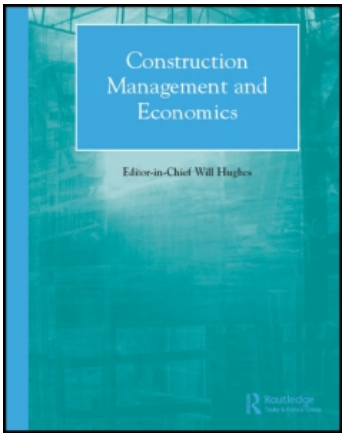

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Managing knowledge in platforms: boundary objects and stocks and flows of knowledge

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Previous research suggests that construction industry companies use relatively little formal managerial procedures when managing knowledge. Instead, many construction companies are relying on informal networks and social capital as conduits for the sharing of knowledge. However, objects play an important role in organizations as vehicles for the sharing of knowledge. The use of *platforms*, standardized packages of prescribed components, routines and practices, in a major Scandinavian construction company (SCC), demonstrates that platforms are potentially useful when sharing and accumulating knowledge. The platform concept is a boundary object integrating various functions and activities and standardizing work procedures while at the same time leaving some room for contingencies and local conditions. SCC's use of platforms contributes to the understanding of knowledge sharing practices by emphasizing the role of formally enacted objects and tools and by underlining the need for bridging and bonding the stocks and flows of knowledge in construction companies.

Keywords: Platforms, knowledge sharing, boundary objects, construction.

Introduction

One of the standing debates in the knowledge management literature is whether to conceive of knowledge as a stock of assets or as a flow of competent activities drawing on a blend of know-how, previous experience and mindful evaluations of situations and choices (Bontis *et al.*, 2002; Amin and Cohendet, 2004). In the former perspective, knowledge is conceived of as a rather fixed body of know-how, embedded in organizational routines, patents and in the expertise of individuals. This view is predominant in the literature drawing on economic theory (e.g. Dierickx and Cool, 1989) when examining knowledge management procedures. For instance, Boisot (1998, p. 63) suggests that 'assets are stocks rather than flows and we have seen that knowledge assets can be stocked in people's heads, in documents, or in artefacts'. In a similar vein, Davenport and Prusak (1998, p. 17) claim that 'the potential for new ideas arising from the stock of knowledge in any firm is practically limitless'. The alternative perspective, conceiving of knowledge as what is constituted as a flow embedded in practices, recursively both drawing on pre-existing know-how and creating and extending the know-how through its actual use (Gupta and Govindarajan, 2000; Cook and Brown, 2002), is a more commonplace perspective in the more sociologically oriented literature. For instance, Orlikowski (2002, pp. 252–3) says that '[k]nowledge is an ongoing social accomplishment, constituted and reconstituted in everyday practice. As such, knowing cannot be understood as stable or enduring. Because it is enacted in the moment, its existence is virtual, its status provisional'. In the knowledge management literature, there is a tension between seeing knowledge as what is laid down in procedures and routines, in patents and standards, that is, what is if not a 'reified thing' at least used instrumentally, and what is constituted and reproduced through everyday use of knowledge. For instance, Starbuck (1992) says that in many cases preservation demands application; only though actual use, a body of knowledge is maintained over time.

In the construction industry, the management of knowledge is a central concern because the construction

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process involves a series of recurrent activities embedded in economies of scale. In addition, much research suggests that in comparison to other industries, construction companies tend to be relatively little concerned with the formalization and codification of operative knowledge; rather than using detailed procedures for capturing operative knowledge, much of the knowledge employed in the construction industry remain personal or community-based. For instance, Rooke and Clark (2005, p. 562) notice that knowledge passed from individual to individual in construction companies is unlikely to be 'adequately recorded', i.e. codified and systematized into formal documents and media. In addition, much of the construction industry work is organized in projects, temporal organization forms, a form of organization that has been proven to pose a number of challenges when it comes to knowledge sharing between projects (Bresnen *et al.*, 2004; Scarbrough *et al.*, 2004; Enberg *et al.*, 2006; Green, 2006; Boh, 2007; Ding *et al.*, 2007). In general, construction companies are experimenting to identify mechanisms that are capable of capturing a set of know-how that is both relevant for a number of activities and settings and flexible enough to allow for thoughtful modification of the standard operating procedures.

A case study of a major multinational Scandinavian construction company (referred to with the pseudonym SCC), working with what they refer to as *platforms* as a vehicle for bridging and bonding the stock and the flow of knowledge in the corporation, was conducted in Stockholm and Gothenburg in Sweden the during the Winter and Spring 2008. The study suggests that platforms are not very easily implemented in the construction industry since there is a strong instituted principle in the construction industry to avoid standardized solutions and off-the-shelf design of buildings. The platform is defined by SCC as '[a] prescribed set of technical solutions verbalized in terms of controlling demands on the design'. In addition, the company information folder suggests that by 'applying standardized technical solutions, standardized purchasing routines and efficient production methods we provide our clients a sustainable construction process'. This definition suggests that the platform is a tool for standardizing both technical solutions and practices involved in construction work. The platform is thus a form of *boundary object* aimed at serving to both structure and guide the actual construction work but also to integrate various functions. However, as being a boundary object, there are two principal features of the platform. First, the status as object implies that an entity has achieved relative stability, an integrated and coherent form. At the same time, in the case of boundary objects, such inherent stability is always at stake; the very idea of the boundary object is that it is capable of being malleable and fluid enough to bridge various groups and communities while at the same time sharing some characteristics across such groups and communities (Knorr Cetina, 2001, p. 182). There are no intrinsic qualities in objects making them qualify as boundary objects. Instead, boundary objects become a centre of relations as soon a group of individuals decides that such is the case. Boundary objects are socially enacted, always open to negotiations and controversies, and therefore they are never fully stabilized but always at stake. However, with the extent of use and its gradual institutionalization, boundary objects become less debated. It is nevertheless important to keep in mind that boundary objects are based on social conventions and practical utility. Second, the weakness of the boundary object is, as emphasized by Sapsed and Salter (2004), that it is by definition operating at the fringe of interest of the groups and communities involved. In order to fully serve its purpose, the boundary object must operate in the intersection between various groups or communities (Yakura, 2002; Bresnen, 2006). In other words, what is the strength of the boundary object is also its weakness, that is, its relatively fluid and amorphous nature. Speaking in practical terms, boundary objects such as platforms must of necessity be articulated and defined in rather loose terms, simultaneously prescribing specific practices and technological solutions and enabling local interpretations and solutions to perceived problems.

Managing knowledge as platforms

Knowledge management has emerged as one of the most important perspectives on organizations and competitive advantage. Beginning in the 1990s, arguably with a special issue in *Strategic Management Journal* (Spender and Grant, 1996) advocating a 'knowledge-based view of the firm', complementing the resource-based view of the firm that was a major contribution to strategic management theory in the 1990s, the term 'knowledge management' quickly gained a foothold in academic circles and eventually poured into the domain of management consulting. Today, the field of knowledge management is diverse and includes a variety of complementary or even contradictory perspectives on how knowledge is playing a decisive role in creating sustainable competitive advantage and above-normal profits (or 'rents') in firms and industries. In the construction management literature, the knowledge management framework has been well received conceptually, albeit there is relatively little research conducted and the findings are far from conclusive. Carillo *et al.* (2004) and Robinson *et al.*

(2005)—being part of the same research team—study the use of knowledge management in the UK construction industry. They found that a majority of the companies actively used knowledge management practices and in 61.9% of the cases a knowledge manager had been assigned the role of being responsible for the firm's knowledge management activities (Carillo *et al.*, 2004, p. 51). Carillo *et al.* (2004, p. 50) show that 63% of the responding firms in the survey regarded their knowledge management work as being 'an ad hoc process'. Furthermore, they (2004, p. 50) suggest that 'the lack of standard work processes' is regarded as the single most important impediment towards the use of knowledge management practices. Kamara *et al.* (2002) found in their research in the British construction industry that a variety of firms in the construction industry do in fact use knowledge management practices but the study failed to account for how the daily routines and activities are carried out. Similarly, in Kazi's (2005) edited volume there is an emphasis on *what* is done in the field of knowledge management rather than *how* it is done, and shortcomings in current activities are helping construction firms to share know-how between projects and between professional and occupational groups. A number of studies conducted by a research team at the University of Warwick in the UK are more detailed in terms of actual practices. For instance, Bresnen *et al.* (2004) studied how the use of a knowledge management tool called 'The Dashboard' was implemented and used in three regions in a British construction company. In another study, Bresnen *et al.* (2005, p. 240) found that co-workers in construction projects favoured rather 'traditional means' for sharing knowledge including 'direct contact, telephone and e-mail', while mechanisms for '[a]ccessing a wider knowledge base (namely, the company's intranet and wider Internet access) was not so well used'. In general the studies of Bresnen *et al.* (2004) and Bresnen *et al.* (2005) portray the construction industry as being rather conservative and only marginally concerned about implementing and using knowledge management and knowledge sharing routines and tools. The lion's share of the knowledge management work derived from everyday conversations and the use of a few elementary planning procedures such as Gantt-charts and milestones and tollgates project management models. In their study of environmental communication in construction projects, Gluch and Räisänen (2009) point at consequences derived from prevalent construction management practice. They showed that for issues with a higher order of complexity such as sustainability, knowledge sharing was restrained not by lack of information, but rather by inconsistencies between the communication cultures and the genres used to mediate the information. Other studies point at the value of knowledge management practices in the day-to-day work. Drejer and Vinding (2002) identified what they refer to as 'knowledge anchoring processes' helping Danish construction firms to deal more effectively with abstract and tacit forms of knowledge:

> The lesson for managers is that knowledge-anchoring mechanisms and partnering may help reduce the shortcomings of project-based organizations as regards capturing, sharing, and diffusing knowledge and learning across projects and instead to become more knowledge-driven. The use of post-projects review and systematic evaluations and diffusion of experiences means that managers may have less difficulty in combining strategies of short-term task performance with long-term learning and knowledge accumulation. (Drejer and Vinding, 2006, p. 928)

In Patricia Carillo's (2004, p. 640) analysis of the oil industry—an industry she believes is sharing a number of characteristics with the construction industry—Carillo recommends what she calls 'people-centred techniques' for the sharing of tacit knowledge, and IT tools for the sharing of explicit knowledge. This recommendation is by and large supported by Rooke and Clark (2005, p. 562) who notice that in construction companies, construction workers have in general three ways of learning: (1) by 'watching more experienced co-workers'; (2) by 'trying things out'; or (3) by 'direct instructions' (Rooke and Clark, 2005, p. 566). These findings are consonant with for instance Fine's (1996) ethnographic study of how restaurant chefs learn the trade, putting much emphasis not on theoretical knowledge but on practical work in a real-life work setting. There is, in other words, a rather *practical* approach to learning in the construction industry; instructions accompanied by observations and eventually actual activities make up a 'learning cycle' constituting the 'experiential knowledge' of the construction workers. In addition, a number of studies emphasize the influence of what sociologists call *social capital* (Coleman, 1988; Portes, 1998; Mouw, 2006), i.e. the relational and collective skills in sharing know-how and experiences. Studies of Styhre (2008), Bresnen *et al.* (2005) and Newell *et al.* (2004) suggest that since construction companies are relatively reluctant to codify and formalize their operative knowledge, such firms become reliant on their ability to share know-how and expertise in a network organization model when problems occur. Social capital is thus a form of collective competence in active problem solving and the sharing of know-how with colleagues is arguably instituted in the professional culture of construction workers. However, from a managerial perspective, social capital is a fickle basis for a knowledge-intensive firm because, as Bresnen *et al.* (2005, p. 237) point out, '[s]ocial capital can be a very costly and inefficient means of

obtaining information as it involves considerable effort in establishing and maintaining relationships'. Therefore, rather than leaving knowledge as a fundamentally distributed resource in construction companies, there are a range of ongoing activities aiming at capturing and formalizing knowledge. One such mechanism enabling a bridging between the stock and flow perspectives on knowledge is the use of platforms, a form of standardization of what resources and activities need to be mobilized when constructing a building or some other civil engineering entity (e.g. bridges, parking lots, parks).

Platforms as knowledge management tools

A platform is defined as a set of prescribed processes, entities, operations and resources that are brought together when producing some relatively standardized output (Chang *et al.*, 2008). In the automotive industry, platforms have been used over a considerable period of time to produce a family of car models sharing a basic set of features derived from the platform, and in the pharmaceutical industry, the concept is used to unify fields of expertise in new drug development and to build dynamic capabilities (Narayanan *et al.*, 2009). The platform is here the shared common ground from which a set of operations and outputs are produced. As sociologists increasingly recognize, objects mediate social relations and provide stability over time (Knorr Cetina, 1997; Law, 2002; Pels *et al.*, 2002; Lowe, 2004; Law and Singleton, 2005; Mackenzie, 2005). Bechky (2003, p. 746) argues

> Artifacts are an important part of organizational life: they surround us, and our work and roles are dependent upon them. As an integral part of work processes, objects help us to accomplish tasks, but not in a merely technical manner. Artifacts, subject to interpretation, participate in the constitution of the social dynamics of organizations.

Examples of objects structuring and shaping social relations are *epistemic objects* (Rheinberger, 1997), *textual agents* (Cooren, 2004), *scripts* (Callon, 2002), or *boundary objects* (Star and Griesemer, 1989; Carlile, 2002; Yakura, 2002; Sapsed and Salter, 2004; Bresnen, 2006). These different types of objects serve different purposes or ends in organizations: *epistemic objects* is a concept that helps scientific communities guide and coordinate their laboratory or field practices and integrate theories, technologies and equipment, and empirical data into a meaningful technoscientific framework; *textual agents* are written or visual documents that help organization members circulate information and instruction over time and space; *scripts* are instructive readings or manuals for how to proceed in a specific field. While there are various epistemic objects, textual agents and scripts in use in the construction industry, the platforms used in SCC are here conceived of as boundary objects, primarily because one of the principal roles of the platforms is to coordinate and integrate activities including a variety of heterogeneous actors.

The boundary object, first introduced by Star and Griesemer's (1989) seminal work on the Natural History Museum in Berkeley, California, is defined by Bowker and Star (1999) as follows:

> Boundary objects are those objects that both inhabit several communities of practice and satisfy the informational requirement of each of them. Boundary objects are thus both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use and become strongly structured in individual-site use. These objects may be abstract or concrete … The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting communities. (Bowker and Star, 1999, p. 297)

Organizations are constituted by various forms of expertise and know-how. Being able to integrate these communities, various objects play a decisive role (Swan *et al.*, 2007). For instance in engineering work, drawings serve the role of boundary objects capable of aligning the designers and operators. Bechky (2003) suggests in her study of the work in a machine-building shop that both drawings and the machines per se served the role of boundary objects:

> Artifacts were also used to mediate occupational boundaries during episodes of problem solving. When problems arose in the building process, both drawings and machines were used as boundary objects between occupational communities to help solve them. (Bechky, 2003, p. 732)

In the same manner, Faulkner (2007, p. 335), studying engineering work, claims that 'drawings act as *the* boundary object' in the profession. This does not suggest, however, that boundary objects are neutral objects under the equal influence of all communities involved. In Bechky's (2003) study, the designer engineers had the authority and credentials to acquire the prerogative to have the final say on how the drawings were to be interpreted and transformed into built machinery. Bechky (2003) even suggests that engineers are maintaining their jurisdiction over their work through mystifying the meanings of the drawings; designer engineers always have the authority to determine how the drawings were to be interpreted and translated into actual practices.

Seeing platforms as a form of boundary object, an integrated formalized model of how a specific social

practice, e.g. building a house, should be undertaken, is to underline its role as a potential means of bridging and bonding various communities in construction firms. Since much knowledge being used in construction projects is either tacit or poorly formalized, a platform is an adequate and applicable tool for coordinating and aligning a set of idiosyncratic practices in the industry. Platforms are in other words serving as boundary objects helping to integrate forms of know-how and experience and other resources being enrolled in the activities without imposing a determinate model of how such resources should be used. Expressed differently, a platform is a mechanism that is potentially capable of bridging the stocks and the flows of the knowledge work in organizations. However, in order to function properly, the boundary object must strike a balance between accuracy and flexibility; it must not be too detailed but neither can it be too loosely defined. When tipping over to either side, the boundary object, i.e. the platform, is potentially losing its role and purpose as a tool for managing knowledge. As the study will show, in SCC, the balance was not (yet) very well managed, making the platform become a bit too general to fully serve its role as an effective tool for knowledge sharing.

The SCC platforms

In the case of SCC, there were three basic types of platforms: *commercial office building*, *housing*, and *sports and training halls*. The platforms specify three areas guided by platform specifications: (1) design work procedures; (2) technical solutions; and (3) building methods (in the production phase). When standardizing these three processes in the construction project, the platform is intended to reduce the costs in the design phase, in the procurement work, and in the production phase. The different product offerings are specific in a number of documents collected at a central platform directorate in the Stockholm office. The platforms are offering a number of choices and alternatives regarding for instance the windows used or what material to use in the various parts of the building. The platforms are thus narrowing down the number of possible choices while at the same time allowing for some local variation and individual creativity. However, which is important to emphasize, the platform is not intending to serve as general tool for cutting costs through e.g., using more prefabricated materials and modules; it is intended to serve as a tool for reducing costs *indirectly* through more effective coordination of a series of recurrent activities throughout the construction projects. As new experiences and insights are made in the construction projects, further advancing the know-how of SCC co-workers, the project managers are encouraged to submit their suggestions for changes in the platform. If for instance one specified technical solution did not work as intended, the platform is modified to avoid future mistakes. Seen in this view, the platforms are intended to serve as flexible and continually changing scripts for how the building should be effectively produced. It is also worth noting that by no means all construction projects within SCC are based on any of the three platforms. The platforms are primarily used in the contracting form where the company serves as both property developer and contractor and thus can wield greater influence over the entire construction project.

Method

This study is part of a broader research project aiming at identifying mechanisms and routines for managing knowledge in the construction industry. The selected firm for the study is a major Scandinavian construction company, here referred to with the pseudonym SCC, having its headquarters in Sweden but operating in the Nordic countries, Sweden, Norway, Denmark and Finland, the Baltic countries and Germany. In the study, 13 co-workers were interviewed. The interviewees were managers either responsible for running some knowledge management procedure or tool or were using these procedures in their daily work. A contact person in the firm was helping out to arrange the interviews. About half of the interviews were conducted in the regional office in one major Scandinavian city while the rest of the interviews were conducted at the head office in Stockholm. All interviews were structured in accordance with an interview guide and included a set of questions that were addressed by all interviewees. The interviews were either conducted by two senior researchers (about half of the interviews) or by one of the senior researchers. Interviews were transcribed verbatim by one of the researchers. The transcribed interview material was examined and analysed by the two researchers individually and the material was coded using procedures recommended by Strauss and Corbin (1998) and Miles and Huberman (1984). The interview excerpts selected were *emplotted* (White, 1978; Czarniawska, 2004), i.e. structured into sequences that were intelligible and made sense for the researchers and potential future readers of manuscripts produced. The analysis of the interview transcripts focused on the ways in which the different actors constructed their social world in their narratives. Key words, phrases and concepts were extracted, compared and contrasted. Representative extracts were then selected to construct the narratives represented in quotes used to illustrate specific

phenomena related to knowledge management practice in general and the platform concept in particular.

Platforms as what bridge stocks and flows of knowledge in construction work

Practically speaking, a platform is a bundle of instructions, blueprints, recommendations and other documents pertaining to the object to be built. That is, the platform is by no means captured in a single text but instead develops as an assemblage comprising a number of entities that are not possible to reduce to one single document. SCC describes their platform vision and concept as follows:

> We [SCC] define the platform concept as a prescribed set of technical solutions verbalized in terms of controlling demands on the design. Applying standardized technical solutions, standardized purchasing routines and efficient production methods we provide our clients a sustainable construction process … A major benefit is the platform's repetitive nature, where positive aspects are repeated throughout the whole value-chain and eventual deficiencies can be eliminated fast on several places once and for all. … The follow up and feedback loop of previous learnt experiences makes the method complete. (Information folder, SCC, 2008)

The skilled project leader and construction site manager is capable of comprehending the various documents and instructions and constructing one single image of the forthcoming building on the basis of heterogeneous resources.

The rationale for the platforms

The ability to share knowledge effectively has been a standing concern for the construction company SCC over the years. Essentially organized into a multi-project form, the sharing of knowledge between phases and projects is more complicated than in companies located in one site. When discussing knowledge sharing mechanisms and tools with construction industry managers, it is at times remarkable how recently more advanced computer media has been brought into the everyday routines. For instance, one of the senior co-workers, approaching his retirement, discussed how a standardized 'folder system' was implemented in the mid-1990s to enable a substitution of co-workers when needed:

> Out on the construction sites, we were using a folder system [containing all information] … we decided [in the headquarters] that the folders should be on the construction sites. In the mid 1990s, the folder systems worked the same in all construction sites. If someone was sick, then a replacement could come there and get some guidance from the folders. Prior to that, each and everyone were using their own system and it was a total mess. When you had to help someone who was sick and you came to the site, then you couldn't find a single paper. The first thing to do then was to develop this folder system. (Interviewee #3)

Today, computer-based media is an integrated component of the working procedure in construction companies but the use of Intranet services to store, share and distribute knowledge was yet a source of improvement in SCC. 'If I am correctly informed', one of the interviewees (#2) said, 'SCC has during a long period of time tried to collect experiences and know-how in databases but that has not worked as intended'. 'We do not have a proper system for absorbing our know-how', another interviewee (#3) claimed quite frankly. However, SCC and the construction industry in general were facing a new challenge, the retirement of a significant amount of co-workers and therefore new procedures for knowledge sharing was called for.

Another rather recent concern for the industry was the rather low barriers for changing employer. Traditionally, many co-workers remained in one company for a substantial period of time, in some cases entire working lives. In SCC there was a constant inflow and outflow of co-workers entering and leaving the company: 'On daily basis, there are co-workers disappearing from the company to work with competitors—in executive positions too. That is how it works. We lose regional managers and business area managers' (Interviewee #5). Beside the recruitments costs and the disruption of work routines, this migration of expertise imposed a knowledge management problem on the company, namely how to extract and codify all the individual expertise. A third tendency in the industry that put pressure on the company to develop more sophisticated routines to share knowledge was what has been called mass-customization of housing. When mass-customizing houses, the end-users were involved in the process and could select for instance interior decoration features from a set of alternatives. Being able to cope with the complexity in the project work derived from the mass-customization procedures demanded a firm structure for how to run the projects. One of the site managers pointed at the increased work in mass-customized projects: 'In one single day, I may receive 60 mails just addressing kitchen and bathroom issues. When I have placed all the orders and have received the response from the suppliers, but then I need to do it all over again' (Interviewee #8). More generally, the construction industry was, some of the interviewees argued, lagging behind other industries in terms of routines for knowledge sharing. For instance, one of the line managers compared with the European Space Agency having some 3000–4000 points where they checked and controlled their procedures when launching a space shuttle, arguing that the construction

industry was not able to demonstrate such a commitment to routines for knowledge sharing:

> Seen in that perspective, the construction industry is pretty lax on joint learning. We tell our business area managers that we expect final project meetings to be arranged … but we do not have enough management control mechanisms to accomplish that … I think it is *unquestionable* that this should be delivered. If you run a project, it shouldn't be that complicated to make five observations and put it down on a paper and submit it to us. Then we would put in it into a computer system to make it searchable. It is not that damn complicated! (Interviewee #5)

Platforms as vehicles for managing knowledge

The constant drainage of individual know-how, the change of generation in the industry, and the relatively poorly developed routines for sharing knowledge all contributed to a sense of urgency in terms of developing and implementing practices for standardizing work routines and for the dissemination of knowledge developed within the company. One such practice was the use of platforms specifying a number of technical features in a certain type of construction work. Besides the platforms, SCC were working with developing more sophisticated Internet-based media for knowledge dissemination and had assigned specific communities named *knowledge centres* to take the responsibility for certain domains of expertise. The Internet-based services were generally regarded as being archaic by the interviewees, complaining about the quality of the search engine and the lack of user-friendliness of the system, and the knowledge centres were not yet fully implemented and therefore little known in the organization. The platforms were, in contrast, implemented and widely used in the organization. 'About 70% of what is built [of the so-called development projects, i.e., new housing. A majority of the total SCC project stock is not this kind of project] is built according to the platform concept', Interviewee #4 claimed. The platforms served a number of functions in the company, for instance as a mechanism for sharing know-how between generations:

> Q: How do you perceive them [the platforms] as a means for knowledge sharing?
> A. As being important.
> Q: In what way?
> Q: Not the least in terms of handling the forthcoming shift of generations. It is very much about capturing the know-how we house and not to make the same mistakes as have been done before. (Interviewee #1)

In addition, the platforms were supposed to serve as a means of capturing previous experience and accumulating a growing stock of experience and know-how in the company over time. One of the interviewees emphasized this function:

> The platform is constructed to avoid that we are reinventing the wheel in every project. That is what we do in the construction industry. The feedback of experience remains in the workplace, and then there's a new project with new challenges. Quite often, things go wrong in the projects. We're going to develop a concept that will be viable. We'll stick to the platforms quite simple. (Interviewee #2)

Rather than developing local knowledge at each construction site, evaporating into thin air or at best being embodied by the individual co-workers, the platform concept should serve as an intermediary link between projects both synchronically and diachronically. One of the possible concerns when using such standardized packages to structure the activities is whether the standardization is being taken too far, thereby eliminating all creative moments in the work. One of the interviewees denied such concern:

> Q: So there are no concerns regarding a too far-fetched standardization and elimination of all creative moments in the work?
> A: No, all of that is there anyway, I can tell you. It is impossible to anticipate all possible events. There are always discoveries to make but we are happy if we are capable of minimizing them to zero, right. (Interviewee #2)

Construction projects are generally perceived in the industry as hosting a series of emergent properties, a number of characteristics that can never be fully anticipated or prevented before they occur and therefore the platforms were instead regarded as in fact supporting more creative thinking since much of the routine work was eliminated and brought into the specifications of the platform. Even though the platform concept had been used for only a few years, it was possible to see the reduction of alternatives to choose from: 'Through the platforms, we have cut down the alternatives significantly: the radiators from 1200 versions to 50 and windows from 1400 to 25 or whatever … There are less products to choose from', Interviewee #5 said. At the same time as a significant amount of choices had been eliminated, the platforms were designed to be capable of handling local modifications and adjustments to specific goals.

It is little wonder that the architect, a specialist aiming at creating qualitative and aesthetically appealing buildings that do not give the impression of being mass-fabricated, is portrayed as a stakeholder potentially being critical of a standardization of housing. In other words, there is a trade-off between on the one hand low costs and standardized building procedures and unique product offerings on the other. SCC and

the construction industry in general are here walking the tightrope between over-standardizing the work and leaving too much leeway for individual actors to make their own decisions. Interviewee #6 made this balancing act appear less complicated than it potentially is in practice: 'It is all about exploiting previous experiences and identify good solutions, to repeat and standardize what we do in almost every project'.

The co-workers in SCC were overall positive toward the platform concept and thought of it as an inevitable movement towards more standardized and transparent work procedures. One of the more senior co-workers, being assigned the role to develop and update the platforms was very positive about the idea:

> When they [top management] started to work with the platforms, they were looking for some production oriented person, and there I was. For me, this is amazing, being able to put all my experience into the platforms. That means all experience is being inscribed into the blueprints and captured by documents and eventually it will be put into use. (Interviewee #3)

Also some of the co-workers with less organizational tenure expressed their belief in the concept: 'I think the platforms work quite good … it is a sound idea that one should identify the easy solutions and use them in all types of projects. I think it works fine from what I have seen' (Interviewee #7).

In summary, the construction industry and SCC were under pressure to implement routines and standard operation procedures for the managing and sharing of knowledge. The platform concept served as a mechanism for such practices that were both capable of bridging and bonding various communities within the firm as well as external to the firm and being flexible enough to apply with modifications when needed. The platforms thus served as a script or a textual agent capable of accomplishing a number of desirable outcomes from the view of the company.

Discussion

In the case of SCC, knowledge is a resource that to a large extent is bound up in individual or collective experiences and operative procedures. When a construction project is finished and terminated, much of such collective expertise is claimed to disappear, or, at best, remain embodied by the co-workers and consequently brought forward to the next construction project. In addition, the exit and entry barriers between competing companies are rather low in the industry in Scandinavia and all kinds of companies experienced a more or less continuous inflow and outflow of co-workers, especially during economically favourable times. In order to cope with such conditions, SCC aimed at implementing mechanisms capturing the accumulated know-how of the firm and enabling a more systematic exploitation of collectively acquired knowledge. The platform concept is here introduced as one such means for managing knowledge. In SCC the platforms were designed to serve as boundary objects (Star and Griesemer, 1989; Carlile, 2002; Bresnen, 2006) bridging a number of occupational and professional communities ranging from clients, architects, construction workers and line managers, yet maintaining a flexibility capable of adjusting to local conditions and demands. The interlocutors in SCC appreciated the platforms because they served as an integrating mechanism reducing the number of alternatives and choices while not threatening or eliminating the perceived creative elements in the work. In that sense the platforms satisfied informational requirements of co-workers belonging to different communities of practice. From a knowledge management perspective, the platforms are potentially capable of serving as boundary objects that can accommodate both the stock and the flow of knowledge in everyday construction work. While much everyday work in the construction site demands extensive experience and know-how to cope with unanticipated occurrences, many choices can be 'frontloaded' to the early phases of the project, i.e. be included in the platforms. Previous experience is in this view already embodied in the platforms, suggesting that choices need to be made on the basis of a much smaller number of alternatives than in the previous regime of working, leaving more space for variation in the design phases. In addition, the relatively limited presence of systematic formal knowledge management models in the day-to-day work in the construction industry put pressure on the major firms such as SCC to implement routines for accommodating acquired experience. While the Internet-based media for sharing experience and know-how were, according to the interviewees, functioning rather poorly and the knowledge centres to date remained a rather abstract and overtly administrative function, the platforms will ideally operate midway between the design work and the actual construction phases of the construction project. Partially abstract and formalistic, partially highly practical and part of the domain of actual work, the platforms were appreciated in terms of potentially integrating entire construction projects effectively.

Much research on knowledge management procedures and routines in the construction industry is either emphasizing the formal use of various tools or mechanisms or emphasizes the relative lack of such tools. The relative lack of formal codification procedures rendering knowledge transferable between sites, companies and regions is one of the concerns both in the construction management literature and in the

industry. This study contributes to the understanding of knowledge management practices by pointing to the use of platforms as a potentially useful tool for organizing and managing knowledge in the construction industry. In terms of theoretical contribution, the study shows that the concept of boundary objects has some analytical merits when studying knowledge management practices. Knowledge does not by any means circulate freely and is not immediately available for all members of an organization. Instead, knowledge tends to be sticky, local, contingent, situational, and otherwise bound up with individual and local practices (Lave and Wenger, 1991; Szulanski, 1996; Von Hippel, 1998; Sole and Edmondson, 2002; Tsoukas, 2005). As a consequence, the sharing of knowledge needs to be supported by the use of various tools and mechanisms. The platform is in this perspective serving as a boundary object enabling knowledge to be circulated from one site to another; it is a vehicle for the management of knowledge (Sapsed and Salter, 2004).

A final note on the limitation of the study and the need for future research is called for. While this study suggests that platforms could serve the role of boundary objects in the construction industry, there is unfortunately relatively little in the empirical material indicating how platforms are actually used in day-to-day practices. For instance, how are local negotiations taking place between architects, concerned about maintaining aesthetic standards, and the centralized platform organization in SCC? What are the de facto possibilities for building cost effectively at the same time as producing qualitative and creative housing and other built spaces? More detailed research on the actual use of platforms would provide further insights into the uses of the platform concept. In addition, a relatively limited sample of interviewees (13 interviews) in one single Scandinavian construction company does not really provide a full understanding of the uses of platforms in the construction industry. If, for instance, as Harty (2008, p. 1030) suggests, it is the case that the automotive industry has been advanced by many commentators as a 'shining example' for the construction industry, allegedly providing a role model for the implementation and use of new organizational principles and managerial practices and tools, then the distribution and implementation of management ideas (see e.g. Sahlin-Andersson and Engwall, 2002) such as platforms deserve more systematic research. That is, rather than dismissing the construction industry as being conservative, backward and lagging behind for instance the manufacturing industry, there is a need for actually exploring how the construction industry may adopt managerial ideas such as platforms in actual day-to-day work.

Conclusion

Knowledge sharing is one of the most complex social processes in today's industry and historically the construction industry has not, critics contend, been at the forefront of the development of tools and mechanisms for the sharing of knowledge. Even though there are formal procedures and routines prescribed in construction companies and Intranet systems have been developed to support knowledge sharing, much of the knowledge sharing appears in personal networks and through oral communication. This makes knowledge sharing local and contingent on personal contacts and relations. However, the study of SCC shows that the platform concept, aimed at integrating accumulated expertise and experience into a standardized package comprising material components, practices and routines, is a knowledge sharing approach recognized by the SCC co-workers. The platform is here serving as a boundary object, prescribing a set of actions while at the same time leaving some space for individual initiatives and local conditions. The platform is in this view a means of bridging and bonding the stocks and flows or know-how and expertise in construction companies.

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