Community of Practice versus Practice of the Community: Knowing in collaborative work

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***Abstract**: How do software developers, field service technicians, and medieval cathedral builders accomplish collaborative work? This paper looks at how they learn from each other by building and sharing knowledge across time and space.*

To illustrate this, we first present Community of Practice (CoP) as a way of understanding collaborative work which puts focus on the community and its social interaction. CoP, introduced by Lave and Wenger (1991), is based on the fundamental belief that dividing theory from practice is unsound. Hence CoP contradicted traditional theories of learning, where learning and working often are conceived as separate processes. Using Orr's (1996) rendition of service technician's work, it is shown that stories act as repositories of accumulated wisdom in keeping track of facts, sequences and their context. Representations made by a CoP to aid their work, are termed Reifications which can be stories, tools, artefacts etc. Practice is seen as a duality of Participation and Reification which both require and enable each other. We find however, that CoP based analyses tend to focus on the human actors in that you start out by looking for the communities and what defines them. We also present examples of alternative approaches that illuminate the technology and artefacts that are present in collaboration. Berg(1997) uses Actor-Network Theory (ANT) to illustrate the responsibility awarded to artefacts in the process of documenting a hospital-patient's fluid balance. Hutchins(1995) describes navigation as a joint accomplishment of artefacts and people. Turnbull(1993) sees a wooden template as a chief enabler of building gothic cathedrals without use of structural mathematics. Facets of knowledge/knowing is discussed, their accumulation and transfer by stressing the value of both the social and the technical approach.

***Keywords**: collaborative work, communities of practice, actor-network theory, role of technology, knowledge sharing*

1. Introduction

What is it that software developers do when building software systems? And what is it that field service technicians do when fixing broken copying machines? For that matter, what did medieval cathedral builders do when raising tall stone cathedrals across Europe? What do software developers, field service technicians, and medieval cathedral builders have in common? In the context of this paper, the answer is *collaborative work*: they build and share knowledge and learn from each other across time and space.

Researchers in different academic fields have made attempts to describe and explain collaborative work. The IS researcher wants to understand the collaborative efforts involved in developing software (Naur, 1992). The ethnographer (Orr, 1996) wants to describe and understand how field service technicians collaborate on fixing broken copying machines, and the historian (Turnbull, 1993) wants to know what the cathedral builders did in order to raise a multitude of tall stone cathedrals all across Europe in a relatively short time.

Let's turn the coin and rephrase the questions posed above. How are software systems built? How are broken copying machines fixed? How is the building of gothic cathedrals achievable? There is of course not one single answer to these questions, but they point us in a direction that forces us to think about the constituents of collaboration.

This paper discusses how different research traditions have opened the black box of collaborative work, trying to explain collaborative work with different approaches. This is not an exhaustive literature review on the topic, but rather the beginnings of one.

The paper is structured as follows. Firstly we present Community of Practice (CoP) as a way of describing and understanding collaborative work. After discussing the contribution to understanding collaborative work provided by the thinking around Communities of Practice, we discuss the approach's shortcomings in addressing the role of technology in collaborative work. We then present alternative approaches to describing and discussing collaborative work which are specific on the role of technology. After discussing these approaches' contribution to understanding collaborative work, we conclude by drawing the implications that such an approach has on the way we think about collaborative work and the sharing of knowledge and knowing.

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2. Programming as theory building

Naur (1992) argues that software development is more than just production of a program and certain texts. Successful software development is a question of having an appropriate theory of the software system. With certain kinds of large

programs, the continued adoption, modification, and correction of errors depends on knowledge possessed by a group of developers who are closely and continuously (in connection with?) connected with the software system. The developers' knowledge transcends that which is recorded in the documentation: they possess a theory of the software. "[A] person who has or possesses a theory ... knows how to do certain things and in addition can support the actual doing with explanations, justifications, and answers to queries, about the activity of concern" (Naur ,1992 p. 229). The notion of theory was proposed by Ryle (1949) in an effort to describe the difference between intellectual and intelligent behaviour. Ryle claims that intelligent behaviour is the ability to do certain things without having any concrete knowledge to build this behaviour on.

Naur's perspective on software systems development is that of the individual developer. While his contribution is significant in that it provides argumentation for viewing software systems development as a knowledge intensive activity, it fails to address the dynamics of collaborative work. Even though he argues that theory must be shared by a group of developers, the theory is still embedded in the individual. By not being specific on the description of *how the theory is shared,* Naur only manages to point out that software development is in fact collaborative work. The context surrounding the development of software is not included in Naur's discussion.

A question then becomes how is knowledge shared, across time and space, and how does context play a role? The related topic of how is knowledge built or acquired across time and space will be touched upon in our discussion.

3. Communities of practice

The way people work differs from the abstract ways organizations describe that work in manuals, training programs, organizational charts, and job descriptions (Brown and Duguid, 1991). The concept of Communities of Practice (CoP) (Wenger, 1998) is an approach often used to better understand the activities and processes going on in work and what kinds of social engagements provide a better context for learning and innovation to take place.

CoP was first introduced by Lave and Wenger (1991), and is based on the fundamental belief that dividing theory from practice is unsound. Hence CoP contradicted traditional theories of learning, where learning and working often are conceived as separate processes. CoP argues instead that learning should be contextualized, by acknowledging its presence and allowing it to continue to be an integrated part of work. Based on the PhD thesis of Orr (later published as Orr, 1996) Brown and Duguid (1991) illustrates in the Xerox case, how formal descriptions of work and learning often are abstracted from actual practice, and how knowledge is socially constructed through informal interaction. The Xerox case is about how a group of repair technicians met regularly in informal,

common areas and traded stories and insights around their work (repairing different types of copying machines). The workers actually made a point out of spending more time in each others company. This slack initially seemed like an excellent opportunity for productivity improvements, but management realized that these activities were actually a very important part of becoming, being and remaining a good technician. It was central to how they learned, how processes improved, how they formed bonds as a community of practice, and how they transferred and honed their knowledge and expertise amongst themselves.

The creation and transformation of knowledge in the Xerox case is related to social interaction among technicians. Taking form as storytelling, the knowledge transfer made the technicians capable of sharing not only the type of knowledge that could be read out of books, but also the type of knowledge not explicitly stated in the company's instruction manuals. The practice included sharing both the explicit and the tacit/implicit. What was said and left unsaid thus served as an intrinsic part of solving the problem. According to Brown and Duguid (1991) stories act as repositories of accumulated wisdom and it allows people to keep track of the sequence of behaviour and of their wisdom, in keeping track of the facts and their context. The technicians were able to construct a shared understanding out of bountiful conflicting and confusing data. Such an approach is highly situated and highly improvisational.

Communities rely on the informal depiction that each member generates of it: who is part of the community, which are the different modes of participation that are accepted, who knows what, what cultural tools are used to mediate communication and interaction, and so forth. The depictions of the community are iterative and evolve continuously as community members share experiences, take action and interact with each other, as well as the outside world which is reasoned about. A shared understanding is negotiated and emerges from scattered pieces of knowledge and knowing. The differentiation between knowledge and knowing is described by Cook and Brown (1999) in that "Knowledge and knowing is seen as mutually enabling (not competing). We hold that knowledge is a tool of knowing, that knowing is an aspect of our interaction with the social and physical world."

In general, Wenger (1998) defines a community of practice along three dimensions:

1. a joint enterprise that is continually renegotiated by the members of the community
2. mutual engagement, that bind the members together into a social entity and
3. a shared repertoire of common resources that the members have developed over time (routines, vocabulary, artefacts, experiences, stories, etc.).

The resources developed by the community can somehow be considered the accumulated knowledge and knowing of the community.

This informal, narrative and contemplative nature or aspect of a CoP, does not preclude that a community may also make formal representations, checklists, tools etc. as well as to define concepts and ideas, to aid them in their endeavours of work (Wenger 1998, pp. 62-71). These representations are termed *Reifications*. Practice can be seen as a duality of *Participation* and *Reification* in which both require and enable each other. “Participation is not merely that which is not reified (p.66). On the contrary, they take place together. ... There is no reification without participation ... [and vice versa]”. The reifications/artefacts play a key role since they are often used as explicit representations of the informal model that is shared among the members. Reifications may also function as *boundary objects* through which different communities can relate to each other. A boundary object has a “common denominator” that each community can identify and relate to, but may play different roles and have “extra meanings” within the CoP, in line with the context and joint enterprise of that CoP.

Discussion of shortcomings

In CoP’s the relation between the subject and the "world" assume that the subject adapts to the surroundings by means of participating in communities of practice. The artefacts and technology which aid their existence remain self-evident and in the background. Practice (implicitly understood as knowing as in doing and learning how to do, is explained, and understood and interpreted by means of the human subject.

In order to see the artefact in the theory of CoP, the artefact must either be the “central joint enterprise, or a boundary object. Brown and Duguid’s example of the Xerox technician’s CoP has the artefact, its representations and interactions within the customers organizations as "The central joint enterprise" around which the CoP evolves. The machine/artefact is also a boundary object that connects their CoP to the CoPs of their customers.

CoPs allow the artefact a place on the agenda in a more or less informal fashion as reifications of human action. They play a critical role in cultivating and coordinating knowledge but are only considered to be frozen reifications that must be interpreted by the human actors. A similar point has been made by Prout (1996 in Timmermanns and Berg 2003, p.9) saying that "Work is constructed as done on and through machines, but not by them".

4. Illuminating the elusive technology

A relevant question is then: Does the theory of CoP adequately cover the relevant aspects of collaborative work? The poignant catch here, is the word

relevant. The relevance of various theories depend of course on the direction of interest in ones application of a theory. Wenger states in his introduction (1998) that his purpose is ".. to propose ... what I call a social theory of learning...which comes close to developing a learning-based theory of the social order. In other words, learning is so fundamental to the social order we live by that theorizing about one is tantamount to theorizing about the other." No wonder then, that the theory of CoP has become widely used, outside its original scope of learning.

CoP has been widely adopted within both communities studying organizational knowledge as well as within management theory. Contu and Willmott (2003) contend that many of these renditions have disregarded or failed to see, some aspects of Lave and Wenger's (1991) original work such as: ".. embryonic appreciation of power relations as media of learning" (Contu & Willmott 2003, p 283) in that the topic of Power Relations in a situated learning context often is not addressed by those who embrace the concept of CoP into their own discourses. There may be many reasons for this end result, Contu and Willmott (2003) reason about both the present oversight of power relation's and for the subsequently necessary re-inclusion of power relations into the situated learning discourse.

We intend to show that in a similar fashion, other embryonic appreciations also tend to disappear when using CoP for theorizing on communities that include artefacts as reifications. Wenger's concept of the boundary object that mediates understanding between communities, albeit sometimes very selective understandings, is both illuminating and useful. Various artefacts and technologies may constitute such boundary objects, along with other reifications such as narratives, rules and norms etc. The concept is a powerful one for grasping constituents of communication and collaboration between different communities in illustrating that it allows them cooperate without a unilateral(universal) consensus on activities, purposes and priorities. However, the deeper aspects of the reifications as resources within the community and across communities is little expanded in CoP. CoP divulges some aspects of artefacts in Communities, but remains ignorant or uninterested in others.

It is our observation that our common concepts concerning the humane inhibit the inclusion of non-human aspects into our discourses of societies, organizations and activities. And so we mostly turn a blind eye to the technologies we interact with. When we do address technology, acknowledging its presence, it tends to be in an instrumental dichotomous fashion where the humans are either in total control or at its mercy. We wish to expand our concepts of both the artefacts and the humane, to stretch the dichotomy into a duality ascribing more than structure or mediation to the artefacts. Wenger does describe such a duality, but the focus of Cop is still mainly on the social aspects.

5. Making technologies explicit

Marc Berg uses actor-network theory (ANT) to look more closely at artefacts themselves within work practice, both the IT system itself but also the other artefacts. However Berg's studies do show, if not the specific IT tool in this case, some qualities of technology as artefact that may be seen as universal in holding a knowledge and transformational power of informal practical world aspects into formal representations.

Marc Berg (1997) takes a detailed look at practice in a hospital intensive care unit. His case describes each minute part of a work process which aims at documenting a hospital-patient's fluid balance, which is a sum of what fluid goes in and what comes out. In observing and recording each minute detail of a particular process the separate elements are identified. This hybrid comprises everything that is needed for the activity to proceed including several people, various artefacts, routines and experiences. The formal tools come to life only as part of the real life activity.

The shape of the bag of diffusion liquid with its quantity scale gives input to the nurse on what number to enter in fluid-balance spreadsheet. The granularity of the scale defines the number's level of accuracy. The size and shape of the drinking cup and the urine container also re-represents the separate liquid in-/outputs of the patients body into formal representations which can be added to the spreadsheet. The person entering the number has no need of knowledge of medical theory, diagnosis, treatment or purpose for performing this specific task. The only interpretation necessary by the human is reading the quantity scale in order to enter it in the spreadsheet. "The task of producing formal representations is delegated to the mundane artefacts which perform, in Latour's terms, 'the practical task of abstraction'" (Berg 1997, p.144)

Berg focuses on the interrelationships between the tools and the human workers in saying that through these interlockings, new competencies can be achieved and higher levels of complexity in work tasks can be achieved. People can be seen as communicating/interlocking via the tools without intimate knowledge of the other parts of the process chain. The distributed nature of the task, shared out between the artefacts and human actors effect a distribution of control and responsibility across the heterogeneous ensemble. The separate actors have no overview of the complete process and cannot affect global workarounds based on an overall picture. The humans are not in control of the overall task. On the other hand, neither is the artefact. The human actors introduce workarounds in performing their own particular tasks pertaining to the unexpected contingencies of either their colleagues or the artefact. Another shape or functionality in effect a different inscription in the involved tools would however shape the human actors tasks differently.

Another point of Berg is that the ensemble of humans and tools – the Actor Network, cannot bee seen as stable once the technology is in place. In line with the view of tools and humans as equal actors in producing the end result of an activity or process, then all actors within a network are affected when changes occur in the forces influencing the network. Most work processes have aspects of drift in which work is continually redesigned to adapt to the circumstances. This drift also introduces the need to continually adapt the use and/or functionality of the tools. A quaint analogy of this need for adapting tools can be related to perhaps our most archaic tool of all – the hammer. A modern day hammer comes in various shapes and sizes – adapted to each craft's particular need. The cleft in today's carpenter hammer arose from the need to pull out misplaced iron nails. This functionality was inconceivable in the times of wooden pegs.

While Berg places technology as embedded locally, Hutchins (1995) is concerned with the "circulation" of cognition in collaborative work. Traditionally human cognition has been placed within the mind of the individual, as exemplified by Naur's notion of programming as theory building. A basic idea in distributed cognition is that human activity does not take place solely in the heads of people, but that the environment (social, physical, and artifactual) provides a cognitive context from where cognition actually should be delineated. Looking at the practice of navigating ships, Ed Hutchins (1995) develops a methodological and analytical framework for understanding how cognitive achievements can be conceptualised as a joint accomplishment of artefacts and people. According to Hollan et al. (2000) in distributed cognition, one expects to find a system that can dynamically configure itself to bring subsystems into coordination to accomplish various functions. At the core of Hutchins' argumentation lies an assumption of equality between people and artefacts in structuring practice. In this way the centre of attention in collaborative activities are the interdependencies between people, and between people and artefacts.

Similarly Turnbull's (1993) treatment of medieval cathedral building, can be read in light of collaborative work. Medieval cathedrals were built in a discontinuous process by groups of masons. The challenge is to understand how the masons could build these tall buildings without knowledge of structural mechanics. During the 13th century 50 cathedrals were raised throughout Europe. Turnbull envisions the cathedral building site as an "experimental laboratory" in which the key elements were the template, geometry, and skill" (p.322). The argument is that the collective work of cathedral builders was not one of human ingenuity alone, but also manifest in tools. He views the templates as accumulations of every design decision that had to be passed on. Because a template is easy to replicate, it could circulate among builders at a site, and among building sites across Europe. In this way, knowledge of gothic cathedral building, as manifested in the template, could circulate and spread. Also, argues Turnbull, the template has an organizing effect, having the power

to organize large number of workers. Turnbull's approach is specific on the role technology plays in transferring knowledge and indirectly coordinating collective work.

6. Discussion

We have so far discussed different approaches to describing and understanding collaborative work. The approaches were presented in two parts. We first presented communities of practice as an approach to describe and understand collaborative work, arguing that this approach conceals or fails to address many of the inscribed qualities of the technology. We then presented different examples that make technology more visible. Our presentation was therefore focused on describing these approaches as dissimilar in terms of the role technology play in their way of describing and understanding collaborative work. In this section, we attempt to extract similarities in the topics these approaches handle. We see two topics running through all the works presented above:

- knowledge accumulation and knowledge transfer
- different facets of knowledge

6.1 Knowledge accumulation and transfer

Knowledge accumulation is a question of where knowledge is stored. While stored gives mechanistic associations, it is not intended in this way. Rather, it is used to describe that different knowledge is embedded in different actors. It is a question of who/what has knowledge. The who/what dimension follows from the differences between the different approaches presented above. The communities of practice approach, exemplified by Julian Orr's (1996) ethnographic study of field service technicians and copying machines, views knowledge as embedded in the practice's of human actors. It is the field service technicians and the human users of the copying machine that has knowledge of the machines. The user knows the specifics of a given machine, while the field service technicians know the general problems associated with series and models of machines as well as possibly having knowledge of the history of the specific machine.

The distinction between knowing and doing is not made explicit. The epistemological assumption in CoP is that doing or knowing is socially situated. Knowledge is an intrinsic property of people's engagement in communities of practice. Accumulation of knowledge is attributed to the human actors in a "collective mind of the community". Application of the knowledge is solely explained by means of human agency.

Conversely, in Marc Berg's (1997) study of cooperative work in hospitals, knowledge is explicitly accumulated along a process chain. This process chain consists of humans as well as technology in a chain of distributed links. The separate artefact links in the process chain also have knowledge inscribed in them. The various liquid vessels have the appropriate size, shape and measurement scales appropriate for their appointed task of collecting liquids and turning them into a numeral representation. They vessels know, as Mol (2003) would put it. This is similar to Turnbull (1993) who argues that knowledge of building cathedrals is based on the key elements of the template, geometry, and skill (p.322). The template, however, plays an important role in accumulating knowledge outside humans. It "encapsulated every design decision that had to be passed down to the man doing the carving in shop and quarry" (ibid.). The way the artefact accumulates knowledge, is a primary explanatory factor in Turnbull's work, as the building of gothic cathedrals was a discontinuous process. It is this discontinuity that is missed by solely looking towards humans as knowledge accumulators.

Narration is an important aspect in the communities of practice approach to collaborative work. The narrative is a way of transferring knowledge. Knowledge is transferred through social interaction, through narratives, through talking about machines. Turnbull, Hutchins, and Berg on the other hand, see knowledge transfer as the circulation of artefacts among people and among communities. In this line of thinking knowledge is shared through circulating artefacts among people. Which is it? Which of these approaches are correct? Is knowledge accumulated in people and shared through social processes, or is knowledge accumulated in artefacts are shared through the circulation of artefacts? Our argument is that both are valid, important and dependant of each other.

6.2 Facets of knowledge

In line with Nonaka and Takeuchi's (1995, p. 235-240) assault on what they term "false" dichotomies we argue that the dichotomy of Human versus Artefact is such a false dichotomy. "The dynamic and simultaneous interaction between two opposing ends of 'false' dichotomies creates a solution that is new and different. In other words, A and B create C, which synthesizes the best of A and B. C is separate and independent of A and B, not something 'in between' or in 'the middle' of A and B" (p. 236). Rather the concepts of knowledge accumulation and knowledge transfer must be seen in the light of the dynamic integration of three of the synthesized "false" dichotomies that Nonaka and Takeuchi put forward (p.237) namely Explicit/Tacit knowledge, Body/Mind and Individual/Organization. Nonaka and Takeuchi however do not include the artefacts in their theorizing. This is in line with Cook and Brown (2003) who state that: "Organizations are better understood if explicit, tacit, individual and group knowledge is treated as four distinct and coequal forms of knowledge

(each doing the work the others cannot), and if knowledge and knowing are seen as mutually enabling (not competing)."

In accepting Berg's argument that knowledge and knowing is distributed among actors, and that no single actor has the complete picture of the collaborative work process, the consequence is that we can argue that knowledge can be accumulated in both humans and artefacts. In this way, knowledge and knowing can be shared through the circulation of artefacts and accessed, interpreted and applied by people. CoP stresses that the interpretation and application is activated through social interaction. This, for us, is the logical consequence of applying Berg's argument to the topic of knowledge and knowing accumulation and sharing in collaborative work. What we are saying is that a medieval mason, although skilled at building brick walls and columns, is unable to raise a gothic cathedral without the template. Conversely, a person not skilled in masonry is unable to build a cathedral no matter how many templates he is in possession of. Using CoP alone to analyze this example fails to appreciate the qualities of the artefacts. Focusing on the technology renders the social barely visible.

Based on the above discussion, it may be argued that the Communities of Practice approach is mainly concerned with the social aspects regarding establishing and sharing of knowledge/knowing. As Wenger (1998, p.141) puts it "knowing is defined only in the context of specific practices, where it arises out of the combination of a regime of competence and an experience of meaning"):, while Turnbull and Berg are more concerned with how knowledge is made durable and transferable across social contexts.

The dichotomy of Body/Mind can be seen as an illustration of the skills that the human has acquired as opposed to the abstract depictions or representations we have of those skills. Knowledge/knowing as read from text books can be seen as knowledge transfer in an abstract manner. Know-how may be analyzed and put into words and numbers in order to externalize its content and make it explicit. In the process of abstraction and transfer, something is lost. Nonaka and Takeuchi give the name tacit knowledge to the part of know-how that cannot be externalized. Wenger states (1998, p 69) that "Classifying knowledge as explicit or tacit runs into difficulties, however because both aspects are always present to some degree. ... what counts as explicit depends on the enterprise we are involved in." In other words, that which may be inexpressible and tacit in one CoP may be "easily" expressible in another CoP whose joint enterprise is different. In order not to confuse Polanyi's (1983) use of the term tacit knowledge with that described by Nonaka and Takeuchi, which we discuss in the following, we use the term implicit knowledge of that which may be difficult to express.

Only some part of the knowledge/knowing is transferable in an abstract and explicit way. CoPs alleviate the problem by strategies that achieve Learning by doing, socializing and telling stories, which will indirectly include extra dimensions in knowledge transfer without needing the same level or type of

abstraction. The narratives include the context of each situation that indirectly may infer these implicit aspects. The scope of interpretations increases when we abstract. In doing, socializing and telling stories we can direct, align, combine, and recreate our understandings to get a clearer picture, in order to narrow or redirect the scope. Through stories people build up a repertoire for improvisation. Narratives are reactivated by adding new elements. They naturally integrate the implicit elements as well as the explicit and are tuned to balance between content and context. In seeing texts, mathematics and books as examples of the embodiment of formal abstractions, we can infer that these abstractions in the form of artefacts like books, represent knowledge made durable in a way that allows explicit knowledge accumulation and transfer. The transfer of implicit knowledge is seen to be more cumbersome. However we believe that the "simple" artefact as exemplified by the mason's wooden template is the embodiment of part of the gothic architects acquired implicit knowledge/knowing. The use of the technology of a template is an embodiment of parts of the explicit knowledge that does without the formal mathematical kind of abstraction. In lack of a CoP with a narrative way of transferring some of the implicit aspects, the template will perform a similar job. The template accumulates and transfers knowledge/knowing in a less formal and less abstract fashion which is durable, scales and transfers differently and perhaps better, than structural mechanics and mathematics.

We find that Wenger's theory of CoP with its *reifications* misses out on this formative aspect that technology may hold in that it fails to recognize that different characteristics of different technologies as exemplified by the book, the template, and the liquid container.

In leaving the dichotomies of the tacit(implicit)/explicit, body/mind and individual/organization behind in regards to knowledge transfer and accumulation, we tender that the dichotomy of humans versus artefact can be left behind.

7. Conclusion

In the introduction the same question were asked in two different ways. By rephrasing the questions our intention was twofold. Firstly, to illustrate how different types of questions focus our attentions differently (and thus lead us towards different approaches in our understanding of collaboration). Secondly, to "implicitly" prepare the reader on the content of the rest of the paper (and hopefully provoke the reader to reflect a bit on the issue). In short the first type of questions emphasised the community aspect of collaboration ("What" questions), while the second types of questions were directed towards the practice part of collaboration ("How" questions). Our intention was not to favour any of the approaches, but to stress the importance of both and illustrate

how they provide different but valuable input to our understanding of collaboration.

To sum up we demonstrate how a focus on the technology might give different insights to the CoP example of Orr's service technicians and how the social position of CoP give additional insights to the examples of Turnbull's templates and Berg's liquid vessels.

Turnbull illustrates that technologies as abstractions, in this case as a wooden template, can hold and transfer knowledge as design information between communities with similar community skills/knowing in effect communities that have the skill to build with brick and mortar. The template works as a boundary object that traverses the community boundaries through both time and space, and comes across with a similar meaning, close enough to enable another master builder to decide to build a gothic rather than a Romanesque church. If this story looses sight of the technology, the artefact, then the transferral of knowledge becomes a mystery. The powerful qualities of this simple artefact are vital to the whole "plot". It scales better than the numerical mathematics, on which we rely today, in that it transcends language barriers and non-existent structural mathematics and it is durable in withstanding wear and tear. It travels well. So, just any technology will not do. Technologies have different characteristics which relate differently to different societal factors. Which technology is best at any point in time and setting will depend of the whole dizzying network of factors that make up and influence our social world, including the artefacts and what reifications we may establish in our communities. In analyzing possible relationships between the social and the non-human, and focusing at least equally on both, we may identify aspects of technology that grant us to be better equipped in reaching our goals.

Berg describes a use of technology where the artefacts are links in a production chain. Loose the liquid-container's specific qualities and the process is seriously hampered. The containers design is a product of knowing how best to collect and transfer the liquid in question into abstractions suitable for their entry into the liquid chart. Now this particular example is not so advanced as to render it impossible to establish a workaround if the vessel should disappear, but it clearly illustrates the distribution of responsibility and control, power and action into the separate links. The end link of the chain need have no suitable knowledge of what the whole process is about, let alone the differing links within the chain. There is no social interaction involved in the production of the end result in relation to a specific patient. The activities of the communities that designed the different artefacts may be long gone and the resulting process chain can scarcely be described as a community. However if you look at the human actor constituent of a particular link in the chain, CoP would see this actor as a part of a community where probably several people carry out that same task for different patients. The liquid vessels would be the boundary object that mediate interaction with the next human actor in the chain. In effect the

CoP based analyses focuses on the human actors because you start out by looking for the communities and what defines them.

Orrs service technicians discuss the technology in their community through sharing stories Through these narratives of humans and artefact, they iterate, rephrase, recombine various bits of knowledge and experience to build new knowledge, knowing and tactics in coping with the machines. The stories are their common stored knowledge, which sit in their collective memory and make sense in light of different contexts and experiences. Wenger uses this example to stress the importance of the community's collective work of producing the knowledge that enables them to carry out their work. However, through these stories, the machines gain a life of their own. The fact that contexts vary, different machines of the same make behave both similarly and differently, is constantly contributing to and feeding the activity of the community. In this case the artefact need not be seen as a boundary object mediating meaning between communities, but also an actor with its own agenda, albeit based on their initial design. The qualities of the machines are highly relevant not only as the focal point of the CoP of service-technicians but also as part of the community, or as actors in the CoP as ANT would allow.

References

Berg, M. (1997). On Distribution, Drift and the Electronic Medical Record: Some Tools for a Sociology of the Formal, Proceedings of the Fifth European Conference on Computer-Supported Cooperative Work, ECSCW'97, Kluwer, pp. 141-156.

Brown, J.S. and Duguid, P (1991), Organizational Learning and Communities of Practice: A unified View of Working, Learning and Innovation, Organization Science, Vol. 2, No. 1, pp. 40-56.

Contu, A. and Willmott, H (2003), Reembedding situtedness: The importance of power relations in learning theory, Organization Science Vol. 14, No. 3, pp. 283 – 296.

Hollan, J., Hutchins, E., and Kirsh, D. (2000), Distributed cognition: Toward a new foundation of human-computer interaction research, ACM Transactions on Computer-Human Interaction, Vol. 7, No. 2, pp. 174-196.

Hutchins, E. (1995). Cognition in the Wild, Cambridge, MA: MIT Press.

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

Mol, A. (2003), The body multiple: Ontology in Medical Practice, Durham, UK: Duke University Press.

Naur, P. (1992), Programming as theory building, in P. Naur Computing: A human activity", ACM Press.

Nonaka, I. and Takeuchi, H. (1995), The Knowledge-Creating Company, Oxford, UK: Oxford University Press.

Orr, J. (1996), Talking about machines: An ethnography of a modern job, Cornell, CA: Cornell Univ. Press.

Polanyi, M, (1966) *The tacit Dimension*, Routledge and Kegan Paul, London.

Ryle, G. (1949), *The Concept of Mind*, London, UK: Penguin.

Timmermans, S. and Berg, M (2003), The practice of medical technology, Sociology of Illness & Health, Vol. 25, No. 3, pp.97-114.

Turnbull, D. (1993), The ad hoc collective work of building Gothic cathedrals with templates, string and geometry, Science, Technology and Human Values, Vol. 18, No. 3, pp. 315-340.