COORDINATING KNOWLEDGE IN BUILDING DESIGN

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The concept of Community of Practice (CoP) represents a promising frame for further exploitation in understanding the handling of knowledge in construction processes. This paper follows this approach and presents a case study of a partnering project and discusses the mechanisms for coordinating knowledge in a complex construction project. As usual, the responsible group for the design counts members from different companies like architects, engineers, and contractors. This constellation is interpreted as a multiple configuration of CoPs, characterized by overlapping practises, multiple memberships and different levels of participation. The diversity of the practices is a condition of possibility of knowledge handling as it enables the synthesis of various forms of knowledge in building construct. Concepts like *arenas* (e.g.. meetings), *brokers* (e.g. design manager), and *boundary objects* (e.g. drawings) are discussed as means for facilitating the coordination of knowledge between practices and thereby enabling a more optimal and flexible flow and use of knowledge.

Keywords: communities of practices, culture, design, knowledge management.

INTRODUCTION

In construction, certain narratives are usually mobilized to explain how management and organization occurs. We thus have to lend ears time and again, to the statement that the inter-organizational cooperation is temporary. The belief is that knowledge production in building design is closely related to realizing 'one of a kind' productions. This is illustrated by referring to the ever-changing context of building projects. The location of the construction site is unique and the building owner and stakeholders vary largely from project to project. However when focusing on a single project and institutional links it will occur that the temporary element is relaxed. An alternative narrative appears rather to be a story about networks of recurring partners in different constellations, with rather well defined and well-exercised roles in place. Loosemore and Tan (2000) analyse these as stereotypes. This tension between temporality and stability is central to our interest in coordinating knowledge in building design.

Without much underpinning provided here, we content that a central characteristic of construction is the organization of the supply chain, which exhibits a specific division of labour and institutionalized roles such as the manufacturers of basic parts, building companies (including craftsmen), engineering companies and architects. Although there are examples of transcending these institutionalized roles they are generally maintained in the majority of building projects. Consequently, every project is organized cross-organizational, thus making the knowledge production in the project an inter-organizational task. This cross-organizational setting is maintained in the

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Thuesen, C and Koch, C (2003) Coordinating knowledge in building design. *In:* Greenwood, D J (Ed.), *19th Annual ARCOM Conference*, 3-5 September 2003, University of Brighton. Association of Researchers in Construction Management, Vol. 2, 643-52.

design process as it usually encompasses collaboration with a set of actors including architects, various engineers and other professions.

This fragmentized characteristic is of major importance when discussing the management of knowledge in building design. The product of the design process combines knowledge stemming from these various professional practices into a documentation representing a new building. This includes areas as mechanical and electrical engineering, building physics, project and construction management. Due to the various practices that is involved in the design the coordination of knowledge is essential. We will in this paper try to understand the underlying mechanisms of this activity drawing on Thuesen and Koch (2003, 2003)

The paper opens with a description of the theoretical base for discussing the coordination of knowledge in heterogeneous groups. Subsequently follows some methodological considerations. Then a case study is presented discussing the coordination of knowledge in building design. Ultimately the paper is closed by a conclusion winding up headlines of the paper.

THEORY–COORDINATING KNOWLEDGE

Concepts like 'Knowledge Management' and 'Organizational Learning' have been a subject of increasing interest during the last decades. Since it is out of scope to present a review of positions within these fields in this paper, we will just point to Stacey (2001) who in our eyes offers a substantial critique.

One of the most influential contributions, which our approach stems from, is the concept of Community of Practice developed by (Brown and Duguid 1991, Lave and Wenger 1991, Wenger 1998) and numerous commentators/adopters. CoPs develop through a process of people acting together creating meaning through negotiation. This negotiation of meaning has two complementary elements, *participation* and *reification*. From the point of view of a single CoP, participation stands for the social interaction of members that keep the CoP together, whereas reification stands for the material manifestations of a diversity of cognitive activities by which the members create meaning.

In this approach practice is the foundation for transferring knowledge, as knowledge is seen as something socially constructed and contextual. A basic requirement for sharing knowledge between people is therefore a presence of a shared practice. Knorr-Cetina (1999) identifies this prerequisite in her work with epistemic cultures and Brown and Duguid (2001: 204) uses this to explain the sticky and leaky nature of knowledge as they states that "knowledge…runs on rails laid by practice".

With the exception of Gherardi and Nicolini (2002) most mainstream literature including the concept CoP does not discuss the issue of handling knowledge in heterogeneous and temporary groups. These are according to Meyerson *et al.* (1996: 167) characterized by performing tasks with high degree of complexity and lack of formal structures that facilitate coordination and control. Furthermore they depend on an elaborated body of collective knowledge and diverse skills and they often entail high-risk and high-stake outcomes. Another key characteristic that might be added is the mutual dependency of the participating partners, which stems from a division of labour where each task is dependent of another.

Drawing on Alvesson (2002) and Wenger (1998), Thuesen and Koch (2003a, 2003b) shows how a heterogenic and temporary group can be interpreted as a multiple

configuration of Communities of Practices (CoPs) characterized by overlapping and partly shared practices and individuals with multiple memberships of communities with different levels of participation. CoPs overlap in the organizational settings, and are rarely tightly connected to the social structures of the organization.

The diversity of heterogeneous groups makes it possible to carry out a complex task. As stated previously a shared practice (including a common language) is however, a requirement for developing knowledge as it enables the flow of knowledge within the group. This implies that the struggle in a project is a balance between diversity and homogeneity – a mingling with competencies. The shared practice is needed in order to facilitate the flow of knowledge and the diversity for solving a complex task without making everyone in the group know everything. Iansiti (1993) discusses this balance by using the T-form as metaphor for illustrating the depth of a particular knowledge area combined with a general understanding of other disciplines.

As the output of the knowledge production in heterogeneous project groups should be characterized by consistency between the areas the coordination of knowledge is of outmost importance. Especially between successive tasks in a 'production process' the coordination of knowledge seems critical due to the interdependence between the tasks.

In our view *coordination knowledge* is the 'knowledge work' in the boundaries between CoPs, based on the interdependence between the practices in a project. Knowledge is coordinated through negotiation of meaning between practices and is highly context dependent due to the situated nature of knowledge. Three elements facilitate the coordination of knowledge between CoPs: boundary objects, brokers, and arenas.

Boundary objects: CoPs can interact by reification: the exchange of boundary objects, which are tangible or intangible artefacts than crosses boundaries between CoPs and are objects of reification in these. Wengers (1998) discussion of boundary objects draws heavily upon Star and Griesmer (1989) who sees boundary objects as anchors or bridges between CoPs. According to Star and Griesemer (1989: 414)

> *"Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites."*

This implies that boundary objects have different meanings in different CoPs but their structure is common enough to more than one community to make them recognizable. Wenger (1998: 107) introduces four elements characterizing boundary objects: Modularity, Abstraction, Accommodation, and Standardization.

Brokers: The other type of interaction is by *participation*; that is, by sharing individuals – *brokers* in Wenger's terminology – who actively participate in several CoPs. Through this connection, people can introduce elements from one CoP into another and thereby coordinating knowledge.

Star and Griesemer (1989) also touch the element in terms of multiple memberships of 'social worlds' that they term 'marginal man'. They are referring to Hughes (1984) discussion of problems regarding identity and loyalty with multiple memberships of social classes. This discussion of marginality is also found in Wenger (1998) as *brokers* usually not are at the very core of the CoPs that they are a part of but work in the boundaries through legitimized peripheral participation. What characterizes an

influential *broker* is the ability to introduce new possibilities for meaning that however requires some kind of status in the community.

Arenas: At last we will emphasis the context in which *boundary objects* and *brokers* are in play. We term these contexts *arenas* as the places where CoPs meet, negotiate, shape meanings and transform *boundary objects*. We thus use the term for a space for intersection between CoPs (Clausen and Koch 1999). In Wengers (1998: 112) notion this is 'boundary encounters' which includes meetings, visits, etc.

Arenas can be en either formal like meetings or informal like small talk over lunch. In fact the role of the informal part has been empathized, especially with Julian Orr's ethnographic study of Xerox's photocopier repairmen and their practice (Orr 1996) "Talking about machines" whenever they were meeting each other sharing and constructing war stories. These informal environments are sought created in open office with central 'coffee machines' facilitating room for small talk. Newell *et al.* (2002: 130) emphasis the context in relation to heterogeneous groups as they state that

> *"…collaborating with members of other communities in the context not only helps to break down the social and cultural barrier's that prevent knowledge-sharing, but it also gives on an insight into their perspective"*

In relation to *Arenas*, Wenger (1998: 111) points out that it is often advantageous to have artefacts and people travelling together as *brokers* accompanied by *boundary objects* stand a better chance of bridging practices.

RESEARCH METHOD

The method is multidisciplinary tying together engineering, interpretive sociology, organization theories and management. In particular we are drawing on analytical strategies from anthropological (Lave and Wenger 1991, Orr 1996, Wenger 1998) and organizational culture perspectives (Alvesson 2002). The case material stems from an ongoing ethnographic study of a construction project focusing on the design activities. Over a period of nine months one of the authors (Thuesen) has on a daily basis been present in the project participating in the "main" design activities, covering all design meetings, workshops, and some internal and external meetings. Apart from participant observation, seven interviews of project members have been conducted so far. Furthermore, have the formal documents created by the actors been available to us. After a period where the researcher was just present in the field, the design meetings were taped with acceptance from all the participants. To adopt such a time span was necessary in order to create a familiarity of the researcher. It can be noted that both authors share the professional background as engineers why a potential occupational bias from the authors towards the players in constructions is recognized (Loosemore and Tan 2000a). In an effort to minimize this problem the interpretations have been discussed with the people in the field and academia.

CASE–COORDINATING KNOWLEDGE IN BUILDING DESIGN

The design process, which is followed, is part of an ongoing construction project with the aim to develop the school system of a municipality including a construction of a new school and refurbishment of four existing schools. The main actors (companies) in the project are besides a main-contractor an architect, a technical consultant and a client advisor taking care of the contact to the municipality. The contractor has composed a team with members from two different departments for the refurbishment of the existing schools and building of the new school. The technical consultant has

four specialists from different departments assigned. Besides these specialists they have assigned a project leader and draws regularly on other competencies in house. The architect has around six people working on the project with two different teams and one project leader.

The production of knowledge through this design process involves the different professions for the participating companies mentioned above. Each practice is responsible for their part of the design through a division of labour. The architect is designing the building according to aesthetical and functional ideals, gradually detailing it down to dimensions of centimetres. The engineers are taking care of the stability of the constructions, the water, heating, ventilation, electrical and IT infrastructure. Finally the contractor is responsible for managing the budget as they are economical responsible for the project. Furthermore they have a motivation for ensuring the buildability of the design.

Most of the design occurs at the home bases of the practices drawing on a bricolage of practical experiences from previously projects, formalized information, knowledge about the customer etc. At regularly design meetings facilitated by a design leader from the contractor, the different practices come in play presenting and synchronizing their work. It is however not only at meetings the professions interact. It also occurs by using email, faxes and phone calls. But as the professions though physical are separated they seldom arrange other meetings automatically. When they however are together the coordination of knowledge is striking.

Elements for coordinating knowledge

The coordination of knowledge between the CoPs in the design process takes place in *arenas* as *boundary objects* and *brokers* are bridging the different design activities. As a total mapping of these elements would be an impossible exercise, we here focus on how they enable the coordination of knowledge in building design.

Boundary objects

Various types of *boundary objects* are kitting the design process together. The most visible are drawings spanning from sketches to CAD-drawings, resumes, descriptions of customer wishes, spreadsheets, economical calculations etc. These formal objects are constantly developed throughout the process gradually getting closer to the final proposal. The drawings and descriptions are usually abstract representations of the final building except from the refurbishment drawings, which are relating to an existing building. The existence of a building as an informative and complex *boundary object* is actually a key difference between the refurbishment part of the project and the building of the new school.

In many of the *boundary objects* we find a *modularity* where one *boundary object* is a hierarchy of other smaller parts. An example is the existing schools, which consists of a wide range of smaller *boundary objects*. The different CoPs can then attend to different parts of the schools.

The drawings are *abstractions* of the future building, as they only describe a part of the ‘real object’. The abstraction is important in terms of coordinating knowledge as it is assigning value to a certain type of information of the real object. This effect makes it possible to discuss solutions, as the CoPs do not have to pay attention to all the information regarding the real object.

We also find *boundary objects* with a high degree of *standardization.* This enables the coordination of knowledge, as the interpretations of the object are similar among the

CoPs based on a shared practice. We se this in the standardized way of representing the design in drawings and we also find it in the widely used IT-systems as CAD.

The different *boundary objects* are usually rooted and produced in one practice. An example is that the drawings come from the engineering and architectural practices while the contractor produces the economical calculations. This does not keep a CoP a way from commenting on *boundary objects* produced in another CoP, as a *boundary object* in one CoP is applying constrains to the work in the other CoPs. This element makes the design process a matter of negotiating the right solutions suiting the different CoPs.

Brokers
The *boundary objects* produced by the CoPs are continually developed and regularly discussed at the design meetings. The representation in these design meeting is usually sustained by one or two persons functioning as *brokers* between the design group and the home base. From the participating CoPs the *brokers* might be marginal but in a larger perspective, these persons are of outmost importance sustaining the flow of knowledge between the CoPs – being responsible for the negation of the right solutions, delivering the right design to the customer in the end.

The interdependence makes the design group vulnerable to substitution of members. Especially the *brokers* tying the multifaceted landscape of practice together are crucial. It was shown in the case as the broker representing the architects, had a personal tragedy that meant he left the project for at least a month. It had a huge impact on the multiple configurations of CoPs due to the interdependence; the internal time schedule drifted and people were assigned new roles.

Arenas
In *arenas*, both *brokers* and *boundary objects* are represented making it possible to negotiate and discuss solutions. The design meetings are examples of *arenas* for coordinating knowledge between the different practices. There is however also examples of ‘virtual’ *arenas* like conversations over the telephone substantiated by drawings.

We therefore see different ‘intensity’ of *arenas* based on the level of participation of *brokers* and the amount and quality of the *boundary objects*. Different types of *arenas* are suitable for solving different types of problems as some can be solved over the phone while others needs to be discussed ‘face to face’.

Such a ‘face to face’ intersection between the CoPs occurred during a visit by the design team to the supplier, which produces the glue-laminated timber for the schools. Standing in front of the real rafters and pillars the construction principle was discussed by the carpenters, the construction engineer and the producer each representing different CoPs. In this dialog confronting each other with their perspectives, they developed an optimal solution that was technical secure and ‘buildable’. The foundation for the development of this solution was the existence of an *arena* - the shop floor of the supplier, the *brokers*, and a *boundary object* i.e. the pillar of glue-laminated timber.

The coordination of knowledge in practice: an example
We will here illustrate the concept of coordination knowledge, by using a transcription from a status meeting with the presence of the three participating companies. In the actual situation an architect, a ‘water and heating’ (W&H) engineer, an electrical engineer, the design leader and the project leader participates.

As the deadline for the project has drifted, the contractor convened to this meeting in order to identify how far the different professions are from finishing their work. The project leader prioritizes the tasks based on his experiences identifying what needs to be done in order to start the actual production on time. In that context he is mentioning the refurbishment of the floor patching the linoleum.

Transcription

W&H engineer: *Discussing the linoleum, there exist some minor borderline cases where we have to break up the floor.*
Design leader: *Yes*
W&H engineer: *and if I have to describe it e.g. "under" the plumber then I'll describe that it's him who are going to break it up and pour in concrete* … (he is interrupted)
Project leader: *but you shouldn't do that*
W&H engineer: (he continues) … *up to the underside of the linoleum*
Architect: *We're making…* (he is interrupted)
Project leader: *Then you just have to write that the breaking up is carried out by one craftsman and the linoleum-work is carried out by another.*
Architect: *We're making some outline drawings* … (he is interrupted)
W&H engineer: *but how do we then explain what the different craftsmen have to do?*
Architect: (he continues) … *try and listen.*
W&H Engineer: *Yes*
Architect: *We're making outline drawings for the ceiling and floor at the whole school when we e.g. are removing some walls. If there besides this are some places where you know there are changes then you can give your input to these plans.*
W&H engineer: *well okay, it then appears from my current drawings where the craftsmen are going to patch the linoleum.*
Architect: *Yes, but it can be difficult for us to foresee the consequences of what you have drawn, right?*
W&H engineer: *Yes, yes*
Architect: *so when we have made the outline drawings* (he is interrupted), *that's something Charles* (another architect) *takes care of.*
W&H Engineer: (appear elated) *Then the drawings need to be coordinated with me.*
Architect: *Then these drawings show what should be done in each room.*
Project leader: *and we have a similar problem with you (he address the electrical engineer), at least in one place.*
Electrical engineer: *Yes, it is the main electrical panel, which is moved.*
Project leader: *It's the main electrical panel we are talking about. Here we also need to break up the floor and patch the linoleum.*

Analysis

(1-5) The W&H engineer mentions a problem about the border between two work procedures patching the floor when he is removing an existing refrigerator on his drawings. He suggests that he solves it by describing that the plumber does the patching.

(6-10) The project leader opposes this solution as he states that the break up of the floor is carried out by one craftsman and the patching of the linoleum is done by another. This also shows the extreme division of labour where the relatively simple process requires the participation of two different professions.

(12) The W&H engineer however doesn't see how the work is going to be split.

(15-17) After the architect has tried to make himself heard in a couple of situations he finally is allowed. He proposes a solution using a *boundary object*, which he is responsible for – the sealing and floor drawings. Here the architects are describing the areas where the floor needs to be patched when e.g. a wall is removed. He suggests that the W&H engineer gives his input to these drawings.

(18-19) The W&H engineer gets the idea and relates it to his own work and practice.

(20) The architect point out that they cannot estimate the consequences of what the W&H engineer has drawn showing the differences in practices.

(21) The W&H engineer acknowledges this statement.

(22-23) The architect states to himself that these drawings need to be produced at home by a special person.

(25) The W&H engineer is exhilarated over the solution and repeats it in relation to his own work.

(26) The architect puts the solution in perspective to the planning of the production represented by the project leader, as the tool can be used for describing what needs to be done in each room.

(27-) The project leader project the solution from one practice to another as the electrical engineer has a similar problem. The electrical engineer knows which case he is talking about, as this has been negotiated at another meeting prior to this one.

It is noticeable that the *boundary object* solving this problem comes from an unexpected profession as the architect suggests that they just place it on his drawings of the sealing and floor. It should also be noticed that the architect tries to make himself heard without success (line 6 - 15). This might be interpreted as they intentional are holding him out of the conversation. It is however more likely that they do not expect him to be able to contribute to their discussion. Nevertheless, he is the facilitator of the coordination as he recognizes how his work is suitable for solving a problem outside his practice. We here see an example of the insight in other member's areas – a shared practice as an enabler for coordinating knowledge. It however also requires a mutual accept of each other illustrated in this example by the architect proposing the solution even tough it will not make his life easier. Situations like these occur repeatedly and it is symptomatic that only a part of the group is participating in the coordination session due to the dependences in the design team. The coordination in this example is characterized by harmony between the professions. Usually it is however influenced by power and politics and takes form as a negation between the different worldviews. This might lower the motivation for actually participating in the coordination. When asked two months later the architect and engineer did not remember this situation and the negotiated solution were not implemented as the architect and engineers were drawing their details on separate drawings. Although it was a good idea, the reason why it did not succeed should be seen in the light of the separated working environments and that the situation was not followed up. The solution could have become part of the shared practice and thereby been used at the other schools.

DISCUSSION: THE COORDINATION OF KNOWLEDGE

The coordination knowledge combines to elements the temporary and the stable. It varies from context to context e.g. due to the uniqueness of the projects. However, it also encompass a repetitive element based on the traditional overlap between practices e.g. between the architect and construction engineer which requires a coordination of knowledge. This means that the design leader on one hand needs to ensure repetitive coordination areas but also needs to be aware of situations that occur unexpectedly – as the one analysed previously. It is a managerial challenge to chase these situations of coordinating knowledge and continually follow up on them. Furthermore, he needs an

overview over the dependence of the areas, which is not a part of the project group and thereby be able to position them within the larger constellation of practices. This requires an insight and experience from the design leader coordinating knowledge, catching up the situated nature of knowledge, acting as a facilitator – orchestrating the practices. It is however not only a matter of centralized leadership from the design leader as the coordination of knowledge also has an individualistic and team perspective. The individual needs to pay attention to the areas where his competencies is valuable and should be encouraged to play the game of coordinating knowledge. Contemporary construction actors, managers, teams and individuals could focus on the creating environments and procedures, which enable coordination of knowledge. This can be done by splitting the design meetings up in several sub meetings, letting people do the design in smaller groups and letting the leaders from the companies constitute a coordination group aligning the different practices. The meetings could be arranged around themes instead of professions enabling the practices to dispose their competencies. The themes could be identified based on the initially produced specification but should be developed throughout the design process. An example of a theme is the indoor climate, which at least would require the presence from the architects and the ventilation engineer. Coordinating knowledge in the design process is however also an aspect of drawing on the competencies and experiences from the craftsmen. In respect to this, there is a need to overcome the barriers sustained by the traditional contracts where the craftsmen are drawn in the project when it is too late.

CONCLUSION

Winding up, this paper has attempted to illustrate how knowledge is developed in heterogeneous project groups. Heterogeneous group organizations are in our perspective an important lever for realizing the products of the knowledge economy. These products are complex, multifaceted and encompass intangible and tangible elements. It implies human resource intensive projects with members from a range of professions. Project and knowledge management thus need to find ways as to develop this type of organization in order to realize the potential and address the challenges. Through our case we have demonstrated the importance of intersections between Communities of Practices through *arenas*, *brokers* and *boundary objects*. In some instances these intersections are smoothly running (like the example of the glue-laminated timber), in others the intersection implies power games, politics and communication problems. The latter element we haven't touched upon since a political and power perspective is requiring its own paper. Thereby it sets an agenda for future research – ARCOM 2004.

REFERENCES

Alvesson, M. (2002) *Understanding Organizational Culture*. Sage, London.

Brown, J. S. & Duguid, P. (1991) "Organizational Learning and Communities of Practice: Toward a Unified View of Working, Learning, and Innovation", *Organization Science*, **2**(1), 40-57.

Brown, J. S. & Duguid, P. (2001) "Knowledge and Organization: A Social-Practice Perspective", *Organization Science*, **12**(2), 198-213.

Clausen, C. & Koch, C. (1999) "The role of occasions and spaces in the transformation of information technologies", *Technology Analysis and Strategic Management*, **11**(3), 463-482.

Gherardi, S. & Nicolini, D. (2002) "Learning in a constellation of interconnected practices: Canon or dissonance?", *Journal of Management Studies*, **39**(4), 419-436.

Hughes, E. C. (1984) *The Sociological Eye.* Transaction Books, Rutgers.

Iansiti, M. (1993) "Real-world R & D: jumping the product generation gap", *Harvard Business Review*, **71**(3), 138-147.

Knorr-Cetina, K. (1999) Epistemic Cultures: How the Sciences Make Knowledge Harvard University Press, Cambridge, MA.

Lave, J. & Wenger, E. (1991) *Situated learning. legitimate peripheral participation* Cambridge University Press, Cambridge.

Loosemore, M. & Tan, C. C. (2000a) "Occupational bias in construction management research", *Construction management and economics*, **18**, 757-766.

Loosemore, M. & Tan, C. C. (2000b), "Occupational stereotypes in the construction industry", *Construction Management and Economics*, **18**, 559-566.

Meyerson, D., Weick, K. E., & Kramer, R. M. (1996) "Swift Trust and Temporary Groups," in Trust in Organizations: frontiers of theory and research, *In:* R. Kramer *et al.*, (eds) Sage, Thousand Oaks, pp. 166-195.

Newell, S., Robertson, M., Scarbrough, H., & Swan, J. (2002*) Managing Knowledge Work.* Palgrave Macmillan.

Orr, J. (1996) *Talking about Machines: An ethnography of a Modern Job.* Cornell University Press, Ithaca, NY.

Stacey, R. D. (2001) *Complex responsive processes in organizations: learning and knowledge creation.* Routledge, New York.

Star, S. L. & Griesemer, J. R. (1989) "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39", *Social Studies of Science*, **19**, 387-420.

Thuesen, C. & Koch, C. (2003a) "Cultures, Practices and Politics - a case study of a multiple configuration of Communities of Practices in building design", EGOS, Copenhagen.

Thuesen, C. & Koch, C. (2003b) "Managing Knowledge in Construction - the multiple configuration of Communities of Practices", 3. Nordic Conference - Construction Economics and Organization, Lund.

Thuesen, C. & Koch, C. (2003c) "Managing Knowledge in Heterogeneous Groups - A case study from the Construction Industry", IAMOT, Nancy.

Thuesen, C. & Koch, C. (2003d) "Project, Company or Profession? Tensions in and Barriers for developing Knowledge in Building Design", Organizational Learning and Knowledge, Lancaster.

Wenger, E. (1998) *Communities of practice learning, meaning, and identity.* Cambridge University Press.