, organization, management, accountability, innovation, QA and customer-relation

Industrial design and planning. The professionalization of the design and planning processes

Industrialized building system The development of flexible building-systems, which are industrial manufactured and delivered in modules and sections at the construction site, in order to reduce the activities on the construction-site.

The industrial construction site The establishment of a rational and flawless construction process, which are adapted to integrate industrialized building-systems and industrialized design and planning
(By- og Boligministeriet, Erhvervsfremme Styrelsen 2000 :160)

The strategy of 'industrialization' was thus rendered still more elusive and less capable of informing concretization activities in any coherent way. This strategy thus became characterised by a still more profound lack of centrality. The concept thus disintegrated into a foggy in-decisiveness.

Project House, which was originally intended to integrate the experiences of project refurbishment and the PPB initiative into a clear and operational grand-scale sectorial transition strategy represents another illustration of this increasing strategic opaqueness. Before the initiative was terminated it was organized into a series of theme-groups which had to address a range of core challenges of the sector (By- og boligministeriet 2000:8). In total these theme-groups identified no less than 66 so-called 'development elements' as relevant for the initiative (By- og boligministeriet 2000:3-4). These included elements such as self-organizing gangs, meeting culture, process consultancy, qualification of the client, tools for logistics, prefabricated basement units, space for experimentation by dispensing from regulation and traditions, client driven change of the construction culture etc.

As indicated by the following quotation the strategic opaqueness which this uncoordinated complexity of local problem-solving strategies amounted to in their totality was recognized as a main challenge of the initiative:

"By the review of the different suggestions for development products offered by the theme-groups and the elaborations by the consultants (...) it is clear, that the emphasis of the groups is to define and develop new ideas on a technical level. There has not been dedicated much resources in putting the ideas into a focussed development process (...) (By- og boligministeriet 2000:8)

In order to cope with the lack of coordinated sectorial directionality it was accordingly suggested that the individual development elements should be grouped into the following categories 1) client part / real estate market 2) construction part / construction market 3) industry part / component market 4) Development part / knowledge and framework-condition (By- og Boligministeriet 2000:9). These categories were later organised into the following 4 themes (i) the client as change agent (By- og Boligministeriet 2001) (ii) close collaboration in the construction part

(By- og Boligministeriet 2001b) (iii) new-industrialization and (By- og Boligministeriet 2001c) (iv) construct with communication and innovation (By- og Boligministeriet 2001d).

Rather than establishing a forward-looking and attractive strategic orientation for the sector as a whole this organisation of the proposed development products however seemed more as an attempt to merely gain some kind of clarity by means of rather conservative categories.

The argument that the learning from the experimental concretizations activities in the 1990ties did not diffuse because of impeding framework conditions thus appears to be a somewhat jumpy conclusion. The problem was as much that the concretization activities themselves generated a situation of strategic opaqueness. The development activities of the 1990ties thus failed to generate a coherent and attractive strategic configuration of theorization, concretization and institutionalization processes which was able to build collective capacity for coordinated sectorial change

Chapter 6 - Digital Construction

As demonstrated in the previous chapter the sector development initiative project house was originally intended to interconnect the experiences of the experimental sector development activities initiated by the 1993 resource area analysis. The ambition of the initiative was to achieve 'double value at half price' within a single decade by means of orchestrated sector development (By- og Boligministeriet 2000). The experimental sector development activities of the 1990ties had however generated an explosion of uncoordinated complexity, and the initial phases of project house were not able to convincingly organize this complexity into an operational and attractive sector representation.

Prior to the implementation of project house the overall sector development agenda was furthermore re-organized and project house was terminated as part of this re-orientation. At the same time the Housing Ministry was closed down and the policy domain was re-organised into a governmental agency called Danish Construction and Enterprise Authority (abbreviated EBST) organized under the Ministry of Economic and Business Affairs.

This did however not imply that the sector disintegrated as an object of strategic development. Rather two initiatives characterised by more coherent configurations of theorization, concretization and institutionalization processes emerged from the strategically opaque experiences which had been generated by the sector development activities in the 1990'ties.

One of these sector development initiatives was called digital construction (DC) and the other was called Building Lab DK. In order to characterise how the sector as an object of development came to exist in the post 2001 period the following chapters offer an analysis of how DC and Building Lab DK surfaced and operated as alternative configurations of theorization, concretization and institutionalization processes.

The Theorization of DC

One of the striking characteristics of the sector development activities of the early 1993-2001 period was the absence of technology driven sector development strategies, especially on the ICT (information and communication technology) area.

This absence of an ICT oriented sector development strategy is even more striking as an ambitious ICT initiative - called the TR initiative - concerned with 'data exchange in the construction industry' had been running during the late 1980'ties and the early 1990'ties. This initiative comprised approximately 30 individual projects and operated with a budget of 30 mio. Dkk (EFS 2001c:16).

The de-coupling of ICT technology from the sector development activities of the early 1990'ties was however to a large extent a result of the TR initiative itself. By the TR initiative ICT was not just envisioned as a box of tools intended to support the existing work processes of the industry. Rather ICT was perceived as a much more strategic tool which was envisioned to fundamentally develop and 'industrialize' the processes of the 'craft-based' industry. In order develop ICT into such a strategic tool a very central element was of the initiative was the development of data standards allowing for integrated data utilization across the different professions, trades and companies of the industry.

This strategy was inspired by experiences from abroad where large and dominant contractors had succeeded to develop and diffused database driven information systems to their business partners, thereby developing new patterns of inter-organisational coordination. As the Danish construction industry was however not populated by such power-full contractors a central challenge of the initiative was to develop alternative mechanisms by which to stabilize and diffuse a shared sectorial ICT-platform, which could facilitate a coordinated use of data and thereby support an 'industrialization' of the processes within and between companies and professions.

In two central respects the TR initiative was however ahead of its time. First, the ICT technology was still in an early phase of development especially in relation to standards which supported data exchange. Secondly the initiative also aimed to

address the construction industry as a coherent sectorial challenge, though the industry at the time did not exist as a coherent object of development.

In course of the experimental activities the vision of an integrated sectorial ICT-platform capable of developing new industrialized mechanisms of coordination and exchange in the sector as a whole thus began to disintegrate as the actual it-use developed into profession-specific tools and solutions not coordinated by a common communication platform. The consequence was that the original vision of the initiative gradually came to be perceived as empty wish-thinking by outsiders. The final disintegration of the envisioned sectorial ICT strategy accelerated as the state refused to provide further funding in the early 1990'ties, as reflected in the quotation below:

”It came to be about how I, engineer X, am able to profit from my investment in CAD in an efficient manner, more that how I collaborate in a good manner with the architect. From a broad interest in applying a cross-industrial perspective, the horizon narrows completely for them all (Interview, Hauch)”

The end result was that the vision of a common and coordinated ICT-platform disintegrated into a range of uncoordinated tools, procedures and practices. Contrary to the ambitions of a comprehensive and coordinated sectorial 'industrialization' the initiative thus came to serve and preserve the existing 'craft-based' organization of the industry.

To those concerned which sector development in the early 1993-2001 period ICT subsequently lost its attraction as a sectorial logic by which to theorize the construction sector in a strategically attractive manner, as reflected below:

”There is no doubt that the industrial IT-understanding is marginal after the TR initiative. It is limited to a narrow group which carries that understanding. And we cannot sell it. That is the experience of all of us (...) There is a great respect for the steering group which ran the TR initiative, but nobody wanted to hear what we said and do what we did. (Interview, Hauch)”

ICT was thus effectively de-legitimized as a sectorial logic and thus excluded as a strategic element of the theorization activities catalysed by the sectorial re-enactment of the early 1990'ties reviewed in the previous chapter.

This did however not prevent ICT from being increasingly utilised in some parts of the industry. Relatively isolated from the sectorial re-enactment and the activities which this re-enactment generated a set of profession-specific ICT trajectories thus evolved, strongly supported by the organisations established during the TR initiative. The main organizations which carried these trajectories forward were IBB, EDI-byg and BPS which were concerned with standardization and the utilisation of CAD software. Within these trajectories ICT was however developed to support existing processes rather than to develop and support new 'industrialized' ones, as it had been the vision of the TR-initiative, as reflected in the quotation below:

”Though we got new tools we thought and worked just as craft-like as we had always done. Very few thought that here we have data which can be re-used, here we got flows of information, here we got new ways of thinking and working. It does something to our organization. Not very many thought in that direction (Interview Friborg)”

The growing but uncoordinated use of IT during the 1990ties had thus only marginal impact on the actual work-practices and even less impact on the organization and division of work of the industry, and was virtually decoupled from the theorization activities aiming to conceptualise how to develop the sector. This remained a frustration to the small community which represented the sectorial perspective of the TR initiative who experienced how the concept of industrialisation was de-associated from the utilization of ICT, as reflected below:

“There is a split which is one of the larger disasters of the 1990ties, that those who are interested in an industrialized development of the construction industry isolate themselves or become isolated from those interested in ICT utilization and ICT. It is a very significant shift. There is suddenly someone who becomes interested in industrialization and then there is someone who runs further with the ICT perspective but in a wrong context (Interview, Hauch)”

Furthermore, in some of the areas where ICT actually succeed in influencing the work-practices the implication were not entirely positive. In an architectural context the introduction of CAD tools thus tended to result in restricted two dimensional heuristics as reflected below:

“We were many who experienced that there was made quite bad architecture in the beginning because of 2D. Many of the new-comers did not have an understanding of space and the 3 dimensions and corner-interfaces, because they operated in 2D and everything is possible in 2d and looked right. Just until the 3rd dimension was added in the real world. Then you looked terrified on what had been produced. And experienced architects shook their head because of the missing understanding. (Interview, Friborg)”

However, despite the lack of a common sectorial ICT platform the utilisation of ICT grew within the different and isolated perspectives of the various professions during the 1990'ties. Not in a strategic and equally distributed manner, however. Available tools and solutions were applied where they could immediately support existing processes. The ICT utilisation grew most rapidly among consultants, and to a lesser degree among contractors and architects. The utilization was primarily based on standard software such as the Microsoft office suite and cad programmes. These programmes made it possible to optimize some existing processes; drawings could be more easily changed and text-descriptions could be reused through the 'copy-paste' function.

During the mid 1990ties some initiatives did however aim to establish a sectorial ICT perspective. One of these was an initiative to establish an IT-construction center (ATV 1996). The initiative was formulated and promoted by Hauch, the head of the former TR-initiative. The idea was to establish a center with 5-7 employees and furthermore to associate a number of p.hd's. A rather detailed plan for the center was developed before the funding and support finally collapsed. Contacts and negotiations were thus initiated with the organized interests of the existing ICT trajectories in the industry and contacts were also taken to Nordic and international development initiatives.

More successfully the Technical University of Denmark succeeded to establish a research group called IT-byg. This group did however not operate with a sectorial perspective. ICT was accordingly perceived as a means to *support* the existing processes and not as an independent sectorial logic capable of industrializing the processes of the industry (see for an example Howard 1998; Howard & Petersen 2001). The most sector oriented project which this group engaged in before it was closed down was a center-contract on the development of a building classification. This project however failed entirely in developing an operational classification or in establishing a platform from where this could be achieved (Byggeklassifikationssamarbejdet 2003)

While the attempts to re-establish ICT as a sectorial logic failed in the mid 1990'ties a pragmatic ICT strategy was integrated into the PPU consortium operating under the PPB initiative, which was one of the sector development initiatives laid out by the 1993 resource area analysis (EFS 2001a:36). As mentioned in the previous chapter the objective of this initiative was to develop strategic partnerships where consortiums of companies were supposed to collaborate across several projects. The ICT utilization in the PPU consortium did however not prove to be entirely successful in term of ensuring an integrated use of ICT. The identified barriers included lack of procedures which could facilitate a coordinated integration of drawings, models and texts and the absence of commonly agreed file formats among the companies in the strategic partnership. However, also the overall work division, the contractual procedures (ownership and responsibility of data), the day-to-day working procedures and the CQ procedures were identified as barriers (EFS 2001a:41). The conclusion of the final evaluation of the PPB programme accordingly was that:

“The experiences from the communication project once again points to the need for the development of a common foundation, which enables the construction sector in utilising the information technology at a level where integrated planning based on digital exchange of data can take place between shifting partners – consortium or not. It is a question of common fundamentals and a common IT-infrastructure

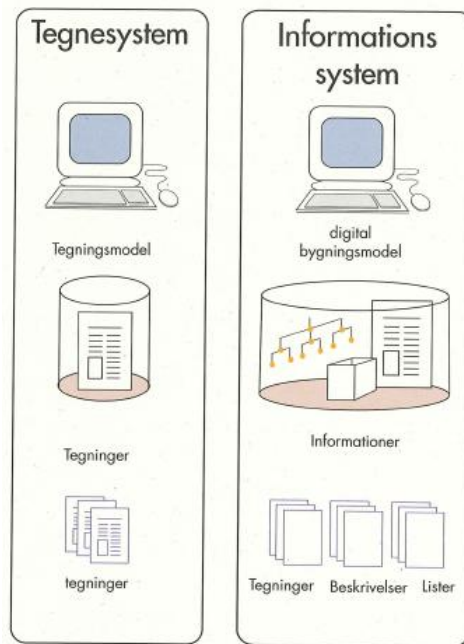
which will bring the construction industry on level with other key industries (EFS 2001a:40)”

Again it was Hauch, the head of the former TR initiative, which was at work in the crafting of this formulation. While the strategic impact of this evaluation itself remained modest, a more critical sectorial event was a publication titled ‘IT in the future of the construction industry (EFS 2001c)’ which further elaborated on the experiences of the PPU consortium and this time from a sectorial point of view. This report once again mobilised ICT as sectorial logic, as reflected in the quotation below:

“The IT practice of the construction industry (...) needs to be revisited. It must be developed and adapted to the technological possibilities. For the industry as a whole this development can most appropriately be characterised as a whole new sector concept - a new sector practice – which in the end implies that all routines and patterns of internal function and cooperation is up for re-assessment, and that all agreed standards and rules are taken into revision (EFS 2001c:4)”

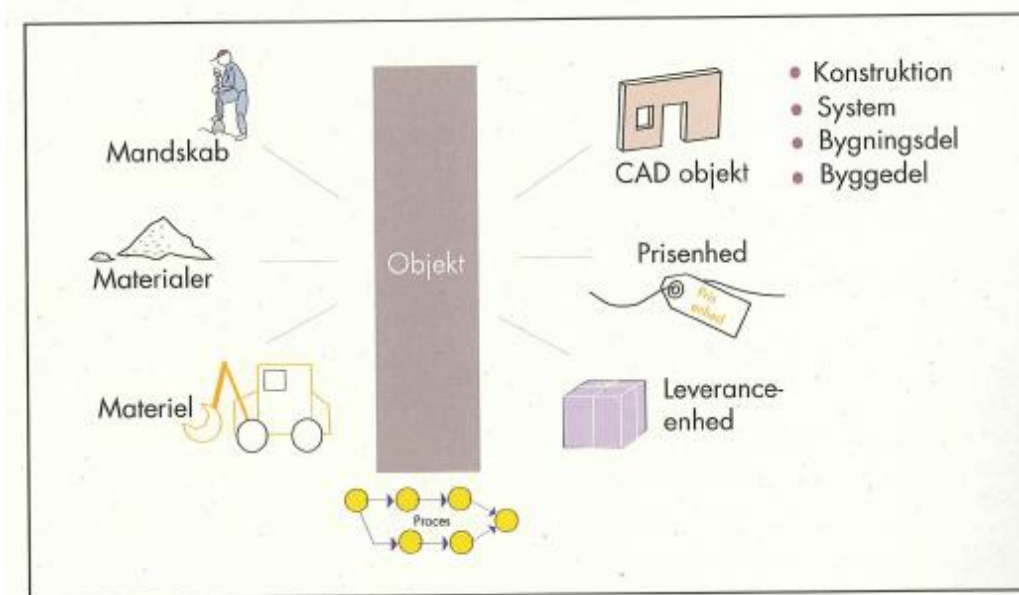
Again it was argued that the organization and activities of the industry needed to be fundamentally re-organized in compliance with the requirements of a common integrated ICT platform. The critical sectorial move in this report however was to mobilise ICT as sectorial logic in guise of an object oriented information model. This move facilitated a distinction between a ‘drawing-system approach’ and an ‘information system approach’.

The drawing system approach was used to portray the existing ‘craft-based’ utilization of ICT in the industry, relying on narrow and un-coordinated profession specific ICT practices. The drawing system approach thus represented an ICT utilisation which merely replicated the traditional paper-based practises characterised by a series of manually coordinated flows of drawings, descriptions and calculation, which were pictured as time-consuming and prone to failures and inconsistencies.



(EFS 2001c:58)

The information system was on the other hand advocated as an ICT approach which operated by interconnecting different kind of information 'intelligently', in the sense that new or changed information would automatically impact on all other data throughout the system. In the information system approach otherwise isolated streams of information would thus be intelligently coordinated into a single 'information model'. This approach was further specified as an 'object oriented' approach in the sense that 'the object' would act as a carrier of interrelated information which could support as well design, price and budgeting, delivery, and the planning of the construction process itself.



(EFS 2001c:84)

The 'information system approach' was accordingly crafted as a logic which was able to distinguish a superior *sectorial* ICT utilization from the sub-optimization of the professions-specific use of ICT represented by the drawing system approach. The logic of the information system approach in conclusion offered a strategically powerful representation of the sector as a series of *inconsistent and uncoordinated information flows*. By this sectorial representation the existence of inconsistent and uncoordinated information flows was accordingly theorized as the sectorial root cause to the poor performance of the construction industry, and the information system approach represented the solution by promising to

- (i) integrate and coordinate otherwise uncoordinated flows of information and
- (ii) enable a coordinated exploitation of information by means of 'the object'.

This sector representation came to play a very decisive role the design of the sector development initiative Digital Construction (hereafter abbreviated DC). As a coherent sector-level development initiative the first traces of DC however appeared in the governmental action plan “The future of construction from tradition to innovation” from 2001 as a proposal of establishing a ‘center for IT, organization and competence in the construction industry’ (By- og Boligministeriet & Erhvervsfremme Styrelsen 2000:166).

From the governmental perspective, represented in by the action plan, the motivation for establishing a sector-level initiative in relation to 'digitalization' was i) that the investment and utilization of ICT in the sector was perceived as low compared to other industries and ii) that it was assessed that the investments had not resulted in general sector level productivity gains (By- og Boligministeriet & Erhvervsfremme Styrelsen 2000:166). It was a further motivation that the technology was perceived as mature and thus readily available. It was thus argued that a sector level initiative would be able to avoid expensive technology development, and that it could rather focus exclusively on the implementation of existing ICT technologies and solution as reflected by the quotation below:

“With the information technology the technological possibilities for achieving this is available. The challenge is in particular to adapt management, organization, collaboration and competences (By- og Boligministeriet & Erhvervsfremme Styrelsen 2000:167).”

The most specific element of the proposal was to develop a public project web which should host documents and drawings. It was furthermore suggested that the project-web should be supported by new contractual models and collaborative organizational models such as partnering. An additional idea was that public procurement-policies should be formulated to ensure the utilisation of new ICT technologies. (By- og Boligministeriet & Erhvervsfremme Styrelsen 2000:168-169).

Based on the proposal out-lined in the action-plan EBST – the governmental agency which had adopted the policy domain of the former Housing Ministry - now established a working-group which comprised representatives from the industry (Erhvervsministeriet 2001). The aim of this working group was to elaborate on the possibility of a government accelerated digitalization of the sector. A member of the group was Hauch, the head of the former TR-initiative and the author of the report ‘IT in the future of the construction industry’ and the result of the working-group was accordingly influenced by the central logic developed in this report.

The fundamental challenge in relation to a digitalization of the industry was thus articulated as the lack of a common ICT-infrastructure. The sectorial advantages of

the ICT utilization was thus suggested to remain marginal if the narrow profession specific tools and practices were not transcended, as reflected in the quotation below:

”(...) The IT-investments and the system-development are primarily conducted to the benefit of the internal needs of the companies, and not developed to optimize the whole construction process. On the supply-side, the it-technology (software) is thus primarily developed to support isolated functions in the specific branches. There has thus not been a development of systems which attend the overall needs of the construction process, in co-planning and integration by the use of IT.”
(Erhvervsministeriet 2001:11)”

A two-stringed strategy was accordingly formulated. The central element in this strategy was the development of an object-oriented ICT infrastructure which should actively promote an industrialization of the processes within and between companies in the sector. The report thus suggested that the development of an IT-infrastructure:

'(...) should aim to render the whole construction-process efficient – and not just “translate” existing work-practices into IT'
(Erhvervsministeriet 2001:4)'

The initial suggestion of a project-web was thus developed into the need of 3D object oriented building models:

“The goal is to enable the utilisation of object-oriented data, where the project-material consists of 3D-information models (digital models), which fits with digital descriptions (the alpha-numeric data of the project) of the construction parts, and with internet based product-information- and trading-systems (Erhvervsministeriet 2001:4)”

In relation to the implementation of this digital and object oriented infrastructure the fragmented demand of the clients was singled out as the main barrier. The other element of the strategy thus was that governmental procurement policies needed to

be developed in order to support a broad and coordinated utilisation of the sectorial ICT-infrastructure.

In short the working-group formulated a sector representation in which the 'object oriented ICT-infrastructure' operated as the central sectorial logic. Coupled with proper procurement policies it was thus suggested that this object oriented ICT infrastructure would be able to organize a development of new tools and practices and thus promote an industrial transition of the craft-based practices and organization of the industry.

The logic of the 'information system approach' which had succeeded to inform the sector representation outlined above however became partly de-stabilised in the further development of the initiative. On the one hand the proposal had thus succeeded to attract funding. The initiative accordingly became part of a governmental competition strategic and was funded with 20 mio dkk. With an anticipated co-financing of 50 pct the total funding of the initiative was 40 mio dkk (EBST 2003:3). On the other hand a series of hearings conducted by the EBST concerns however raised concerns regarding the radicalism of the initiative as it had been outlined by the working group.

Based on these hearings a consultant named of Tage Dræbye - who had been a central figure in the crafting of the sectorial development agenda in 1993-2001 period - was hired to reformulate the initiative (EBST 2003). This reformulation weakened the basic distinction between the 'drawing system approach' and the 'information system approach'. Dræbye thus destabilised the very central idea that an object oriented IT-infrastructure would be able to catalyse a coordinated development of the processes and organization of the industry.

Contrary to the exclusive focus on the integrated object-oriented ICT infrastructure Dræbye emphasized the need to also prioritize immediately applicable solutions in a more loosely coordinated way. Technologies and processes which had been excluded from the initiative due to their incompatibility with the 'information system approach' could thus once again be part of the strategy

Additional to the focus on readily available tools which also included tools that did not necessarily comply with the information system approach the re-formulation by Dræbye pointed out the need for 'standardization'. The idea of standardization promoted by Dræbye was however much more pragmatic than the idea of an objects oriented information infrastructure promoted by the working group, as reflected in the quotation below:

”Standardization as I see it is to bring order in an existing reality and not to create a new construction of reality. The basis of standardization is that you are faced with some systems which do not fit together, and then you create a certain level of order. But you do not create a brand new utopic construction (interview, Dræbye)”

The question of whether ICT should act as an active logic was however considered in some detail by Dræbye as suggested below:

”The classic problem in relation to IT utilization is, whether it is the existing processes which are to be automated, or if there should be developed entirely new automated processes. (EBST 2003:20)”

Although interviews with representatives in the industry suggested that ICT should in fact be developed into an active logic able to develop new processes Dræbye maintained that the existing industrial organization and work processes were not likely to allow ICT to act as such an active ingredient.

”Based on the investigation it is difficult to see ICT as a central driver for a renewal of the construction industry. There are however general areas, where ICT can support a development. (EBST 2003:22)”

The vision of the object oriented ICT infrastructure as an active sectorial logic was in conclusion destabilised

- (i) by questioning whether the industry had the capabilities to integrate and absorb radical new ICT solutions and

- (ii) by questioning whether an integrated sectorial ICT infrastructure could be developed within the framework of the initiative.

The destabilisation of the strategy of the work-group was further achieved by breaking open the hitherto successful black-boxing of the 'object oriented IT infrastructure' as a coherent logic. Rather than a single infrastructure Dræbye thus constructed a picture of several loosely coupled infrastructures which consisted of a series of different standards for data exchange in the areas of (1) trade documents, (2) component-identification, (3) component-classification, (4) project-documents (5) construction-part-classification (6) Meta-data (7) object data-format and product models and (8) communication (EBST 2003:16). Finally Swedish experiences were mobilised to suggest that the development of an object oriented approach had a long time-perspective (EBST 2003:10).

The re-formulation was further organized by addressing four types of barriers namely (1) technological barriers, (2) economic barriers, (3) organizational/cultural barriers, and (4) formal barriers. It was argued that especially the organizational/cultural barriers were likely to hinder a tightly orchestrated increase in ICT utilization across companies and professions as there was substantial variation in educational background, age as well as ICT utilisation across companies and professions (EBST 2003:21). However, the economic and formal barriers were suggested to be significant too. The return-of-investment was thus perceived as 'uncertain' and the legal aspect in regard to the ownership and responsibility of the generated data was argued to be 'unsettled' (EBST 2003:21).

The re-formulation accordingly suggested that an object-oriented information infrastructure - represented by the information system approach - would need to be developed by a research oriented rather than an industry oriented sector development initiative. (EBST 2003:35).

In conclusion, the re-formulation thus destabilized the sector representation outlined by the working group as demonstrated in the quotation below:

”The work group report "digital construction" is very focused on object-oriented, 3D building models as the basis for data exchange

between the parties of the construction industry. Neither the desk research nor the debates in the focus groups has given reason to dismiss, that in the long run this is true. There have however been identified several matters, which imply, that the time perspective in this development need to be revised (EBST 2003:35)”

By Dræbye the strategy of the working group was thus de-composed into to a series of more loosely coordinated tools and practices by which to ‘support existing developments’. Client demands should thus accelerate the utilisation of available ICT solutions which supported existing processes in the industry. The logic of the object-oriented ICT infrastructure was thus replaced by the logics of so-called ‘IT bridges’ which should be developed to ease the coordination and exchange of information between the idiosyncratic worlds of the different professions of the construction industry.

The final strategy-memorandum of EBST aimed to balance the radical vision of ‘the object information system approach’ against the pragmatic approach of ensuring ‘IT bridges’ (EBST 2003b). The ‘object-oriented IT infrastructure’ was thus articulated as a ‘point of orientation’ rather than ‘a specific goal to be achieved’ and it was specified that:

“Digital Construction has focus on learning and implementation of utilizable technology. That the technology can also be utilised tomorrow and the day after is however just as important as it can be used today” (EBST 2003b)”

The concretization of DC

As demonstrated above the sector representation which informed DC characterised the Danish construction industry as a series of uncoordinated information flows of drawings, descriptions and calculations, which were prone to inconsistencies and ambiguities. These information flows were thus articulated as a shaky foundation for the coordination across the phases and between the actors of the construction project. The sector development strategy of DC accordingly was to utilise ICT as a

means to develop more integrated and consistent information flows from the early planning phase to the utilisation and maintenance of buildings and thereby significantly improve the efficiency of the sector.

But what type of activities should to be initiated in order to develop and implement such a coordinated digital information infrastructure in the sector as a whole? And how should the 'information system approach' be balanced against the more pragmatic idea of 'IT bridges'?

In regard to this question the working group analysis and the Dræbye analysis offered different recommendations.

In the working group analysis where the initiative had initially been outlined it was suggested that specific development activities should combine the development of an object oriented ICT infrastructure with the development of IT-guidelines for (public) clients (Erhvervsministeriet 2001). The basic idea thus went that harmonised clients-guidelines and client demands would be able to ensure the diffusion of digital information utilization, as the companies in the industry would anticipate to be faced with identical and standardized demands in all the individual projects. The assumption further went that if these guidelines were initially implemented through public client demands they would later be adopted by private clients as well (Erhvervsministeriet 2001:19).

By the working group it was further proposed that the specific development activities should be organized as a so-called 'network collaboration' coordinated by a more permanent secretariat headed by a board comprising (i) representatives from the industry, (ii) construction clients and (iii) and building authorities (Erhvervsministeriet 2001:22). It was accordingly a fundamental conviction that success was predicated on the inclusion and alignment of as many actors and interests as possible as well as on the ability to make decisions on a so-called 'strategic level' in regard to changes in the industrial work-division and concerning the responsibility of data. Further it was argued that private co-financing would ensure ownership to the initiative:

"It is critical that the construction industry has a sense of ownership for "digital construction". There should therefore be a co-financing of 50 pct from the private part in relation to "Digital Construction". In the same way as it is seen in the industry, that leading companies participate in the standardization work, it must be anticipated that companies in the construction industry have an interest in developing and influencing IT-formats (Erhvervsministeriet 2001:22-23)"

The strategy of the working group accordingly was to engage and commit a broad array of industrial parties in the development of the ICT infrastructure and the it-guidelines in order to avoid that the state came to be seen as an independent actor aiming to impose its own ICT concepts and solutions onto an unwilling and alienated industry.

The vision of a fully object oriented construction process with radical consequences for the operations of the industry - in relation to the division of work, the contractual and legal distribution of responsibilities - was however questioned in the strategic re-theorization by Dræbye. This re-formulation thus anticipated that it would not be possible to align the radical vision of an object oriented construction process with the existing operation and capabilities of the industry by means of the resources and capabilities available to the initiative.

According to the analysis of Dræbye the initiative should thus ensure the build up of technological and organizational capacity in order to prime the industry for a digital future. This implied that the initiative would need to ease up on the radical vision of a fully integrated information flow organized by an object oriented ICT infrastructure. The Dræbye analysis thus argued that the initiative should focus on

- (i) greater transparency in relation to the economic benefits in the utilization of IT
 - (ii) client demands
 - (iii) implementation of technology and standards.
- (EBST 2003:36)

Also it suggested a very broad set of development mechanisms. First, the analysis placed great emphasis on the need to advocate ICT from the perspective of the specific interests of existing actors rather than from an aggregate sectorial perspective. The analysis thus argued that methods for effect evaluations of ICT tools as well as a paradigm for 'best practice cases' needed to be developed. Three other elements were strategic research, experimental demonstration and tools for client demands (EBST 2003:38).

The programme design outlined by Dræbye thus had a patchwork like character as it was more focussed on initiating semi-coordinated processes of change in the intersection among a variety of dynamics, rather than realising 'the object oriented construction process' as a specific pre-defined end goal.

In the final governmental outline of the initiative this more open and patchwork-like design was however replaced by a more narrowly targeted set of activities aiming to support 'learning and implementation of available technology' pointing towards the 'object oriented construction process'. Despite the reservations pointed out by Dræbye it was thus stated that:

"The final goal is still a digital integration of all processes from the first thought to the finalized construction. Including both purchase of goods and operation and maintenance (EBST 2003b:2)"

The final program design of the initiative aimed to archive this level of digital integration by the development of a set of operational and coordinated client demands concerning ICT utilization which had to become mandatory for all participants in construction projects financed by state clients (EBST 2003b 3-4).

More specifically the concretization process was organized into 6 industry consortiums. These were (a) four consortiums responsible for the development of operational client demands and (b) a consortium called digital foundation responsible for developing supportive standards and methods for the exchange of information between actors and across the phases of the construction project. Finally the last consortium (c) called 'best in construction' was responsible for developing a series of 'best practice cases' which should be utilised to communicate

the benefits of digital tools and information handling to the companies of the industry (EBST 2003b 4-5).

A series of mechanism were established to ensure coordination between these consortiums. On the one hand a project council, which operated as a board for the initiative as a whole was established along with a secretariat located at the governmental agency. (EBST 2003b 6-7) Furthermore a so-called learning network was established to ensure 'development synergies' between the consortiums and between DC and the companies of the construction industry (EBST 2003b:7).

The six consortiums were however the main building blocks of the concretization process. These consortiums were tendered to companies *within* the industry. Two main reasons for this can be noted. One was to ensure broad industrial ownership to the initiative and the other was to ensure knowledge about the industry as formulated by a key employee at the secretariat located in EBST:

"(...) it was about establishing some consortiums which had knowledge about what the industry is capable of delivering and (...) to make them formulate the demands they would come to face themselves (Interview, Hellman)"

A final argument was that strong representation of industrial interests would ensure that the program would not fall victim to theoretical abstractions as the industry participants were anticipated to keep a keen eye on the business potential of the client demands.

A challenge in the coordination between the consortiums was however that they all had to be initiated almost simultaneously in order to be completed within the three years duration of the initiative.

In order to get an impression of the concretization process it may however be appropriate to begin by introducing the activities of 'digital foundation' as this consortium tried to define an overall strategic orientation for the concretization activities in their totality.

The organizational setup of this consortium represented an exception as it comprised only a single organization by the name of Bips. Bips was however established as a merger between three existing organizations working with standardization and ICT utilization in the industry.

The core challenge of the consortium was to position itself in the tension between the radical vision of a coherent object oriented information infrastructure which would be able to coordinate the flow of information throughout the lifecycle of a building and its obligation to support the client consortiums which had to develop client demands which were manageable by state clients as well as by the average company in the construction industry. The consortium thus had to navigate between the obligation to the present and the vision of the future. In the report which concluded the initial idea development phase the success criteria of the consortium thus on the one hand went that 'the solutions of the project must be coordinated with the solutions of Digital Construction focus area client demands'. On the other hand it was also stated that 'the results must be applicable with both the present and the future technology' (EBST & BIPS 2004:3).

Within the complex field of interests, requirements and various time horizons in which the consortium operated the report identified the 'shared digital construction model' as the end goal for DC. For Digital Foundation the digital model thus came to represent organizing elements of DC as a whole (EBST & BIPS 2004:9).

While the working group and Dræbye had offered opposite assessments of the object oriented 3d model 'Digital foundation' thus launched a third interpretation. To the working group which formulated the initial draft of DC, the 'object oriented 3d model' was thus tightly associated with new work flows and new forms of organizational collaboration. In the re-theorization of Dræbye the 'object-oriented 3d model' was dismissed precisely because of its association between the technological artefact and the processes and organization of the industry.

Digital foundation however re-introduced 'the object oriented 3d model' by neutralising its relations to the work division and the work processes of the industry all together. A central argument by which the consortium reintroduced the 'object oriented 3d model' thus went that it could be made compatible with the existing as

well as the future organizational structures and work processes of the industry as suggested below:

"The goal and strategy of digital foundation will therefore be to develop ICT standards and working methods which supports the existing organizational structures and working processes that operate in the construction industry today. It however also has to be insured, that future organizational types of collaboration between the many parties in the construction industry will not be obstructed hereby (EBST & BIPS 2004:9)

Referring to the Dræbye report it was thus argued that ICT standards had to be able to cope with the complex character of the construction process rather than sort out this complexity (EBST & BIPS 2004:8-9). The consortium thus aimed to neutralise the association between the object oriented information infrastructure and the work processes of the industry by suggesting that a 3D object oriented information infrastructure could be rendered compatible with both existing and future work processes and forms of organization.

The establishment of 'the object oriented 3d model' as the organizing element of DC enabled the consortium to define a) 'classification' and b) '3d working methods' as the main components which had to be developed in the project phase (EBST & BIPS 2004:12).

The aim of the classification project was 'to ensure a comprehensive and coherent conceptual apparatus covering the entire lifecycle of a building from the overall conceptual model down to defined classification tables for the objects of the construction industry as well as the associated property data (EBST & BIPS 2004:12)' whereas the aim of 3d working method project was to 'specify and describe the 3d modelling processes, compiled by each party, in order to ensure an efficient and qualitative exchange of 3d models between the parties of the construction industry (EBST & BIPS 2004:12)'.

The common element supposed to interconnect the 'classification' and the '3d working method' was 'the object'. '3d working method' thus entailed a strategy of

replacing 2d drawing with 3d models and advancing from 3d models organised by 'layers' to 3d models organized by 'objects' (Bips 2006:11-12). The classification project was then supposed to develop a shared language specifying how to name and categorise the resources and processes of the construction process from this object oriented point of view (Bips 2006b:2). A coherent and integrated flow of models, drawings, descriptions, calculations and timetables were thus envisioned to be coordinated by their relation to a single unequivocal object oriented ontology.

This object oriented approach, advocated by digital foundation, was however by no means established as un-challenged strategic orientation of the concretization process. The initial outline of the four client demand consortiums were thus influenced by the interests expressed by the state clients and industry representatives rather than by their compliance with the object oriented ontology. The industrial representatives thus conditioned their support to the initiative on the use of *existing technical solutions*, rather than experimental development of new ICT solutions. From the viewpoint of the state-clients, for whom the implementation of the demands would become mandatory, it was critical that they would not result in increased costs.

The main criteria in the design of the four client demand consortiums were accordingly that they (a) should be based on available technology and (b) that they should form communication bridges *across* phases and actors in the construction process.

The object oriented ontology advocated by Digital Foundation did accordingly not play any significant role in the initial design of the client demand consortiums. By the secretariat which formulated the tender of the client consortiums a certain level of scepticism towards the object oriented 3d approach furthermore prevailed, as reflected in the quotation with a key employee:

"What the construction ICT nerds mostly fantasised about was 3d modelling, object oriented construction, intelligent lego blocks which you can build on top of each other and so on. But the digitalization of the construction sector was really so much more than 3d models (Interview, Hellman)"

In the secretariat it was thus considered more important that digital information flows were initiated in a pragmatic way which could be handled broadly in the industry, and less important whether the information was organized according to a coherent object oriented information infrastructure.

Based on literature reviews, conference attendings and interviews with software providers the four client demand consortiums listed below – which were anticipated to be more or less readily implementable - were thus formulated by the secretariat:

- (i) Project web: a client demand making it mandatory for all main participant (the client, consulting engineers, contractors) in the project to communicate via a project-web solution
- (ii) The building model: a client demand making it mandatory to develop 3d models of the building in order to facilitate visualization and simulations
- (iii) Digital tendering: a client demand making a digital tendering processes between the planning phase and the construction phase mandatory
- (iv) Digital delivery: A client demand making delivery of digital operation and maintenance data mandatory at the delivery of the building to the client

A main challenge which faced these consortiums was to develop client demands which on the one hand were operational to the state clients and the companies of the industry and which on the other hand were also in line with the vision of the 'object oriented information flow' as it was being formulated by Digital Foundation.

So which of the client consortiums was most critical for the overall success of the initiative?

Assessed from the perspective of the Digital foundation, which gradually came to dominate the concretization process, the building model consortium played the critical role since the development of a well organized 3d model represented the prerequisite for the object oriented information flow. In the other end of the scale the project web consortium represented a client demand which was largely independent of the 'object oriented approach' and furthermore relied on a technology which was already widely in operation within the industry.

The 3d model consortium was accordingly very central to the overall vision of a coordinated object oriented information flow. The tender of this consortium was won by a consortium called b3d which consisted of a) Rambøll - a large Danish consultant b) Aalborg University, c) Arkitema - a leading Danish architect company - and d) NCC - a large Scandinavian contractor. As it went for all the consortiums a state client responsible for providing projects for the testing of the client demand was associated to the consortium.

The tangible output of the b3d consortium was presented in a report named 'Client demand 3D-models, guidelines' published in July 2004, i.e. roughly at the same time as Digital Foundation' had finished its preliminary idea development phase but not yet initiated its project phase (B3D 2004). The b3d consortium thus had to anticipate the results of the development of the '3d working method' conducted by Digital Foundation which was very critical for the development of the client demands concerning the use of 3d models. The content of the 'client guidelines report' developed by the b3d consortium thus remained rather conceptual as the work of Digital Foundation on the '3D working methods' remained unknown.

A very basic orientation of the b3d consortium however was to associate the 'building model' with a re-organization of the processes and the work division in the design- and planning phase. In their solution it was thus argued that one of the main problems of the existing design- and planning process was the successive clarification in pre-defined phases which were concluded by formal approval by the client (B3D 2004:5). According to the consortium this organization of the design- and planning process often resulted in technical sub-optimization as the design and planning process on a very early stage became divided into fragmented sub-projects. It was further suggested that:

"One of the contributing courses to the phase-division is the use of analogue tools (B3D 2004:6)"

This argument tacitly implied that the main advantage of utilising *digital tools* in contrast to analogue tools was that they allowed for a 'dynamic' planning and design process, as reflected in the quotation below:

"On this background the B3D consortium proposes that one instead of relating the use of 3D to the existing phases, introduces a much more dynamic model concept (...) In the dynamic 3D building model the design process proceeds in a reversible process: the decisions are incorporated in the building model, and assessed in relation to the whole. This is repeated until the final decision. Hereby all decisions become part of the optimal solution - not sub optimization detached from the whole (B3D 2004:5-6)"

The proposal of the consortium thus suggested that object oriented 3d models should be used to facilitated a 'dynamic' detailing and planning process where each part was continuously linked to the whole be means of a) virtual reality (B3D 2004:19), b) visualizations (B3D 2004:24) and c) simulations of acoustics, fire, evacuation, indoor climate, light and statics (B3D 2004:27). According to the consortium the potentials of the '3d object oriented building model' could thus only be realised if the existing design and planning process based on predefined phases became re-organised.

In order specify how the client should formulate his demands in order to support this dynamic design- and planning process the report differentiated between a series of model types in relation to classification and also suggested how the detailing of the model could be organised.

In relation to the classification of the building model the report identified the four levels outlined below:

- (i) Geometrical elements which are not classified
- (ii) Geometrical elements which are indirectly classified by their association with a layer in a CAD model
- (iii) CAD-objects which are provided with an identifier and a classification independent of a layer in the CAD-model
- (iv) Models that consist of objects whose classification is related to and derived from their relation to other objects in the model, and thus independent of a layer.

(B3D 2004:11)

The more advanced levels of classification were envisioned to enable the model to be utilised for more complex purposes such as extraction of specific quantities, economic calculations, planning of logistics (last planner system) and planning of the operation and maintenance of the building.

In relation to the detailing of the design- and planning process the report identified the following 7 model types:

- (i) demand model
- (ii) volume model
- (iii) room model
- (iv) element model
- (v) building model
- (vi) Construction model
- (vii) As-built model

(B3D 2004:14-15)

Each model type represented an increasing level of detailing both in relation to the geometrical specification and in relation to the classification of the objects.

Depending on the planned utilization of the model the clients were expected to specify the necessary type of classification and level of detailing in the formulation of his demands.

In order to test the realism of the solution proposed by the consortium a series of test activities were conducted in collaboration between the consortium and the associated state client.

One of these test-cases concerned an architect competition on an addition to a museum. On this case it was made a requirement of the client that the bids were delivered as 3d models in an open IFC format. The initial challenge was to develop an appropriate tender material. A main complication was that the tender needed to include a detailed terrain map as the addition was to be located on a descending hillside. Due to legal considerations it was however not possible to include a 3d

terrain model in IFC format. Another problem was that technical terms of the tender material had to be translated into English as the project was tendered internationally. The consequence of the experimental tender material was that the bids were characterised by very different level of detailing, which made the bids very difficult to compare and assess, as reflected in the quotation below:

"In total we were faced with a material which could be used for some purposes, but from a competition viewpoint the judge committee concluded that the material could not be used to settle the competition. From our point of view the end was that we as client took responsibility for too poorly formulated demands. That is very costly, and you simply do not place poorly formulated demands. There is so much at stake in these cases (Interview, Gyldenvang)"

Based on these experiences the state clients, who would have to enforce the demands, voiced two concerns in relation to proposal of the b3d consortium. One concern related to the importance of ensuring that the client demands did not conflict with the existing legal frameworks, as suggested by a former employee:

"There are incredibly many limitations related to the formulation of a law. It is here that the legal aspects enter, and where I as a client had to say that I would only be able to use it, if I did not get into conflict with the competition authorities (Interview, Gyldenvang)"

The other main concern was to identify and communicate the advantage of using building models in the design- and planning phase seen from the perspective of the client. The state clients thus felt that the consortium paid more attention to the development of a model which could support the building process as a whole and less attention to the specific advantages that could motivate the state clients operating in the early design- and planning phase to push for the implementation of the 3d model demand:

"There were far too many elements in play and too radical expectations about inclusion of all the phases. As a client I focused on the first part of the phases. They [the consortium ed.] could see that the benefits

were related to the re-use of data. I was afraid of reuse of data, as this implied that I would have to formulate demands in relation to the process. I understood that I could use these 3d models to communicate with my users (Interview, Gyldenvang)"

Both these concerns indicated that the consortium operated on an experimental and conceptual level, which from the perspective of the state client was too abstract.

The tension which faced the B3D consortium did however not only concern its relation with the state clients. Another set of tensions emerged in the relation between the b3d consortium and Digital Foundation. As argued above digital foundation had managed to establish the 'object oriented 3d model' as a key element of DC as a whole by neutralising its relation to the work division and organization of the construction process. The b3d consortium however challenged this neutralization by associating 'the object oriented 3d model' with a re-organization of the existing workflows through their idea of a dynamic design- and planning process which conflicted with the existing phase division of the design and planning process.

The discrepancy between the idea to re-organise the phases and workflows in the design and planning process implied by the vision of 'the dynamic design and planning process' and the overall strategic stabilization of the 'object oriented c3d model' achieved by digital foundation became evident as the project '3d working methods' undertaken by digital foundation began to crystallise. In line with the strategic orientation crafted by digital foundation in the idea development phase the '3d working method' thus implied a concept which was compatible with the existing phases and the existing work division of the design and planning process. In the report '3d work method 2006' it was accordingly stated that '3d working methods' needed to:

"support the products and work procedures, which make up the construction process today, without obstructing potential future re-organizations of the work processes of the industry (Bips 2006:1)"

This implied that the 'object oriented 3d-model' was decomposed into a series of profession specific models, in order to resemble the work division of the traditional design- and planning process. These profession specific models could then be combined to make up a common model used for specific tasks such as simulation, viewing and collision control between the different installations and between installations and the structural elements of the construction (Bips 2006:17-26). More importantly the model was however furthermore conceptualised into seven 'information levels' and in contrast to the dynamic concept envisioned by the b3d consortium these information levels were characterised by non-reversibility in the sense that the design process was defined by successive detailing in pre-defined phases, as suggested in the quotation below:

"When a mile stone has been reached, the profession model is saved with the information which has been developed in the phase concerned. A new phase is initiated with a copy of the profession model which is added further information and value during the activities of the next phase (...) (Bips 2006:29)"

Not only did '3d working method' exclude the possibility for reversibility of the detailing process. The concept did also not allow different parts of the building to exist on different level of detailing. The '3d working method' project was thus considered much too un-flexible by the b3d consortium as expressed below:

"Bips had the idea that the lowest level of detailing should apply to the entire model. But if you make a house with an industrial kitchen, you may say that this should be handled by others. Then you cannot claim that you know nothing about the building because you know nothing about the kitchen (Interview, Karlshøj)"

Though the 3d model concept defined by Digital Foundation in the end got the upper hand in relation to the dynamic concept proposed by the B3D consortium, the ongoing debate situated the 'digital tender consortium (abbreviated BANK)' and 'the digital delivery consortium (abbreviated DaCapo)' in a vacuum of uncertainty, as the client demands which these consortium had to formulate depended on the re-use of the information from the 'object oriented 3d model'. This vacuum was even

more distressing as the demands which had to be formulated by these consortiums had to combine the 3d model with the classification, as the classification was a prerequisite for structured re-use of data

The classification project thus aimed to develop an entirely new object oriented classification by the name of Danish Building Classification – abbreviated DBK (Bips 2006b:2). The vision was a very comprehensive classification for the sector as a whole divided into the following four domains a) the resource domain b) the process domain c) the result domain and d) the property/characteristic domain. The idea was a classification able to capture how a) processes transform b) resources into c) results characterised by specific d) properties. (Bips 2006b:14).

The first domain to be addressed in some detail was the result domain. This domain was structured as a so-called reference system (Bips 2006b:18), which could be accessed through different aspects (Bips 2006b:17). The logic of the reference system approach was to specify each building-component by its relation to the building as a whole by use of specific codes. The code -205.02.01 would e.g. signify a window (01) which was part of a series of windows (02) which was part of a wall system (205) (Bips 2006:18). The purpose of using aspect was to be able to address the building in different ways i.e. as (a) a function (b) a product (c) a location and (d) a form. The aspect was indicated by a prefix in front of the construction part code (-, +, =, #) (Bips 2006:21)

From the viewpoint of the two client consortiums which depended on the re-use of data from the model the problem however was that it was not specified exactly how the classification should become operational, and to which extent it could be used as basis for formulating the client demands.

One of the consortiums which relied on re-use of data from the object oriented 3d model was the BANK consortium which had to develop a client demand concerning digital tendering of construction services (BANK 2005). The vision of the consortium was a tender process taking place on a digital platform by utilising data from the object oriented 3d model (BANK 2005:1). The idea accordingly was to replace the traditional tender processes where each bidder had to measure and calculate the quantity of the tender based on 2d drawings in favour of a tender

process based on use of quantity bills extracted automatically from the 3d model. The problem for the consortium however was, that the DBK classification proved unable to provide a structure and a detailing which could be used to organise the quantity bill. The consortium accordingly ended up relying on the old SfB classification which the DBK classification was meant to replace (BANK 2005b:11). An additional problem was that the specific measurement rules by which to calculate each quantity post could not be settled upon. This was critical since the quantity posts on the bill had to form the legal basis for the bidding. (BANK 2005b:17) A series of critical issues thus remained to be clarified before the solution proposed by the consortium could become operational.

The DACaPo consortium which had to develop a client demand concerning digital delivery of operation and maintenance data operated in much the same vacuum. The objective of this consortium was to develop client demands which could ensure that relevant information from the construction process was delivered in a form and a structure which supported the operation and maintenance of the building (DACaPo 2005:5). Also this consortium operated with the vision of utilising the 3d model as a carrier of structured information. Both the DBK classification and the 3d working method however remained non-operational as the client demand had to be formulated. The consortium accordingly ended up developing its own building model concept organised by a specific operation and maintenance classification consisting of the following objects: (1) property (2) building/terrain (3) floor (4) room (5) building part (6) components which could be associated with the following objects (1) documents (2) contracts (3) land register (4) organization (5) Area (6) operation and maintenance (DACaPo 2006:9). This classification which was not coordinated with the DBK classification was operationalized into a so-called DACaPo xml format (DACaPo 2006:14).

The last client demand consortium called PKW had to develop a client demand concerning the use of project webs. This consortium succeeded to come up with the most operational client demand for a series of reasons. First of all the technology was already widely in use in the industry. Secondly the consortium included a provider of project web solutions and thirdly the solution could be formulated independently of the building model and the classification. The consortium developed a rather simple solution which divided the project web into a file

structure consisting of a) a work space b) a space for approved documents and c) an archive space (PKW 2005:23). The client demand further specified a series of roles concerning the responsibility for the dataflow (PKW 2005:19). Among the other consortiums there was however a tendency to perceive the PKW consortium as part of the old document oriented reality which DC as a whole aimed to transcend, as reflected in the quotation below:

"There was a large discussion concerning why we still talked about documents: We should not talk about documents we should talk about objects (...) There were many who did not want us to talk about documents, because it would keep us stuck in the old paper-thing and all the related processes. We should rather talk about objects to the benefit of the common good (Interview, Foldager)"

During the work of the consortium the vision of an object oriented approach also played a prominent role. An idea accordingly went to classify the documents of the project web according to a structured set of meta categories, as this would allow for customized displays of the information. As the number of meta categories however continued to grow the consortium in the end chose to organise the project web in a traditional file structure.

As demonstrated above the concretisation process of DC was as a whole characterised by the development of a series of interdependent entities. Some of these were however oriented towards compatibility with the existing operation of the industry while others represented the more radical vision of a construction process organised by means of the integrated object oriented building model.

This lack of a common orientation produced a series of incompatibilities which remained un-resolved throughout the concretization process. The pragmatic 'bridge strategy' and the more radical strategy of the 'object oriented construction process' thus concretised into somewhat separate trajectories of development.

The most obvious result of these tensions was the disintegration of the object oriented information infrastructure as single reality. The non-operational building model concept and the DBK classification thus ended up existing along side with

the SfB classification and the operation and maintenance classification developed by the DACaPo consortium.

Also these un-resolved tensions came to consume an increasingly large amount of resources and attention. The broad inclusion of interests which had characterised the beginning of the concretization process thus became increasingly narrow as the process ended up focussing more narrowly on technical matters. Towards the end of the concretization process most activities were thus dominated by engineers concerned with ICT technicalities. Also the initial focus on integration across the phases of the construction projects was increasingly superseded by a narrow focus on the planning process.

The institutionalization of DC

As demonstrated above the concretisation process of DC was designed to associate specific types of digital utilisation (the four client demands) with the overarching object oriented ICT infrastructure (in the guise of the DBK classification and the 3d working method) in order to ensure a single integrated flow of information throughout the construction process.

The core mechanism by which to bring the solutions of the concretization process into operation in the industry was by means of the client demands which had to be implemented in the state building law which applies to all state financed construction projects. According to this law the state clients would thus have to include mandatory demands concerning ICT use into their contracts. This mechanism was envisioned to inspire a broader utilization of the solutions among private clients as well as the companies of the industry.

In a narrow sense the institutionalization process can thus be measured by the success of enforcing the client demands by the state clients.

The institutionalization process however also included a series of other initiatives which aimed to support and shape the diffusion process. Within or in close relation to DC two initiatives were thus established to support the diffusion of the solutions

developed in the concretization process. One of these initiatives was a consortium tendered within the framework of DC called 'best in construction' and the other was the establishment of an 'implementation network' which comprised a series of the major professional organizations within the industry (Danske Ark, Dansk Byggeri, Foreningen af Rådgivende Ingeniører, BAT-Kartellet, Teknik og Bygherreforeningen) as well as the governmental agency EBST.

Another critical player in the institutionalization process was an industry network which had been established independent of DC between 7 leading contractors (Pihl, NCC, MT højgaard and NCC) and consultants (COWI, Grontmij | CarlBro and Rambøll) called DiCon. This network was established in 2001 in order to support digital standardization and data exchange in the Danish construction industry as a whole. Although DiCon was involved in DC in a number of different ways the network however operated more or less independent of DC and because the network comprised some of the largest and most competent companies in regard to ICT the success of DC in diffusing its solutions in the industry critically relied on the support of the DiCon network.

In total the institutionalization processes thus relied on a) the implementation of the client demands b) the activities of 'best in constructions' and 'the implementation network' and c) the support of the DiCon network

As noted above the client demands which had to be enforced by the state clients represented the 'hard' implementation mechanism. Prior to the January 1 2007 the material developed by the consortiums thus had to be organized into operational client demands which could be formulated as a law text in the state building law. During this packaging process it was however realised that the gap between the material provided by the consortiums and the end-goal of an operational law text which could be enforced by the state clients was substantial. The first step taken by the governmental agency in order to bridge this gap was to hire an external consultant. The success of this consultant however proved to be limited and gradually the frustration grew as reflected in the quotation with a state client below:

"The worst and most useless of these consortiums was digital delivery. We tried to arrange a series of sessions in house in the process in order

to keep our staff oriented. We knew that we would be hit by the January 1 2007 and then our project managers had to be ready to enforce the demands. We had accordingly invited the project manager from COWI. And it was simply Greek! Nobody understood anything! (Interview Hancock)"

Frustrations such as these reflected an increasing awareness that a substantial part of the elements generated in the concretization process remained highly experimental and that the integration between the client demands and the overarching object oriented classification had not yet been achieved. The state clients consequently felt burdened with undigested technical matters in their interaction with the consortiums.

The initial strategy by which to turn the work of the consortiums into operational client demands was by developing a configuration tool which was envisioned to generate customized demand recipes. The growing awareness that the elements of the concretization process were yet experimental and uncoordinated however also spurred debates on whether the client demands should be enforced stepwise in the sense that only the less advanced demands should be implemented on time. The agency however insisted that as many of the demands as possible should be implemented on schedule. Out of a total of 10 client demands which the agency succeeded to formulation 8 were thus enforced by January 1 2007.

These client demands had to be enforced relative to the contract sum of the total construction service to be delivered. The less advanced demands had to be enforced in projects with a contract sum above 3 mio dkk. The more advanced had to be enforced in projects with a contract sum above 15 mio. Dkk. and the most advanced in projects with a contract sum above 40 mio dkk, as reflected in the table below.

Contract sum	Demands
Above 3 mio dkk	<ul style="list-style-type: none"> -The use of project web by all relevant parties (1 and 2) - Generation of printable drawing

	<ul style="list-style-type: none"> material suitable for onsite use (3) - Assessment of need for 3d building models in project competitions (4a) - Assessment of the need for a 3d building model (5a) - Standardized tender material and descriptive quantity bill (6a) - digital tender of building contracts (7)
Above 15 mio dkk	<ul style="list-style-type: none"> - digital delivery of operation and maintenance data (8) - extend of delivery of digital operation and maintenance data (9) - method of delivery of digital operation and maintenance data (10)
Above 40 mio dkk	<ul style="list-style-type: none"> - Mandatory demand of 3d building models in project competitions (4b) - Mandatory demand of a 3d building model (5b) - Standardized tender material, descriptive quantity bills, and quantity extraction from 3d building model (6b)

(BEK 1365 2006:2)

Out of the ten demands only demand 6 (a and b) concerning standardized tender material and descriptive quantity bills were postponed. This demand stated that descriptive quantity bills - containing all price-carrying post - should be generated from specified measurement rules. By January 1 2007 no commonly recognized measurement rules had however been developed and agreed upon. Also the demand stated that the descriptive quantity bill had to be organized according to the DBK classification which remained untested in actual use.

In effect a series of loopholes were also incorporated into the formulation of the law text. The demands thus remained only partly mandatory. On the one hand § 3 piece 2 thus stated that:

"The client shall meet the demands concerning the utilization of information- and communication technology listed in appendix a (BEK 1365 2006:1)"

At the same time § 3 piece 3 however stated that:

"Based on a sufficient analyses, the client may in a specific construction project refrain from enforcing a specific demand concerning the utilization of information- and communication technology, c.f. piece 2, in the case that the analysis shows, that the enforcement of the demand is assessed as disproportionate economically adverse (BEK 1365 2006:1)"

The state clients were thus allowed not to enforce demands which could be documented to be *disproportionate economically adverse*. Another loophole was incorporated into the enforcement of the DBK classification, as DBK should only be use *to a relevant extend* as stated in § 6 :

§ 6. The client shall to a relevant extend ensure the use of Danish Building Classification (DBK) (BEK 1365 2006:2)

These loopholes on the one hand ensured the success of the governmental agency in terms of enforcing the client demands on time, while they at the other hand left room for the state clients to manoeuvre in relation to the experimental and unfinished character of the demands and the classification.

An internal minute from the state clients from September 2008 reflects the initial experiences of the enforcement of the client demands (UBST 2008). The minute concluded that project webs were widely used as communication platforms also in project with a contract sum below 3 mio dkk (UBST 2008:1). Also it concluded that the digital platforms for the tender of construction services were easy to use (UBST 2008:6).

The conclusion regarding the use of 3d models was however much more indecisive and reflected that no experiences had yet been obtained. The minute thus stated that

- (i) existing guidelines and documentation do not provide a paradigm which enables the state clients to order and obtain 3d construction models in a uniform quality across projects and between consultants.
- (ii) no method on how to assess the economic consequences of a 3d supported design and planning process exist.
- (iii) the definition of a construction model is unclear
- (iv) the IFC format may be problematic as information may be lost during conversion.

(UBST 2008:3-4)

It was further found that the operation and maintenance activities of the state clients only to a limited extend were supported by ICT systems, and that the systems in use were of very different quality which made it difficult to develop standardised demands regarding digital delivery (UBST 2008:7)

In conclusion the minute thus reflected that the law had only succeeded to generate very limited effects in terms of implementing and diffusing the solutions of the concretization process as a coherent information infrastructure. Only project web solution was thus being used on a regular basis, and all clients furthermore used the solution of the provider which had participated in the PKW consortium. Any organized ICT utilization coordinated by the object oriented DBK classification had however not been initiated and core questions of how to do this in practice still remained unresolved.

Complimentary to the client demands a series of activities were established to persuade the industry to embrace the solutions developed by DC out of their own free will. One of these initiatives was 'best in construction' and the other was 'the implementations network'.

'Best in construction' was part of the original design of the DC initiative. It was tendered as a consortium in the same way as the four client demand consortiums and digital foundation. The aim of 'best in construction' was to persuade the

industry to digitalise its information flows by producing a series of 'best practice cases' demonstrating how ICT could benefit the companies in the industry. More specifically the aim of 'best in construction' was to document cases of successful inter-firm coordination between small- and medium size companies by means of ICT. These cases were envisioned to supply the managers of such companies with documented decision making support (Gain3 2007:67). Despite the focus on the small and medium size companies the tender was however won by the DiCon network briefly introduced above which consisted of 7 large contractors and consultants.

As *business cases* envisioned to provide decisions making support credibility was perceived as a cardinal virtue. The focus on credibility was reflected a very detailed method- and case selection manual (Bit 2005a; Bit 2005b). These manuals however ended up being of very limited use as the consortium was not able to identify interesting cases reflecting ICT aided coordination between small and medium size companies. In order to produce the cases the companies of the DiCon network accordingly chose to generate experimental test activities on their own projects. The consortium thus ended up providing a series of case studies which were highly experimental and which were largely inconclusive in relation to the benefits. These cases furthermore came to focus predominantly on the ICT use of large companies as the DiCon network consisted of large companies - rather than small and medium size companies.

The inconclusiveness of the cases is reflected in the case reports. In one case concerning the use of a project web solution it was simply acknowledged that the ICT concept had not been implemented as an inter-organisational communication tool:

"The VVS alliancen A/S has not yet utilised the ICT-concept and the case thus point to the challenges of getting all parties of a construction project to use the concept (Bit 2006c)"

Also in a case concerning the use of digital defect lists, the ICT concept was not successfully implemented. In this case it was however concluded that:

"The hypothesis is for that matter fulfilled as all parties saw a clear advantage in using the same digital defect lists in order to establish an overall overview over the quantity of defects and the status on their repair (Bit 2006b)"

In this case it was thus argued that the ICT concept had been a success because the participants *perceived* digital defect list as a potential advantage though these list had not actually been successfully put into operation.

In a third case a so-called 'expert board' was established to legitimise the case result as a success as suggested below:

"According to the assessment of the expert board the hypothesis has been fulfilled. It should be noted that the conclusion is exclusively based on the assessment of the board, because as already mentioned there has not been identified gains by the participating companies. It should however be added that the participants agreed to the conclusion of the board (Bit 2006a)"

In conclusion quite a lot of effort and linguistic creativity was invested in turning the experimental and largely inconclusive cases into credible best practice business cases.

The other element of the persuasion strategy was constituted by an implementation network. This network was established in late 2005 and its purpose was to take responsibility for the implementation and diffusion of DC after the concretization activities were concluded. By the governmental agency the implementation network thus represented an exit strategy from its involvement in the initiative. The industry network, which organized the major interest organizations of the industry, was accordingly established to take responsibility for the broader implementation and diffusion of the solutions provided by the state.

In February 2006 - 10 months prior to the planned launch of the client demands - the implementation network presented its strategy for the implementation process (Implementeringsnetværket 2006). This strategy concentrated on supplying

information and learning activities to the companies of the industry in order to upgrade their organizational- and technical capabilities to meet requirements of the client demands. This strategy was based on an analysis which concluded that some elements of the client demands were not yet operational - and a stepwise implementation of the demands was accordingly recommended (Implementeringsnetværket 2006:21). Despite this analysis the implementation activities of the network focussed exclusively on the need to upgrade the knowledge and capabilities of the industry. The challenge of how to further develop and operationalize the client demands and how to institutionalise the overarching ICT infrastructure was accordingly not included in the strategy of the network. Only slowly did the network thus acknowledge that it had become partly responsible for the implementation of a tool-box which turned out to much be less operational than anticipated as indicated by the quotation below:

"There has been some kind of mis-match between how much the concepts had been developed and the articulation which tried to sell the stuff. I think that to both us and especially to the agency it has been an aha-experience that though the announcement was out, it didn't necessarily imply that the material supposed to lie behind was 100 pct finished. And that was probably the starting point for the implementation network: That some finished products were available, and that now they had to be taken down from the shelves and put into work (interview, Bang)"

By presupposing others to take responsibility for the further development of the solutions which had to be implemented the strategy of network thus came to focus on information, learning and capability building among the companies of the industry. A short sighted implementation strategy was developed to make the industry ready for implementation of the client demands by January 1 2007 while a more longsighted strategy was developed to support the implementation until January 1 2008, after which the implementation was believed to be concluded.

The short sighted implementation strategy, designed to increase the knowledge and awareness of the launch of the client demands by January 1 2007 resulted in 10

information meetings in November and December 2006 which was attended by approximately 1400 persons (Implementeringsnetværket 2007a:9).

The long-sighted implementation strategy which had to be concluded by the 1. of January 2008 was design to increase learning about how to meet the requirements of the client demands. This learning strategy comprised (a) the tendering of four learning consortiums responsible for the development of learning material, (b) a series of learning events aiming to initiate the implementation of the learning material and (c) a financial support scheme for companies and educational organisations involved in capability building in relation the implementation of the client demands (Implementeringsnetværket 2007b:14).

As the learning material had to be available from the launch of the client demands on January 1 2007 these the four consortiums were established medio 2006. At this time the client demands and the classification were however not concretized to an extend which could be communicated to outsiders in any operational form. This situated the learning consortiums in a very difficult situation, especially since they were commissioned to operation from a so-called 'experience-pedagogic paradigm' focussing on 'practice-oriented learning', 'learning-by-doing', 'inductive learning' and so forth (Implementeringsnetværket 2007b:16). The consortiums thus had to develop very specific learning tools based on a set of highly fluid solutions. In an evaluation of the material which was provided by the learning consortiums a general critique was not surprisingly that they had failed to engage sufficiently with the 'experience-pedagogic paradigm', as they had produced 'conceptual articles' rather than 'practice-engaging learning tools'. (Implementeringsnetværket 2007b:22)

Towards the end of the implementation period it became increasingly evident that the utilisation of DC remained critically limited. From 2008 the implementation network however succeeded to carry on its activities in a new project called "project new knowledge in the construction professions". With a budget just below 2 mio euro (14 mio dkk) this project was co-funded by a) regional EU funding b) the foundation Realdania and c) EBST. The strategy of this new project was to support specific projects operating under the client demands and to create and disseminate knowledge specifically to small and medium size companies. Also this strategy

however proved difficult to carry out because few of the solutions had become operational, as suggested below:

"We have faced difficulties in testing the move from e.g. planning to execution, i.e. the descriptive quantity bill. Simply because nobody was there. There are no tools. When we have asked UBST: do you have a project where we can test these things they have answered no. We are far from able to say that we have tested the descriptive quantity bill or digital delivery for that matter" (Interview, Jensen).

Thus, by conceptualising the implementation challenge in terms of capability building among the companies of the industry the implementation network came to operate as if an operational toolbox existed.

Quite an alternative role in the institutionalization process was played by the DiCon network which organized the lead ICT using companies in the industry. In different ways the network and its member companies had been involved in the concretization process of DC. For one thing the network had been responsible for the consortium 'best in construction'. Also some of the member companies had been more directly involved in the concretisation process. Rambøll had accordingly played a key role both in the b3d consortium which formulated the demand regarding 3d models, and in the project '3d working method' under digital foundation.

Despite these different involvements in the concretization of DC the network however represented an independent position in relation to the implementation and diffusion of DC. Because of its independent position DiCon was thus able to focus on the coherence and implementability of the ICT concepts developed within DC

The involvement of DiCon in the institutionalization process of DC was initiated by two hearing statement concerning the formulation of the law by which the client demands had to be implemented (DiCon 2006a; DiCon 2006b)

The first hearing statement by DiCon was organized by an initial definition of a sectorial ICT concept, which they characterised as a combination of a

"(...) viable technology which includes technology, organization, resources, competences and culture (Dicon 2006a:1)"

and a

"value adding and a financially viable investment for the construction industry as a whole (DiCon 2006a:1)".

Informed by this definition the hearing statement suggested that a sectorial ICT concept presupposed a) the association of good standards with operational software solutions and b) the establishment of good practice through front runner activities. (Dicon 2006a:1).

From this point of departure the DiCon concluded that DC as a whole had not succeeded to develop an operational sectorial information infrastructure. It was thus assessed that the concretization process had not succeeded to associate the specific client demands with an operational classification, as reflected in the quotation below:

"Standards to support the demands are regularly short in supply. They are either entirely absent or ambiguous (...). Presently there are thus no recognized or unambiguous descriptions for descriptive quantity bills, measurement rules, building classification (DBK) and format and structure for the tender material" (DiCon 2006a:4)"

It was further argued that the dependencies between the various client-demands hampered the overall implementability even further. A second critical problem pointed out by DiCon was a general lack of available software solutions (ibid).

According to the assessment of DiCon a number of very critical associations thus remained to be forged before the client demands and the classification made up an operational sectorial information infrastructure. The hearing statement thus concluded that only the project web solution could readily be implemented through

a mandatory client demand by January 1 2007. Concerning the other client demands it was stressed that:

"The lacking steps need to be attended as soon as possible in order to avoid that the process loses progress from January 1 2007 (DiCon 2006a:5)"

While the first hearing statement concerned the implementability of the client demands the second hearing statement concentrated on the object oriented building classification DBK. In this hearing statement DiCon portrayed DBK

“(...) not only as a prerequisite for the desired effect of DC, but also as a foundational element which can contribute to the future development of the construction industry” (DiCon 2006b:1).

In this hearing statement DiCon thus disassociated DBK from its narrow association with the client demands by perceiving it as

- (i) a general prerequisite for modelling every element of a construction process in all its phases
- (ii) a prerequisite for unequivocal and efficient communication between systems without human interference (ibid).

DiCon however suggested that a broad industrial utilisation of DBK would presuppose that the classification was not primarily developed as a classification of 3d cad-objects but that it was also developed as an 'XML based representation'. It was further argued that the classification in some respects lacked the necessary consistency which was needed to inform the development of software solutions. Last but not least DiCon noted that the classification remained to be tested in specific construction projects as well as in the development of specific ICT solutions (DiCon 2006b:1).

In late 2008, approximately two years after the launch of the client demands, DiCon however assessed that neither the client demands nor the implementation network had succeeded in diffusing the DBK classification. This provoked the

network to publicly problematise the future of DBK as a classification standard. In December 2008 the headlines in nationwide newspapers accordingly stated:

"The construction industry threatens to boycott digital standart"
(Ingeniøren 2008b)

and

"Big cracks in Digital Construction" (Ingeniøren 2008a).

These headlines were based on a newspaper feature in which the companies in DiCon launched a shared criticism of the DBK classification. In this feature it was argued that:

"Nearly two years after the enactment of the ICT executive order, the discouraging status is not surprisingly that DBK remains largely unused. Nobody has taken the lead in securing that DBK is finished and implemented, and there is still no answer on the purpose, extend and value of its utilization (Ingeniøren 2008a)"

The feature concluded that the five issues below needed to be attended if DBK was to become a winning standard and gain the support of the DiCon network.

- (i) the classification needs to be owned and operated by a robust and competent organization.
- (ii) the classification needs to be further developed and operated.
- (iii) the classification needs to be communicated to the users.
- (iv) the classification needs to be integrated in software solutions and the software suppliers must be encouraged to use the classification.
- (v) the classification needs to be translated into English and adapted to other international standards
(Ingeniøren 2008a)

This feature was based on a virtual test case in which DiCon had tested the ability of the DBK classification in organizing the information flow of a virtual construction

process (DiCon 2008). The main experience was that the classification could be utilised, although the level of detail remained an open question. However, as the classification had not been integrated in software solutions the various professions had to manually match the building components with the classification codes (DiCon 2008:16ff). The main conclusion thus pointed to a pervasive need for software integration:

"The need for software support was pervasive throughout the entire process. In each phase a significant conclusion was that manual use of DBK, as in the test case, is in practice much too time consuming whereby the gains of the individual parties are lost. (DiCon 2008:30)"

The test case accordingly argued that the generation and flow of information needed to be automated. (DiCon 2008:30).

The immediate response of the agency was voiced two weeks later. In a newspaper feature the agency thus ensured that it would remain actively involved in the development and implementation of DBK. (Ingeniøren 2008c). The feature was however less clear about how to ensure an organizational anchoring of DBK and how to ensure that the standard would be supported by software solutions.

A more elaborate response to the critique was presented in a report called 'anchoring of digital construction' released in June 2009 approximately 6 month after the DiCon network had publicly questioned the future of DBK (Cowi 2009a). In contrast to the earlier implementation strategy this report did not focus on test and information activities but rather identified the need to establish a permanent operation organisation responsible for the development and maintenance of DBK. The report thus concluded that:

"In the long run it is anticipated that a common classification can contribute heavily to the effect of DC, as the classification is the backbone in the digital infrastructure, which is sought established. The classification can be perceived as the common kit which insures that information can be reused and enriched across the phases of the lifetime of a building (Cowi 2009a:8)"

The report however also concluded that the classification did not yet make up an operational and attractive sectorial solution and accordingly identified the need for a permanent operation organization. It was suggested that the success of such an operation organization would presuppose (a) solid revenues based on a business concept, (b) an organization with the necessary capabilities and understanding of the actors in the sector, and (c) a long-sighted ownership - at least 7-10 years (Cowi 2009a:6).

Three scenarios were developed for the activities of this organization; a full completion, a partial solution, and a small solution. The full completion was budgeted to 56 mio dkk (40 mio dkk financed by the state and 16 mio dkk financed by the industry) Approximately half of these investments would go into the development of the DBK classification whereas the remaining funding would be used to develop other elements of DC.

During 2009 and 2010 the criticism raised by the DiCon network however also coincided with a more fundamental destabilization of the sector representation which had hitherto informed the digitalization strategy. In the months before the criticism of DiCon the digitalization of the construction industry was thus put on the agenda by a newly established inter-ministerial unit called the domain board for buildings, housing and supply. In contrast to the sector oriented perspective of DC which was to use digitalization to support the construction process the strategy of this board was to use digitalization as a means to develop the public administration of buildings and the broader supply system (Cowi 2009b). The aim of this initiative was accordingly not to utilise digitalization to develop the construction industry but rather to develop and optimise the public administration of the build environment. This implied a radical shift in focus of the digitalization strategy from the optimisation of the project oriented construction process to the optimization of the operation and administration of the build environment. A report thus estimated that a digital administration of the build environment could result in societal benefits of no less than 17 billion dkk. Of these almost 13 billion dkk was related to 'better area use' and 'improved maintenance'. In comparison the use of building information models in the construction process, which had been the main digitalization strategy

of DC, was only estimated to generate societal benefits for 2,7 billion dkk (Cowi 2009b:10)

More specifically the report suggested that the realisation of the benefits associated with operation and maintenance would presuppose a) that the classification work of DC was developed into a so-called digital 'building archive' which could digitally integrate public system and registers (charges register, the planning register, the building and housing register) and b) a digital registration of existing building mass. (Cowi 2009b:10-13). In the agency this re-orientation implied that the focus on standardization and classification was prioritized at the expense of the work of the implementation network (DiCon 2010).

At the same time new development funding was provided to support the digitalization efforts. In December 2009 it was thus decided that an industrial development pool of 49 mio dkk should be tendered within two areas of industrial development. One of there was "the establishment of a knowledge center for increased productivity and digitalization of the construction industry". The funding of this industrial development pool would cover 50 pct. of the total development cost whereas the remaining 50 pct. had to be provided by the governmental agency (25 pct) and the winning tender consortium (EBST 2010:1).

The aim of the tender was to ensure the development of an operational digital infrastructure for the construction sector. The tender however also reflected the re-orientation of the digitalization strategy from digital support of the building process towards digital support of the operation maintenance and administration of the build environment as it was specified that the development of an operational digital information infrastructure should target the operation, maintenance and administration of the build environment in particular (EBST 2010:3).

The institutionalization process of DC in conclusion faced two main challenges. One challenge was that the results of the concretization process were not operational at the time of implementation. The other challenge was to recognize this fact and act on it. At the time of the implementation nobody thus had an overview of the situation - or the will to accept that DC was still in a development phase. The initiatives which were established to diffuse the solutions and to support the

implementation of the client demands thus pre-supposed that the solution were in fact more or less operational. It was accordingly the criticism of the DiCon network which finally forced the organizations behind DC to recognise DC as development challenge rather than an implementation challenge approximately two years after the introduction of the client demands.

The confusion and critique which grew as the implementation activities did not take off as anticipated further coincided with the formulation of an alternative representation which suggested that ICT should support the operation, maintenance and administration of the build environment rather than the building process.

Conclusion

As a sectorial development agenda DC emerged as specific configuration of theorization, concretization and institutionalization processes after the sector development activities of the previous decade had disintegrated. The theorization processes of the initiative were however partly rooted in these sector development activities. More specifically they emerged from the experimental ICT use in the PPB initiative. A report which elaborated on these experiences thus succeeded to frame ICT as a sectorial logic by developing a distinction between the prevailing ICT use in the industry which was represented by the fragmented and uncoordinated 'drawing system approach' and the superior integrated sectorial 'information system approach'. This distinction thus succeeded to mobilise ICT as a sectorial logic in the guise of the object oriented 3d model. This logic informed a representation of the sector as series of inconsistent and uncoordinated information flows and thus pointed to the need for a shared sectorial object-oriented information infrastructure able to ensure unequivocal information flows able to coordinate the activities of the project specific construction process.

Sectorial logic	Sector representation	Strategic orientation
The object oriented 3d model	The construction industry as a series of inconsistent and uncoordinated information flows	The development of a shared object-oriented classification and infrastructure able to

		ensure unequivocal information capable to coordinate the project specific construction process
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During the concretisation and institutionalization processes the strategic orientation informed by the sector representation was however balanced against two other priorities which were to a) engage a broad series of actors from the industry in the development of the initiative and b) to develop solutions which were applicable broadly in the industry

The purpose of the broad inclusion of actors from the industry in the concretization activities was to ensure ownership to the solutions. This strategy however had two adverse consequences. First of all it became difficult to ensure coordination between the different development activities especially because all activities were initiated almost simultaneously. Also the initiative became very industry internal as actors from the industry were prioritised at the expense of outsiders. Actors from outside the industry such as software developers were accordingly not included in the concretisation of the initiative

The focus on the development of broadly applicable solutions was among other things a consequence of the use of public client demands as the core diffusion method because such demands could only be integrated in the state building law if the ICT utilisation which they prescribed could be managed broadly in the industry. In the theorization process the focus on broadly applicable solutions was reflected in the idea of 'IT-bridges' which represented a strategy of more pragmatic and loose coordination of the information flow than envisioned by the idea of an infrastructure based on the 'object oriented 3d model'. During the concretization process the tensions between the vision of the object oriented dataflow and the need to developed solutions which were broadly applicable in the industry resulted in further coordination problems between the concretization activities.

The consequence of these coordination challenges was that most solution did not become operational during the concretization activities. Also nobody had a clear

picture of the situation. The diffusion of the solutions did thus not take off as anticipated and the 'development problem' which the initiative faces was not acknowledged openly until criticism was launched by the DiCon network. As DC was finally acknowledged as a 'development problem' rather than an 'implementation problem' another agenda concerning ICT utilization in the construction industry was being formulated. This agenda suggested that the major economic benefit of ICT technology was not related to the information flows of the construction process but rather to the administration and maintenance of the build environment.

DC did thus only to a very limited extent succeeded to develop and diffuse a coordinated sectorial ICT infrastructure able to coordinate and integrate the information flows of the project oriented construction process.

On the other hand the initiative did achieve a build up of organizational capacity within the area of coordinated sectorial ICT use. The establishment of the organization BIPS was thus a more or less direct effect of the initiative as it was established as a response to the tender of the consortium digital foundation. The organization is however closely related to the interests of the consulting engineers and do only to a limited degree reflect the perspective and interest of the clients and the other profession in the construction process. Though the DiCon network was not a direct result of the initiative, also this organization has developed as clear agenda due to its role in the institutionalization process

Though the actual result of the initiative was limited the initiative thus succeeded to firmly position ICT a central element of the sector development agenda. The broad mobilization of interests and the build up of organizational capacity has thus established ICT as a core sectorial logic. It however remains an open question whether this logic will continue to inform a representation which focuses on optimising the construction process or if it will come to inform a representation which focuses on the administration and maintenance of the build environment.

Chapter 7 - Building Lab DK

As demonstrated in the previous chapter the opaque strategic situation which characterised the sector development activities towards the end of the 1993-2001 period was transcended by the sector development initiative Digital Construction (DC).

As a coherent sectorial object of development the Danish construction industry was however not monopolised by DC. DC thus co-existed with another sector development initiative called Building lab DK which was characterised by a very different configuration of theorization, concretization and institutionalization processes. The purpose of this chapter is to analyse how Building Lab DK emerged as an alternative configuration of theorization, concretization and institutionalization processes.

The theorization of Building Lab DK

In relation to the 'PPB initiative' which followed 'project refurbishment' as part of the sector development strategy laid out by the 1993 resource area analysis, two PhD projects were carried out. One of these projects focused specifically on the innovation dynamics in the consortiums of the initiative and analysed the challenges of supporting strategic learning processes in the project-oriented production environment in which the consortiums operated (Clausen 2002).

The other PhD project concerned 'the economic organization of the construction industry' and may be seen as an attempt to elaborate on the appealing but also somewhat tentative idea of a sectorial 'lock-in'. A passage which reflects the main argument of the thesis analysed a roof refurbishment project in which a gang of carpenters from one firm was replaced by a gang of carpenter from another firm. A part of this passage is referred below:

“They announced this in the beginning (Tuesday) of the week in which they left. New carpenters, previously employed in another firm, were

hired by the clerk of works and started the following Monday. They met, as always, at 7.00 and after eating breakfast and talking socially (among other things about which sites and firms each of them had worked on), the foreman showed them the site, equipment was handed out (each carpenter got a tool box), one or two questions were asked and at 8:15 work was carried on, as if they had worked there for many weeks.” (Thomassen 2004:181)

This incidence illustrated how one gang of carpenters was able to replace another gang of carpenter with a minimal loss of efficiency on the construction site. The thesis went on to explain such incidences as the result of the more general organization and work-division of the industry which was suggested to be characterised by the need to cope with the project oriented in-situ construction processes.

The analysis of these project oriented in-situ construction processes pointed to two interconnected characteristics in particular. First, it was argued that firms often tended to operate within a very limited string of continuous activities after which the work was then passed on to another company (Thomassen 2004:297) . Secondly it was argued that this made long sighted strategic planning difficult as the production processes were characterised by frequent delays because of the complex contingencies between the activities carried out by different companies (Thomassen 2004:233).

So how were these characteristics of the project oriented in-situ production process reflected in the organization and work division of the industry, and what were the strengths and limitations of this industrial organization found to be?

The thesis argued that the single most important capability for companies in the industry was to ensure flexibility in relation to the complex contingencies and the low level of repetitiveness which was found to characterise the project oriented production environment and it was argued that this need for flexibility was reflected the organization and work division of the sector. More specifically it was argued that inter firm flexibility was ensured by the existence of a pre-industrial trade-specific industrial organization and work division.

The thesis thus represented the sector as a production environment characterised by a trade-specific work division which specified how things were done and by whom.

While this trade-specific industrial organization and work division was argued to facilitate flexible inter-firm coordination on the construction site it was however also argued to hinder firm-specific learning and organizational specialization. It was thus argued that organizational specialization and the development of company specific capabilities were impeded because such processes of specialization would disturb the trade-specific coordination codes which allowed the individual firm to engage in flexible and continuous coordination with other companies. (Thomasson 2004:274)

Simply formulated the argument of the thesis thus went that carpenters tended to remain carpenters and bricklayers tended to remain bricklayer, because companies with generic capabilities fitted into the overall industrial work-division of the complex production environment which characterised the construction site.

The thesis thus concluded that the need to be compatible the trade-specific interfaces of the industrial work division drove companies toward so-called 'organizational isomorphism', i.e. towards replicating each others compatibilities, rather than towards organizational specialization and firm specific capability building. A generalised conclusion accordingly went that:

“The less repetitive sequences of activities are, the more individuals and firms are driven towards isomorphism rather than innovation and specialisation.” (Thomassen 2004:237)

It was thus suggested that the industrial organization and work division - optimised to cope with the on-site project specific construction process - preserved a situation where companies exclusively competed on cost-reduction, because the production methods and the work division was fixed by the trade specific interfaces.

The thesis in conclusion developed a sector representation which offered an explanation of the sectorial lock-in which had been suggested to keep the sector

trapped. In the view of this sector representation it was suggested that companies were left to pursue one of two different strategies, which were to

“(…) (a) stick to innovations that do not alter its interface with other firms; or (b) try to promote / wait for simultaneous change in the behaviour of its partners. With respect to (a), the possibilities of doing so are usually limited due to the short string of activities internalised in firms working in temporary interfirm organisations. Concerning (b), change in the behaviour of a few collaborative firms is not enough, as the constellation of firms changes from one project to another. Hence, it appears that a rather large subset, and perhaps even the whole sector, has to change at the same time in order to allow for new interfaces”
(Thomassen 2004:274)

As illustrated by this citation the sector representation did accordingly not attribute the individual company any significant possibility of departing from the prevailing lock-in situation maintained by the trade specific industrial work division.

The final part of the PhD did however tentatively suggest some strategic strategies by which transcend the lack of organizational specialization and company specific capability building. The idea was to support ‘long-term cooperation’ between companies as this was argued to reduce the reliance on the trade-specific interfaces and thus allow for a higher degree of organizational specialization and company-specific learning (Thomassen 2004:305). The more specific means by which to catalyse a development towards ‘long-term cooperation’ was however only vaguely outlined. An idea went that some kind of external shock would be needed. The thesis referred to so-called radical ‘war-time’ innovation dynamics which combined less risk adverse behaviour with centralised coordination (Thomassen 2004:306). To ensure organizational specialization and company specific learning processes it was suggested that such a ‘war-time shock’ should provide a combination of (a) so-called ‘islands of stability’ in demand and (b) central coordination and collaboration among different actors. (Thomasson 2004:306)

It was thus proposed that major clients should ensure the development of mass-markets characterised by a continuous demand of large and standardized

construction-projects while large contractors and consultants should answer to these mass-markets by initiating an industrialized production in 'long-term cooperation'.

In a version of these arguments a two-stringed organization of the sector was imagined where companies were organized according to either the existing trade-based industrial organization or according to the new industrial organization:

”One could imagine a divided structure, where some companies are specialized in optimizing a continuous stream of construction tasks in long-term cooperation (...), while another part of the companies (as it is today) is specialised in coping with variation in shifting collaborative combinations. In any case there will presumably be a rather sharp division between these two types of companies. The organization, pay, working methods and behaviour will differ to an extent, that few will be able to handle both working methods simultaneously”
(Thomassen 2004b:31)

As indicated above the central element in the strategy was the idea of 'islands of stability' which suggested that organizational specialization and company specific learning could be accelerated if major clients placed large coordinated orders. The ability of this strategy in generating tightly-knitted and innovative strategic partnerships was tested as Thomassen, the author of the thesis, became employed by a large contractor on a project initially planned to comprise approximately 100 buildings per year over a 5 years period.

In line with the concept of 'islands of stability' the strategy of the contractor was to exploit the large contract to forge a strategic alliance with specific sub contractors. It however proved very difficult to gain the anticipated benefits from the strategic alliance as the sub contractors in the alliance kept to their traditional project-specific behaviour, as reflected in the quotation below:

“In the meetings with the smaller contractors it became apparent to me that when we addressed the idea of close collaboration they thought: is this just a new smart way to by which to keep us down! (Interview, Thomassen)”

Not only the reaction of the contractors, but also the technology-use of suppliers progressively disintegrated the belief that 'islands of stability' could catalyse development processes which were able to transcend the project specific industrial organization as reflected in a meeting with a supplier of bath cabins as referred below:

“I encountered a turning-point in a meeting with a supplier from Ringsted. My question was: How much cheaper will it be if we go for 100 rather than 10 bath cabins. He replied: Well, it doesn't get any cheaper. But, I replied, that can't be so! It may be marginal cheaper in respect to planning costs he then answered, but the major expenses are for the casting moulds, and our technology is based on wooden casting moulds. And a wooden casting mould will only do for 10 pieces. That was an important insight. This industry is project-oriented all the way down to the casting moulds! (Interview, Thomassen)”

These experiences progressively disintegrated the belief that 'island of stability' in demand would be able to accelerate a process towards organizational specialization and company specific learning though long-sighted cross-project collaboration between existing companies in the industry.

In the meantime Thomassen had however been enrolled in a series of product development activities outside the construction industry which included some large Danish manufacturing companies. The experiences from these product development activities came to inform a new strategy by which to accelerate process towards organizational specialization and company specific learning in the construction industry.

Specifically the concept of product families and late variation became a source of inspiration. The philosophy of product families was to enable the production of individual or customized products from a base of standard components by means of a modular product architecture. The purpose of product families characterised by a modular product architecture accordingly was to allow for maximum variation with a minimum complexity in the production process:

”It made a great impression on me to see the production-map and the physical organizations of the modularization principle. On the one half you have the standard components and on the other you have the configuration of the individual product. They all worked with the idea of late variation (Interview, Thomassen)”

This modular product architecture thus solved or at least softened the contradiction between standardized industrial mass production and the demand for unique and customer tailored solutions, which had been reflected in the idea of a two-stringed industrial organization of the industry which targeted different markets. The concepts of product families, modularization and late variation thus allowed for the possibility that industrial manufacturing strategies, characterised by project independent production and development processes, could be used to supply individualized solutions to the construction industry. These concepts thus enabled the strategy of long sighted collaboration, organizational specialization and company specific learning to be re-formulated independently of 'island of stability' in demand.

From the physical organization of the production site at the manufacturers it was furthermore evident that the modular product architecture was critically predicated on standardized interfaces which allowed a series of individual components or subsystems to be combined into different individual solutions. During a series of meetings between the manufacturers and their suppliers it furthermore became apparent that the standardized interfaces also functioned as a coordination code which organized the interaction between the manufacturers and the supplies.

The product development activities had thus disclosed how organizational specialization and firm specific capability building in the manufacturing industries was predicated on the modular product architectures characterised by standardized interfaces.

These ideas progressively began to inform an alternative sector representation of the construction industry which allowed the lack of organisational specialization and company specific capability building to be seen as a symptom of an under

modularized production environment. The logic of modularization thus informed a representation of the construction sector as an under-modularized mode of production characterized by project-specific problem solving and short term collaboration at the expense of organizational specialization emanating from project independent production- and development processes

Some early ideas of how to turn this sector representation into specific experimental concretisation activities were outlined in a preliminary project proposal for an initiative called 'mind-byg' which Thomassen developed during his employment at the contractor (Thomassen 2003). The idea of this proposal was to establish a 'sectorial R&D department' in order to compensate for industrial propensities to focus on cost-reduction rather than innovation and organizational specialization. The cornerstone of this proposal was to develop mechanisms by which to transcend the project specific ad hoc-organization related to the individual construction project in favour of project independent production and innovation processes archived through strategic collaborative arrangements among companies. The idea of the proposal accordingly was to support the establishment of consortiums operating to realise so-called 'radical' innovations, implying that they were (a) informed by competencies from outside the construction industry and (b) that they integrated and took control over the entire – or major parts – of the value chain from manufacturing to installation and operation and maintenance. The specific proposal was to establish an 'innovation platform' which should shield development activities from the existing industrial work division and which should furthermore attract actors and utilise methods from outside the construction industry. A main building-block of this platform was a 'project-hotel' in which consortiums would be able to operate independent of project specific routines.

This emerging sector representation which characterised the Danish construction industry as an under modularized production environment was however not turned into experimental concretization activities as the 'mind-byg' proposal was never realised.

The sector representation was however enrolled in another series of events which were triggered in 2000 as a result of a merger between a mortgage credit institute and a private bank. As the equity of the mortgage credit institute was formally

owned by its clients this equity was not allowed to enter into the new shareholder owned company. An independent foundation called Realdania was consequently established to administer these funds. And as the funds originated from a mortgage credit institute - and were thus generated by construction clients - the purpose of Realdania became to invest and to 'support objectives of the common good throughout Denmark, specifically within the build environment'.

This new and financially very powerful foundation thus came to compliment the state as an organizer of sector development activities. The foundation was thus established with a complimentary strategic objective to that of the state, namely to develop and support 'the build environment'. Or rather, not quite the same objective. Whereas the state operated to developed the sector in order to increase its productivity the activities of Realdania were based on a commitment to “create life quality through the build environment”¹

Beside investment activities the objective of the foundation accordingly became to support philanthropic activities within the build environment. These philanthropic activities were divided into the following three policy areas; qualities of the city, the future of construction and the build heritage.

The further development of the policy area 'the future of construction' turned out to be dominated by a sector representation quite similar to the one cultivated by Thomasson. Before the foundation was established this sector representation had been developed by a small fraction of the sector development community which had emerged during the sector development activities in the 1990ties. This fraction was constituted by a series of knowledge institutions and representatives from the association of component manufacturers, but did not include the major organised interest of the industry. Mobilising similar lines of arguments as those developed by Thomassen this fraction perceived the trade-based industrial organisation as a 'medieval' barrier to an industrial development. The fraction was informed by the vision that the development within ICT technology would enable a higher level of flexible factory-produced prefabrication with which would be able to avoid

¹ <http://www.realdania.dk/Om-Realdania.aspx>

replicating 'the standardized concrete-boxes on top of each other (interview, Svendler)' which had characterised the industrialization of the construction industry in the 1960ties and 1970ties. By this fraction the potential impact of this ICT-supported 'neo-industrialization' was framed as analogous to the transition from the crossbow to the rifle as illustrated by the quotation below:

"At the time when the rifle is invented, the best available weapon was the crossbow. As the rifle was invented a tremendous development of the crossbow was initiated. Suddenly it was technologically challenged. It was thus refined within the context of being a crossbow. However, after 70 years or so the rifle revealed so much greater potential, that the crossbow was outdated. Our picture was that the traditional construction industry with craftsmanship and partnering was the crossbow. It could be optimized to a certain point, but not beyond that point. Therefore you needed the technology-leap which could be fostered by IT and IT supported steering (interview, Svendler)"

While this sector representation had been developed in an informal study-group like setting prior to the establishment of Realdania it now became influential in the formulation of the strategy for the policy area 'the future of construction'. In the formulation of this policy area it was thus argued that processes of 'professionalization' specialised in addressing the demand of specific market segments were emerging in the sector. It was however also argued that these professionalization processes were impeded as suggested below:

"the incentive structures and the organization apparently do not to a sufficient degree support and reward innovation. Construction companies does thus face difficulties in differentiating themselves and obtaining competitive advantages by developing new products and services (Realdania 2004:16)"

In order to support the emerging professionalization and specialization processes it was accordingly suggested that both companies and sectorial interest groups needed to strive to overcome the prevailing complex of conservative professional roles and identities. Specifically it was suggested that attention needed to be paid to

industrially produced system deliverances and the ability of such system deliverances to 'pull new company-types and new relations of collaboration (Realdania 2004:16).

In conclusion the strategic objective of the policy area 'future of construction' was framed in the following terms:

"Realdania will focus on initiatives, which support long-term, strategic forms of collaboration in order to support a new industrial organization and structure (...) The strategic collaboration should be coupled to a product oriented perspective, e.g. in the form of the development of system deliverances- and providers with a softening and re-thinking of traditional professional and organizational borders (Realdania 2004:17)"

From its previous marginal position on the sector development agenda this sector representation thus succeeded to influence the agenda of the new influential philanthropic foundation Realdania. A cornerstone in the strategy which was formulated to support this new-industrialization was the need for production independent development processes. The experiences of the 1990ties thus were that many companies perceived the development activities of experimental development projects as a cost associated with the access to otherwise attractive contracts as suggested by the quotation below:

"An element of what was wrong in the way it was done at the time [the development activities in the 90'ties ed.] (...) was that development activities were associated with the construction process. It is logical that if you say that you have X hundred millions of construction activities, and who want to participate in development activities? Then all the consultants and contractors hear the word 'construction activities' and 'turnover' and 'contracts'. They like to be a part of that. And then of course they would like to develop also (...).But in reality they probably said so mainly to get the contracts (Interview, Svendler)"

Drawing on these experiences the strategy of Realdania was to support development activities which operated independent of production activities in order to filter away the firms which were interested in the turnover rather than development activities.

In order to turn the idea of a neo industrialisation initiated by project independent development activities into specific concretization activities Thomassen was contacted and signed for a nine month employment. In course of this period the sector development initiative 'Building Lab DK' was formulated. The shape of the initiative was coined during a series of meetings in an 'innovation think tank' whose purpose was:

“(...) to outline a powerful and well-organized innovation-secretariat which can initiate a new-industrialization of the Danish construction industry (Innovationstænketanken 2004:2)”

The objective of this think-tank accordingly was to establish a secretariat which combined (1) persons which did not represent specific interests, but could act independently and (2) money, in order to support development projects which had to have 'meaning' outside the individual project (Innovationstænketanken 2004:2).

In order to frame the role of this secretariat the analogy of the transition from the crossbow to the rifle - which did not identify any specific change agent - was replaced by analogies to specific entrepreneurs of industrial revolutions. In the introduction to the third meeting the vision of the secretariat was accordingly framed in the following way:

"Flying has had the Wright brothers! Car production has had Ford!
The Windmill industry has had a series of blacksmiths from Jutland!
The vision of the secretariat is to enable an equivalent quantum-leap in the construction industry (Innovationstænketanken 2004c:unnumbered pages) "

Initially it was proposed that the secretariat should operate as advisors in relation to an expected state-financed framework agreement by supporting consortium driven development. The initiative was thus initially outlined as a collaboration between the

governmental agency EBST and Realdania. This collaboration was framed as a 'new deal' in which (a) the 'delivery system' should deliver better and more innovative solutions in return for (b) clients with longer time-horizons able to reduce the risk of the 'delivery system' (Innovationstænketanken 2004b).

This idea of a new deal however disintegrated for a series of reasons. First, the framework agreement which had to provide the demand side of the strategy disintegrated. Secondly, some of the funding which the agency aimed to provide had to be used for research oriented activities rather than industrial development activities.

Rather, the focus of the initiative began to concentrate more exclusively on the 'delivery system'. It was thus specified that the innovation consortium constituted 'the real driver' in strengthening the innovation. It was furthermore specified that the success of such consortiums was predicated on the ability to engage with actor outside the construction industry.

Also the concepts of system deliverances, modularization and customization were worked out in greater detail. Different scenarios were accordingly debated on how a house could be decomposed into a series of sub systems or system-deliverances and how this would offer the client a single and transparent entrance to the 'delivery system' (Innovationstænketanken 2004c:Un numbered pages). Also a series of companies in the industry - some of which Thomassen had been in contacted with for some time - expressed their interest in the initiative.

In the final project plan the construction industry was framed as a sector which was exposed to a very complex series of pressures and possibilities such as individual customer needs, globalisation, societal demand for development, increased complexity, new technology, new production methods and new forms of procurement (Realdania 2005b:4). It was then argued that a coordinated initiative focussing on new industrialization would be able to take advantage of these very complex pressures and possibilities by nurturing a context in which companies and good ideas could be brought together. This new industrialization was argued to depend on the development of subsystems or system deliverance which had to be developed and produced independent of the individual construction project. These

system deliverances furthermore had to be made compatible with one another by means of well defined interfaces as illustrated by the quotation below:

"These interfaces and modules will, in contrast to the existing ad hoc organization of the industry, be developed in long-sighted collaboration between companies. (Realdania 2005b:5)"

On a sectorial scale it was envisioned that this new industrialization would imply a transition from a sector organised by trades to a sector organised by manufacturers of larger construction parts or sub systems. (Realdania 2005b:5)

In the final project plan the sector development initiative Building Lab DK was provided with a funding of 52 mio dkk in the period from 2005 to 2008. 30 mio dkk had to support a series of innovation consortiums with up to 50 pct of their development costs, while the remaining funding had to finance the operation of a secretariat which had to establish and provide consultancy to these consortiums (Realdania 2005b:19).

The concretization of Building Lab DK

Whereas the sector representations of DC pictured the Danish construction industry as a series of uncoordinated information flows which needed to be organized by means of a shared ICT infrastructure the sector representation of Building Lab DK suggested that it was the trade specific industrial organization designed to support the work on the construction site which was the key problem because this organization hindered specialization and company specific learning. According to the sector representation which informed Building Lab DK the project specific operation of the industry thus needed to be transcended rather than optimized.

The concretisation activities of the two sector development initiatives were thus informed by sector representations which provided different and incompatible pictures of rational behaviour.

Rather than optimising the project specific and trade based operation and organization of the industry through the development of a common sectorial language and information infrastructure the sector representation of Building lab DK thus suggested that buildings needed to be decomposed into a series of flexible and modular components or subsystems which could be developed, designed and manufactured independent of the construction site and the trade-specific work division. This would according to the sector representation catalyse strategic innovation processes due to

- (i) project independent production and development processes
- (ii) integration in the value chain as system suppliers would be able to operate across design, planning, production and operation and maintenance.

Because the sector representation with informed Building Lab DK represented a radical alternative to the representation which informed DC the concretization process was also organized very differently.

The objective of the concretization processes were according not to develop a coordinating language for the industry as a whole – rather quite the opposite - namely to develop specific consortiums among companies what would have to operate as suppliers of customizable system deliverances. The aim of the concretisation processes accordingly were to bring system-suppliers into existence as a new type of players in the construction industry either by turning the operation of existing project oriented companies within the industry into system-suppliers or by establishing entirely new companies backed up by venture capital.

The strategy of the concretization processes accordingly were to focus exclusively on the most innovative companies of the industry in order to create so-called spear-head projects capable of demonstrating the innovative potential and business superiority of operating as system suppliers. In contrast to the ambition of DC which was to target the activities of the sector in their totality the concretization activities of Building Lab DK thus had a much more narrow scope as they were focussed on generating local but radical alternatives to the project oriented mode of organization, production and development. In order to turn this strategic

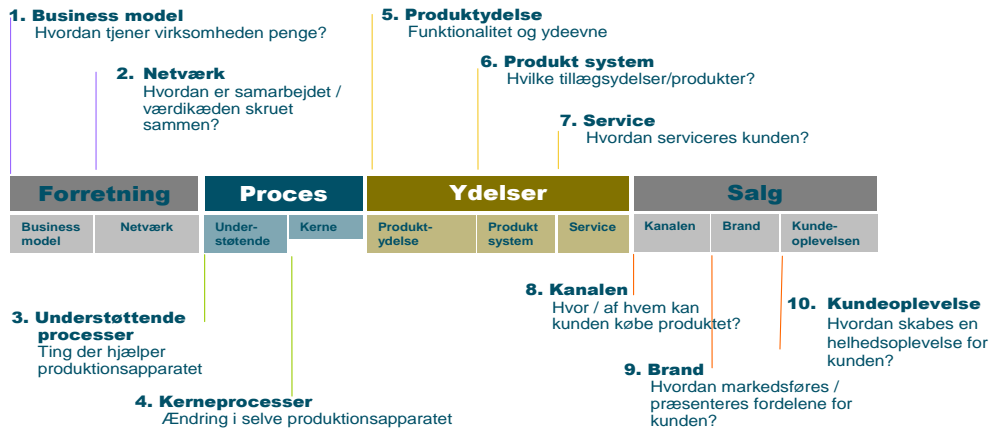
orientation into specific and organized concretization activities the project plan of the initiative argued that the initiative would need to:

- (i) identify and engage the frontrunners in the construction industry through open invitations and by direct contact
 - (ii) support these companies in establishing consortiums
 - (iii) advise Realdania on which consortiums to support financially
 - (iv) assist the consortiums in the development of business ideas, information search, workshops, recapitulation etc.
 - (v) ensure progress and continuity until commercial sustainability has been reached
 - (vi) collect knowledge, methods and tools for use in later projects
 - (vii) ensure the visibility of the efforts and results of the consortiums
 - (viii) coordinate, advise and participate in initiatives which can support innovation in the construction industry
- (Realdania 2005c:unnumbered pages)

It order to meet these objectives two core concretization methods were developed. These were a) a generic consortium structure informed by the modularization philosophy (Byggeriets Innovation 2006:56) and b) a set or structured development activities by which to organise the consortium according to this structure (Byggeriets Innovation 2006:49). The aim of these two concretization methods accordingly was to frame and organise the activities by which to develop the spearhead projects that were envisioned to inspire broader development dynamics within the sector.

The formulation of the generic consortium structure was inspired by an innovation model which divided the innovation concept into 'business innovation', 'process innovation', 'product innovation' and 'marketing innovation'. These types of innovation were further subcategorized into a total of 10 types of innovation as specified in the model below.

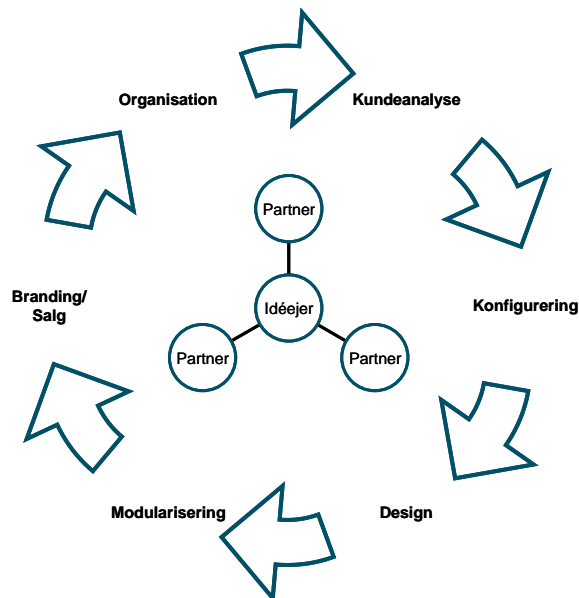
10 typer af innovation



Source: Dublin analysis

(Byggeriets Innovation 2006:9)

The generic consortium structure, represented in the figure below - and informally referred to as the tumble drier model - was developed by combining the innovation model illustrated above with the modularization philosophy as illustrated below:

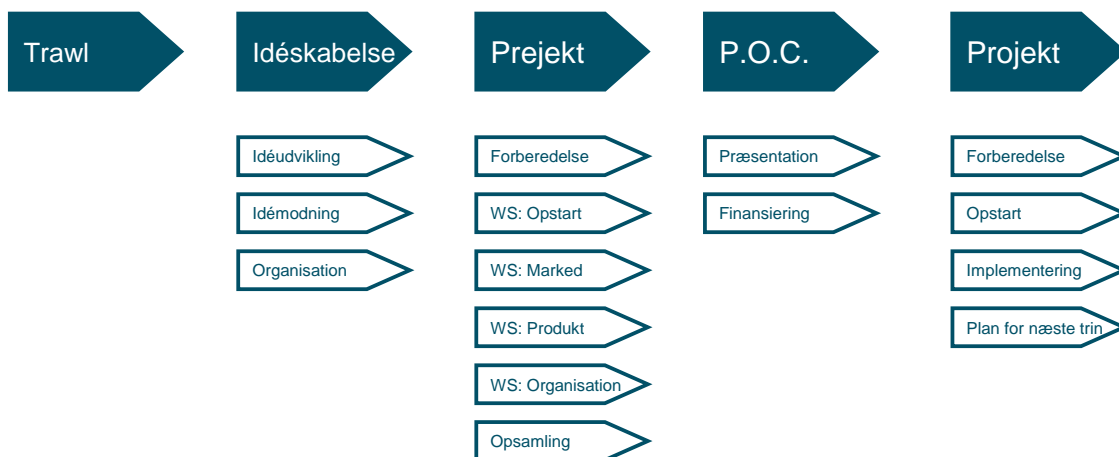


(Byggeriets Innovation 2006:56)

The figure illustrates the ideal structure and activities of a consortium made up of a central 'system owner' and a series of associated 'partners' who in their totality

operate as a 'system supplier' by integrating a) organization b) marketing c) configuration d) design e) modularization and f) branding and sale into a coherent 'system deliverance'.

The development activities envisioned to realise such a consortium was represented by a five staged process model consisting of 1) trawl 2) idea formulation 3) preject 4) proof-of-concept and 5) project as illustrated by the figure below



(Byggeriets Innovation 2006:46).

In contrast to the four other phases the trawl was not related to the establishment of a specific consortium. Rather, the trawl signified a continuous screening of potential companies and ideas. The aim of the trawl accordingly was to identify resources and ideas which could potentially be configured into specific consortiums activities. The idea formulation phase referred to the activities by which the most promising ideas, companies and resources would be configured into a potential consortium and documented in a preject application.

In preject or 'pre-project' phase the innovation concept outlined in the preject application had to be developed into the 'tumble drier' structure outline above. This phase consisted of a series of workshops in which the consortium had to be specified into a modularized concept concerning product, process, design and marketing. Also in this phase the relevant actors and companies of the consortium had to be identified and committed.

The project phase had to be concluded by a project plan which would have to be assessed in the proof-of-concept phase. If the project succeeded to pass this phase the project would finally have to be turned into actual development activities in the project phase.

A project secretariat with a permanent staff of four employees was established to initiate and support the concretisation activities of the initiative based on the strategy outlined above. Within the overall economic framework of the initiative this secretariat was mandated to cover up to 50 pct. of the development costs of the consortium activities given acceptance from Realdania.

In total Building Lab DK succeeded to initiate and support 14 projects and 7 projects during its 4 years of operation (Vind & Thomassen 2009:184-187). A general characteristic of the concretization activities was that it did not prove possible to attracting external venture capital. All development activities were accordingly carried out by existing companies in the industry.

The following analysis of the concretization activities focuses on two projects characterised by different types of interface with the traditional project oriented construction process which Building Lab DK operated to transcend. The two projects accordingly represent different ways in which the strategic orientation of Building Lab DK was concretized into specific development activities. The first case concerns the development of a configurable balcony and the second case concerns the development of a modular installation unit for residential tower blocks.

The configurable balcony consortium was the first consortium to be supported by Building lab DK. The central actor in this consortium was a contractor named Ringsted bygningsenterprise (RB) specialized in exterior refurbishment. The initial contact between Building Lab DK and RB was established by a manager at the contractor who had a prior personal relation to the head of the Building lab DK secretariat. This manager initially wanted to stream-line the somewhat troublesome process of installing new balconies and furthermore wanted to improve the client interaction. His ideas were however only vaguely formulated.

In order to develop these vague ideas within the logic of modularization and system deliverances a university based consultant specialized in product modularization (IPU) and a spin-off company of this consultant specialized in ICT based configuration software (3d facto) were enrolled in the consortium by Building Lab DK. These companies brought competences in modularization and ICT-supported configuration into the consortium.

The innovation consortium was thus established as a merger between two existing networks. One of these was the network of RB. This network included two component manufacturers; Weland Aluminium, a manufacturer of aluminium profiles and Kecon a medium size blacksmith company. The RB network also comprised Bascon a consulting engineering company. Taken as a whole this network represented the value-chain from design to production, sale and installation. The other network comprised IPU and 3D facto.

The development of the initial vague idea came to evolve around the utilization of a configuration software solution which should allow the balcony to be represented as a digital and configurable 3D model. In particular two perspectives were articulated based on the vision of a configurable 3d model. One of these focused on the client interaction and visualization and the another focused on optimization of the production- and information flow between the contractor and the component suppliers and between the contractor and the public planning authorities (Byggeriets Innovation 2005).

The initial idea development phase was concluded with a preject application which effectuated a closure and an opening. The preject application thus closed the entrance of new actors to the consortium while opening for a deeper elaboration of the innovation ideas. The preject phase took place during three two-days workshops. The preject phase was characterized by relatively little development in the relation to the overall innovation idea. The core ideas accordingly were (i) to offer the costumer a configuration tool which allowed freedom to configure and visualize solutions; and (ii) to establish a production platform which allowed for better performance in relation to cost and quality.

Although the core innovation ideas remained largely unaltered throughout the project phase the activities in this phase however succeeded to stabilise modularization as the central principle for the development of the consortium. This stabilization of this principle was ensured by an IPU representative who introduced modularization in an illustrative and tangible manner by presenting a detailed illustration of how an industrial product had been modularized. He then explained the pervasive effect which the modular product architecture had had on the production flow and the ability to control the complexity of the product and the processes. Also the sales-dimension was unfolded within the perspective of modularization. A sales meeting in which a salesman how was advocating a balcony solution to a cooperative housing association had thus been tape-recorded. This recording showed how the salesman illustrated the maybe-to-be balcony-solution by drawing on the asphalt outside the building while explaining the light-effects. In dialog with this salesman it was elaborated how the ICT supported configuration tool could be used as a visualization tool in order to improve the communication.

Other dimensions which were less well-represented by company representatives themselves were also unfolded. An external consultant was thus hired to conduct a customer- and market investigation. A lasting result of this investigation was a change in perspective from outside-in, i.e. a perspective where the balcony is perceived as an attribute to the exterior of the building, to inside-out, i.e. a perspective where the balcony is perceived as an extension of the private inner room of the flat (Byggeriets Innovation 2005b:6). This inside-out perspective were further developed into a branding strategy which suggested that the balcony should be marketed as a life-style-product, in the same way as kitchens and bathrooms. In line with this reasoning a long-sighted business model was formulated to turn the balcony solution into a life-style brand rather than a product solution.

External consultancy was also used to develop other elements of the innovation concept. Different focus groups were invited to test and develop specific aspects of the innovation idea. Regulatory authorities from municipalities were invited to discuss how information could be automatically extracted from the configuration tool in order to ease and standardize the process of obtaining permissions. Also lead-users in ICT-supported customer interaction were invited to discuss the utilization of the configuration tool to instant online visualization.

In the actual development phase of the project the most pervasive effect was however an organizational restructuring of RB itself. In January 2007 the head and founder of RB accordingly chose to sell off those refurbishment activities of the company which did not have to do with balconies in order to prioritize the production and development of the balcony section in a new independent company called Altan DK.

An element of this re-organization was that the manager which had initiated the project was appointed head of the new refurbishment company. The client perspective consequently lost some of its priority as this manager had been a central advocate of this perspective. Another reason was that the configuration tool turned out not to be able to deliver the level of visualization which was envisioned in the project phase. While the software was able to deliver visualization of the individual balcony it could not as easily as initially anticipated integrate balconies into the visualization of the entire building. Also instant price calculation was given up.

More headway was made in relation to the production perspective as an alignment process was initiated between the configuration tool and the production process. The initial step in this process was the registration of the components at Weland, the supplier of aluminium profiles. Based on this registration a so-called product-family-master was created in order to define the modular architecture of the balconies. A result of the systematic modular representation of the product architecture was that the complexity was reduced. An example was that the number of mounting fittings was reduced from 17 to 4.

Progressively the configuration tool however encountered further problems and setbacks and the development of the tool was altogether disbanded in fall 2008. By this time traces of the modularization philosophy was however being incorporated in a broader series of tools and strategies. Most specifically means to control and reduce complexity was being concretised in a process- and document handling system. Also a project on Quick Response Manufacturing was initiated in order to reduce the lead time of a balcony project and thus improve the customer satisfaction. Yet another effect of the modularization philosophy was a much tighter and controlled product portfolio.

The initial innovation concept aiming to re-organize RB into a 'system owner' by means of the computer aided product configuration tool thus disintegrated. Rather, a series of less tightly coordinated interventions and developments strategies replaced the computer aided 3d product configuration tool as the central organizer of the innovation process. These interventions did however display traces of the modularization philosophy aiming to catalyse organizational specialization and company specific learning and capability building. The innovation project thus resulted in a process of organizational specialization as the balcony section of RB was established as an independent company. Also within this new company measures were taken to strategically control and reduce the complexity of the product as well as the processes of planning and installing the balconies.

A further spin-off of the balcony consortium was that the manager who originally initiated the balcony project and who was appointed head of the refurbishment company during the re-organization of RB chose to utilise the modularization strategy to develop a new modular facade refurbishment concept (RBE 2009). Partly supported by Building Lab DK the different processes and technique of facade refurbishment activities were thus identified across the different actors and professions involved in the processes. From this analytical work a series of specific combinations of processes and techniques were organised into a process chart, thereby optimising the process of the refurbishment activities as well the client interaction (RBE 2009:38). Inspired by the modularization philosophy the company also developed a configurable elevator concept designed to increase the accessibility of existing tower block.

In relation to the construction industry more generally the balcony consortium however represented a special case in the sense that the solutions could be developed independent of the traditional coordination activities across companies and professions because the balconies solution was developed to be installed only on existing buildings. In contrast to the balcony consortium another consortium which aimed to develop a modular installation unit operated in the very midst of the coordination challenges between the companies and professions of the project specific construction process.

The overall vision of this consortium was to replace the in-situ assembly of the vertical installation shaft in residential tower blocks with a modular, factory produced installation unit.

The innovation concept of the consortium materialised from the remains of another innovation idea aiming to combine decentralised horizontal installations units for control of indoor climate and technical installation with reduced vertical installation shafts for use in commercial buildings (Byggeriets Innovation, year of publication not specified). Out of the remains of this innovation idea a large Scandinavian contractor named NCC launched its own idea of a modular vertical installation shaft solution for residential tower blocks and offered to operate as system owner of the modular installation unit solution.

In total the consortium comprised NCC, a small architect company (RH arkitekt) and a consultant specialised in modularization and product development (Valcon).

The vision of the contractor was to optimise both the design and planning process as well as the in-situ construction process. In relation to the construction process the modular shaft solution was envisioned as a means by which to avoid the traditional in-situ assembly of the shaft which required coordination and collaboration between several different professions and trades on a very limited space. A configurable shaft fabricated and largely assembled on a factory was accordingly perceived as a means to reduce one of the most critical and complex part of the in-situ construction process.

In relation to the design and planning process the vision was to optimise the traditional project specific design and planning processes by developing a generic and project independent solution, as formulated by the project manager:

"A bit simplified we now have a process which starts with a blank sheet of paper, and then you invent something along the way which then has to be produced. What we really want is to start a project by choosing among known solutions which may be combined instead of inventing project specific solutions (Interview, Jespersen)"

As formulated by the project manager the challenge of the consortium accordingly was to develop a generic solution which operated according to the logics of “the big square root” i.e. independent of the specific project. Although the challenge of the balcony consortium had also been to develop a solution based on this logic of the "big square root" the challenges faced by the installation unit consortium were however in several respects radically different. The installation unit consortium thus operated much closer to the traditional organization of the project oriented construction process. The solution thus had to work in the complex process of designing, planning and building a new construction in coordination between several companies comprising different trades and professions.

Also the solution had to be developed in the context of a larger company which operated according to project specific priorities and logics. It was accordingly not the contractor as such which operated as system owner, but rather a sub department within the contractor. The managerial room for manoeuvre was thus much more limited than it had been in the balcony consortium, as the department had to calibrate the innovation project with the broader organizational interests, priorities and capabilities.

During the technical development of the shaft one of the main challenges accordingly was to convince and enable the installation engineers - traditionally trained and evaluated on their ability to create and improvise project specific solution - to operate according to a modular and project independent production and product development logic.

An additional challenge was to articulate and promote the project and its generic logics within the wider context of the company as formulated by the project manager:

"We need to take some specific building-parts and develop configuration-solutions for them in order ensure that it is not perceived as a threat. If we plan to develop configuration-solution for entire buildings a lot of people would feel that their interests are being compromised. If you develop a solution for an installation unit and a

floor - which we are also planning to do - then it can become a tool (Interview, Jespersen)”

Much energy thus had to be invested in ensuring the support of the top management. The top management was accordingly exposed to several seminars by representatives and consultant from other industries working with modular product development. A complimentary strategy was to frame the project as a continuation of an existing initiative in the organization aiming to optimize and centralize the purchasing of building materials and components.

Beside the technical development and configuration of the shaft a core challenge of innovation processes was to develop a strategy for how to bring the shaft into use in the traditional project specific design- and planning process. This challenge was addressed by the other main actor in the consortium, a small architect company. This company accordingly had little to do with the technicalities of developing the internal architecture of the installation shaft as the role of the company role was to render the solution attractive in to architects working in the design process.

Inspired by the ideas of configuration and modularisation the company approached this challenge by outlining a simple proto-type design configurator defining the technical, structural and regulatory interdependencies between the design of the installation unit, the bathroom, and the kitchen installations. This configuration based design and planning tool was advocated as a means by which to dispense the often conflict tormented communication between architect and engineer as it formalised the technical and regulatory interdependencies as suggested in the quotation below:

"What happens today is that the architect more or less blindly draws a sketch, and somewhere he places the installation shaft. On a good day he phones the engineer and says: I've made this plan. But there are so many interdependencies between the installation shaft and the sketch. The engineer says it has to be 2x2 meter and then we draw it 1x1 because it is not very easy to sell. It's a complication between the perspective of the architect and that of the engineer (interview, Ramlyng)”

As illustrated by the quotation above the configuration based design tool which formalized the technical and regulatory interdependencies related to the shaft into a series of design rules was thus advocated as a means by which to prevent un-buildable designing due to poor coordination between the architect and the engineer.

Additional to the installation unit/toilet/kitchen configurator the modularization heuristics were further developed to also embrace the relation between these three interdependencies and the overall architectural design of the flat. A number of typical flat designs were identified in existing buildings and these were then related to the different installation-unit/toilet/kitchen configurations.

During the development of these design tools the architect-company also came to perceive configuration supported designing as a method by which to codify the tacit heuristics of the 'skilled architect'. Configuration was accordingly perceived as a method by which to turn the trained skills of senior architects into a tool by factorising and formalising the interdependencies which defines a design space.

Compared to the balcony consortium, where a new independent firm had been established, dynamics of organization specialization remained more impeded as the key actor of the consortium was a department within the larger contractor. This meant that the logics of modularization had to be negotiated and calibrated against the more traditional interest and concerns of the company.

The difficulties of making use of the project independent modularization principles in the project oriented context of the company were most clearly experienced by an industrial consultant specialised in modularization and product development, as reflected in the quotation below:

"In the machine-industry you may communicate with the most primitive sub-contractor and he will understand why we have made it in this specific way. Or actually ask about that interface: 'what is that?' I don't in any way need to articulate what we are doing; it's taken for granted everywhere. (...) In the construction industry you need to

articulate in order merely justify that an effort is needed here. (...) If you begin to invest time in this people will be uncomprehending (Interview, Juul Rasmussen)”

Inspired by the experiences gained during the consortium activities both the contractor and the architect company did however continue to explore the logics of modularization. 'The logic of the big square root' however remained fragile as it had to be balanced against the traditional project specific framework as indicated by the architect:

”The architect wants to design. Here is a tremendous challenge. To make the architect realise that this is a tool and not a limitation. That is a challenge for the idea of configuration. That was also reflected in our test: Oh dear, doesn't this confine our creativity! (Interview, Ramlyng)”

At the contractor initiatives were however taken to further develop the shaft and also to establish modularization as a more generic development agenda. In the further development of the installation shaft specific attention was devoted to the development of the design configurator in order to enable the shaft to marketed to external customers, as reflected in the quotation below:

”Our goal is that the architect logs into skakten.com and designs his bathroom aided by a configurator which helps him to comply with the rules and to define the position and size of the shaft. And thereby he avoids, or is prepared, with the dialog with the engineers. (...) (Interview, Kudsk)”

These development activities were supported by successful attempts to bring the shaft into use in specific construction projects and by successful attempts to utilise the shaft as a sales parameter in the tender process. The shaft solutions was further partly detached from the project oriented operation of the company as it was organised into its own sub department which succeeded to market it to company external customers.

As a generic development agenda within the contractor modularization however co-existed with a set of partly alternative strategic development agendas. One of these was the object oriented building information model agenda which had been cultivated by the contractor's involvement in DC. Another development agenda which was more in line with the philosophy of modularization was to develop so-called concept houses. The purpose of these concept houses was to strategically identify where standard solutions could be utilised without compromising the demand for customer-tailored solutions. These concept houses were however not tightly associated with component specific modularization and modular designing, but rather aimed to take advantage of more a more traditional standardization approach.

The component oriented modularization agenda, represented by the shaft, however continued to exist somewhat in the shadow of the two alternative development agendas.

The two cases above in conclusion illustrate some of the challenges and opportunities which characterised the processes by which the strategic orientation of Building Lab DK was concretized into specific experimental development activities. In every case these activities aimed to transform existing project oriented companies into providers of system deliverances.

The institutionalization of Building Lab DK

Informed by the logic of modularization the concretization activities of Building Lab DK aimed to transform existing project oriented companies into providers of system deliverances. But what did the activities and experiences of the concretization activities look like in their totality and how were they framed and advocated as a more aggregate sectorial development agenda indented to catalyse broader industrial effects?

Even though all the different concretization activities of Building Lab DK were informed by the logic of modularization they however took a variety of different

forms. Additional to the two consortiums reviewed in the previous section five other consortiums were supported by Building lab DK

Two of these consortiums aimed to exploit new or alternative materials. One of these aimed to develop an integrated building envelope based on composite materials rather than aluminium which is traditionally applied. This was the most international consortium and included Arup, a large international consulting engineer, Permesteelisa, an international company specialised in the production and installation of facade systems and Fiberline, a Danish manufacturer of composite materials (Vind & Thomassen 2009:184). The other material oriented consortium aimed to develop a modular building system based on high strength concrete (Vind & Thomassen 2009:184).

Another consortium aimed to exploit the logic of modularisation to develop new types of collaboration between firms in the industry. This consortium developed a generic configuration tool for light constructions based on wood. The aim of the consortium was to develop as a configuration tool for several producers of such constructions in order to allow learning to be shared among these producers (Vind & Thomassen 2009:200).

Yet another consortium aimed to develop a digital dialog tool designed to support collaboration between the different parties in the early planning phase of a construction project. This consortium may be seen as the least radical in terms of dispensing with the traditional project oriented operation of the industry (Vind & Thomassen 2009:194)

Despite their differences all consortiums however aimed to transcend the prevailing project oriented mode of production in the construction industry characterised by the trade specific industrial work division. The aim of the concretization activities thus were to detach companies from the project oriented operation of the industry by developing modular and customizable solutions which could be produced and developed independent of the individual construction projects.

During the concretization activities the logic of modularization was however not advocated as sectorial development strategy. The individual consortiums were

accordingly not framed as an element of a broader development strategy for the sector as a whole. In this respect the concretization activities of building Lab DK were very different from the concretization activities of DC which were continuously related to a more comprehensive sectorial ambition.

But how were the experiences of various concretization processes then advocated as a coherent sectorial development agenda aiming to catalyse broader industrial effects?

From the early theorization of Building Lab DK a profound conviction was that by providing 'good examples' a more general development towards modularization, organizational specialization and company specific learning processes could be initiated broadly in the industry. By beginning with the most innovative companies in the industry the conviction was that a development agenda with broader appeal would emerge and that this agenda would develop through imitation from competitors.

The strategy of the initiative accordingly was to establish and support specific consortiums as reflected in the quotation below from one of the early think-tank meetings in which the design of the initiative was outlined:

“The end-goal is to create innovation in the industry as a whole. But rather than beginning with the whole industry the innovation-secretariat will on a local scale support 'sunshine-stories' which can pave the road for a broader development (Innovationstænketanken 2004d:2)”

The belief in 'the good example' as a mechanism for motivating other companies in the industry to engage with the modularization agenda was also central to the final project plan as reflected in the passage below:

"The mission mirrors our belief that development starts with the good example, and that to a start it is more important to work with forerunners than with the mass (Realdania 2005b:7)"

This emphasis on 'the good example' thus on the one hand reflects a deliberate strategic belief but it on the other hand also reflects the position of the initiative in regard to the wider sectorial development agenda.

The strategy of the Building Lab DK was accordingly not to build new sectorial institutions - such a shared sectorial ICT infrastructure - but on the contrary to illustrate how companies could benefit from fewer and more simple sectorial coordination mechanisms. One place this was illustrated by comparing the prevailing organization of the construction industry with an orchestra where coordination is achieved from the central position of the conductor - which in the case of the construction sector signified the trade specific sectorial work division (Vind & Thomassen 2009:30). This image was thus used to illustrate how the innovative potentials of the individual companies were incubated by the need to comply with the sectorial work division.

Building Lab DK was then framed as an attempt to transcend this type of coordination in favour of the coordination represented by the jazz band where a minimum of common understanding is used to facilitate individual improvisation. Drawing on this image it was accordingly suggested that:

"(...) the construction industry must be developed through intelligent coordination which at the same time ensures integration and decoupling of different roles, languages and visions. According to this logic the problem of the construction industry is not - as it is commonly argued - that the architect and the engineer need a 'common understanding', but on the contrary that they need intelligent systemic coordination which can turn their differences into a strength and strengthen their differences (Vind & Thomassen 2009:31)"

In this sense the sectorial ambition of Building Lab DK was to initiate a de-institutionalisation of the sectorial work division in order to pave the road for the innovative dynamics associated with organizational specialization and company specific learning and capability building. From this perspective the 'good example' represented a logical element of the broader sectorial development strategy as the consortiums exemplified how to transcend the work division of the industry.

The emphasis on 'the good example' however also illustrates that the sector representation which informed Building Lab DK was not calibrated with the broader complex of industrial interests or with the interest of the state. In this respect Building Lab DK operated very differently from DC by which the enrolment of existing industrial interests was a core strategic concern. Within DC ongoing calibration between the industrial interests was thus an ongoing activity which was often achieved at the expense of strategic coherence. In the case of Building Lab DK the priorities were the other way around. Here the strategic orientation was established by dispensing with attempts at achieving broad support from the industrial interests and the state. In the eyes of Building lab DK the industrial interest organisations thus embodied much of the inertia with the initiative aimed to transcend, as reflected in the quotation below.

"The professional organizations were also given up, and I think that it was a sensible thing to do because they would immediately try to promote their own agendas (...) That was the assessment we made: If we don't do it in this way it will be an endless discussion with all the parties whose interests are being compromised. That was also why we didn't go for anybody but the companies (Interview, Petersen)"

This in conclusion implied that only those individual companies which accepted to buy into the strategic orientation which Building Lab DK represented were enrolled in the activities of the initiative.

In relation to the broader sectorial policy formulation processes the initiative thus continued to occupy a very marginal position. Even by people relatively close to the activities of Building Lab.dk the initiative was seen more as an experimental playground than a potentially influential sectorial agenda, as indicated by the chairman of the advisory board:

"The advisory board was also characterised by being composed of persons which by and large did not represent anything but themselves. (...) So nobody was obligated. Also in that case, nobody would have

entered the advisory board, if they had to obligate themselves (interview, Pedersen)"

The consequence of the exclusive focus on radical but local innovation consortiums however was that the sector representation of the initiative which in the beginning of its lifetime had only enjoyed marginal support did not become anchored in the institutions of the broader sectorial development agenda and nor did the initiative succeed to establish an alternative policy platform.

Though it was a deliberate strategic choice not to try to position Building Lab dk on the traditional sector development agenda, this left the initiative in a weak position also within Realdania itself.

Before the close down of Building Lab DK there were however indications that the initiative would be prolonged for another 3 years. One indication was that the staff of the secretariat was offered permanent positions one year before the end of the first period and two additional employees were furthermore hired. Also a process was initiated to develop the strategy for the second period of the initiative and this process progressed very much in the anticipation that the initiative would be prolonged for another three years. While continuing the consortium specific activities from the first period this new program placed focus a) dissemination of experiences b) on attracting venture capital and c) on developing a pipeline aiming to cultivate broader community activities independent of the specific consortium activities. The overall idea accordingly was to broaden out the development strategy of building lab DK and make it attractive to the so-called early adopters in the industry.

The focus on attracting venture capital aimed to demonstrate that the development activities of the first period which had been heavily supported by funding from Realdania (up to 50 pct) had now become financially sustainable. The idea thus was to demonstrate that the strategy developed by Building Lab DK could stand on its own and that it was attractive also without financial support.

The purpose of the pipeline activities was to anchor the development strategy of Building Lab DK independent of the individual consortium activities and thus

cultivate a broader community or niche environment. The strategy accordingly was to support learning and capability building through activities which operated independently of the specific consortium activities as reflected in the quotation below:

"One of the things I worked on before it closed down was that we needed development forums which are independent, i.e. in reality to formalise our pipeline, which is anchoring and supportive of the niche environment we established (interview, Mossin)"

The strategy was to establish a broader and more inclusive development platform through different networking activities. Some of these activities were envisioned to render the environment visible to outsiders through open activities, while others had to be of a more closed and private character, aiming to cultivate specific agendas in more intimate settings.

As these strategy formulation processes were running in the anticipation that Building Lab Dk would be prolonged for another three years a re-organization of the initiative however indicated that Realdania itself felt increasingly uneasy about the lack of anchoring which characterised the initiative. By the end of 2007 Building Lab DK was thus integrated in The Danish Architecture Center (DAC). This integration was however not experienced as entirely consistent with the strategy of the initiative because DAC was not primarily a business oriented organization. DAC was rather a cultural institution established to promote general public debate concerning the development of the build environment.

It was however not primarily the lack of industrial anchoring that resulted in the final destabilization of the initiative. A more critical event was that Realdania suffered massive financial losses from its investments as reflected in the quotation below:

"(...) do not forget that the decision to close the initiative was taken as the foundation lost approximately half of its financial assets. In a period there were considerations about stopping all support. (Interview, Pedersen)"

In conclusion the board of Realdania decided to turn down the project proposal for the second period and Building Lab DK was accordingly terminated by the end of 2008.

So what did Building Lab DK leave behind as it was terminated, and what kind of attempt to re-organise a coordinated strategic orientation was initiated?

A core outcome of the initiative was the experiences gained by the consortiums. The diffusion of these experiences however remained limited because the initiative did not have access to the information infrastructure of the interest organisations and to the broader policy formulation arenas occupied by the state and the professional interest organizations of the industry.

An attempt to develop a coherent and organized framing of the activities and experiences of the initiative was however presented in a book by the title 'Building Lab DK - innovation of construction in theory and practice' (Vind & Thomassen 2009). This book aimed to summon up the results of the initiative in order to provide inspiration to the companies in the industry. The book thus offered a integrated presentation of a) the sectorial critique of the project oriented organization of the construction industry b) the modular alternative to this organization based on project independent production and development processes c) methods for assessment of market potentials, d) specific tools by which to facilitate and manage innovation process and d) examples of some of the consortiums established and supported by building Lab DK.

Another outcome was the specific consortiums and the community of individuals, institutions and companies which had been established during the concretization activities organised by Building Lab DK. An analysis from 2010 assessed the progress of the consortium activities a year after the close down of Building lab DK (Smith 2010). A general finding was that the development of the consortiums was strongly influenced by the general economic recession in this period. On the one hand it was thus found that several of the solutions developed by the consortiums had been introduced to the market. On the other hand it was however also found that inter firm collaboration had been weakened and that the use of external

consultancy was low. The development activities had thus become increasingly internal to the individual companies (Smith 2010:5). Within some of the companies the development activities had however become increasingly separated from the project specific production and development processes (Smith 2010:5). Also the separation of development activities from production activities was however under pressure due to the economic recession and the lack of strategic development funding.

Though some of the solutions developed by the consortiums had been introduced to the market both the strategic inter-firm collaboration within the consortiums as well as broader community building processes had thus been weakened and the development activities had become increasingly company internal.

But what kinds of attempts were initiated to re-organise a coordinated strategic orientation as Building Lab DK was terminated?

The most direct continuation of Building Lab DK was the establishment of the private consultancy company Smith innovation. This company was established by the former head of the Building Lab DK secretariat and one of the former employees. This company continued to support the consortium activities which had not been concluded within the framework of Building Lab DK. In several respects the activities of this consultant did however not represent the strategic orientation of Building Lab DK. Though the ambition of the company was to support company specific consortium activities only a marginal part of its activities actually came to focus on such activities. First of all such consortium activities were more difficult to establish as they were no longer guaranteed external funding. But also the general economic recession which had been partly responsible for the close down of Building Lab DK had severely influenced the construction industry and was resulting in cut backs in strategic development activities. Most of the activities of the consultant thus concentrated on policy analysis rather than direct support of specific innovation processes.

A key strategy of the company was furthermore to attract external development funding, and this strategy was pursued somewhat at the expense of the

modularization agenda which had informed building lab DK, as reflected in the quotation below:

" A question which is becoming increasingly important is how to attract external development funding to the construction industry and this is not only a question in relation to system-deliverances (...) In order to position the construction industry at a sectorial level we need to be able to attract external development funding (Interview, Thomassen)"

In the activities of the consultant the modularization agenda was thus partly replaced by the question of how to attract strategic development funding to the construction industry and partly replaced by more policy oriented analysis.

Attempts to re-construct and carry forward the modularization agenda were however also initiated independent of the activities of Smith Innovation as a research network on modularization called sysbyg was established in late 2009 supported by Realdania. This network was established in collaboration between a series of knowledge institutions and included four P.hd. scholarships. Some of the actors which had participated in the concretization activities of building Lab DK were associated to this network. By this research network the approach to modularization was however somewhat different from the approach of Building Lab DK. By Building Lab DK modularization had thus been utilised as a method for developing integrated business concepts. By the research network modularization was however addressed from a more research oriented point of view in relation to e.g. environmental sustainability and architectural quality. The activities of the research network did however support some of the consortium activities which had been initiated and supported by Building Lab DK. A commercial P.hd. was thus established in collaboration with the contractor which had developed the installation unit in order to develop modularization and system deliverances as more general business area within the company.

Yet another effect of Building lab DK was related to the activities of DAC - the organization which came to host Building Lab DK in its last year of operation. In the strategy of this organization Building lab DK had represented an ambition to

compliment its cultural activities with more industry related activities. The close down of Building Lab DK thus forced DAC to re-organise its industry related activities. An effect of this re-organization was an initiative called Danish Resources. The purpose of this initiative was to support the development of so-called green competence clusters aiming to target the demand of the Chinese market. The aim of these cluster activities accordingly was to develop new competences in the intersection between companies, knowledge institutions and framework actors.

The program executive for these activities was yet another former employee in Building Lab DK. From her new position she tried to develop and cultivate the community perspective which had been formulated during the development of the programme proposal for the never-to-be-realised second period of Building Lab DK. Her idea accordingly was to use DAC as a platform for stimulating agenda setting network activities rather than company specific development activities which had been the core focus of Building Lab dk. Her experience however was that the agenda-setting activities tended to loose orientation, since there was little room for the development of methods by which to organise the agenda setting activities, as reflected in the quotation below:

"What is especially important in my view - and what was a freedom in Building Lab DK which I am not sure that the times will provide again - is to focus on the development of the construction industry by being obligated to parameters such as cadence, formats, the level of inclusion and representation across branches and things like that. But not be obligated to agendas, and thus be able to choose agenda on the move. That is something that this organization has difficulties in understanding (interview, Mossin)"

The close-down of Building lab DK in conclusion resulted in a disintegration of the modularization agenda at least as sectorial development strategy, primarily because the anchoring of modularization as a recognized sectorial agenda had been of low priority. As a sectorial development agenda modularization thus remained closely dependent on the existence of building lab DK itself as it had not been advocated to other actors working to influence the sectorial development agenda.

Conclusion

As demonstrated in the previous chapter the opaque strategic situation which characterised the sector development agenda towards the end of the 1993-2001 period was transcended by more organized sector development activities in the post 2001 period. This did however not imply that the sector development agenda came to exist as a single strategic orientation. It rather came to be defined by two different configurations of theorization, concretization and institutionalization processes.

The purpose of this chapter has been to offer an analysis the configuration which was represented by the sector development initiative Building Lab DK.

While the sector representation of Digital Construction can be traced back to the 1980'ties, the theorization of the sector representation which informed Building Lab DK was rooted in the sector development activities of the 1990'ties. This sector representation was inspired by ideas of industrialization and vertical integration of the 'delivery system' and based on criticism of the craft based organization of the industry. It was however the logic of modularization which succeeded to organise this criticism in a strategically attractive way, as it allowed the sector to be represented as an under modularized production environment.

The strategic orientation informed by this sector representation pointed to the development of configurable system deliverances produced and developed independent of the individual construction project thereby allowing for organizational specialization and company specific learning and capability building as illustrated in the table below:

Sectorial logic	Sector representation	Strategic orientation
Modularization	The construction industry as an under modularized production system characterized by project specific problem solving and short term	Configurable system deliverances developed and produced independent of the individual construction project thereby allowing for organizational

	collaboration which hinders organization specialization and innovation	specialization and company specific learning and capability building
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Compared to Digital Construction the initiative was defined by a very different configuration of theorization, concretization and institutionalization processes.

As the initiative was exclusively supported and funded by the newly established philanthropic foundation Realdania it was theorized much more independent of the existing complex of industrial interests compared to DC.

Also the concretization processes targeted the industry in a very focussed or narrowly way as the experimental activities aimed to demonstrate how specific constellation of companies could benefit from dispensing with the craft based sectorial work division by means of the modular production and development logic. Rather than building new sectorial institutions the concretization process thus aimed to demonstrate how innovation dynamics could be catalysed by decreasing the dependencies of the sectorial work-division. The initiative did accordingly not aim to target the sector as a whole as the strategy was to create local sun-shine stories and then hope that these examples would inspire the most innovative part of the industry.

In course of the experimental concretization activities Building lab DK succeeded to establish and influence as series of innovation consortiums by means of their strategic orientation. As the companies which participated in the consortiums were however all in different respects embedded in the project oriented construction process the outcome of the consortiums represented compromises between the realities in which the companies operated and the radical strategic orientation of Building Lab dk.

A consequence of the local consortium oriented concretization strategy was that the experiences from the concretization activities were not systematically discussed against the sector representation which informed the initiative. The experiences from the consortium activities were accordingly not systematically used to develop, re-frame and promote the sector representation. The concretization activities of the

initiative consequently came to appear more as a series of individual consultancy services than as an expression of a coherent sectorial development agenda.

The low priority given to the development of the sectorial perspective was however also a consequence of the belief that the individual consortiums would be convincing and transparent enough to diffuse the modularization strategy. This belief in the power of the 'sun shine story' thus implicitly implied that community building or political agenda setting activity was unnecessary. Due to this belief and to the narrow consortium oriented focus of the concretization activities modularization as a sector development agenda remained tightly dependent on the existence of building lab DK as it had not been advocated to other actors with the ability to influence the sectorial development agenda. The consequence was that modularization as sectorial development agenda largely disintegrated with the close down of building lab dk.

The most direct continuation of Building Lab DK was thus the establishment of Smith Innovation, a private consultant which continued the development activities which had not been concluded at the time when Building Lab DK was closed down. The activities of this small firm was however increasingly oriented towards attracting venture capital to the industry.

Building Lab DK was in conclusion characterised by theorization and concretization processes which were narrow and which operated very independent of the existing complex of industrial interests. The aim of these processes was accordingly not to ensure broad industrial support but rather to outline the possibility of a radical alternative trajectory to the project oriented mode of production and development. The strategy to detach the theorization and concretization activities from the existing complex of industrial interests however also implied that modularization as sectorial development agenda remained very marginal.

Chapter 8 - Governing strategic sector development

The purpose of this chapter is to conclude the theses by discussing how the analysis of the previous chapters may inform strategies aiming to manage or govern sector development activities as they unfold in a present-day context.

This concluding chapter accordingly has a twofold agenda.

First the chapter elaborates on the analysis presented in the previous chapters by discussing the contemporary conditions for the build-up of collective capacity for coordinated action through strategic sector development activities. Secondly, based on this discussion the chapter offers some reflections and recommendations on how to support and manage processes of strategic sector development, given the conditions under which these processes operate in a present-day context.

The contemporary condition for doing sector development

Compared to the sector development activities in the Danish construction industry in the post WW2 decades the contemporary sector development activities have had difficulties in building collective capacity for coordinated change as it has proved very difficult to establish durable configurations of theorization, concretization and institutionalization processes.

The sector development agenda of the post WW2 decades was thus in contrast to the contemporary sector development agenda monopolised by a single sector representation which framed the sector as traditional and irrational by mobilising manufacturing inspired rationalization as the sectorial logic. As a sectorial object of development the construction industry accordingly existed in singular and it succeeded to orchestrate a series of relatively coherent interventions and development activities.

The contemporary sector development activities which were initiated in the early 1990ties have on the contrary been characterised by diverging theorization processes and no single or hegemonic strategic orientation has succeeded to dominate the sector development agenda. But why hasn't a single configuration of theorization, concretization and institutionalization processes succeed to monopolise or a least dominate the sector development agenda in the post 1993 period?

A main difference between the contemporary sector development activities and those of the post WW2 decades is that the post WW2 sector development activities were embedded in a broader societal development agenda. In the post WW2 decades the construction sector thus constituted an element of a broader societal modernization agenda which transformed Denmark into a modern industrial and urbanized society supported by a welfare state. Framed by this broader modernization ideology of the post WW2 decades the state thus succeeded to bring a set of hierarchical relations into operation in the development of construction industry which subsumed the practical execution of the craftsman under the calculative optimization of the planning engineer and these hierarchical relations were turned into experimental development activities through large scale coordinated public demand in social housing.

The role of the construction industry as sectorial object of development has been much more opaque during the contemporary sector development activities as the sector has disintegrated as a vehicle for a broader societal modernization because the housing shortage has been solved. The contemporary re-articulation of the construction industry as a sectorial object of development has thus been done in the absence of a larger societal purpose.

This diminishing role of the construction industry for the societal development at large has furthermore had a series of consequences for the housing ministry which has constituted the central actor in concern to the sector development activities. First, the housing ministry has become a ministry which is no longer central to the core policy formulation. Secondly, the development capabilities of the ministry have been weakened, specifically concerning its ability to guide a coordinated development through public demand.

The ministry has consequently been unable to articulate the construction industry as a sectorial object of development by reference to its broader societal role and it has furthermore not possessed the capabilities or resources to bring the type of hierarchical relations into operation which succeeded to give direction to the sector development activities in the post WW2 decades. In course of the contemporary sector development activities the relatively centralised theorization processes of the post-WW2 period have thus been superseded by more horizontal and uncoordinated theorization processes.

The contemporary sector development activities of the post 1993 period have in conclusion been conditioned by

- (i) theorization activities which have operated to establish the construction industry as a sectorial object of development in the absence of a broader societal orientation or purpose.
- (ii) a state oriented towards brokering rather than leadership
- (iii) the disintegration of the hierarchical relationships which in the post WW2 decades subsumed the practical experienced based execution of the craftsman under the calculative optimization of the planning engineer

The contemporary sector development processes

So how has the contemporary sector development activities unfold under these conditions?

As demonstrated in chapter 4 the contemporary sector development activities were initiated by the 1993 resource area analysis. It was accordingly this analysis which framed the contemporary sector development activities. So how did this analysis bring the Danish construction industry into being as a sectorial object of development?

Compared to the logic of the policy analysis which initiated the resource area analysis, the resource area analysis was itself informed by a very different logic.

Whereas the initial policy analysis had been informed by a cluster approach which suggested that industrial development should be catalysed by identifying and nurturing narrow and specific innovative combinations of technologies, companies and business concepts the resource area approach was on the contrary based on business economic logics which suggested that interventions should be informed by broad statistical analysis of the structure and organization of the resource area in its totality. While the resource area analysis informed by this business economic approach was able to put numbers on the sector and its activities in a variety of different ways it however remained unable to organize a representation of the industry which was able to directly inform concretization activities in a coordinated and operational way.

While the sector representation developed in the analysis was unable to directly inform concretization activities in any clearly defined way it however established a specific discursive structure which defined how it became possible to strategically talk and theorize the activities of the construction industry in the following decades. The industry was thus conceptualised as a series of challenges such as 'low productivity', 'low level of innovation', 'organizational fragmentation', and 'poor collaboration' and it argued that these challenges should be strategically addressed through so-called integrated sector development activities. The analysis accordingly suggested that these challenges were somehow connected with one another. It was accordingly indicated that these challenges needed to be addressed in an integrated and coordinated way. The analysis thus established a differentiation between a series of 'symptoms' and some kind of sectorial 'root cause'. This discursive structure was further developed through the concept of the sectorial 'lock-in' which suggested that the industrial symptoms were not likely to be solved through local and uncoordinated activities.

In short, the initial sector development activities of the 1993-2001 period establish the sector as a strategic object of development by portraying the construction industry as a system or organism which a) was out of balance (as indicated by the symptoms) and which b) did not possess the means to regain balance by itself (i.e. characterised by a lock-in situation).

The 1993 resource area analysis and the early sector development activities thus defined a specific *sectorial way* of addressing the Danish construction industry and it was the structure of this sector problematization which framed the theorization activities of the following decades of sector development activities. The contemporary sector development activities in the Danish construction industry may thus be perceived as an ongoing interplay between the structure or grammar of this sector problematization and a series of strategic expressions or theorization activities playing within this problematization. The theorization as well Building lab DK as DC may thus be seen as attempts to diagnose a series of sectorial symptoms as the effect of an underlying sectorial 'root cause'.

Two examples from the theorization processes of these initiatives may serve as illustrations of how both DC and building lab DK were formulated in the strategic play defined by this sector problematization.

The first example concerns the theorization of DC. During the theorization process the working group which provided the initial draft of DC was commissioned to:

"(...) identify and substantiate the need to establish the initiative "Digital Construction" including render probable that the establishment of an integrated and digital information- and production process will not develop on its own, but demand public involvement" (Erhvervsministeriet 2001:24)

In the term of reference the working group was thus commissioned to theorized the absence of an integrated digital information infrastructure as the 'sectorial root cause', implying that

- (i) such an information infrastructure would be able to cope with a series of the sectorial 'symptoms'
- (ii) such an information infrastructure was not likely to emerge without coordinated 'sectorial' intervention (That it would 'un-lock' the sectorial 'lock-in').

The project-plan of Building Lab mobilised the same type of 'sectorial' lock-in arguments by suggesting that a sectorial re-organization towards system-deliverances was not likely to appear spontaneously. An argument thus went that coordinated sectorial intervention was necessary because:

"the project oriented organization of the construction industry implies that it is difficult for the actors to think and operate in long sighted strategic development. It is the projects which control the companies rather than the companies which control the projects (Realdania 2005b:6)"

As demonstrated in the previous chapters the development of the sector problematization and the ability to make productive use of it was however a complicated process characterised by frustration and disintegrations especially in the 1993-2001 period.

In the 1993-2001 period the sector problematization was thus turned into semi-coordinated initiatives which hosted of a broad series of experimental activities. Concretization activities were however initiated largely at the expense of explicitly articulated theorization activities. The consequence was that the concretization activities became increasingly fragmented and uncoordinated. The lack of organized theorization activities were most clearly exposed in the early phase of 'project house' as it proved increasingly difficult to organize the proposed development activities into a coherent and integrated sectorial orientation. From the sectorial viewpoint the situation did thus become increasingly opaque as a consequence of the uncoordinated experimental activities which addressed the 'symptoms' rather than the 'root cause'.

As the former chapters have demonstrated the termination of 'project house' was however followed by the two much more coherently theorized sector representations which informed DC and Building Lab DK. The theorization processes which generated these two sector representations thus operated by addressing the problems of 'productivity', 'organization fragmentation', 'collaboration' and 'innovation' as symptoms of a single underlying sectorial 'root-course'. While the sectorial differentiation between the 'symptoms' and the sectorial

'root cause' had become increasingly opaque during the experimental activities in the 1990'ties these two sector representations thus succeeded to make productive use of it.

The sector representations of DC and Building Lab DK did however diagnose the symptoms by means of very different logics and their different diagnosis suggested different and mutual incompatible pictures of rational agency.

Mobilising the object oriented 3d model as the sectorial logic the sector representation of DC thus pictured the sector as *inconsistent and uncoordinated information flows*. Mobilising modularization as sectorial logic the sector representation informing Building Lab DK on the other hand portrayed the sector as *an under modularized production environment characterized by the absence of organizational specialization and company specific learning and capability building*.

Sectorial logic	Sector representation	Strategic orientation	sector development programme
Modularization	The construction industry as an under modularized production system characterized by project specific problem solving and short term collaboration which hinders organization specialization and innovation	Configurable system deliverances produced and developed independent of the individual construction project thus allowing organizational specialization and company specific learning and capability building	Building Lab DK
The object oriented 3d model	The construction industry as a series of inconsistent and	The development of a shared object-oriented	Digital Construction

	uncoordinated information flows	classification and information infrastructure able to ensure a unequivocal information flow capable of coordinating the project specific construction processes	
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The two sector representations thus generate different and incompatible images of rational agency as demonstrated in the table above. Some of these incompatibilities are listed below:

- (i) The objective of DC was to optimise the project specific design, planning and construction processes. The objective of Building Lab DK was to transcend these project specific design, planning and construction processes in favour of configurable and customizable system deliverances developed and produced independent of the individual construction project.
- (ii) The objective of DC was to develop a shared and comprehensive digital classification and information infrastructure for the industry as a whole which would be able to coordinate all processes and activities of a construction project. The objective of Building Lab DK was to reduce the dependency on shared industrial knowledge and information by only defining the interfaces between system deliverances.
- (iii) The objective of DC was to optimise and develop the work division between existing trades and professions. The objective of Building lab DK was to transcend the existing work division and the professional identities and allow for company specific specialization and capability building.

The image of rational behaviour reflected by the representation of DC thus suggested that the organization of the project oriented construction process needed to be optimized and coordinated by means of a comprehensive and shared digital information infrastructure. The image of rational behaviour reflected by the representation of Building Lab DK on the other hand suggested that the project oriented organization of the industry needed to transcend rather than optimised in order to facilitate organizational differentiation and company specific learning and capability building.

As a sectorial object of development the construction industry in conclusion came to exist as two representations with incompatible pictures of rational agency after 2001. Both these representations however emerged as a response to the 1993 sector problematization which had established the sector as 'root cause' indicated by a series of 'symptoms'.

The contemporary sector development agenda has in conclusion been organised very differently from the sector development agenda of the post WW2 decades as illustrated by the table below:

	1945 -	1993 -
Sector problematization	Housing shortage	Symptoms indicating underlying sectorial root cause
Sectorial logic(s)	Rationalisation	(a) The object oriented building model (b) Modularization
Sector representation(s)	Irrational and traditional	(a) Uncoordinated information flows (b) Under-modularization

Whereas the newly established housing ministry succeeded to establish a sectorial development agenda monopolised by be a single sector representation in the post WW2 decades, the contemporary sector development agenda have on the contrary been characterised by different and incompatible sector representations.

A key question in concern to the contemporary sector development activities is furthermore why DC and Building lab DK succeeded to transcend the foggy and opaque strategic situation which characterised the sector development agenda towards the end of the 1993-2001 period. What triggered this re-orientation?

One imaginable explanation could be that the more coherent sector representations which informed DC and Building Lab DK after 2001 were the result of the learning and mobilisation processes of the 1990'ties. I however suggest that a more comprehensive explanation also need to take account of the re-organization of the actor constellation which operated to define and influence the sector development agenda.

In the 1993-2001 period the housing ministry thus operated as the single most important actor in relation to the sector development agenda. After 2000 the central position of the Housing Ministry was however challenged. One change was that the ministry was closed down and replaced by the governmental agency EBST. A more important change was however that the philanthropic foundation Realdania went into operation as an alternative sector oriented actor.

The fact that the theorization of both DC and Building Lab DK emerged from the sector development activities in the 1993-2001 period thus indicates that a series of incompatible sector representations were already partly established during the sector development processes in this period. Since these theorization activities could however not be turned into concretization activities without direct support from the ministry, the overall orientation of the sector development agenda depended on the ability and willingness of the ministry to engage in the these theorization processes characterised by fundamental incompatibilities. The ministry however had to balance its engagement in the theorization activities against its obligation to build broad coalitions among the existing industrial interest on its policies. The sector development activities hosted by the ministry thus needed to be closely calibrated with the organized interests of the industry, as suggested by the quotation below:

"The state represents the common interests. The state has no interests of its own beside the political ones. And the political interests in question are productivity gains; ensure fewer fault and defects, create a

higher productivity per hour, because the construction industry amount to such a large part of GNP. The companies, the interest organizations and the research institutions each has their opinion on how to get there. It is thus the task of the state to mediate between these interests and ensure the largest possible support and to ensure that the end-product will be used by as many as possible (interview, Hellman) "

In the 1993-2001 period the ministry thus aimed to mediate between different lines of theorization activities. In effect this mediation implied that the ministry operated as if a single overarching sector representation which was able to integrate the different theorization activities could be established. The existence of theorization activities which pointed towards sector representations with incompatible pictures of rational agency was thus ignored and the concretization activities consequently felt victim to fragmentation and internal conflict as they were informed by incompatible logics.

With the establishment of Realdania an alternative sector oriented key actor was however established and this allowed some of the different theorization activities which had hitherto been forced into unity to develop separated from each other.

Realdania did however not only constitute an additional key actor to the governmental agency in relation to the sector development agenda in the post 2001 period, but also a very different one. As an independent philanthropic foundation a strategic concern of Realdania thus was to avoid being caught up in longsighted operational commitments based on calibration of existing interests. In relations to the wider play of interests the foundation thus represented an alternative to the governmental agency. The strategy of the foundation accordingly was to outline the possibility of radical sectorial alternatives rather than supporting politically robust but pragmatic alternatives which could gain broad support as indicated below:

"A very critical point in our thinking is (...) that we always give support for X years. We make a little experiment. Put a speedboat in the water, and see what it is capable of. And then we wish it good luck (Interview, Svendler)"

The two sectorial key actors which in the post 2001 period allowed different lines of theorization activities to developed independent of one another were thus defined by very different obligations and dependencies to the wider play of interests in the industry. This was also clearly reflected in the design of the development strategies which the governmental agency and Realdania supported in the post 2001 period.

As DC was hosted by the governmental agency this initiative was thus characterised by ongoing calibration with a broad series of interests in the industry. A key concern accordingly was to ensure the broadest possible ownership to the initiative among the organized interests of the industry. The consequence of this broad and ongoing calibration of interests was that the sector representation which informed the concretization activities remained ambiguous. The strategic orientation of the initiative as well as the key elements such as the building model thus continued to co-exist in a variety of ways.

Building Lab DK was on the other hand characterised by a more coherently theorized sector representation which reflects that this initiative was hosted by Realdania which compared to the governmental agency operated much more independent of the existing industrial interests. The strategy of this initiative accordingly was to bring its logics into operation among companies which were embedded in a project specific reality. A consequence of this focus however was that the initiative did not succeed to position and institutionalise its sector representation on the broader sector development agenda.

Neither DC nor Building Lab DK in conclusion succeeded to convincingly stabilize their strategic orientations beyond the operation of the initiatives themselves. In different ways it may be possible to criticize the initiatives for their inability to influence the sector development agenda through the development of more robust strategic orientations. DC may be criticized for its inability to stabilise a coherent strategic orientation and for its inability to make the object oriented information infrastructure exist in a singular and operational way. Building Lab DK may on the other hand be criticized for its lack of cross-consortium learning processes and for paying too little attention on achieving support from institutionalized and organised interests.

While these criticisms are important it may however also be argued that incompleteness is a condition facing any attempt at doing strategic sector development within a period of 3-4 years of development activities because any configuration of theorization, concretization and institutionalization processes that operates within such a short time horizon faces a series of dilemmas or trade-offs.

One of these dilemmas or trade-offs concerns the openness towards the surrounding environment. Openness may accordingly ensure broad mobilization but may also jeopardize effective coordination

Another trade-off is the relation between flexibility and the need for guidance. A fixed strategic orientation may accordingly help to guide experimental activity but may on the other hand be unable to adjust to the complex settings in which the development activities operate.

Sector development initiatives with a relatively short duration thus operate in a series of strategic dilemmas which cannot be ultimately solved. Rather than trying to avoid failures, the strategy of such initiative should thus rather be to deliberately choose among forms of failures. A close calibration with existing interest may thus succeed to build organizational capacity but may on the other hand jeopardize the coherence of the development agenda. A more narrow and shielded approach on the other hand allows for more radical development strategies, but may on the other hand make it difficult to anchor the strategic orientation in existing institutions.

Dilemmas and trade offs such as these indicate that incompleteness and tensions are conditions facing any attempt at doing strategic sector development within a very limited timeframe.

The question then is how the incompleteness of specific development initiative may be managed within the context of the broader sector development agenda.

Governing the sector as an object of development

As demonstrated above the contemporary sector development activities in the Danish construction industry have been faced with difficulties in developing a coherent and robust sectorial development agenda which has been able to transcend and organise more local strategic considerations. Rather, a multitude of more local and uncoordinated strategic considerations have continuously succeeded to prevent the sectorial development agenda from taking any definite form.

The aim of this section is to outline a possible governance response to sector development processes operating under conditions where more local and conflicting strategic interests cannot ultimately be subsumed under a single dominant sectorial development agenda.

I suggest that the literature on network governance may offer a point of departure for this discussion by pointing to a governance approach based on reflexivity and irony. The purpose of the network governance literature is to understand how capacity for change may be established under conditions like those which have characterised the contemporary sector development activities in the Danish construction industry. More specifically the literature aims to understand how capacity for change may be established in societal contexts characterised a) by increasing fragmentation due to functional differentiation and b) by increasing complexity due to the growth and interweaving of ill defined policy problems (Torfing 2005:306). Such contexts are according to the literature characterised by actors who are not organised according to unequivocal hierarchical structures but who do never less depend on each other in a variety of ways.

The suggestion of the literature goes that capacity for concerted action under such circumstances depend on so-called network governance processes, i.e. processes of coordinated interaction between actors guided by a negotiated and relatively stable horizontal articulation which entails some kind of public purpose (Torfing 2005:307). Network governance process thus designate processes organised by a common understanding developed between independent actors who have however recognised that they are mutually dependent on each others actions.

So what characterises network governance processes and how may they be cultivated and managed? Sørensen & Torfing (2009) suggest that network governance processes:

"(...) rely on precarious social and political processes that are easily disturbed by external or internal events. The socio-political context might be unstable and subject to profound changes, and the centrifugal forces within the network emanating from conflicts and power struggles might be stronger than the centripetal forces rooted in mutual dependency and institutionalized norms and identities (Sørensen & Torfing 2009:243)"

Following a similar line of argument Jessop further suggests that while network governance processes may constitute a strategy by which to ensure coordinated progress in complex societal contexts these processes may however also themselves fail for a variety of reasons. Specifically he suggests that:

- (i) Network governance processes may fail if they do not succeed to stabilise their object of governance through the development of a hegemonic articulation. Competing and partly incompatible articulations may accordingly destabilise the object governance and thus generate incompatible pictures of concerted agency
- (ii) Network governance processes may fail if the articulation over simplify the condition for action
- (iii) Network governance processes may fail due to resistance by the actors whose identity and interest are directly or indirectly represented by the articulation. This may lead to problem of securing compliance
- (iv) Network governance processes may fail if the articulation is not able to respond to changing conditions in turbulent environments

(Jessop 2003b 12-13)

In order to cope with these potential failures Jessop has cultivated the idea of a so-called meta-governance strategy. Meta-governance is thus about developing a response by which to cope with the potential failures of specific network

governance processes. The key concepts informing his meta-governance approach are *reflexivity* and *irony* (Jessop 2003:7).

Reflexivity is about recognising that any representation of a complex societal context intended to build collective capacity for coordinated action necessarily involves a reduction. Reflexivity is thus about inquiring into the material, social and discursive construction of the object of governance, and into why some representation or articulation has become hegemonic or naturalized (Jessop 2003:7). Reflexivity accordingly implies reflecting critically on the strategic implication of selecting one representation of the object of governance over others.

Accepting that representations depend on a precarious construction of material, social and discursive associations also implies accepting that failures, disintegration and breakdowns are possible or even likely outcomes of network governance processes. In order to cope with the likelihood of failure as a condition for network governance Jessop suggests irony as an appropriate stance. Irony on the one hand implies accepting that the ability to act in complex social settings depend on a simplification of reality and thus also accepting incompleteness and failure as an essential feature of network governance processes. Irony thus on the other hand implies dispensing with the 'pessimism of intelligence' by proceeding as if success were possible however in an informed way (Jessop 2003:10). Irony is thus about the willingness to continuously re-evaluate objectives and strategically choose among forms of failure and it is in this way different from the stance of the stoic who may choose to deny failures or redefine them as successes.

So how may a (meta) governance response to the contemporary sector development activities in the Danish construction industry be conceptualised and formulated informed by reflexivity and irony?

I suggest that the analysis above has identified two core governance challenges in relation to the contemporary sector development processes in the Danish construction industry.

The first governance challenge is about the development and formulation of an attractive sector problematization which allows sector level theorization activities to

emerge which aims to transcend and organise strategic activities which operates from more local and uncoordinated perspectives. This type of governance intervention is a central prerequisite for strategic sector development activities as the sector does not in itself represent a natural or privileged strategic perspective. Strategic activities are thus likely to operate from a multiplicity of alternative viewpoints. They may accordingly be organised from the perspective of the individual, the company, the region or a specific profession.

The second governance challenge concerns the ability to control and organize the theorization activities which a specific sector problematization generates. This governance challenge is central because a sector problematization is only likely to result in the theorization of a single hegemonic sector representation under very special circumstances. This is because sector representations are not theorized in an abstracted space which exists independent of more local strategic interests. Theorization activities rather operate by mobilising and aligning local interests, experiences and resources by means of a sectorial logic. The same sector problematization may accordingly generate very different lines of theorization activities which mobilise and aligns interests, experiences and resources by means of different logics. If governance measures are not mobilised to effectively organise a sector development agenda that consist of several strategic orientations with incompatible pictures of rational agency the sector development agenda is accordingly likely to develop into conflict and disintegrate.

The analysis above suggests that the main difficulties in structuring the contemporary sector development agenda in the Danish construction industry relates specifically to the problems of coping with this second governance challenge.

Two strategy papers which reflect the sectorial discourse in the post 2001 period furthermore indicate that the governance capability to organise the theorization activities remains underdeveloped. One of these is a paper titled 'vision 2020 - sense in construction', commissioned by EBST and produced in collaboration between a broad group of managers within the construction industry in 2006 (EBST 2006) and the other is the latest governmental action plan for the construction industry released in 2007 (Økonomi- og Erhvervsministeriet 2007).

By vision 2020 the sector is represented by its ability to 'make sense'. Mobilising 'sense' as the sectorial logic the paper identifies the fragmented organisation of the industry as the key challenge. This fragmentation is accordingly found to make the sector weak in delivering sense to the individual as well as to the society at large. This sector representation thus points to the need for better integration and collaboration as a prerequisite for addressing the need and dreams of the individual and the society.

Within the frame of this strategic orientation modularization and system deliverances is envisioned to play an important role as reflected in the quotation below:

"In 2020 the construction industry has developed a market for system deliverances and this has increased the quality and productivity in the sector. System deliverances are developed in strategic partnerships between companies across the value chain of the industry - and companies in other sectors (EBST 2006:18)"

Also traces of the sector representation of DC are integrated in the strategic orientation. In order to deliver sense to the individual customer it is accordingly argued that:

"The companies and research institutions of the construction industry need to establish strategic collaborations to develop and implement ICT in the sector (EBST 2006:11)"

Additional to the logics developed within DC and Building Lab DK it is however also suggested that sector development activities should cope with legal barriers, faults and defects, ensure labour market mobility, ensure collaboration across sectorial boundaries and between companies and knowledge institutions (EBST 2006). The ability of the sector representation in providing a coherent and focussed strategic orientation is thus limited. This is also implicitly recognized in one of the final recommendation which goes that:

"the construction industry should work to establish a single united sector-organization, which can ensure a common direction and guidelines and strengthen the impact and image of the industry (EBST 2006:18)"

Perceived as a governance attempt to structure and organise the sector development agenda the vision thus resembles the theorization activities of the 1993-2001 period as it remains inclusive enough to embrace very different logics without coping with the contradictions and incompatibilities between them. While 'vision 2020' may be criticized for operating with a very inclusive strategic orientation and for neglecting the incompatibilities between the logics which it mobilises the governmental action plan 'better and cheaper construction' is however characterised by the absence of any organized sector representation all together. The action plan thus consists of 24 proposals for interventions with weak resonance to any overarching sector representation (Økonomi- og Erhvervsministeriet 2007:5-6). The sector thus appears to be an arbitrary container of problems, relations and activities, rather than a coherent totality of interdependent problems, relations and activities which may be subjected to orchestrated development activities.

The attempts of these governance interventions in organising the different logics at play do accordingly not provide a usefull point of orientation to actors engaged, affected or attracted by the sectorial development agenda. As an objects of development the sector is thus left in an under specified state of uncertainty by these governance interventions.

But what type of governance response would then be able to structure and stabilise the sector development agenda? I suggest that a necessary starting point is to accept that as an object of strategic development the sector is only likely to emerge as a single hegemonic configuration of theorization, concretization and institutionalization processes under very special circumstances. Under conditions where such a single hegemonic configuration cannot be established the governance response should accordingly avoid attempts to integrate and force incompatible logics into an apparently unified development agenda.

I accordingly propose that a productive governance approach should appreciate that the sector development agenda consists of different logics with informs incompatible representations of the sector and incompatible images of rational agency. This implies that governance interventions should articulate the sector development agenda as a choice between a structured and transparent set of different problem representations and development agendas informed by different sectorial logics. Such an approach should thus aim to actively recognise and frame the incompatibilities between the different representations as well as the fundamental difference in their visions of development. Such an approach would consequently need to dispense with the vision of a transition from one industrial configuration to another and rather begin to imagine the future operation of the construction industry as the co-existence of production and development activities organised by a set of clearly differentiated mechanisms of coordination and development.

A specific objective of such a governance approach would be to anchor the sectorial logics and the representations with these logics inform independent of specific concretization activities. The analysis above thus demonstrates that sector representations which are narrowly associated to specific concretization activities with a duration of 3-4 years are like to disintegrate. This indicates that specific concretization activities need to be embedded in a more strategic development agenda with a time perspective of decades which should organised on the level of the sectorial logics.

Such a sector development agenda specified on the level of the sectorial logics could then be embedded in an analysis of the exogenous pressures on the industry such as climate change, international competition, mitigation patterns etc.

So what would the advantages of such a (meta) governance response be?

First, organizing the sector development agenda as a choice between a structured and transparent set of clearly differentiated problem representations and development activities informed by different logics would help actors in the industry to gain an orientation and make deliberate and informed choices on how to engage in these development activities.

Secondly, such a governance approach would help stabilise the different development agendas independently of specific development initiatives. The analysis above thus demonstrates that specific initiatives tends to be followed by radical uncertainties because the initiatives are only very weakly embedded in a more encompassing framing of the sector development agenda.

Thirdly, such a meta-governance approach could help define an alternative work division between the state and other sector oriented actors such as Realdania. Instead of supporting their own configuration of theorization, concretization and institutionalization processes the state and Realdania could thus operate to support the different configurations through different types of activities. The state could thus operate to support institutionalization activities aiming to anchor the strategic orientations through regulation and client policies while Realdania could be active in the more experimental concretization activities. In this way the state and Realdania could become more supportive of each others development activities

Fourthly, such a governance approach could be used to structure and organise thematic research- and development activities on e.g. user driven innovation or sustainability. Such thematic research- and development activities could thus be unfolded differently within the different strategic orientations of the over all sector development agenda.

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List of interview persons

Digital construction

Bang, Henrik

Head of the building Client Association and involved in the implementation network

Bertelsen, Sven

Central figure on the sector development arena since the early 1990'ties

Brinch, Stig

Employed at Niras, a consulting engineer, which was part of the project web consortium and involved in the development of a digital classification of the construction process

Foldager, Andreas

Project manager of the project web consortium (PWK)

Friborg, Gunnar

Head of Bips and the consortium Digital Foundation

Dræbye, Tage

Advisor to the Governmental agency EBST in relation to the formulation and concretization of Digital Construction.

Gyldenvang Steffensen, Kikki

Former employed as state building client

Hancock, Eva

Employed as state building client

Hauch, Peter

Former head of the TR initiative and actively involved in the formulation of Digital Construction

Hellman, Nicolai

Former employed in EBST. Was key actor in the secretarial of Digital Construction located in the governmental agency EBST

Jensen, Frederik

Employed at EBST, the governmental agency hosting for Digital construction

Jensen, Jørn

Employed at the Danish Construction Association (Dansk Byggeri) and involved in the work of the implementation network

Karlshøj, Jan

Project manager of the consortium B3D

Sørensen, Niels Lykke

Employed at the National Building Research Institute

Building Lab DK

Clausen, Lennie

Project manager at the foundation Realdania

Hvam, Lars

Employed at IPU, a university based consultancy in product and process development, which was part of the configurable balcony consortium

Jespersen, Gert

Employed at NCC, a Scandinavian contractor. Project manager of the modular installation unit consortium

Juul Rasmussen, Janus

Consultant in modular product development and employed at Valcon which was part of the modular installation unit consortium

Kjær, Rolf

Employed in the architect firm Arkitema which was part of the consortium 'modular building systems in high strength concrete.

Kudsk, Anders

Employed in NCC, a Scandinavian contractor. Working with ICT and Strategic Business development

Mossin, Natalie

Former employed in the Building Lab DK secretariat

Ramlyng, Bo

Architect, partner in the architect firm RH arkitekter which was part of the modular installation unit consortium

Ross Pedersen, Erik

Head of the advisory board of Building Lab DK

Svendler, Hans Peter

Director of the philanthropic activities in the foundation Realdania

Thomassen, Mikkel Andres

Head of the Building Lab DK Secretariats