

***INNOVATION, ORGANISATIONAL LEARNING AND MODELS OF
SLACK***

Theme: The Social Processes of OL and KM

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Introduction

The idea of slack hails from traditional economics. It is used by organisational economists in a negative sense to signify systems that are running inefficiently. In organisational terms, it means that companies that have slack or excess resources (e.g. capital, labour, capacity) are not operating in an optimal way. This is seen as poor management and ways are sought to reduce or eliminate the surplus. This language of optimisation and efficiency was inherited by modernist management writing and still pervades some management discourse, although it is not unchallenged.

In 1963, Cyert and March defined slack as a “supply of uncommitted resources”. Instead of regarding slack as a problem, they saw it as having an important role to play in organisations. They saw slack as beneficial to more long-term issues such as innovation and strategic development. An organisation which is operating at optimal efficiency is maximising its short-term gains but may be damaging its ability to change, adapt, and be creative in the long-term.

Slack and Organisation Theory

This idea was taken up by Organisation Theorists who found it “intuitively appealing, since it conveys the notion of a cushion of excess resources available in an organisation that will either solve many organisational problems or facilitate the pursuit of goals outside the realm of those dictated by optimization principles” (Bourgeois, 1981). Since then a literature about the role and effects of slack in organisations has developed, with a number of themes and foci. To begin with, a lot of the writing in this area was theoretical, hypothesising relationships between slack and various organisational outcomes (e.g. Bourgeois, 1981) or conditions (e.g. Sharfman et al, 1998). The empirical work in the field followed more slowly, partly because of the difficulties of both identifying slack and isolating measurable bottom line effects.

Many studies have therefore considered quite straightforward kinds of slack such as “excess resources in budgets, unused capacity, employees’ redundant time and excess short term profits” (Bowen, 2002). These studies are often quantitative in nature and rely on secondary financial data (e.g. Geiger & Cashen, 2002) or highly structured questionnaires (e.g. Damanpour, 1987).

A number of different studies have attempted to identify theoretically different aspects of slack. Bourgeois & Singh (1983) made the point that different forms of slack within an organisation would take different lengths of time to mobilise. They outline three different forms of slack:

- Available slack consists of resources which “have not yet been assimilated” and could therefore be redeployed within the organisation immediately;
- Recoverable slack is resources which are currently part of the organisational design but could be recovered if the company needed them in times of difficulty;
- Potential slack exists in the firm’s environment and could be tapped into in the future.

Singh (1986) has slightly modified this classification, in order to emphasise how easily different forms of slack might be mobilised within the current managerial cycle. He therefore distinguishes unabsorbed slack (corresponding to Bourgeois & Singh's (1983) available slack) and absorbed slack (corresponding to Bourgeois & Singh's (1983) recoverable slack).

Sharfman et al (1986) agree with the importance of these issues but their work has a slightly different emphasis: they differentiate between high and low discretion slack. They believe that slack resources can be defined by how many uses they could be put to, or, looked at another way, the variety of different options they give the management of an organisation.

Slack and Innovation

The question of how organisational slack affects innovation is a well established one (e.g. Damanpour, 1987;1991; Nohria & Gulati, 1996; 1997). Some of this work, like the more general literature, is also concerned with slack as the opposite of efficiency. For example, there is a tranche of work which attacks the effects of downsizing on the ability of companies to innovate (e.g. Fisher & White, 2000; McKinley, Zhao & Rust, 2000). They suggest that short-term efficiency gains have been made to the cost of long-term competitiveness through the loss of adaptability.

Others (e.g. Jensen, 1993) have taken their lead from organisational economics and have argued the opposite case: that slack (in their eyes waste) reduces innovation. They believe that in times of excess resources, management controls are less vigilant and internal politics and personal agendas lead to the sanctioning of "pet projects", which will benefit individuals or particular functions, but not the organisation as a whole.

In their important study, Nohria and Gulati (1996) reconciled these theoretical positions by hypothesising an inverse U-shaped relationship between slack and innovation. They went on to show empirically that slack had a positive relationship with innovation up to a certain point, after which the benefits tailed off, eventually leading to a state where slack did have a negative impact on the organisation's innovation levels.

A new interest in slack

With the demise of the 1990's boom economy has come a new interest in efficiency and a new set of writers defending the notion of slack in organisations. Some have attempted to complexify the approaches taken to defining and measuring slack in companies. Some of this is in the traditional vein, such as Geiger & Cashen's (2002) study, which essentially seeks to update Nohria & Gulati's (1996, 1997) work. Others are widening the scope of the concept to embrace new areas. Bowen (2002) for example has implemented Bourgeois' (1981) classic framework in the field of environmental management.

Perhaps the most interesting development is that some writers are now moving away from the established notions of slack as physical and tangible resources altogether. Instead this work uses the notion of slack in a much more casual way, or as a metaphor to help understanding of how organisations change or learn. This new work borders the Organisational Learning literature.

Lawson, for example (2001) updates the downsizing debate by pointing out that adaptability and learning in organisations need slack and believes that companies ought to actively design in slack. Slack is used in a similar way in Davenport & Prusak's (2000) Knowledge Management text. They assert that,

“Managers should regard communities of practice as company assets and look for ways to preserve them. Too literal an application of reengineering principles, with their emphasis on efficiency, has weakened some of these informal knowledge networks and groups. Some companies have driven out the ‘slack’ necessary for such groups to function well” (p39).

In his recent book aimed at management practitioners, Tom DeMarco (2002) eloquently argues the case for slack from a common-sense point of view. He believes that without slack, in the form of what he calls the organisational white space, organisations cannot change. Organisations that are designed to be highly efficient at one set of operations or processes are excellent at running day-to-day. However, precisely because they are efficient, the people who operate within them never have time to consider the future. Worse, like a perfectly honed production line that produces perfect car after perfect car, it becomes obsolete if the public's definition of perfect (or even their demand for cars) changes. They cannot change because change requires excess resources and completely new thinking, and these organisations have vilified both. This is not simply an evangelical rant on the benefits of slack. DeMarco does not lose sight of the profound and difficult work involved in changing the way an organisation looks at itself.

What DeMarco does not do is furnish us with either a theoretical framework to examine organisations, nor systematic empirical data to build his vision and anecdotes into the extant theory on slack. As a practitioner work, although it has resonance with other ideas in the wider literature, it contains no references. However in many respects DeMarco pushes forward the theory he ignores.

Contribution

This more qualitative, social idea of slack, needs a different empirical approach and insights from another tradition of management research. Qualitative research in this area has been very scarce. Bowen (2002) and Thompson & Millar (2001) both make use of in-depth interviews to identify levels of slack in organisations. However, both studies are using qualitative methods to operationalise a largely quantitative, resource-bound definition of slack.

This study began by looking at the relationship between organisational slack and innovation, but using a qualitative methodology and employing Activity Theory as a theoretical framework. By moving away from the question of how to measure slack, it has been possible to consider a wider and less concrete range of kinds of organisational slack. Further, it means that rather than limiting debates to the effects on relatively tangible outputs such as product or process innovation, we might extend the field to cover issues such as organisational learning. It becomes possible to think about how slack is manifested in, and supported by, organisational culture.

Since this methodology will give respondents free reign to discuss what they feel is important for innovation and learning, they may raise a wider range of issues than they would if asked about a pre-selected list of concepts. Therefore, by employing a grounded approach it is also possible that this study will present the opportunity to extend the concepts currently debated in the literature.

Using a combination of constructs offered in the literature and empirical data, this paper seeks to articulate different aspects of slack. This is done with the aim of deepening and complexifying our understanding of the role of slack in organisational learning and innovation.

Method

This study draws on data sourced from six different UK companies through a series of around 30 semi-structured interviews. The companies range from start-ups through SMEs to large, well-established and international players. All of these companies are committed to both product and process innovation and therefore see themselves as competing through their ability to innovate and/or learn. They have been selected through a process of theoretical sampling (Gummesson, 1991) by selecting cases which might represent ‘extreme’ positions. Thus the sample includes representatives of start-up and spin-out companies, companies with a highly developed innovation management structure, and companies operating within ultra high technology environments. See Figure 1 for details of the companies involved in the research. All the company names have been changed.

Case Companies	
Spirits International	An international company incorporating many distilleries
Specialist Metals	A company producing bespoke orders and small batches of metal components
Application Ltd	A small, family run software house with a few established products
Recover	A not-for-profit furniture recycling venture aimed at both providing low-income households with start-up kits for their first homes and giving work to people with long-term mental illness
Medires	A university spin-off company founded by a medic and two scientists in its early stages of formation
High Tech	A company making electro-optical products for the defence industry

Figure 1. Brief descriptions of the case companies

Theoretical Framework

In order to analyse the findings from this study, Activity Theory has been used as the theoretical framework. Activity Theory is based on the work of Russian psychologists Vygotsky (1978; 1986) and Leont'ev (1978; 1981) and has been used in many fields. The form that I will base my analysis on has been adapted from this work by Engestrom (1987; 1990) and centres on the relationships shown in the diagram in Figure 2.

Activity theory concentrates on three things and how they relate to each other:

- how a group or individual conceives of themselves;
- what it is they see themselves as doing, (the object of their activity) and;
- who they see themselves as doing it with (their community).

This is represented by the inner triangle on Figure 2.

These relationships are thought to be complexified in two ways. Firstly each of the relationships are mediated by other factors. So for example social rules mediate between us

and our communities of practice. These mediators are represented on the diagram in Figure 2 by the outer triangle.

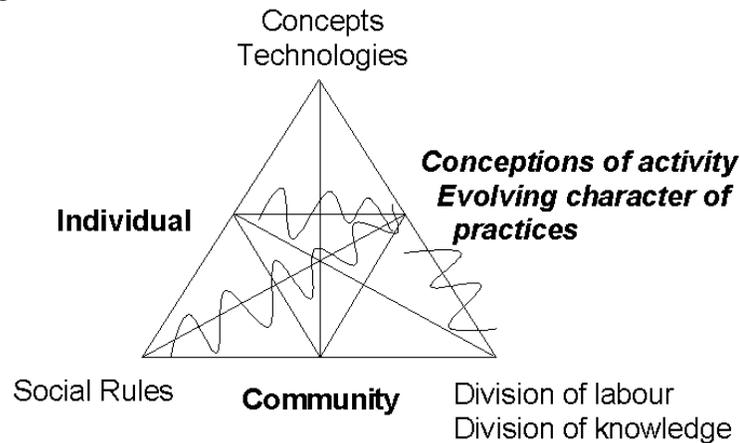


Figure 2. An activity system diagram

Secondly, activity theory believes that activities do not proceed in a smooth, uninterrupted fashion. Rather they see activity systems as ‘disturbance producing’ entities which are full of contradictions, mistakes and problems. These are termed tensions and they are represented on the activity system diagram by the wavy lines.

For a full explanation of the origins of activity theory in organisation studies, see Blackler, Crump & McDonald (2000). For a more detailed discussion of these concepts and an example of them being used in practice, see Blackler, Crump & McDonald (1999).

Results and Analysis

The interview transcripts were analysed by searching for interviewees’ descriptions of slack and their effects on innovation and learning processes. These data were developed into categories as patterns of common themes and concerns were established. What follows is a presentation of these findings interspersed with an activity theory analysis.

An analysis of the formal, or how slack is being ‘built in’

At a very general level of analysis it is possible to discern a number of ways in which organisations have tried to build formal slack into their working practices. Not all the companies that were included in the study have made explicit attempts to foster slack in order to promote innovation or learning in their organisations. The companies that have deliberately sought to make space in their organisations have tended to do it structurally, or for specific, unusual tasks.

Slack can be provided structurally by separating out a section of the company and making it responsible for innovation. Thus the ‘normal’, day-to-day or operational concerns are formally removed from a group or individual in order for them to concentrate on the long-

term, creative or strategic. This is probably the most common way for a company to resource slack for innovation and learning.

One of the most striking examples of structural slack in this study was the designation of a full-time Innovation Manager at senior management level in Spirits International. This role has been created to generally support other departments in their attempts to think differently about what they are doing and how they are doing it. Early work for the Innovation Manager concentrated on using creative problem solving techniques with established work teams. He sees his role as a facilitator and as a promoter of innovation within the firm. A lot of his work is about raising awareness about what innovation means. Interestingly, when I spoke with him, a year after his post had been created and again a year later he was still trying to relinquish responsibilities from his previous role in the company and had lingering operational commitments due to staff shortages. This shows that even within a healthy multi-national that has innovation explicitly written into its goals it can be hard to ignore the operational even when your job description is 100% strategic.

Another large-scale example of a structural form of slack was found in High Tech's approach to some of its new product development. For the development of two of its most important new products, one a new generation of a core product and the other an important new technology and market, High Tech set up two pilot teams. The teams were multidisciplinary, co-located, staffed by the cream of the design and manufacturing engineers and generously funded. Their intention was not only to generate these important new products, but also to pilot new ways of working for the company.

Companies sometimes resource innovation or learning by dedicating specific time for these activities. Once a year the husband and wife team that are the driving force behind Application Ltd take themselves away from their business for 24 hours. They book into a hotel in the country where they have dinner and stay over. The next day they spend a full working day in one of the hotel's conference rooms, completely out of contact with both staff and customers. They use this time to work on their strategy. They think about what they have done in the last year, and make decisions about their priorities for the next one. They gaze out of the window. They ask some very difficult questions. This is protected, creative, future-oriented time. This is an example of a common kind of slack used to support strategy-making efforts.

In all of these cases, the company has enlarged its object of activity to include an explicit innovation goal by sectioning off part of the company, either physically or temporally, to concentrate on innovation. For the group or individuals involved, it certainly means a new (or in most cases actually an added) object of activity. Making these changes has also involved a change in the concepts and technologies used: in High Tech co-location, for example, in Spirits International, the idea of an Innovation Manager, and the new creative problem solving techniques.

From the point of view of the company as a whole however, this is an example of increasing slack through manipulation of the division of labour and knowledge. Little has changed apart from a superficial alteration of the concepts. The transformation has only been a reality for either a small sub-set of the organisation, or for a short period of time. This might have an impact on particular innovations, but the presence of a pilot team or an away day only adds to the message that this is unusual behaviour and does not promote organisational learning.

An analysis of the informal

What is interesting is the many ways in which more informal, less deliberate kinds of slack seem to be at work in these organisations.

Time

At the end of each interview I asked the interviewees what they would do first to encourage innovation in their organisation if they were suddenly omnipotent. By far the most common answer was time. But respondents often qualified this – they didn't want more of the same kind of time, they wanted more unstructured time that did not have specific outputs or procedures attached to it. The managing director of Application Ltd put this very well when she yearned for, "time to play...time to gaze out the window...time to let things settle...time to read and react". This is echoed by one of Medires' founders who had the idea to pursue the notion that their primary product development work is based on whilst on sabbatical in Australia where he, "spent some time under [his] duvet".

These very honest and personal accounts of time are not really what you might expect from ambitious entrepreneurs. Perhaps the answer of the Spirits International Innovation Manager is a more conventional one. If he had a magic wand he would systematically take the whole company completely away from their day-to-day commitments to an environment where he could, "make everyone take a step back and look for opportunities".

When I started to ask the managing director of Application Ltd to tell me about innovations she began to describe a whole series of procedural changes that had been made to the business in order to make it operate more efficiently. However as she went on to explain, these efficiencies were not ends in themselves, but means by which she could protect more 'real' time in her week to do more important, strategic tasks.

On the face of it a request for more time could be thought of in terms of an injection of traditional slack. The idea of support for innovation or learning through the allocation of extra personnel to a task is hardly radical. Nonaka and Takeuchi's (1991) for example offer us the notion of redundancy, whereby excess personnel, often with deliberately overlapping skills or experience are assigned to a project. In the manufacturing literature resonance can also be found with Jaikumar's (1986) non-essential tasks. This would be attempting to support innovation through enlarging the community of practice and perhaps by tinkering with the division of labour and knowledge within that community. However this would not really capture the nature of the requests made in the interviews. What they imply is that there is something important about the nature of that extra time. The reason that we find the first two accounts of time surprising is because they challenge our existing notions of work. What the respondents are actually asking for is that we alter our current frameworks of social rules to incorporate gazing out the window and thinking under the duvet as legitimate forms of work for knowledge workers. Equally it implies a change in the practices that must be declared as objects of activity. This is a very profound and difficult change to affect.

Difficulty, Problems and Failures

One of the other things found in many of the interviews is a sense of the difficulty of achieving innovation. The managing director of Recover talks of the impossibility of working with different bits of the council, of trying to balance the conflicting demands of various funding bodies and of dragging people together who have different ways of working to try to focus them on her agenda. She often finds herself working outside of or despite the established system. She describes many iterations of trial and error until she finally succeeds. The Innovation Manager in Spirits International goes further by using the image of a globe spinning to represent the business as it is and depicting himself as trying to oppose that path and make it revolve the other way. He says that if innovation is going to become widespread, “we need to make some space, we need to push”. One founder of Medires noted that when we write research up in academic journals, we write a sanitised, linear story in which, “people don’t talk about failure or the mess of research”.

These notions of difficulty are not necessarily problematic for the respondents. There is a sense of challenge and achievement in these stories. The Analysis Manager in Spirits International told a story about someone making a mistake in a straightforward test procedure and getting an unexpected result. They couldn’t explain what they found but realised that if they could repeat the result then they could test for a whole range of alcohol properties in a new way. He said, “we had an unknown and that’s meat and drink to the guys in here”. The failure is seen as “serendipity”, an opportunity to solve a problem and to find a new way of doing things at the same time.

The company environments that they work in do not always officially support these kinds of view of innovation however. A senior manufacturing engineer in High Tech tells me that once you have settled on direction for a project and a design process is underway, “the last thing you want is a good idea” because of the timescale implications it will have if the project is to be re-worked. Clearly he is working in an environment with little or no slack and little regard for innovation and learning. In the past this has been a problem for Spirits International where, “people almost had to do things underground”.

The question of how systems reinforce their own norms and how legitimate it is within an organisation to challenge, work round, or ignore those norms is one of the basic questions of organisational learning and has been written about widely (see e.g. Daft & Weick, 1984; Orr, 1990). However an activity theory perspective would emphasise the tensions that arise between the individual and their object of activity when the means to reaching their aims may not be seen as legitimate within their working environment. The social rules within the activity system must be adapted to allow failure, iteration and the difficulty of forcing existing systems into new ways of working to be recognised not as anti-objects of activity, but as positive sub-objects of activity.

Expertise

Another issue that featured in many of the interviews for this study was expertise. This is not so much in the sense of a company employing an individual who is highly qualified, but rather in terms of the experience of others and how it is possible to have access to that experience so that you can engage with it, or have it engage with your problems. One of the founders of Medires spoke with great satisfaction about how the formalisation of the company had brought him real and direct access to scientists who could answer his questions and realise his ideas in a concrete and practical way. They all worked within the same university, but without the formal link of the company structure, he believes he would never have dug them out of their departments or got them to take his problems seriously.

Sadly the freedom to meet and talk directly with both academics and industrial scientists was something no longer afforded to the researchers in Specialist Metals. This fact was lamented by their site manager who used to travel widely both to meet customers and to speak at conferences. The CEO however did still see the importance of this sort of exchange. He told me that he devoted some of his time to attending meetings of the industry association and other gatherings of senior industry figures. It was his firm belief that nothing could compare with the way you understood issues if they were presented to you first hand and discussed amongst peers. This gave him invaluable insight into the future of both markets and technologies relevant to his company.

One of the aspects of his co-founders' expertise that one respondent at Medires particularly valued was that it was quite different from his own. This sentiment was echoed by the MD of Recover who often sought out views other than her own, testing her ideas and plans with many different kinds of people whose expertise could help shape them. Her board was deliberately made up of people who represented a wide range of different knowledge bases, experience and networks of contacts. She believes that experience does not necessarily bring any greater chance of having seen a problem before and knowing how to solve it, but rather that it brings confidence that a solution will be found. The Analysis Manager in Spirits International also enjoyed this kind of confidence. He believed that the skills and experience of his analysts gave him access to an important kind of flexibility that can solve any problem and question the status quo. The same attitude to problems and confidence in in-house expertise was found in Specialist Metals. Application Ltd cited their Technical Director's programming skills and experience as one of their most important assets, giving them crucial flexibility in an extremely fast-moving and competitive market.

This is an important kind of slack. It feels like insurance. It can be used reactively to solve problems and proactively to make new connections between fields or new relationships. Whether it comes from bringing together people from different backgrounds or specialisms as in Medires, or having had a number of careers like the MD of Recover, or simply working in many different parts of the same industry like the Technical Director of Application Ltd, this sort of expertise is like innovation or learning waiting to happen.

In terms of the activity system, these groups or individuals seem to have an extended sense of their community of practice. Their object of activity includes a long-term or wide-frame view. Their social rules include a respect for the contribution of other disciplines or individuals. This has a lot in common with the ideas of Boland & Tenaski (1995) who talked about experts 'perspective making' within their own disciplines and 'perspective taking' across the boundaries of other disciplines. Above all the kind of expertise described by these respondents means that people become extremely adept at managing the tensions in their systems. They don't try to patch them up when they are broken but have the confidence to reconfigure them, or to see them for what they are and learn from them. Resonance can also be found with other organisational learning literature: These skills are reminiscent of the 'heedfulness' described by Weick & Roberts (1993) in their study of workers co-operating on an aircraft carrier.

Discussion

The first, more formal kinds of slack found in the companies that were studied have a lot of similarities to the kinds of concepts reported in the literature reviewed above related to slack and innovation. These kinds of structural alterations that companies have made in order to provide slack sit comfortably with the established notion of slack as resources. They are perhaps the sort of thing that the trends of financial indicators used by quantitative researchers to infer slack are designed to pick up. They involve resources that can be measured and tracked over time. These resources have a physical or self evident form: Management time, dedicated hardware, money for training, space on the mezzanine. However an activity theory analysis highlights that these changes are mainly superficial, being restricted to the outer triangle of the activity system. Further, the mediators that these structural changes affect tend to be those that can to a degree be directly influenced by management, such as the divisions of labour and the technologies and concepts.

In the second part of the analysis, another range of factors was considered. These were issues that were raised directly by the interviewees in their stories and observations about innovation. These issues are more informal and less tangible forms of slack and they are not often discussed in the innovation and slack literature. They have a lot more resonance with the organisational learning or culture literatures. On the face of it, there are ways to link these issues with the extant slack literature. Excess managerial or worker time for example is certainly one of the factors considered by organisation theorists as slack. You could argue that expertise is just a form of human resource combined with an element of excess capacity. However this would be to ignore the qualities of the time described by the respondents, and the dynamic flexibility of the expertise that was valued. These concepts go beyond what is accounted for in the quantitative models that measure slack in conventional studies.

Introducing many of these informal forms of slack relies on changes both in the social rules of an organisation and in the objects of activity. These sorts of changes are less straightforward to make as they both have elements that can be only be indirectly controlled by management. Making this sort of change is akin to making meaningful changes in organisational culture. They are neither easy nor comfortable changes to make. Activity theory can help us to see why this is the case. Any changes that require us to adjust

significantly our objects of activity means altering the inner triangle of the activity system. Changing one part of this will cause tensions in both our conceptions of ourselves and which others we see as part of our community of practice. This reconceptualisation is a profound and difficult one.

Perhaps the most striking difference between what is written about slack and what the respondents in this study were concerned about is their respective attitudes to money. In the organisation theory literature money is everywhere. It is considered to be the ultimate high discretion slack (Sharfman et al, 1986), it is the unit of measure of slack in organisations which all other resource forms can be translated into (Bourgeois, 1981), and it is the measure of success.

Not one of my respondents talked about money in a positive sense. Some of them referred to money-saving measures that had damaged innovation in their companies. None of them wanted more money. They wanted more time (protected, unstructured time) and expertise because these are what they regarded as high discretion slack. Given the preoccupation of the slack literature with finances, this is surely an interesting finding in its own right.

While I was writing this paper I began to wonder whether what I was describing could be defined as slack at all. The organisation theorists are very clear in their definition of slack: it must constitute physical resources. Whilst my concerns clearly have a physical component (people, capacity) they are not strictly tangible in the sense that they can be made discrete from each other or are easily measured. You could certainly attach monetary values to these factors but they would not convey either their qualities, their underlying effect on other, more conventional kinds of slack, their potential for learning, nor their dynamic nature.

So is what I am talking about not slack because it is not concrete, or are the traditional definitions too narrow? It may be that this work is extending and enriching (or at least complexifying) the definition. It may be that many of these other authors are just concentrating on the tangible because they aim to measure slack. Given their quantitative perspective it is possible that they only see the tangible. After all their aim is to simplify and model reality, and they use as their measuring stick something instantly recognised and valued by industry: money.

So does this study extend the definition, or is it simply using these concepts as metaphors in a different conceptual frame? I think my answer is that I'm still not entirely sure, but I do think that this sort of qualitative analysis gives important insight into the problems of managing innovation and organisational learning.

Conclusion

At first glance, the literatures relating to slack and innovation on the one hand and organisational learning on the other seem poles apart. This distinction is not one that is

reflected in real life, rather it is one which has been imposed by academics. Two very different underlying epistemological frameworks have fueled this division. On the one hand organisation theorists have used quantitative methods to identify different kinds of slack and measure their effects on organisational performance. On the other organisational learning theorists has made use of more qualitative approaches to unpack more social aspects of learning. There is definitely scope to talk about slack within organisational learning. It appeals to practitioners who recognise it and can discuss it in relation to their own experiences.

This paper draws on ideas from a wide range of work about slack. Its qualitative approach has allowed a wider range of concepts to be investigated from the perspective of the organisations themselves. The use of Activity Theory has helped to analyse the implications of different kinds of slack being introduced within organisations. It has both complexified the notion of organisational slack and moved the analysis of it to a deeper level. Less tangible forms of slack have not been considered in the literature explicitly. These are important concepts as they may underpin other forms of slack and determine their effectiveness for learning and innovation. Informal slack is difficult to study and very difficult to design into organisations. Activity theory can help as it provides a sophisticated framework to investigate the organisation's cultural architecture and can articulate the dynamic nature of the tensions that these changes can bring.

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Abstract

The production of knowledge in projects in building design can be characterised as an interplay between actors within and across several knowledge intensive companies including consulting engineers, architects and contractors. The product usually combines organisational knowledge stemming from various professional practices into a documentation representing a new building. The organisations operate under continual pressures from structural, organisational, professional and individual sources. The knowledge production consists of a bricolage of practical experiences, formalised information, transformation of demands from external alliances and customer demands.

This paper combines a critique of the knowledge management discourse with contributions on project working and teams. Mainstream knowledge management discourse picture knowledge as either a well-defined tangible entity or describe how it can quickly become one. They also leave the issue of the content of the knowledge blackboxed. Although Community of Practice approaches dismantle the rationalistic perceptions of knowledge, a belief of the stability and non-political, 'power free' features of the knowledge production is maintained. And they still leave out the content issue. It is suggested to view the knowledge production as relying on temporary network building, knowledge alliances, in and across teams in the projects and the companies.

The paper presents an ethnographic case study of a building design process. Several management initiatives in the involved companies address the production and management of knowledge. These managerial initiatives can be seen as an attempt to develop the internal resources as much as possible. However they occur under a continual regime of 'getting things done' in the ongoing project, very often with the project as 'the winner' on behalf of others in the battle of resources and attention by the project managers and employees. It is illustrated how the projects are carried out under continual stress and with restricted room for collective reflexivity.

We discuss through the empirical material, barriers for the knowledge production in building design which includes: group polarization, group thinking, power and politics, time pressure and the structure of the design process. It turns out that an important knowledge type to be handled is coordination- knowledge between various technical/professional areas, across projects and across companies. The empirical case presented shows how these domains continually are in tension with each other making coordinative knowledge political.

Keywords: Design, Community of Practice, knowledge, coordination, construction

Introduction - the fragmentation of building design

In construction certain narratives are usually mobilised to explain how management and organisation occurs. It is thus an often celebrated sectorial myth (interpreted here as a part of the sectorial symbolic culture (Alvesson 1993)), that the inter-organisational cooperation is temporary. The belief is that knowledge production in building design is closely related to realising 'one of a kind' productions. This is illustrated in the ever changing context of building projects. The location of the construction site is unique and the building owner and stakeholders vary from project to project. However when focusing on a single project and institutional links it will occur that the temporary element is relaxed. It appears rather to be a network of recurring partners in different constellations, with rather well defined and well-exercised roles that is in play. (Loosemore & Tan 2000b) analyses these as stereotypes.

A central characteristic is the organization of the supply chain which exhibits a specific division of labour and institutionalized roles such as the manufacturers of the basic part, building companies (including craftsmen), engineering companies and architects. This differentiation of the institutions is developed and sustained by the educational system. In one perspective building design is an art; a major discipline of architecture; something ambitious young people learn at Royal Academies of Fine Art. In a somewhat contrary perspective building design is also a matter of professional practice, of production, dissemination and application of knowledge; something that professionals of the more down-to-earth no-nonsense variety, might find can only be learned in The School of Life.

Although there are examples of transcending these institutionalized roles they are generally maintained in the majority of building projects. Consequently every project is organised cross-organisational, thus making the knowledge production in the project an inter-organisational task. This cross-organisational setting is maintained in the design process as it usually encompasses collaboration with a set of actors including architects, various engineers and other professions.

Drawing on (Alvesson 2002) and (Wenger 1998), (Thuesen & Koch 2003) shows that the landscape of cultures in the project setting can be interpreted as a multiple configuration of Communities of Practices (CoPs) characterised by overlapping and partly shared practices and individuals with multiple memberships of communities with different levels of participation. The interplay between the CoPs is established in arenas by boundary objects and brokers. In other words CoPs are interwoven within and across organisational boundaries between companies, projects and professions.

This fragmented characteristic is of major importance when discussing the production and 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. The knowledge developed within the project group consists of a bricolage of practical experiences and formalised information.

The problem we address in this paper is to understand which problems and barriers there exist for developing knowledge in building design, given the fragmentation of design process. Furthermore we attempt to illustrate how these barriers might be overcome by coordinating knowledge.

The perspective we here are taking are the knowledge production in heterogeneous project groups – a perspective which usually isn't discussed in traditional literature with exceptions as (Garrick & Clegg 1999; Keegan & Turner 2003; Newell et al. 2002). Recently (Bresnen et al. 2003) discusses the management of knowledge in project environments. They however focus on an organisational level while our ambition is to study the project in detail by conducting an ethnographic field research.

The paper opens with a description of the theoretical base: knowledge production in heterogeneous groups. Subsequently follows some methodological considerations. Then a case study is presented with an identification of barriers for developing knowledge. An example of coordination knowledge is presented and is discussed as a tool for overcoming the barriers. Ultimately the paper is closed by a conclusion winding up headlines of the paper.

Theory – knowledge production in heterogeneous groups

Theories on knowledge and learning have traditionally focused on how to support processes by systems and technologies with a tendency to view culture as a blackbox. Gradually the role of

cultures has however come into play, especially with the introduction of the notion of Community of Practice (CoP). We endorse the importance of a cultural approach to management of knowledge and organisational learning, as an understanding of how knowledge is “working” at a micro level is a foundation for creating successful knowledge initiatives. Theoretically we therefore draw on organisational culture, CoPs and organisational politics as three main schools of thought.

We initially open with a discussion of theories handling knowledge production, followed by an outline of characteristics of heterogeneous groups ending up in a discussion of developing knowledge in heterogeneous groups – focusing on the coordination of knowledge.

Knowledge production

Concepts like ‘Knowledge Management’ and ‘Organizational Learning’ has been a subject of increasing interest during the last decades. This development has been dominated by discourses with central figures as Nonaka, Davenport and Von Krogh. We will not present a review of these positions here but point to (Stacey 2001) who offers a substantial critique of the main discourses of knowledge and learning in his identification of 10 taken for granted assumptions with the split between the individual and the social being the most prevalent assumption.

During the development there has been a shift from a structural to a processual approach with an increased focus on aspects as culture and practice. (Gibbons et al. 1994) distinguish this turn from mode 1 to mode 2. Our approach stems from the second tradition. In the second mode practice and knowledge are seen as inseparable which has given (Polanyi 1966)s statement, that knowledge always have an unarticulated component – “the tacit dimension”, a renaissance.

One of the most influential contributions to the mode 2 discourse is the concept of Community of Practice developed by (Brown & Duguid 1991;Brown & Duguid 2000;Lave & Wenger 1991;Wenger 1998;Wenger, McDermott, & Snyder 2002) and numerous commentators/adopters. According to (Wenger, McDermott, & Snyder 2002) a CoP “...is a group of people who interact, learn together, build relationships and in the process develop a sense of belonging and mutual commitment.” (p. 34).

Its noticeable that recent development in cultural studies (Alvesson 2002) and CoP have a lot in common, where the theme ‘shared meaning’ is central in both symbolic organisational culture understanding (Alvesson 1995) and in CoP (Wenger 1998). Both are e.g. drawing on the work of (Bourdieu 1979) and his concept “Social fields”. In (Alvesson 2002)s development of the “*multiple cultural configuration view*” (p. 190) he states that organisations can be understood as shaping local versions of a broader societal and locally developed cultures in a multitude of ways. People are to different degrees connected with organisation, suborganisational units, professions, projects, gender etc. Cultures (interpreted here as CoP) overlap in organisational settings, and are rarely tightly connected to the social structures of the organisation. This is very much in line with (Brown & Duguid 1991)s suggestion that organizations can be seen as a web of CoPs canonical as well as noncanonical - often with the noncanonical practices as the main sources of innovation.

Practice is the foundation for transferring knowledge, as knowledge in mode 2 is seen as something socially constructed and contextual. A basic requirement for sharing knowledge between people is therefore a presence of a shared practice (Wenger, McDermott, & Snyder 2002). (Knorr-Cetina 1999) identifies this prerequisite in her work with epistemic cultures

and (Brown & Duguid 1998; Brown & Duguid 2001) uses this to explain the sticky and leaky nature of knowledge as they states that “knowledge...runs on rails laid by practice” (p. 204). The creation of knowledge has been a subject of interest as it is seen as a source of innovation and thereby a necessity for survival in competitive markets. One of the most influential theories here is Nonakas SECI-model where knowledge is created through an iterative process of converting tacit to explicit knowledge through the phases Socialization, Externalization, Combination and Internalization (see e.g. Nonaka 1998). The foundation of this process is an enabling context which they term *ba* and which facilitates interactions. In contrast to this model (Brown & Duguid 1998) sees the creation of knowledge more from a ecology perspective believing that CoPs is the main source for creation of knowledge. (Cohen 1998) points to the similarities between Nonakas originating *ba* and Browns ecology system as they both emphasis the creation of knowledge within a complex unified organic system (p. 28). Resent critique of the SEIC model (e.g. Brown & Duguid 2001) has pointed out that Nonakas division of knowledge into explicit and implicit not harmonises with (Polanyi 1966)s understanding that these just are *dimensions* of knowledge. While the CoP approach accepts this announcement it is still naive to believe that CoPs only is a source of innovation as they by there shared practices and ‘taken for granted assumptions’ can grow in to be very conservative (Brown & Duguid 1998; Newell et al. 2002).

Heterogeneous groups

Most mainstream literature including the concept of CoP does however not discuss the issue of handling knowledge in heterogeneous groups. Etienne Wenger studies in his significant book from 1998, a group of claim processors who work in fairly stable context. Recalling the discussion in the introduction a project group in our context is a collection of many different practices put together in order to solve a specified task (in our case designing a building). This draws our attention to theories dealing with temporary systems.

According to (Goodman & Goodman 1976) a temporary system as “a set of diversely skilled people working together on a complex task over a limited period of time” (p. 494). (Meyerson, Weick, & Kramer 1996) elaborates on this definition and states that temporary groups are characterised 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 (p. 167). Another key characteristic according to (Meyerson, Weick, & Kramer 1996) is the mutual dependency of the participating partners. This stems from a division of labour where each subtask is dependent of another due to the complexity of the general process.

From a CoP approach a temporary system can be seen as a collection of multiple interdependent communities with different practices that might overlap in the organisational setting. While there are differences in practice between these communities they also to some extend share some practice, which enables communication across the boundaries. Drawing on (Thuesen & Koch 2003) a temporary system might in other words be interpreted as a multiple configuration of CoPs.

Knowledge production in heterogeneous project groups – coordinating knowledge

As heterogeneous project groups are characterised by diversity rather than homogeneity the members are initially likely to have more in common with their colleagues in their organisations than with the others in the project. The diversity of such groups makes it possible to carry out a complex task due to the division of labour. A central condition for success is the organisation of knowledge (Brown & Duguid 1998) by how different competencies are assigned the project (Newell, Robertson, Scarbrough, & Swan 2002). 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.

In the division of labour there is a tradition on focusing on the input and output of the sub processes, with a focus on minimizing the overlap between the processes based on the idea that the optimal use of the labours absorptive capacity (Cohen & Levinthal 1990). This approach however fails when unforeseen events arises. As this is everyday life in temporary systems the standardization and description of boundaries between practices is replaced by overlapping practices in order to cope with the emergent nature of the project.

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) discussed 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. Though his perspective stems from an individual point of view we find it applicable to CoPs, as the domain which the community is gathered around can be seen as the depth knowledge area.

As the output of the knowledge production in heterogeneous project groups should be characterised 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. The knowledge areas are coordinated through interactions in terms of dialogs and negotiations and are highly dependent of the context due to the situated nature of knowledge.

(Alvesson 2002) touches this aspect from a cultural theory perspective by identifying that an organisation must develop some degree of mutual understanding in order to deal with problems and make collaboration possible. He talks about bounded ambiguity. Even if cultures does not produce clarity and consensus it can offer guidelines for coping with ambiguous meanings, giving clues on how to deal with tricky issues.

In the process of carrying out the task the project can be interpreted as a domain in (Wenger, McDermott, & Snyder 2002) universe¹ which are tying people together. Through mutual engagement in this domain they form a community (p. 33), develop a shared practice (p. 37) and create identity. Regarding the diversity the project group might turn into a CoP – a boundary practice (Wenger 1998 p. 114). The coordination of knowledge takes place as each member of the project is brokering by legitimate peripheral participation in the project and the community which they are a part of ‘at home’. Furthermore boundary objects (Star & Griesemer 1989; Wenger 1998) connect the different practices within the group and generate new understandings in both groups as they negotiate the meaning of the object. Through this coordination the boundary object might become a part of the shared practice in the group.

¹ Three elements characterises a CoP. These are further developments of the dimensions in (Wenger 1998) with a strong coherence between; (1) the domain and the joint enterprise, (2) the community and the mutual engagement and (3) the shared practice and the shared repertoire.

This is very much in line the concept “cultural traffic” describing the interaction between and shaping of cultural manifestations (Alvesson 2002). This concept is important since it explains why cultures are not fixed entities but evolves over time.

(Wenger 1998) demonstrates how two CoPs can mutually strengthen each other in everyday practices but downplays the possibility that such deep embedding introduces ambiguity and tensions. The result of this effect is that two CoPs might be in conflict with each other, or even constitute themselves on a stereotypic image of ‘the others’ – a phenomenon well described in organisational culture literature (Alvesson 1993). This suggests that the cultural approach is supplemented political approach viewing the production of knowledge as relying on temporary network building (coalitions), exercise of power, and related to exploiting rooms for manoeuvre along with opportunities, problem settings, boundary buildings and solution formulations.

(Lazega 1992) describes the micro politics of knowledge production in groups as he develops the notion “knowledge claims” illustrating the dynamic and controversial interplay between different world views. He distinguishes between four types of claims the realistic, the expert, the polemical and the initiated, based on an understanding of how they are legitimized and endorsed in a group (p. 54). Though his focus is on the relation between individuals in the setting we find it applicable from a perspective on practices and cultures.

Stephen Fox illustrates the power dimension by synthesizing Actor Network Theory and CoP theory on the basis of (Foucault 1984) conception of power “...as an active resistive or reactive force” (Fox 2000 p. 861). Here decisions are created through a process of persuasion, linking humans and artefacts.

Based on these positions we suggest viewing the knowledge production in a heterogeneous project group as a mingling with competencies, coordinating knowledge relying on shared practices, temporary network building and knowledge alliances, in and across teams in the projects and the companies.

Method

The methodical approach is multidisciplinary tying together engineering, interpretive sociology, organisation theories and management. In particular we are drawing on analytical strategies from anthropological (Lave & Wenger 1991;Wenger 1998) and organisational culture perspectives, as we adopt a position similar to (Alvesson 2002) who observes that culture studies have to be carried out in a specific context, where its impossible to operate with an entirely stable set of concepts independent of setting.

The case material stems from an ongoing ethnographic study of a construction process focusing on the design phase. Over a period of 6 months one of the authors (Thuesen) was on a daily basis present in the project following in the ‘main’ project activities, covering all the design meetings, workshops, and some internal and external meetings. Apart from participant observation seven interviews of members has so far been conducted including one double interview. Furthermore the formal documents created by the actors have been available to us. After a period of ‘just being around’ in the field the design meetings was taped with accept from the participants. To adopt such a time span was necessary in order to create a familiarity of the researcher. Similar the interviews were conducted after one month with the same argument. The participant observation developed a basis for carrying out interviews around some of the respondent’s tangible experiences raising the quality of the interview by digging deeper.

In order to create an overview of the design process and how knowledge was developed a manuscript of the design process has been created stemming from the empirical material. Here central events and activities were positioned on a timeline with link to the collected empirical material.

As the research project is sponsored by a contractor we admit that it might create a pro-company bias. We however attempt to mobilise a critical distance to outbalance the pre-given empathy with the company. Additionally it can also be noted that both authors share the professional background as engineers with a multidisciplinary education and training in management and organisation. A potential occupational bias from the authors towards the players in constructions is recognised, but not analysed, see (Loosemore & Tan 2000a).

In an effort to minimise the bias the empirical material has been juxtaposed with material from a forthcoming study of the same building project (Nielsen & Apelgren 2003). Furthermore interpretations have been discussed with the people in the field.

Case

We will here present a case from the construction industry for illustrating the barriers for developing knowledge in heterogeneous projects groups. Furthermore we will illustrate the concept of coordination knowledge. Initially we will though shortly outline the context in order to comply with (Garrick & Clegg 1999)s statement that there in the discussion of project learning has been to little focus on this aspect.

The context

The case is an ongoing partnering project with the aim of developing the schools of a municipality which includes refurbishment of four existing schools. The main actors in the project are besides the architect, a technical consultant and a contractor. The contractor has composed a team which includes a project leader, a design leader and a couple of procurement managers. The technical consultant has four specialists from different departments assigned. Besides these specialist they have assigned a project leader and draws regularly on other competencies in house. The architect has several people working on the project including one project leader. We here follow a design process of the refurbishment of one of the schools.

The main office is located at the construction site of one of the schools and consists of a large open office housing all the members of the contractor (excluding craftsmen). The persons from the architect and technical consultant are not a part of this environment. They work in open offices at their companies' home bases. Most of the meetings are however held at the main office.

The contract describes the different areas of responsibility and as a part of the partnering concept there has been established an incentive agreement in order to ensure that the project runs within a target budget. It exists however only for the contractor while the architect and engineering consultant is waged on their basis of the projects turnover. This means that they have an economical incentive for expanding the budget of the project by drawing as expensive as possible and they only have an ethical responsibility for keeping the 'design' within the budget.

The production of knowledge in building design

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 the 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.

The design process in the case is formally split in different phases separated by milestones – a way of structuring the process which seems to be a tradition in the sector. After winning the tender, which were setting some constraints on economy and time, the design team gathered knowledge about customer wishes through a series of meetings. These wishes were incorporated in a project proposal, which the customer had to accept prior to the next phase ‘the main project’ where the detailed design was produced. Based on the outcome of this phase the school is currently refurbished as the formal documentation has been handed over to the craftsmen and contracts were signed with subcontractors.

When studying the process in detail it reveals to be much more dynamic – characterised by overlaps between the phases and practices and a highly iterative nature. An example of such overlaps is when ‘design questions’ arises during the production, requiring the presence of architects and engineers. Although the assigned responsibilities to the practices seem clear, people are keen to help other practices if they can contribute with valuable knowledge. The design process is however not only characterised by harmony and collaboration as clashes of interests and world views of knowledge claims constantly evolves, are negotiated and rise again.

Initially the architects worked on the design with a minimum of constraints by creating sketches of the ideas. Constraints were applied during the process by negations as the pool of knowledge grew and the design of the ideas was increasing in details. Gradually the other practices came in play synchronising their knowledge areas with the overall idea in an iterative process getting closer to the final description.

Most of the design occurred at the home bases of the practices drawing on a bricolage of practical experiences from previously projects, formalised information, knowledge about the customer etc. The formal output of these activities like drawings, calculations, notes, summaries etc. were continually developed and put together after each phases constituting a foundation for the customer to review the project. At regularly design meetings facilitated by the design leader the different practices came in play presenting and synchronizing their work. The representation of each practice was usually sustained by one person functioning as a broker between the design group and the home base. In a larger perspective these persons are of critical importance sustaining the flow of knowledge between the professions.

The design meetings followed a rather well defined structure focusing on the development of the formalized knowledge base in order to reach the milestones. Besides topics as economic, schedule etc. the different professions had their own bullet on the agenda. Unfortunately they occurred rather late which caused that most of the time was used discussing other things than the actual design. Repeatedly the architects and the engineers expressed their frustration about this.

It was however not only at these meeting the professions interacted. It also occurred by using email, faxes and phone calls. But as the professions though physical were separated they

seldom arranged other meetings automatically. When they however were together the coordination of knowledge was striking.

The flow of knowledge between professions relied on a shared practice in the group. The practice consists of tools, vocabulary, phrases, solutions, understandings etc. The existing of such practices was shown as 'Thuesen' as an outsider, had a hard time trying to understand a part of the rhetoric. The shared practice is created on the basis of the institutionalized practice in the sector and is developed through out the project by e.g. creating new words and adding them to the shared vocabulary. An example of this was the use of the word 'the music' referring to a new building housing the facilities for teaching in music and performances.

Through the ongoing mutual engagement the design group is gradually developed into a CoP. The trend is seen in this project but it is the stories from previous projects, which tells us that it's possible to develop CoP within a project team across organisational boundaries. The CoPs from previous projects turns into networks as the mutual engagement is decreased. These networks of practice (Brown & Duguid 2001) played an important role in the current project but were often hidden. That the previously projects matters was illustrated in a double interview with two procurement managers from the contractor. They stated that if this project group only contained members from the previous project, they wouldn't have to worry about the emptying of the dishwasher, the parking of the cars out side the office etc. – they formed a community.

The faith of the project group is that the hard established CoP is abandoned, as new projects are requiring the competencies and thereby the people. The history repeats itself in the next project.

Barriers and tensions for creating knowledge in building design

We here attempt to describe barriers and tensions for the development of knowledge in building design based on the current empirical material. Due to limitations of the material this is not a total mapping of the area, but will give an idea of problems which influences the knowledge production.

Polarization - separated learning environments

In this case the different practices participating in the design are placed at different locations. The created learning environments in these companies boost the differentiation of practices due to the amount and quality of the interactions. Even the technical consultants are sitting on different locations and departments and rarely talk to each other outside the design meetings. Narratives are shared of competitors and the practices and persons from the participating organisations. Thereby the local CoPs are strengthening due to the cultural traffic. In this separation of practices the project and customer might be the overall looser if the knowledge between the practices isn't coordinated. (Newell et al. 2002) discusses the downsides of group polarization.

The polarization of the project group is however not only negative as it to some extend are a necessity for accomplishing the complex task of designing a building. Due to the division of labour there exists a mutual dependence between the professions as the work in one practice is dependent of another. The following statement from the design leader is an example of the dependence, the context is a drifted schedule and the architect has a hard time reaching the deadline.

Design leader: *"...If we according to our plan are going to have the smallest hope for starting the 1st. of February – and that's damn close – then there exist some things which needs to be completed. It is not particularly smart for any of us, if we have to sign a contract*

with a subcontractor and then he can only work temporally in a small area and then we have to negotiate with another one later. That's going to be a mess from an economical perspective... ”

The interdependence makes the design group vulnerable to substitution of members especially the brokers tying the multifaceted landscape of practice together are critical. It was shown in the case as the broker representing the architects temporary were replaced by another. This was contributing to the delay in the time schedule.

Group thinking

The opposite problem of the polarization of the group is the group thinking that might occur. This is also discussed in (Newell et al. 2002). The problem is that the group doesn't question the solutions they have proposed since the solutions through negotiations have become taken-for-granted.

The traditional way of minimizing this problem is by an investigation where the solutions are renegotiated e.g. by the use of an external person being able to question the taken for granted. Another way of minimizing the problem is by setting the right team from the beginning based on the assumption that if the knowledge not is present from the start it won't be used. As a design leader in another context once stated *“nobody knows what they don't know”*.

This is also related to the problem of 'reinventing the wheel' which seems to one of the most discussed problems in the struggle of managing knowledge. According to (Bresnen et al. 2003) the capturing and diffusing of knowledge between projects is a major problem as 'the wheel' tends to be reinvented in projects from an organisational perspective.

The traditional way of solving this problem is by using IT systems in an effort to capture the experiences. The problems unfortunately arise as knowledge is socially constructed and highly contextual. But in practice lessons learned do not disappear after the finalization of a project as it is spread together with the people as they are assigned new projects. Combining this with strategies for employee retention, people create an enormous web of contacts. These networks are astonishing stimulating the flow of knowledge in the organisation. But they also create an influential informal organisation which is setting a political agenda in the organisations.

Power and politics

At the project level diversity of the group and the interdependence enables the use of power and politics. Power is exercised where there room for it in terms of dependence. This is illustrated in the flowing example from a status meeting where the options for catching up with the drifted schedule were discussed.

Project leader: *“...If status is that nobody is finished then there is something which we need to prioritize. So forget everything about a carpenter at this moment. Then I start at the school, and then it's me who without exception decides what happens when we're talking refurbishment of doors and windows. Because if we aren't finished then there is only me to do it as I'm responsible for the production. It is similar with the painter. But if we don't want to end up in Armageddon then there is something like glass walls which have a fairly long delivery time. We need to complete the design on elements like that...”*

The political dimension is illustrated in the creation of knowledge claims in the boundaries between the practices. Here coalitions are formed 'in situ' based on the shared practices. This was e.g. the case between the contractor and the project leader from the technical consultant as they both shared a practice in planning expertise which often positioned them on the same side in discussions. These coalitions were also formed outside the meetings as people were

negotiating strategies for supporting their perspective. This implied that the contractor initially was accused by the architects for playing with secret agendas.

Restricted time for reflection

Another problem that influences the production of knowledge is the restricted time for reflection. In this case it is stressed further due to the drifted schedule. This was illustrated by one of the architects regularly complains about the endless queue of meetings.

The battle of resources in the project leaves no room for collective reflectiveness as the project demands the resources, pressing the time schedule and requiring the architects to force. Under these circumstances the project becomes a somewhat constraining condition for learning and organising knowledge, and managerial initiatives under the banner of knowledge management have difficulties overcoming the barriers created by the project logic.

This is very much in line with (Keegan & Turner 2003)s identification of barriers to organizational learning. These include lack of time and reflection at the level of the project team, the tendency to centralize learning and the deferral of learning to future points in time and space. (p.83)

Structure of the process

The last barrier for developing knowledge is the structure of the design process. There is a strong emphasis on the separation of work and in the design meetings the actual design activities are playing an inferior role due to the systematic agenda. Though the formal process only leaves little room for mutual design activities the meetings often unintentional develops into several sub meetings focusing on different subjects where people are coordinating knowledge. These breakouts are hunted down by the design leader.

The structure of the overall construction process is today characterised by the division of labour and people are leaving the project group when their subtask is done. This continual substitution in the project group makes collection of experiences challenging. It further results in an almost non-existing flow of knowledge up in the value chain. This means that people don't see the consequences of their decisions.

Therefore there exist a potential for rethinking the organisation of the process, enabling the use of experiences from the craftsmen by incorporating them earlier in the design process – ensuring the buildability, coordinating knowledge up the stream.

The coordination of knowledge in practice

We will here illustrate the concept of coordination knowledge, by using a transcription from the previously mentioned 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 identify how far the different professions are from finishing their work. The project leader prioritizes the tasks based on his experiences specifying what needs to be done in order to start the actual production on schedule. In that context he is mentioning the refurbishment of the floor patching the linoleum.

Transcription

- 1 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*
- 5 *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*
- 10 *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*
- 15 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.*
- 20 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.*
- 25 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's 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 a 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 show 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 are allowed. He proposes as 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 purposes 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 can't 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 state to himself that these drawings need to be produced at home.

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

(25) The architect put 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.

(26-29) 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 don't expect him to be able to contribute to their discussion. But in fact 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. But it also requires a mutual accept of each other illustrated in this example by the architect proposing the solution even tough it won't make his life easier.

Situations like these occur time and again 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 characterised by harmony between the professions. Usually it is however influenced by power and politics and takes form as a negation between the different world views. This might lower the motivation for actually participating in the coordination.

When asked two months later the architect and engineer didn't remember this situation and the solution weren't implemented as the architect and engineers were drawing their details on separate drawings. Although it was a good idea the reason why it didn't succeeded should be seen in the light of the separated working environments and that the situation wasn't followed up. The solution could have become part of the shared repertoire and thereby been used at the other schools.

Discussion: coordination knowledge in a larger perspective

(Bucciarelli 2002)s research has focused on the nature of design. One of his significant contributions is the notion of 'Object Worlds', which can be interpreted similar as a part of a shared practice. Each person is having his own collection of objects and is to some extend sharing them with others in the design team. In this context the object world can be related to the project, companies and profession and coordinating knowledge is about relating objects from different worlds by using a proper language.

(Borland & Tenkasi 1995) in (Newell et al. 2002) highlights the idea of coordinating knowledge, saying that "the problem of integration of knowledge ... is a problem of

perspective taking in which the unique thought worlds of different communities of knowing are made visible and accessible to others.” (p. 130). Coordination knowledge is in other words created by working together getting insight in other practices and object worlds.

We will here emphasis the role of arenas as contexts where the coordination of knowledge takes place gathering the practices by legitimized peripheral participation of brokers. The coordination of knowledge is furthermore boosted by informative boundary objects (Thuesen & Koch 2003).

In relation to the problems and barriers for the production of knowledge in the design process the coordination of knowledge can be seen as a resource for repairing these problems except from the power and politic issue. Coordination knowledge is about finding the right balance between polarization and group thinking balancing between diversity and homogeneity. Coordination knowledge is about organising knowledge, drawing upon the right competencies within as well as outside the group.

The coordination knowledge varies from context to context e.g. due to the uniqueness of projects. There is though also 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 which occur unexpectedly. 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 isn't a part of the project group and thereby be able to position them within the larger constellation of practices. This require and insight and experience from the design leader coordinating knowledge, catching up the situated nature of knowledge, acting as a facilitator – orchestrating the practices.

It however not only a matter of centralised leadership from the design leader as the coordination of knowledge also has an individualistic perspective. The individual needs to pay attention to the areas where his competencies is valuable and should be encouraged to actively play the game of coordinating knowledge. This idea is central in self managing teams (Molleman 2000).

We have to 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 letting the leaders from the companies constitute a coordination group aligning the different practices. The meetings could with advantage be arranged around themes instead of professions enabling the practices to dispose their competencies. The themes could be identified on the basis of the initially produced specification but should be developed throughout the design process. An example could be an area as the indoor climate which would at least 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. This means we try to overcome the barriers sustained by the traditional contracts where the craftsmen are drawn in the project when it is to late.

Spending more time designing together, talking about perspectives, coordinating knowledge, creating room for collective reflection, is key characteristics for stimulating project based learning creating a shared practice through the value chain.

Conclusion

Winding up, this paper has attempted to illustrate how knowledge is developed in the heterogeneous project groups. This seems especially important to understand in the light of the increased focus on the customer, which is prevailing in many industries today. While there indeed is a potential for developing practices in the participating companies in a project, it might be a sub-optimization from the customer perspective, as development of a shared practice in the project is neglected.

The empirical case presented shows how the domains of professions, project and company are in tension with each other, making coordinative knowledge political. We have identified barriers for the knowledge production in building design which includes: group polarization, group thinking, power and politics, time pressure and the structure of the design process. Except from the power and politics we have illustrated how coordinating knowledge can act as a tool for sorting out these barriers. By coordination knowledge we understand the knowledge work in the boundaries between practices synchronizing their work in order to reach more robust solutions.

We find that coordination knowledge is a concept worthwhile chasing in the context of heterogeneous project groups, as an understanding of the synchronization of knowledge between practices. It is a foundation for the act of balancing between developing specialist competences and a shared practice – the balance between diversity and homogeneity.

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