

Chasing, Pacing or Drifting? Organisational Knowledge and Management in Consulting Engineering

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Abstract

This contribution discusses the knowledge production in a consulting engineering company. Consulting engineering practices and knowledge areas undergo rapid development, which make a description by discipline less obvious, but the focus here is on the production of buildings, mobilising mainly mechanical and electrical engineering, building physics, project and construction management. This kind of engineering is typically pictured as a knowledge intensive activity, but also involve large elements of routinized work such as CAD-drawing. Building on a five month emic ethnographic study, it is illustrated how the organisational knowledge production in a medium size consulting engineering company relies on a bricolage of practical experiences, formalised information, external alliances and customer demands. Several management initiatives address the production and management of knowledge. Information technology, organisation, office design, training and other human resource oriented management tools all play a role. The succession of initiatives does not take place as part of an all-encompassing strategy, although such a strategy does formally exist. Rather it mirrors conditions of possibility occurring over time and the ability to improvise by central actors. The initiatives can thus be seen as a combination of chasing options or just drifting with them and at the same time developing the internal resources as much as possible (pacing the internal options). Understanding knowledge management in this broader sense enables an analysis of what different kinds of knowledge production “deliver” under the circumstances.

Theoretically the contribution builds on a critique of mainstream knowledge management positions, which picture knowledge as either a well defined tangible entity or describe how it can quickly become one. Although community of practice approaches dismantle such overly rationalistic perceptions of knowledge, they still suffer from a belief of the stability and non political features of the knowledge production. It is suggested to view the knowledge production as relying on temporary network-building related to drifting along with opportunities, problem setting and solution formulation. It implies continual reconfiguring of some elements of knowledge in coexistence with longer term and more stable basic knowledge elements. The local engineering cultures both preserve the long term elements as well as host the dynamic new ones. The cultures are characterised by an orientation towards designing with new techniques in new ways. The strong project dynamic of the company preserves and develops these cultures. Project and department managers interact with their external network constantly chasing new options of projects, and partly using them to pace certain internal competency building. It is as a totality creating a drift, which leaves the conscious top level management initiatives as a somewhat sideshow.

Introduction

The construction industry features a division of labour and set of institutions, which has generated distinct bodies with particular focus on knowledge handling. The traditional split between planners and executors implies that the consulting engineers (and architects) in contrast to the contractors have become more intensively focussed on knowledge production, than the case is in manufacturing, where the split is less profound. Today the handling of knowledge has become the task of entire industrial systems, and indeed also the construction industry. Nevertheless the consulting engineers maintain a role as knowledge intensive players in the new knowledge economy of construction, something some of them obtain by crossing boundaries to other sectors.

In the center of the consulting engineering companies knowledge creation is a mingling of engineering knowledge and competencies with managerial and business economics. This first attempt to conceptualise the content of the knowledge and competencies turns out almost tautological, and it is indeed not an easy task in a comprehensive fashion to map the mobilised types of knowledge and it will not be attempted here. It should be stated clearly however that the knowledge mobilised is a precarious assemblage of technical, social, organisational, managerial and economical elements.

The paper follows a traditional structure. After some opening methodological remarks, the theoretical part discuss mainstream and cultural approaches. The theoretical part offensively mingle studies of engineering with studies of other types of knowledge production. It is assumed that these elements all help framing the subsequent case study. The case study discuss first three types of frames around the the knowledge production; organisation, human resource efforts and office design. Second tow examples of project processes is given. The paper end up with a discussion and conclusion. The paper builds and extends the argument developed in Koch (fo).

Method

The paper views knowledge and knowledge management through interpretive sociology. The theoretical elements stem from management, innovation, design studies and anthropological contributions to the discussion on knowledge and on management of knowledge.

The paper's empirical part draws on qualitative case material from a Danish consulting engineering company, carried out as a combined interview-based case study (Kvale 1996) and an ethnographic study (Emerson et al 2001). The company is medium sized, but still among the major twenty players in consulting engineering in Denmark. Certain elements in the cases has been changed to assure anonymity.

The company has been visited several times by the author, but it is investigations carried out by Rolf Simonsen, which is the backbone of the material, used here (Simonsen forthcoming). Simonsen carried out a series of formal and informal interviews with employees, managers and staff officers on the Knowledge Management activities. Simonsen was employed for five months in a cooperation project between DTU and the company with the aim of studying and improving KM in the company. Simonsen participated in three building design projects, doing participant observation and carried out dialogues with members of the project organisations. Moreover the author carried

out two interviews with managers of the organisation and further informal dialogue. This was supplemented with written material from the company.

Conceptualising knowledge and knowledge management

Texts, articles and books as well as events on knowledge and management of knowledge are skyrocketing (see Scarbrough, Swan & Robertson 1999, 2000, 2001, Raub & Ruling 2001 for discussion on this fad phenomenon). Nevertheless there is not much sign of cumulation or progression towards a coherence in the understandings. Rather it seems that different professionalisms and perspectives each strive at getting their cake of the prosperity linked to selling knowledge on knowledge and knowledge management (see Pritchard for a discussion of this commodification tendency, Pritchard 2001).

There is certain positions which threatens to dominate and almost kidnap the central concepts of knowledge and management of knowledge. Rather than developing a fullblown critique of these positions, this contribution will limit itself to give a few positional comments before focussing on cultural and sociopolitical approaches, which is cautiously believed to give most trade off in terms of guiding production of knowledge and management of the related processes in a dynamic consulting engineering setting. The core competency, knowledge based theory of the firm, intellectual capital and mainstream knowledge management positions are all positions under development. Nevertheless there is still a strong tendency to view the firm as a blackbox, and a somewhat static view on organisations. Moreover these position picture knowledge as either a well defined tangible entity or describe how it can quickly become one, converting tacit to explicit (Nonaka et al 2000) or of information to knowledge (Cohendet & Steinmuller 2000, Davenport & Prusak 1998). The analytical distinctions between categories of knowledge that follow along seem to be less operationable in practice (Nonaka et al 2000, Cohendet & Steinmuller 2000, see Robertson 2001 et al for a critique).

Cultural and sociopolitical approaches

A growing body of literature take a cultural approach to learning and knowledge (Lawe & Wenger 1991, Bucciarelli 1995, Orr 1996, Downey 1998, Wenger 1998, 2000). According to this position knowledge is embedded in a culture consisting of shared systems of meaning, rituals, verbal and psycial symbols (Alvesson 1995). The notion of "community of practice" is used to describe that collective learning results in practices that reflect both the pursuit of the framing enterprises and the attendant social practices. These practices are thus the property of a kind of community created over time by the sustained pursuit of shared enterprise (Wenger 1998:45). Knowledge is related to and attached to a set of practices. Knowledge develops through mutual engagement, joint enterprise and a shared repertoire. The understanding it thus picturing knowledge as a heterogenous assemblage of tangible and non tangible elements and as something strongly contextual.

Studies of professional cultures, engineering cultures point at the importance of *object worlds*, somewhat ordered abstractions that represent the technologies which the engineers work with (Bucciarelli 1994). Designing engineers interaction is marked by numourous and varied tools, verbalisation and other other means. Orr (1996) thus highlights the importance of *storytelling*.

The boundary of the organisation is in the cultural view a less obvious limit to the knowledge creating processes (at least in contrast to the economics oriented positions mentioned above, Nonaka et al 2000). Engineering cultures can be assumed to cross organisational boundaries and encompass informal networks enabling the maintaining and development of a professional object world, culture and formal status (Bloor & Dawson.1994).

Although community of practice approaches dismantle overly rationalistic perceptions of knowledge, they still suffer from a belief of the stability (see below) and non political features of the knowledge production. Political approaches would suggest to view the knowledge production as relying on temporary network building (coalitions), exercise of power, and related to exploiting rooms for manouver along with opportunities, problem setting, boundary building and solution formulation. It implies continual reconfiguring of some elements of knowledge (in located accountabilities as Suchman (2001) put it) in coexistence with longer term and more stable basic knowledge elements (Lazega 1996, Contu & Willmott 2000).

The role of dynamics in and around the knowledge producing processes

While there in the cultural approaches seem to an underlying feeling of stability in storytelling, object worlds and professional culture a growing body of studies suggests that knowledge work actually is characterised by a number of pressures to deliver:

Pressure to deliver on a *organisational level*. Consulting engineering is characterised by a strong projectorientation, where projects is an organisation of resources and tasks (inputs) relating to some kind of output/product demands (see Dunford 2000, Augier et al 2001)

Pressure to deliver on a *professional group level*. In the debate on future engineering competencies and knowledges, engineers are expected to deliver systemic solutions tackling a range of aspects of an innovation (Winch 1998, Gann 2000, Gann & S 1999)

Pressure to deliver on a *individual level*. Garrick and Clegg (2000, 2001) analyse how knowledge workers are exposed to demands relating to crossdisciplinary approaches and the new competencies required relates extensive communication, problemsolving and coordination skills. On a more simplistic level lack of time is often mobilised as explanation for insufficient knowledge sharing and registration in IT-systems (Dunford 2000, Sørensen 2000)

In engineering cultures characterised by such pressures, the production of knowledge coexists with and is embedded in continual political processes of negotiation of content of the work, as well as the frames around the work (Kunda 1992). It is characterised by active attempts to build boundaries around ones work as attempts to regulate the work load and influence spheres around project groups and departments and in relation to external cooperation partners. Project managers, sales representatives and others strive at exploiting conditions of possibility occurring over time in the external landscape of customers. The chasing of (external) options is developing internal pressures, where managers and employees are inclined to pace each other in developing the project and the related competences, which thus reflects organisational learning processes carried out under circumstances far from the rosy “long term cultural” regime Wenger is representative for.

Case Knowledge Management in a Consulting Engineering Company

Consulting engineers operate in a project driven context where external alignment of a builder and other partners are a central activity. Nevertheless the focus below is on the internal organisational issues of the a consulting engineering company. More specifically the focus is on design processes in the realisation of a building construct. The companies/projects usually have to combine and align areas of professionalism within engineering with the dynamic flow of knowledge along with projects of realising a building a combination that challenges the balance between professional specialisms and the development of multidisciplinary skills (Gann 2000, Lea 1999, Gibbons et al 1994). It can be argued that the knowledge production process within construction projects is a one way stream within the single building project leading into disposing the knowledge in the built construction, with no further flow of knowledge to the next project. Project management usually focuses on the economy of the single project, which implies clear obstacles to attempts to span knowledge from one project to the next. With in the project a transformation of back and forth from knowledge resting with participants into interactions, drawings and documentation onto artefacts; buildings, bridges etc. The knowledge shifts representation a number of times. In this process one can point at the following activities:

- Knowledge sharing, co-ordination and communication is important in the design phase and relates to solving problems in specialists areas drawing on others expertise.
- Knowledge production related to developing new knowledge and/or combining a number of existing knowledge types and practices (building physics, materials knowledge, craft-related knowledge and site management competencies). These might be in internal controversy.
- Knowledge acquisition relates to new forms of knowledge needed for projects and/or for basic function of the engineering company, such as IT-knowledge, expert knowledge in “exotic” areas etc.
- Information storage is important as background for the individual project as well as dynamic maintenance of preliminary results in the design process.

Project management often is forced to focus on the economy of the single project, and this poses obstacles to explicit knowledge management initiatives, as we shall see in the empirical part below. Since the needed competencies, are also articulated as social groups, they are potentially competing and contesting each other. Learning, producing knowledge and political processes are there intrinsically intertwined (parallel to Sverlinger more restricted idea on “making meaning”, Sverlinger 2000). Dialogues in the project group as well as outside mingle technical and political considerations (See also Cohen et al 1998, Lazega 1992). So-called knowledge claims will be articulated in the project group and might, might not, be contested. To contest some knowledge claims and solidify others is thus integral to developing the under the circumstances best design.

The dynamics of the projects will surpass knowledge management unless these dynamics are properly understood and tackled. The engineering process is a intertwined knowledge producing and political process. Which knowledge is necessary is a precarious balance between existing and new knowledge. It will moreover consist of very contextual elements as well as generalised ones. And it should be noted along with Cohen et al 1998 that participating and coordinating project work in itself constitutes social and political skills.

The consulting engineering company described below, has positioned knowledge management as part of their corporate strategy. The section is structured in two. First some elements of knowledge

management are dealt with. This includes organisation, training and personnel issues and office design. Second the knowledge production in the project processes is discussed.

The company employ more than 500 members of staff. The organisation is as mentioned a matrix-organisation. The focus horizontally is on customer groups and/or products, whereas the vertical focus is major areas of professional specialisms. The companies have major competencies, albeit with different emphasis, within say:

- Energy
- Environment
- Building
- Construction Management
- Information Technology

Within the building areas, which are in focus here, the companies operate with specific portfolios of competencies, such as building physics, thermal engineering, electrical engineering and the like.

Organisation

The organisation is characterised by an emphasis on projects as the main value adder. The enterprise emphasises small organic departments and few hierarchical levels. Departments are split if they are assumed to encompass too many members. Knowledge management means focusing on and enhancing existing professional disciplines, the aspiration is to create an “adhocracy of networks”. These professional networks acknowledge proposals for best practices, which is then registered in the companies intranet. In contrast to Nonaka and Takeuchi’s “middle up down management”- thesis (Nonaka and Takeuchi 1995), the focus is *not* especially on middle management. Developing the manager group as such is given a lot of emphasis.

Training and Personnel

The company encompasses a strong element of Human Resource Management in their understanding of knowledge management. Recruiting and training are important ways of developing knowledge resources. Moreover an emphasis is adopted on making it attractive to stay with the company, making the employee loyal. The company experiences a fall in the (previously long) length of employment and managers feel that employee turn over could be improved. The loyalty activities also relates to the understanding that an important part of the companies’ knowledge resides with the employee. Training is used as part of KM but is not uncontested, since some managers and employees feel they mostly learn by participating in direct project work.

There is attempt to support knowledge sharing behaviour by changing the culture (see below) but not by using economic reward directly.

Office Design

The company has rearranged parts of the office space as part of an effort to physically support sharing of knowledge. It is characteristic that the company have a piece-meal implementation of new office ideas. Moreover the shared open spaces are organised according to the departmental structure in order to support exchange of knowledge within the same specialism. The projects

typically cuts across departmental structures and thus still have to meet formally and the members have to interact in other ways. The co-local fashion of interaction is therefore less prevalent and. E-mails and phone is used. There is an attempt to downplay hierarchy by letting the department manager work in the open space among the other employees, corporate management works in open office with each other as well. However corporate management has been organisationally strengthened, at the same time.

Part of the space dynamic in engineering relates to large projects with site management and local engineering and design, where groups of employees or single site managers might be absent from the main building of the company. Such absence enables desksharing, but this is not in use. It also implies that coordination and management with groups of employees might have to be done in a virtual way in long periods of time.

Project Processes- Knowledge production

In the period where the design activities were followed several projects delivered important contributions the character of the production of knowledge production. The first example illustrates how the external demands change rapidly and how the project group cooperated on top on this. The second example focuses more on a software calculation program than on the product to be delivered.

Project One : Chaotic external relations ?

The project is the establishment of a fitness center, offices and storage facilities in a previous factory building. The budget was at 4,5 mio. £ and the fee of the civil engineering company was at 350.000 £. The tasks were organised as sub contracting for a developer, which had the responsibility of the site management. The first phase of the project was focused on designing a retail facility. The investor behind this project withdrew however and it was halted after three months. Half a year later a new investor was found and the design of the fitness center in the same building commenced. The responsible project manager nevertheless interpreted the content of the project as "standard". The formation of the project group was therefore carried out by the project manager. He manned the project with seven engineers. The engineers stemmed from three internal departments and technical draughts(women) was attached to the project group. The major competencies were interpreted as being related to water and heating engineering, electricity, and building physics.

The frequent change of demands from the builder underlined the need for updating basic information on the tasks in the projects especially between the project manager and the project members. Moreover the handling of information relating to overlaps between the engineering disciplines was crucial, such as the power need of pumps, which link water and heat-engineering tasks with electrical engineering tasks. While designing the water and heat functions in the fitness center both technical and organisational methods were used to share and develop knowledge. The design of bathing facilities (with showers) was carried out by several engineers. After initially having shared the tasks among them, there was later a need for an informal meeting where the importance of the factor of co-inciding use of the bathing facilities was discussed. An experienced designing engineer described a set of rules of thumb for the design and underlined the role of "coincidental use" through telling an anecdote of 400 Japanese guests on a hotel using the bath at 8 o'clock in the morning. Such informal meetings and dialogues thus strengthened the single engineering profession (in this case water and heating) in their design. More spreadsheets and

design programs for heating systems were used by most of the engineers. The spreadsheets were often designed to a specific task, but some are also informally distributed among the design engineers. None of those are however formally distributed (to everyone).

The design was carried out under time pressure. The developer wanted to rent the offices and the fitness center as quickly as possible. This resulted in the abandoning of the quality review, which is usually carried out as one of the last activities in the design. The actual building did actually encounter failures, which can be ascribed to the incomplete communication between the contractors and the designers.

Project two: Accepting a project assignment to gain internal competency

In this project the consulting engineer was asked to develop a wastewater treatment facility component. It is characteristic that previous cooperation existed between the municipality, who ordered it and the department as well as the particular engineers involved. Although the company does have some competencies on the particular component, the project represented a further development of knowledge “delivered” more or less directly from the municipality, which specified the use of certain elements and that the design should be documented in Autoplant (a CAD-system for designing process plants).

This second case resembles the first in the a bit chaotic establishment. The municipality was slow “coughing up” with a contract and after establishing of an 8 man project group, the municipality changed central parameters in the component several times, also information on flow of wastewater etc was changed. The group exercised weekly meetings, whereas the project manager also met on a continual basis with the representatives of the municipality. A flow of information from meetings with the customers is thus central for the coordination. Technical specifications on valves pneumatics and the like is another.

The project manager and one of the engineers asserted that taking this assignment on board enabled them to develop competencies relating to the waste water facility components as well as to Autoplant. The client represented extensive knowledge on the component and training with the software could be carried out within the frames of the budget of the project.

Discussion

Looking across the different project processes studied and according to the interview with members of the organisation, the further dynamics of the project have features like

- The client might change the demands for the project radically. In the case-projects, the conditions for the project was not stable and the content was changed profoundly several times. The economy of the project sets clear frames for innovative and creative activities. Project managers are nevertheless frequently monitored on a narrow economic result basis only.
- Projects might not be fully manned from start to end, especially not medium size projects. Rather the project manager and/or a few others are members and active in the entire design, whereas others enter the project when a certain engineering speciality is needed. This put pressure on coordination.
- The technical IT has to be used in marked different ways according to cooperation partners. Some contractors do not even employ CAD-systems and merely ask for plain drawings and documents as representation of the design. Others –as in the case- ask for the use of advanced

software, including multi layer intelligent drawing and might demand that the cooperation is exerted through project webs.

The single project gives rise to negotiations on necessary knowledge, potential reuse of knowledge and how to create new knowledge. The quotation phase and the start up of projects often lead to early identification by project managers or others of needs for sourcing of knowledge. This often – as in the cases- occurs on the basis of participants “here and now”-understanding of existing competencies in house and wished developments of new.

In the design process, problemsolving most frequently occur as directly asking colleagues, searching for persons who has solved a similar problem before. This again is predominantly done on the basis of direct interpersonal interaction. Also the use of previously developed spreadsheets are used in an informal fashion among the design engineers.

The windows of opportunities that opens in the interaction with external contacts, developers, building societies and others thus sets in as framesetters and forces that drives the development of knowledge and competence in certain directions. This drift can hardly be described as conscious moves in knowledge management. Rather it is a result of the exploitation of paths set by previous products designed and made and the related social and economic networking. On a more personal level, finding and developing project with external partners becomes central parts of the project managers identity building and competencies. By getting orders the managers express himself and reify his/ hers position and status. On the organisational level large scale orders, which need to a large extent to be developed onsite, drains and locks resources from the company. On the professional group level certain new components, methods etc becomes fashionable through professional associations and other mediators of new knowledge. There is thus a whole set of mechanisms setting out to drift the organisation in various directions according to current and future projects.

The argument here is not to strive at avoiding the drift. Rather to accept it as a precondition for meaningful management of knowledge production. For example it would be a mistake to assume that the interaction with the clients can be void of what is experienced as chaotic processes. The establishing phases at a client is not only chaotic and full of unclear assumptions. It is also the phase where the client is open to establishing cooperation! Viewed as a political process, leads to the interpretation that the consulting engineer needs to be there as early as possible, in contrast to the rational interpretation which would argue for striving at clarification. Chasing the options thus leads to processes that follow social rules rather than instrumental.

Nevertheless there is a room for manouver for corporate and departmental management. Conscious choices and priorities is given to internal development of competencies as well as attempt to configure orders and opportunities in a way that *also* serve strategic purposes. If not *pacing* new competencies, it at least means that the company attempts to be ready for new business areas and to exploit the existing further. This room for manouver becomes bigger through the production of surplus and overheads in company, which reconfigure the tight project economy to other economies. Internal development projects and corporate management initiatives can flourish under such circumstances.

Conclusion

In this article knowledge production has been portrayed as a much more precarious and less controllable process than in most mainstream contributions. Knowledge production relies on temporary network-building related to drifting along with opportunities, problem setting and solution formulation. It implies continual reconfiguring of some elements of knowledge in coexistence with longer term and more stable basic knowledge elements. The local engineering cultures both preserve the long term elements as well as host the dynamic new ones. The cultures are characterised by an orientation towards designing with new techniques in new ways. The strong project dynamic of the company preserves and develops these cultures and they are therefore not automatically a constraint, as some mainstream would assume. Project and department managers interact with their external network constantly chasing new options of projects, and partly using them to pace certain internal competency building. It is as a totality creating a drift, which leaves the conscious top-level management initiatives as a somewhat sideshow. To tackle the tyranny of projects is a central competence in management of consulting engineering knowledge.

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